# Geophysical Abstracts 153 April-June 1953

(Numbers 14389–14598)

# Geophysical Abstracts 153 April-June 1953

(Numbers 14389-14598)

*By* MARY C. RABBITT, S. T. VESSELOWSKY *and* OTHERS

*Abstracts of current literature pertaining to the physics of the solid earth and geophysical exploration*

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*


GEOLOGICAL SURVEY

W. E. Wrather, *Director*

# CONTENTS

# GEOPHYSICAL ABSTRACTS 153, APRIL–JUNE 1953

## By MARY C. RABBITT, S. T. VESSELOWSKY, and others

### GENERAL INFORMATION

Geophysical Abstracts attempts to provide informative abstracts of published material on the physics of the solid earth, the application of physical methods and techniques to geologic problems, and geophysical exploration. Related material of interest to individual geophysicists will also be found in other abstracting journals such as the Bibliography of Seismology, Chemical Abstracts, Meteorological Abstracts, Nuclear Science Abstracts, and Physics Abstracts.

The form of the bibliographic reference is believed to be self-explanatory. A list of abbreviations of journal titles was given in Geophysical Abstracts 152. Additions to that list are given below. Unless specifically indicated otherwise, the language in which the article is written is the same as that given in the title. The system of transliteration used by the United States Board on Geographic Names is employed for transliteration of Russian names and titles. Translations of author's abstracts are indicated as "Author's Abstract" followed by the initials of the translator.

Geographic names included within brackets are those recommended by the Board on Geographic Names.

### ABSTRACTORS

Geophysical Abstracts are prepared and compiled under the direction of Mary C. Rabbitt with the assistance of S. T. Vesselowsky and Dorothy B. Vitaliano. Patent information is compiled by Louis C. Pakiser, Jr. Other abstracts in this issue have been prepared by the following: P. Edward Byerly, William J. Dempsey, Henry Faul, Roland G. Henderson, F. W. Stead, and Isidore Zietz.

### LIST OF JOURNALS

The following list gives the full titles of journals referred to in this issue of the Abstracts and not included in previous lists. The sponsoring organization and place of publication are given where they are not part of the journal title.

| *Abbreviation* | *Publication* |
|---|---|
| Acta Geol. Acad. Sci. Hungaricae_____ | Acta Geologica Academiae Scientarum Hungaricae. Budapest. |

| Abbreviation | Publication |
|---|---|
| Bohrtechnik-Brunnenbau_____ | Bohrtechnik-Brunnenbau. Also published as Brunnenbau-Bohrtechnik and Brunnenbau-Tiefbohrtechnik. Berlin and Hannover. |
| Czechoslovakia, Státní. Geol. Ústav Sbornik. | Sbornik Státního geologického ústavu Československé Republiky. Praha. |
| Geol. Mag_____ | Geological Magazine. Stephen Austin and Sons, Hertford, England. |
| Geophys. Prosp_____ | Geophysical Prospecting. European Association of Exploration Geophysicists. The Hague. |
| Hokkaido Univ. Faculty Sci. Jour_____ | Journal of the Faculty of Sciences, Hokkaido University. Sapporo. |
| Inst. geol. y min. España notas y comunicaciones. | Instituto geologico y minero, notas y comunicaciones. Madrid. |
| Jour. Geography (Tokyo)_____ | Journal of Geography. Tokyo Chigaku Kyohai. |
| Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények. | Magyar Állami Eötvös Loránd Geofizikai Intézet Geofizikai Közlemények. Budapest. |
| Min. and Geol. Jour_____ | Mining and Geological Journal. Melbourne. |
| Naturwiss. Ver. Steiermark Mitt_____ | Mitteilungen des Naturwissenschaftlichen Vereines für Steiermark. |
| Peru Inst. Geol. Bol_____ | Instituto Geologico del Perú Boletin. Ministerio de Fomento. Direccion de Minas y Petroleo. Lima. |
| Rev. Cienc. Apl_____ | Revista de Ciencia Aplicada. Madrid. |
| Univ. Chile Facultad Cienc. fis. y mat. Anales. | Anales de la Facultad de Ciencias fisicas y matematicas, Universidad de Chile. Santiago de Chile. |
| Zeitschr. angew. Mathematik u. Physik_ | Zeitschrift für angewandte Mathematik und Physik. Basel. |

# GRAVITY

## GENERAL AND THEORETICAL PAPERS, INCLUDING THOSE ON ISOSTASY

14389. Vening Meinesz, F. A. Physical geodesy: K. Nederland. Akad. Wetensch. Proc., Ser. B, v. 56, no. 1, p. 19–33, 1953.

According to the usual system of geodetic surveying, stations are considered to be projected to sea level along normals to the ellipsoid. Errors are introduced due to deviation of the geoid from the ellipsoid. Vening Meinesz proposes a modification which involves projecting the stations to the geoid along real verticals and using the net thus obtained as the reference net for the relative position in the horizontal sense. This method avoids some of the undesirable consequences of the usual system and more nearly approaches reality. Elaborating on his proposal, Vening Meinesz discusses projection of the sea-level net from the geoid to the ellipsoid, projection of the stations to the geoid, determination of the position of the nets with regard to the ellipsoid, and possible unification of existing nets and their extension into a world-wide system.—*D. B. V.*

14390. Bragard, L.   La méthode dynamique en géodésie [The dynamic method in geodesy]: Bull. géod., no. 23, p. 35–57, 1952.

Stokes' formula was initially derived with certain approximations, neglecting members of the second and higher order of the flattening of the earth.   The author shows that this formula remains valid for any shape of geoid that differs little from the spheroid if it is isostatically compensated.   Accurate formulas are also derived for the intensity of gravity and for the deviation of the vertical from the meridian and the prime vertical, and the intensity of gravity normal to the surface of the International spheroid is computed.—*S. T. V.*

14391. Renner, János.   Gravitációs mérések és a Föld alakja [Gravitational measurements and the figure of earth] (In Hungarian with summaries in Russian and French):   Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz.   Közlemények, kötet 1, szám 2, p. 5–12, 1952.

Two methods are known for the precise determination of the figure of the earth;   one based on geodetic and astronomical measurements and the other on measurements of gravity.   The theoretical basis of the latter method is given in the formula of Stokes, recently extended and modified by Vening Meinesz.   The gravimetric determination of the figure of the earth is facilitated by the network of gravity measurements from numerous gravitational surveys extending over the entire earth, particularly the very detailed gravity surveys in Hungary.— *S. T. V.*

14392. Lassovsky, Károly, and Oszlaczky, Szilárd.   A Nap és Hold gravitációs hatása a gravimétermérésekze [The effect of sun and moon on gravitational measurements] (In Hungarian with summaries in Russian and English):   Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 1, szám 3, p. 13–29, 1952.

In their studies of lunisolar effect on terrestrial gravity the authors took into account parallactic effect and computed, by the methods of celestial mechanics, the disturbing effect of the moon and sun on gravity measurements in Budapest. During August and September 1951 precise determinations of gravity were made using two Heiland gravimeters.   The observed values were compared with computed values, the difference being the measure of the deformation of the earth due to tidal effect.   The mean value of the ratio of observed tidal variations to theoretical values for a rigid earth was calculated as 1:16.—*S. T. V.*

14393. Lassovszky, Károly, and Oszlaczky, Szilárd.   A nehézségi gyorsulás nemzetközi normális értéke [International standard gravity values] (In Hungarian with summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 1, szám 4, p. 30–40, 1952.

Differences between the values of *g* computed by the International standard formula of the year 1930 and the corresponding values published by W. D. Lambert and F. W. Darling are given.   Numerical data are computed to 6 decimals for every 10' between 0° and 90° latitude and for every 0.5' between 45°40' and 48°40' latitude for the territory of Hungary.—*S. T. V.*

14394. Cailleux, André.   Compensation isostatique de l'ensemble des continents et des océans [Isostatic compensation of the continents and oceans as a whole]: Rev. gén. sciences pures et appl., tome 59, nos. 1–2, p. 3–5, 1952.

The thickness of suboceanic sial, 0 according to Wegener, is calculated on the basis of several other hypotheses and found to range from 6 to 20 km. No matter which pair of values are adopted for density and depth, all theories lead to contradictions which cannot be resolved without resorting to other hypotheses. These values thus seem to have only regional rather than worldwide significance.—*D. B. V.*

14395.    Rosenbach, Otto.    Theoretische Untersuchung zum Problem der Isostasie [Theoretical investigation of the problem of isostasy]: Geofisica Pura e Appl., v. 22, fasc. 1–2, p. 1–36, 1952.

Pratt's and Airy's hypotheses of isostasy are analyzed and the conclusion is reached that it is possible that an infinite number of "gravimetrically equivalent" structures of the crust could produce identical results.    Therefore, only by supplementing gravimetric data with seismologic evidence and general geologic considerations is it possible to clarify the problem of isostasy.

An extensive appendix contains detailed calculations.—*S. T. V.*

## INSTRUMENTS AND METHODS OF OBSERVATION

14396.    Haázné, Rózsás Hajnal. (Mrs. H. Haáz).    Kísérleti vizsgálatok a TNK 1427 gy. sz. Nörgaard-graviméterrel [Experimental investigations with the Nørgaard gravimeter TNK 1427].    (In Hungarian with summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemenyek, kötet 1, szám 7, p. 56–76, 1952.

Extended experiments were made both in the laboratory and in the field, to check the functioning of this gravimeter.    These experiments have immediately established the impossibility of dispensing with a thermostat.    No azimuthal or magnetic effects on this gravimeter were detected.    Drift of the zero point was positive in the laboratory, being 1 to 2 mgal per day at 20 C and 4 to 5 mgal at 40 C.    In the field the drift sometimes became negative.    The mean error of an observation was found to be 0.11 mgal, that of mean values equal to 0.05 mgal. The results of the experiments are represented on tables and in graphs.—*S. T. V.*

14397.    Komáromy, Istvan.    Különböző azimutokban végzett graviméteres észlelések vizsgálata [Proof of the azimuthal effect of Heiland gravimeter] (In Hungarian with summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 1, szám 8, p. 74–80, 1952.

Experiments indicate that Heiland gravimeter has a considerable azimuthal effect, due probably to the action of the horizontal component of terrestrial magnetism.—*S. T. V.*

14398.    Běhounek, Rudolf.    O přesnosti tíhových měřeni statickými gravimetry [On the accuracy of gravity measurements by static gravimetry] [In Czech with Russian and English summaries]: Czechoslavakia, Státni. Geol. Ústav. Sborník, svazek 16, díl 2, p. 633–642, 1949.

The paper discusses the accuracy of measurements made for geological purposes by static gravimetry in the area of southwestern Slovakia, and analyzes the size as well as the causes of the total margin of error of the gravity anomalies derived. From the size of the mean errors for the measuring of one gravity anomaly it becomes apparent that static gravimeters can be used with good results also for very exacting geological mapping, and that in uneven terrains they can also replace the torsion-balance.—*Author's English summary.*

14399. Zagorac, Željko. Contribution to the method of torsion balance surveying in underground: Geophysics, v. 18, no. 2, p. 448–458, 1953.

In areas of rough terrain, torsion-balance work on the surface is of little value. In underground work, however, the topographic contributions may be readily calculated. The effect of the hollow space of the gallery is small for gradients and large for curvatures except for the quantity $U_{xy}$. The latter may be effectively used in interpretation along with the gradients $U_{xz}$ and $U_{yz}$. Values of $U_{xy}$ and $U_{xz}$ are composed as vectors in the $Z-Y$ plane; $U_{yz}$ and $U_{xy}$ are composed in the plane $Z-X$. Using illustrations for a sphere and a cylinder it is shown that this method of analysis gives an effective means for determining the position of ore bodies. An example of a torsion balance survey in an iron-ore mine is presented. A method of correcting for mass irregularities close to the instrument by means of parallel profiles is discussed.—*I. Z.*

## METHODS OF ANALYSIS AND INTERPRETATION

14400. Niem, G. de. Berechnung der Schwereintensität von Rotationsellipsoiden [Calculation of the gravitational intensity of ellipsoids of revolution]: Gerlands Beitr. Geophysik, Band 62, Heft 4, p. 302–306, 1952.

The disturbing effect of an ellipsoid of revolution is calculated and numerical values are given in the table for various forms of the ellipsoid at different depths underground.—*S. T. V.*

14401. Griffin, W. Raymond. Approximation to the lateral variation of residual gravity due to a frustum of a vertical cone: Geophysics, v. 18, no. 2, p. 401–415, 1953.

The formula is derived for the vertical component of gravity due to the frustum of a cone whose top radius is small compared to the depth of burial. Curves and tables are prepared to facilitate the numerical calculations. Applications are made to two Gulf Coast salt domes whose dimensions are known from previous drilling.—*I. Z.*

14402. Haáz, István Béla. Gravitációs és mágneses hatású ferde réteg helyzetének méreteinek és mibenlétének megállapítása [Determination of an infinite inclined dike from its gravity and magnetic effects]. (In Hungarian with summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemenyek, kötet 1, szám 5, p. 41–50, 1952.

Relations between the anomalies of the magnetic force and second derivatives of the gravitational potential are established by the methods of vector analysis. Applying these relations to an infinite inclined dike expressions of similar form are derived both for the gravitational and magnetic effect of the dike. The coordinates of the gravitational and magnetic maxima and minima also satisfy analagous and simple quadratic equations. The method is shown for determining the position, depth, and width of the dike from the roots and the coefficients of these quadratic equations and from the coordinates of the points of extreme gravitational and magnetic anomalies. The dip angle, excess density, and magnetic susceptibility can also be computed.—*S. T. V.*

14403.   Baranov, V.   Sur le calcul de l'influence gravimétrique des structures définies par les isobaths [On the calculation of the gravimetric effect of structures defined by isobaths]: Geophys. Prosp., v. 1, no. 1, p. 36–43, 1953.

The triple integral for the attraction of a mass on a point is transformed in a double sum.   This double sum serves to construct a graph for the rapid determination of the gravimetric influence of structures given by depth contours.   The influence of topography can also be computed with this graph.—*Author's Abstract.*

14404.   Lejay, Pierre.   L'effet indirect et l'interprétation des anomalies gravimétriques [The indirect effect and the interpretation of gravimetric anomalies]: Annales Géophysique, tome 7, no. 3, p. 175–198, 1951.

Lejay deplores the fundamental difference of approach between geodesists and geophysicists toward the application of values of gravity.   Geodesists, whose object is precise measurement, care little about the physical reality of the cogeoid.   This imaginary surface was introduced to facilitate calculations of the distance between the geoid and ellipsoid of reference.   With the indirect effect included in tables of isostatic correction, the reduction to the cogeoid demands no supplementary work.   Geophysicists, on the other hand, are concerned only with discovering the causes of anomalies and thus understanding the internal constitution of the earth.   They correct for all known influences and try to compare the residual anomalies with values calculated on the basis of different theories.   They are reluctant to apply the indirect effect because it introduces as a point of departure a surface which does not correspond to physical reality.

Lejay shows that geophysicists could apply the indirect effect in their interpretations by using a simple supplementary correction (irregularities of less than 400 km assumed to be without effect).   The magnitude of error introduced is shown to be of a much smaller order than those already resulting from other factors such as density and altitude.—*D. B. V.*

14405.   Pentz, H. H.   A least square method for gravity meter base stations: Geophysics, v. 18, no. 2, p. 394–400, 1953.

Two applications of the method of least squares to obtain the most probable values of gravity-meter base stations are discussed.   The first may be considered as an approximation which comes closer to the most probable value as the number of conditional equations increases.   The second application gives the most probable values for a finite but unknown number of base stations as long as the number of conditional equations required to produce the necessary accuracy is maintained.—*I. Z.*

14406.   Jung, Karl.   Some remarks on the interpretation of gravitational and magnetic anomalies: Geophys. Prosp., v. 1, no. 1, p. 29–35, 1953.

An approximate two-dimensional mass distribution yielding a given simple gravity anomaly can be determined geometrically from the maximum, half-maximum, and quarter-maximum points of the anomaly.   In the case of a thin magnetic dike, the location of the head point and the angle between the dip and direction of magnetization can be determined geometrically from the maximum, minimum, and zero points of anomalies in the vertical and horizontal components of the magnetic field.   It is also shown that Nettleton's method for determining density can be reduced to a system of simple mathematical formulas from which the best value of density can be easily computed.—*R. G. H.*

## OBSERVATIONS OF GRAVITY AND GRAVITY SURVEYS

14407. Ledersteger, K. Die absolute Lotabweichung in Potsdam und die geodätischen Ausgangswerte des gesamteuropäischen Netzes auf dem Hayfordschen Ellipsoid [The absolute deviation of the vertical at Potsdam and the geodetic base values of the all-European network in the Hayford ellipsoid]: Bull. géod., no. 23, p. 101–104, 1952.

The absolute deviations of the vertical detectable at Potsdam from astronomical-gravity comparisons differ significantly from earlier values obtained from the astronomic-geodetic observations which form the starting elements of the European triangulation network. It is possible to show, by the use of values of the deviation of the vertical extending over the whole of Europe as far as longitude 30°, and referred to the undulations of the geoid of Tanni, that the starting elements adopted at Potsdam are too large by 3.0″ in latitude and 1.4″ in longitude.—*Author's Abstract*

14408. Howell, B. F., Jr., and Vozoff, Keeva. Gravity investigation in north-central Pennsylvania: Am. Geophys. Union Trans., v. 34, no. 3, p. 357–359, 1953.

A gravity survey of an area of about 900 sq mi centering on Lawrenceville, Tioga County, Pa. disclosed a roughly circular positive anomaly of 22 mgals. Such an anomaly could be interpreted as indicating a buried intrusion of diabase or peridotite. A similar anomaly has been observed close to the Bradford oil field.—*M. C. R.*

14409. Bacon, L. O., and Wyble, D. O. Gravity investigations in the Iron River-Crystal Falls mining district of Michigan: Mining Engineering, v. 4, no. 10, p. 973–979, 1952.

Tests of gravity methods in iron-ore exploration were made by a series of surveys in southern Iron County, Mich. In general a positive residual was found over areas underlain by iron formation, but further work is needed to determine if the residual is caused by the density contrast between iron formation and ore or between iron formation and foot and hanging wall. Regional gravity surveys outline the major structural features of the Iron River-Crystal Falls synclinal basin. A large anomaly about 15 miles west of Iron River may be associated with another structurally similar basin.—*M. C. R.*

14410. Bott, M. H. P., and Masson-Smith, D. Gravity measurements over the Northern Pennines: Geol. Mag., v. 90, no. 2, p. 127–130, 1953.

In a gravity survey continuing the work of Hospers and Willmore a closed elongate area of negative Bouguer anomalies was outlined in the northern Pennines. The steep gradient indicates the anomaly cannot be of deep-seated origin and must be caused by a direct density contrast between lighter and denser masses of rock. The anomaly is assumed to be due to a covered acid intrusion. The origin of the intrusion is magmatic inasmuch as a negative anomaly must be produced by a total removal of actual mass, which in this area, could only have been downward.—*M. C. R.*

14411.  Hospers, J., and Willmore, P. L.  Gravity measurements in Durham and Northumberland: Geol. Mag., v. 90, no. 2, p. 117–126, 1953.

Gravity measurements were made in Durham and Northumberland in the region of the Alston block to determine whether such observations could help in elucidating geologic structure.  Observations across the eastern part of the block are consistent with the idea that the 20 mile block between the Ninety Fathom dyke and Butterknowle fault is a horst.  Observations across the western part are interpreted as due to a granite intrusion not yet exposed by erosion.—*M. C. R.*

14412.  Pícha, Jan.  Vyšetřování tíhového pole v oblasti Praha-Plzeň-Č. Budějovice [Investigation of the gravitational field in the area Praha-Plzeň-Č. Budějovice] (In Czech with Russian and English summaries): Czechoslovakia, Státní. Geol. Ústav Sbornik, svazek 18, oddil geol. 1951, p 337–375, 1952.

By analysing 278 gravity measurements graphically Pícha derives the equation $g = 980.423_0 - 3.78141 \cos 2\varphi - 0.0001957v + \delta A$ for the distribution of values of $g$ in the gravitational surface field in the area Praha-Plzeň-České Budějovice. Plotting the relative common isoanomalies on a map of the area shows agreement with geological and tectonic conditions as well as with geophysical, seismic, and geomagnetic data, indicating that the relative common isoanomalies actually express gravity anomalies proper.

Another result of the investigation is a new method of regional determination of most suitable density for an incomplete topographic reduction directly from measured values of $g$.—*D. B. V.*

14413.  Iida, Kumizi, Hayakawa, Masami, and Katayose, Kuniyoshi.  Gravity survey of Mihara Volcano, Ooshima Island and changes in gravity caused by eruption [In Japanese with English summary]: Geol. Survey Japan Rept. 152, 28 p., 1952.

Four gravity surveys were made on Ooshima [Ō-shima], one at the end of the active period of July–September 1950, one during the dormant phase, one in the early stages of the active period of February–April 1951, and the last at the most violent stage of the latter period.  Readings were made at 50 stations, 20 within the somma and the remainder around the volcano.  Significant changes were observed between each successive survey with gravity values increasing during the dormant phase, particularly within the somma.  Changes in elevations were determined by levelling and were insufficient to account for observed changes. To explain the observations, a sphere 150 to 200 m in diameter is assumed to lie $2\frac{1}{4}$km beneath the crater, which gradually fills with magma and is drained or partially drained by the eruption.—*M. C. R.*

14414.  Cantos [Figuerola], José.  Aplicación de los métodos geofísicos a la prospección de aguas subterráneas [Application of geophysical methods in prospecting for ground water]: Inst. geol. min. España, notas y comunicaciones, no. 29, p. 3–31, 1952.

This is a description of the exploratory work of the Instituto Geologico y Minero, especially of its Section of Geophysics.  This section started in 1930, using chiefly the gravimetric, seismic-refraction, and electric-resistivity methods. Twenty-two examples in which geophysical prospecting was used, as well as of the results obtained, are discussed.—*S. T. V.*

## MAGNETISM

### MAGNETIC FIELD OF THE EARTH

14415.  Vestine, E. H.   On variations of the geomagnetic field, fluid motions, and the rate of the Earth's rotation: Nat. Acad. Sci. Proc., v. 38, no. 12, p. 1030–1038, 1952.

Brouwer's studies of changes in the annual rate of the earth's rotation since 1820 indicate systematic fluctuations over a period of about 50 years. Changes in the angular momentum of the atmosphere, oceans, crust, or mantle are too small or too slow to explain the major part of the nonseasonal changes. A westward drift of fluid moving near the surface of the core has been inferred from the westward drift of the earth's eccentric dipole field of geomagnetism. A northerly drift of fluid in the core is also inferred, though less accurately, from geomagnetic data as well. Fluctuations of these fluid motions in the core since 1900 agree qualitatively with fluctuations observed by Brouwer. If Bullard's model of the core is used, in which the motions are attributed to convection currents, Brouwer's results are in good quantitative agreement also. The fluid motions would also predict a variation of latitude, the amount and direction of which are roughly compatible with results from astronomy.—*M. C. R.*

14416.   Blackett, P. M. S.   A negative experiment relating to magnetism and the earth's rotation: Royal Soc. London Philos. Trans., v. 245, no. 897, p. 309–370, 1952.

A detailed study of the possibility of making a direct test of the Schuster-Wilson hypothesis, by measuring the very small magnetic field of the order of $10^{-9}$ $G$ which would be produced by a rotating body of reasonable size in the laboratory, led to the conclusion that the experiment would perhaps be possible but would certainly be exceedingly difficult. However, a much easier but still worthwhile subsidiary experiment presented itself. This was to test whether a massive body, in fact a 10 x 10 cm gold cylinder, at rest in the laboratory and so rotating with the earth, would appear to an observer, also rotating with the earth, to produce a weak magnetic field with a magnitude of the order of $10^{-8}$ $G$. That such a field might exist is a plausible deduction from a particular form of the Schuster-Wilson hypothesis considered in some detail by Runcorn and by Chapman. This paper describes the design, construction and use of a magnetometer with which this "static-body experiment" was carried out. It was necessary to investigate the theory and use of such an instrument in considerable detail. The bulk of this paper is concerned with this instrumental study. The actual static-body experiment is described and it is there shown that no such field as is predicted by the modified Schuster-Wilson hypothesis is found. This result is in satisfactory agreement with the independent refutation of the hypothesis by the measurements by Runcorn and colleagues of the magnetic field of the earth underground. When the magnetometer was completed it was found to be very suitable for the measurement of the remanent magnetism of weakly magnetized specimens, in particular certain sedimentary rocks.—*Author's Abstract*

14417.   Macht, Hans G.   Die Potentialanteile zweiter und höherer Ordnung des Erdmagnetfeldes, pt. II, 1. [Contributions of the members of the second and higher order to the potential of the geomagnetic field]: Gerlands Beitr. Geophysik, Band 62, Heft 3, p. 222–247, 1952.

The geomagnetic potential terms (coefficients) of the second and higher order are explained on the basis of definite spherical magnetization models ($I$-distribu-

tions) instead of abstract multipole components. The nonsectorial potential components $P_2^0$ and $P_2^1$ can be interpreted as "pseudo-homogeneous" distributions in which the vector $I$ is parallel to the $x$-axis at all points of the earth's interior, but varies in intensity with the $x$-, $y$-, or $z$- coordinates. The corresponding coefficients $C_2^{0'}$ and $C_2^{1'}$ are then directly proportional to the linear magnetization variations parallel or transverse to the $x$-axis, with $\delta I/\delta x = 0.597 . C_2^{0'}/R$ and $\delta I/\delta y = 0.690 . C_2^{1'}/R$, where $R =$ earth's radius.

Combined with a superimposed $C_0^{0'}$ component (dipole moment), the coefficients $C_2^{0'}$ and $C_2^{1'}$ can be interpreted as corresponding to the average linear deviations from the equivalent homogeneous magnetization. On the other hand the sectorial $C_2^{2'}$ component can be interpreted only as an "absolute transverse magnetization", that is, a pure transverse distribution with, for instance, $I = I_y = b' . z/R$, which shows no dipole moment perpendicular to the magnetic axis $(b' = 0.69 . c_2^{2'})$. In spite of its extensive analytical invariance and apparent physical independence, this "absolute" $C_2^{2'}$ quadrupole component is nevertheless related to the terrestrial dipole moment, as will be shown in part III of this study.

The zonal geomagnetic potential components $P_n^0$ of the third and higher order can be produced by complex pseudohomogeneous distributions, dependent only on $x$, of at least the $(n-1)$th degree; their coefficients $C_n^0$ are then directly proportional to the average nonlinear variations of $I(\delta^{n-1}I/\delta x^{n-1})$. These $P_n^0$ terms include only the equivalent magnetic distributions in relatively shallow crustal and subcrustal strata of geomagnetic polar zones. On the other hand, the $P_n^{n-1}$ "semi-sectorial" terms which generally can be explained only through complex pseudohomogeneous $I$-models, primarily express such shallow magnetization constituents in the region of the geomagnetic equatorial zone.

These $I$-models of different kinds are introduced here just as feasible equivalent magnetizing distributions which can be represented as definite systems of currents localized in the interior of the earth. It is not possible to attribute geomagentic meaning to separate terms of this expression, but these models make it possible to visualize purely abstract formal component parts of the harmonic analysis of the geomagnetic potential as concrete forms, based on the principles of physics and geometry. These $I$-models could be useful and effective in fundamental theoretical geomagnetic research.—*Author's abstract, D. B. V. and S. T. V.*

14418.    Macht, Hans G.   Die Potentialanteile zweiter und höherer Ordnung des Erdmagnetfeldes, pt. II, 2 [Contributions of the members of the second and higher order to the potential of the geomagnetic field]: Gerlands Beitr. Geophysik, Band 62, Heft 4, p. 281–301, 1952.

As shown in a previous paper by Macht [see Geophys. Abs. 14218 and 14417] the second order geomagnetic potential coefficients admit physical interpretations leading to certain fundamental conclusions concerning the general geometric constitution of the geomagnetic field. In particular the empirical parameters $C_2^{0'}$ and $C_2^{1'}$ indicate definite planetary asymmetries of the equivalent pseudo-homogeneous magnetization of the earth. A weak asymmetry in the north-south direction, as indicated by the $C_2^{0'}$ value results in a magnetic intensity of the northern geomagnetic hemisphere some 2.5 percent stronger than that of the southern hemisphere. The asymmetry in the east-west direction, determined by the $C_2^{0'}$ value, is by far more pronounced, the eastern hemisphere being on the average 26.5 percent more strongly magnetized than the western one. These asymmetries in turn produce the corresponding "planetary" anomalies of the horizontal ($H$) and the vertical ($Z$) intensities, superimposed over the intrinsic regional $H$- and $Z$-anomalies of the geomagnetic surface field. An example is

the worldwide $H$-anomaly observable in the region of the magnetic equatorial belt. Another type are the dislocations of the dipole field produced by the geomagnetic component member $C_2{}^{2'}$, appearing primarily in polar regions; they should be interpreted also as superimposed planetary anomalies.

Geomagnetic potential members of the second order together with the main dipole field determine an extended "planetary fundamental field" which presumably is located deep in the earth's interior. On the contrary, potential members of the third and higher order primarily determine regional details in the final geomagnetic field; in particular the zonal components $P_n{}^0$ (with $n \geqq 3$) express deviations, noticeable in geomagnetic polar zones, from the ideal (central) dipole field in full analogy with their $I$-distributions. As this was concluded from the investigation of the eccentric dipole field, these spherical harmonics include primarily the equivalent magnetic aggregations of the shallow, crustal and subcrustal layers of those zones.—*Author's summary, S. T. V.*

14419. Chapman, Sidney. The morphology of geomagnetic storms: An extension of the analysis of $D_s$, the disturbance local-time inequality: Annali Geofisica, v. 5, no. 4, p. 481–499, 1952.

The "D" field of magnetic disturbance has in the past been analysed into a part $D_{st}$ depending on time reckoned from the storm commencement—storm-time—and a part whose distribution has a simple form relative to the meridian containing the sun. This part reveals itself at times of weak or moderate magnetic activity as an addition to the field of the solar daily magnetic variation ($S$), present in its pure form $S_q$ on quiet days; the addition is called the disturbance daily variation, denoted by $S_D$. But during storms with definite commencement, the average course of this part of the $D$ field, which is nonuniform round the earth, and is oriented in a definite way relative to the noon meridian, can be followed not only from one day to the next, as had been done in the past, but over shorter periods, even from hour to hour; as then studied, it is not a daily variation at all, but a distributed field changing in form and intensity with storm time. This part of the field is here called the $D_s$ field, or disturbance (solar) local-time inequality. It varies with storm time in a manner materially different from $D_{st}$, developing more rapidly than the main phase of $D_{st}$ and decaying much faster.—*Author's summary*

14420. Kato, Yoshio, and Ossaka, Justo. Further note on the time variation of the earth's magnetic field at the time of bay-disturbance: Tōhoku Univ. Sci. Repts., 5th ser. Geophysics v. 4, no. 2, p. 61–63, 1952.

Twenty-two records of magnetic bay disturbances observed at Onagawa magnetic observatory, Japan, and at the Tamanrasset observatory in Algiers, were compared and it was found that $dH/dt$ at both observatories is simultaneous and in phase. It is concluded that the changes in $dH/dt$ are caused by fluctuation of the velocity or density of the incoming corpuscular beam when it enters the upper atmosphere.—*S. T. V.*

14421. Burkhardt, K[urt]. Positive und negative magnetische Baistörungen [Positive and negative magnetic bay disturbances]: Geofisica Pura e Appl., v. 24, p. 54–56, 1953.

Magnetic bay disturbances are usually divided into two classes according to positive or negative sense of $\Delta H$. The variation of $H$ alone does not define uniquely simultaneous changes of the ionospheric current, and only by considering corre-

sponding fluctuations in $D$ is it possible to obtain precise correlations between these phenomena. In many bays the $\Delta D$ maximum appears before that of $\Delta H$; this corresponds to a change of the initial meridional direction of the ionospheric current into a zonal direction. Several magnetograms of typical bay disturbances recorded at the Fürstenfeldbruck magnetic observatory are reproduced.—*S. T. V.*

14422. Lipskaya, N. V. O nekotorykh sootnosheniyakh mezhdu garmonikami periodicheskikh variatsiy elektromagnitnykh zemnykh poley [Some correlations between the harmonics of periodic variations of terrestrial electromagnetic fields]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, p. 41–47, 1953.

In a previous study [see Geophys. Abs. 14259] Lipskaya has derived a system of equations correlating the values of various harmonics of periodic variations of terrestrial electrodynamic field with electric properties of the ground, as well as with the rotational velocity of the earth at the point of observation. In the present paper certain analytical deductions are made from these equations. The ratios of amplitudes of harmonics of electric and magnetic fields (for the $H$-components) are determined as functions of electric parameters of the ground. Differences of the phase angles of these components are derived, and the range of variation of these amplitude ratios and phase differences is established.

Computed values are shown to agree with those observed at magnetic observatories at Tucson, Ariz. and Toyokhara and Zuy in eastern Siberia.—*S. T. V.*

## MAGNETIC PROPERTIES OF ROCKS AND MINERALS

14423. Néel, Louis. Antiferromagnetism and ferrimagnetism: Phys. Soc. London Proc., Ser. A, v. 65, no. 11, p. 869–885, 1952.

This is a review of present knowledge on the subject. Discussion of the magnetic behavior of some ferrites and pyrrhotite is included.—*M. C. R.*

14424. Velayos Hermida, Salvador. Teoria del campo coercitivo de los materiales magneticos [Theory of the coercive field of magnetic substances]: Rev. Cienc. Apl., año 6, fasc. 5, no. 28, p. 385–408, 1952.

Among different properties characterizing the magnetic state and magnetic properties of a substance, its coercive force is one of the most indicative and sensitive features. This property is discussed in the light of recent studies on magnetism. Of special interest to the geophysicist is the discussion of energy variations accompanying magnetic changes, the effect of mechanical forces (magnetostriction), evaluation of magnetoelastic energy and of the exchange integral, and the influence of nonmagnetic inclusions.—*S. T. V.*

14425. Petrova, G. N., and Yukhnovets, N. I. Ismeneniye magnitnykh svoistv gornykh porod v zone rasloma [Changes in the magnetic properties of rocks in the vicinity of fractures]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 2, p. 115–123, 1953.

During a magnetic survey of the northern slopes of the Khrebet Ala-tau, mountains in central Asia, magnetic lows were frequently observed along fault planes even when the formations on both sides of the fault had almost identical magnetite content. The decrease in the magnetic intensity was sometimes several hundred gammas. It is suggested that the change in the magnetic properties near the fracture plane may be attributed to high mechanical stresses, deformation and partial rotation of magnetic domains by the tectonic processes leading to faults.—*S. T. V.*

14426. Mooney, Harold M., and Bleifuss, Rodney. Magnetic susceptibility measurements in Minnesota. Pt. 2: Analysis of field results: Geophysics, v. 18, no. 2, p. 383–393, 1953.

Seventy-five samples of 7 rock types have been analyzed for magnetite content by magnetic separation and chemical analysis, making allowance for iron which occurs as ilmenite, hematite, and silicates. Magnetic susceptibility shows a clear dependence on magnetite content but with too much scatter to permit prediction of one from the other. For small magnetite content $V$ (in volume percent), susceptibility $k$ is roughly given by $k=3,000\times10^{-6}$ $V$ cgs. Based on [field measurements of] 200 outcrops of 11 rock types, the approximate mean susceptibility of basalt and diabase is $2,500\times10^{-6}$, of rhyolite and gabbro $1,000\times10^{-6}$, of acid intrusives including granite $400\times10^{-6}$, of greenstone $100\times10^{-6}$ and of slates $50\times10^{-6}$. Variability is high for acid intrusives, intermediate for basalt, rhyolite, and greenstone, and lower for diabase, gabbro, and slate.—*Author's Abstract*

## MAGNETIC INSTRUMENTS AND METHODS OF OBSERVATION

14427. Borrego González, Joaquin. El magnetómetro aerotransportado [The airborne magnetometer]: Inst. geol. min. España notas y comunicaciones, no. 26, p. 79–88, 1952.

This is a brief description of the construction and use of the airborne magnetometer and its advantages in mineral prospecting.—*D. B. V.*

14428. Schonstedt, E. O., and Irons, H. R. Airborne magnetometer for determining all magnetic components; Am. Geophys. Union Trans., v. 34, no. 3, p. 363–378, 1953.

The NOL vector airborne magnetometer Type 1A (VAM–1), designed for measuring components of the geomagnetic field from aircraft, consists of a modification of the AN/ASQ–3A equipment employed for geophysical exploration by air. The VAM–1 continuously records the total intensity of the field and its direction with respect to vertical and horizontal coordinates established by a pendulum. The effects of accelerations of the aircraft on the vertical accuracy of the pendular reference are largely eliminated by averaging the magnetometer data over a period normally required for two phugoid oscillations of the aircraft. The operation of the magnetometer is limited to regions in which the magnetic dip exceeds 45°. The magnetometer is estimated to measure $F$, $H$, and $Z$ to an accuracy of 200 gammas.—*Authors' Abstract*

14429. Sohoni, V. V., Pramanik, S. K., Malurkar, S. L., and Venkiteshwaran, S. P. Effect of electric current on the magnetic instruments at Alibag Observatory: Indian Jour. Meteorology and Geophysics, v. 4, no. 1, p. 45–61, 1953.

Experiments were carried out to determine possible harmful effect of industrial electric installations on the operation of magnetic instruments installed at Alibag Observatory. It is concluded that alternating current can be considered harmless, and that the possible effect of direct current can be mitigated by certain precautions. The scale of the experiments, especially the intensity of the currents, were too small for American conditions.—*S. T. V.*

14430. Jenny, W. P. Surface micromagnetic survey method, U. S. patent 2,635,134, granted April 14, 1953. 1 claim.

An airborne magnetometer method of simultaneously surveying at two levels.

14431.  Marchand, J. A., and Platis, J.   Apparatus for determining the orientation of underground strata from core samples, U. S. patent 2,634,317, granted April 7, 1953.   3 claims.

An apparatus for determining magnetic orientation of core samples.

## METHODS OF ANALYSIS AND INTERPRETATION

14432.  Wait, James R.   Induction by a horizontal oscillating magnetic dipole over a conducting homogeneous earth: Am. Geophys. Union Trans., v. 34, no. 2, p. 185–188, 1953.

The magnetic field of a horizontal magnetic dipole over a flat semi-infinite conducting homogeneous earth is calculated.   It is assumed that the significant dimensions in the physical situation are much less than the free-space wavelength. The calculations for the horizontal and vertical components of the magnetic field are made by considering the Hertz vector.   Wait observes that by using the reciprocity theorem the vertical field component is identical with the expression derived by Gordon for the horizontal field component of a vertical magnetic dipole. The horizontal field components also check with a previous calculation made by Belluigi.—*I. Z.*

14433.  Rikitake, Tsuneji.   Analyses of geomagnetic field by use of Hermite functions: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 4, p. 293–304, 1952.

Hermite functions may be used in obtaining the subterranean magnetization directly from the surface anomaly.   The method is similar to but avoids some of the limitations of the Fourier analysis methods developed by Tsuboi and Nagata. The two dimensional calculation of magnetization $J(x)$ at depth involves computing the field component measured on the surface and expanding the potential in a series of Hermite polynomials.   The coefficients thus calculated are used to determine the coefficients of the expansion of $J(x)$.   The advantages of the method are demonstrated in an example.   The separation of the external and internal parts of the geomagnetic field can also be effected with the aid of Hermite functions.—*R. G. H.*

14434.  Törnquist, Gösta.   Om den matematisk-geologiska tolknigen ab magnetiska anomalier [On the mathematic and geologic interpretation of magnetic anomalies]: Acad. Aboensis Acta, math. phys. 18, no. 2, 120 p., 1952.

After a short introduction dealing with fundamental principles of magnetism and magnetic measurements, computations are given of the characteristics of the fields generated by a magnetic pole, vertical double pole, inclined double pole, linear configurations differently placed, and of combinations of these elements. These are followed by a discussion of the magnetic fields produced by a sphere, cylinder, ellipsoid of revolution, two-dimensional bodies in general, elliptic cylinder, and plate.   Tables of numerical data for special geometric conditions, which are also illustrated by graphs, are given.   Several practical examples of the use of the formulas and graphs are included.

The article also contains a table of magnetic data of different rocks and a theoretical discussion of the correlation between magnetic and gravitational anomalies.—*S. T. V.*

14435. Khalevin, N. I. Primeneniye elektrorazvedki dlya interpretatsii magnitnykh anomaliy [Employment of electric methods of prospecting for interpretation of magnetic anomalies]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 61–68, 1953.

When interpreting the results of magnetic surveys often it is difficult to decide whether the observed magnetic effect is caused by a definite circumscribed ore body or by dissemination of magnetic particles in the formation. Only the first is economically important. The electric resistivity method, in addition to the magnetic survey, was used by Khalevin in several cases, so that both magnetic profiles and electric resistivity curves were available for the area. From analysis of both, it was possible to make a decision, which was subsequently confirmed by drilling.—*S. T. V.*

14436. Hurwitz, L. Reduction of airborne magnetometer results: Am. Geophys. Union Trans., v. 34, no. 3, p. 360–362, 1953.

Reduction of observations obtained with the vector airborne magnetometer, Model 1A, is somewhat simplified by the computation of reduced (level-flight) angles. Aircraft swing data are analyzed by magnetic field components $X, Y, Z$ rather than by elements $D, H, Z$. Similarly corrections for aircraft magnetism are applied to components, thus facilitating the application of punch-card processing methods.—*Author's Abstract*

## MAGNETIC OBSERVATIONS AND SURVEYS

14437. Fanselau, G[erhard]. Vorläufiger Bericht über die Beobachtungen am Adolf-Schmidt-Observatorium für Erdmagnetismus in Niemegk in der Zeit vom 1 Januar bis 30 April 1952 [Preliminary report on the observations at the Adolf Schmidt Observatory for Geomagnetism in Niemegk for the period January 1 through April 30, 1952]: Gerlands Beitr. Geophysik, Band 63, Heft 1, p. 71–78, 1953.

This is the first of a series of brief summaries of magnetic observations at the Niemegk observatory. Data are given in the form of tables and graphs.—*D. B. V.*

14438. Blundell, C. R. K. Magnetometric mapping for haematite in south Wales: Geol. Mag., v. 90, no. 1, p. 57–64, 1953.

In the search for large deposits of haematite and other feebly magnetic minerals it is suggested that mapping the magnetic residuals may be of greater value than mere linear traverses. Not only is the method more suitable for exploring virgin areas but it also affords a means of differentiating between the effects of large deeply buried masses and small objects at shallow depths. At the same time the graphical expression of the results on the map becomes more easily intelligible. The application of the method at known haematite ore bodies in south Wales has yielded striking results, and the extension of the survey into an unexplored area indicates the possibility of proving at least one further large haematite deposit.— *Author's Abstract*

14439. Powers, Harold, Scharon, [H.] Leroy, and Tolman, Carl. Geophysical case history, Fredericktown lead district, Missouri: Mining Engineering. v. 5, no. 3, p. 317–320, 1953.

Geophysical surveys have been successfully used in the Fredericktown district as guides in the development of known ore bodies. The ore deposits occur as a bedded disseminated type, chiefly of galena and pyrite with minor amounts of

chalcopyrite and siegenite. Economic mineralization is characteristically confined to the lower 20 to 25 ft of the Bonneterre dolomite at average depths of 300 to 400 ft. Ore bodies occur in fractured zones where the Lamotte sandstone pinches out against the pre-Cambrian surface or in areas of unusual highs and lows in the Lamotte. Magnetic surveys show the presence of buried igneous knobs and ridges or subsurface extensions of those already known. Resistivity surveys then are used to determine depths to the pre-Cambrian surface and to contacts of the different sedimentary horizons and to locate zones of fracture.—*M. C. R.*

## ELECTRICITY

### GENERAL AND THEORETICAL STUDIES

14440. Rikitake, Tsuneji. Electromagnetic induction within the earth and its relation to the electrical state of the earth's interior, Pt. 1: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, p. 45–98, 1950.

This paper is an extension of studies on electromagnetic induction in the earth. In the first chapter the justification for the assumption of the earth's magnetic permeability as $\mu = 1$ is presented.

In the second chapter electromagnetic induction due to diurnal variations of the earth's magnetic field ($S_q$ field) is discussed. Rikitake examines the extent to which large oceans shield the inner part of the earth from the outer field. He estimates the extent to which $S_q$ is affected by sea which is bounded by 2 meridians 90 degrees apart in longitude. It is demonstrated that the magnetic field produced by oceanic currents amounts to $\frac{1}{10}$ or less of $S_q$ except near the geographic center of the ocean. Although the ocean-effects only amount to a few gammas, they can be detected by eliminating the fields which depend on local time and other irregularities. Because of the irregular distribution of land and sea it is difficult to estimate the influence of the ocean. A theoretical analysis is made and applied to the Pacific Ocean using the data obtained at the observatories of Kakioka and Tucson. It is concluded that although the effects of the ocean are small and not too reliable, they can be detected under suitable assumptions.

A review of the various spherical harmonic analyses of $S_q$ is presented. Chapman assumes as a model of the earth a uniformly conducting core of conductivity $\sigma = 3.6 \times 10^{-13}$ emu surrounded by a nonconducting layer 250 km thick. This is called the "uniform core model." In 1933 with considerably more data available, Benkova made another and perhaps more accurate analysis of $S_q$. He computed $\sigma = 5 \times 10^{-12}$ emu and a thickness of 400 km for the nonconducting layer. In order to construct an electrical model of the earth in accord with the earth's structure as inferred from seismic data, the model was altered somewhat to consist of a core, mantle, and a superficial nonconducting layer. According to Chapman's analysis, $q$, the ratio of the radius of the conducting core to that of the earth, is 0.97, the electrical conductivity of the core $\sigma_3$ is $3 \times 10^{-11}$ emu, and the electrical conductivity of the mantle $\sigma_2$ is $3 \times 10^{-13}$ emu. The thickness of the nonconducting layer is 200 km. According to Benkova's analysis $\sigma_3 = 5.0 \times 10^{-11}$ emu, $\sigma_2 = 5 \times 10^{-12}$ emu, $q = 0.94$, and the thickness of the outermost nonconducting layer in 400 km. Though the determination of $\sigma_3$ is rough, the results are in accord with Lahiri and Price where the increase of $\sigma$ with increasing depth was reported. The distribution and depth of penetration of induced currents in the earth are discussed. It is demonstrated that the currents induced in the core are very small compared with those induced in the mantle.

In the third chapter, the electromagnetic induction resulting from solar diurnal variations ($SD$ field) is analyzed. The values obtained from the actual data are

consistent with the calculated ones based on the uniform core model only if the conductivity of the core is of the order of $10^{-12}$ or $10^{-13}$ emu and the thickness of the nonconducting layer is a few hundred kilometers.

The fourth chapter is concerned with electromagnetic induction resulting from storm-time variations ($D_{st}$ field). The electrical model of the earth deduced from the study of $S_q$ field is compatible with electromagnetic induction by storm-time variations.

In the fifth chapter electromagnetic induction by bay-type disturbances is discussed. The model inferred from the $S_q$ field is confirmed by bay-type disturbances in which the distribution of the disturbing forces over the earth differ a good deal from that of $S_q$. Since bay-type disturbances generally end within several hours, the induced currents penetrate into the earth more shallowly than in the case of $S_q$.—*I. Z.*

14441. Rikitake, Tsuneji. Electromagnetic induction within the earth and its relation to the electrical state of the earth's interior. Pt. I (2): Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 3–4, p. 219–262, 1950.

Electromagnetic induction associated with solar eruption and radio fadeout or Dellinger effect was studied by means of a Fourier analysis of data collected by Birkeland for the magnetic variation of October 6, 1902. On the theory of plane earth induction it is inferred that the conductivity increased below a depth of 400 km and was of the order $10^{-12}$ emu and that the outer layer was nonconducting in agreement with the electrical structure of the earth's interior previously obtained in studies of $S_q$, $S_D$, $D_{st}$, and bay-type disturbances.

Analysis of induction by sudden commencement of a magnetic storm yielded coefficients of the external and internal magnetic potentials in the ratio of 3.9:1. The superficial layer was found to have a low conductivity of the order $10^{-15}$ emu comparable to that usually found in rocks on the earth's surface. Sea water has a conductivity $10^4$ times that of surface rocks and is believed to have a pronounced effect during sudden changes in the earth's magnetic field. The vertical intensity at Honolulu presumably could deviate as much as 10 gammas from this cause.

Because of paucity of data, in some cases plane-earth induction rather than spherical-earth induction theory was employed. A comparison of the two approaches in an appendix shows that it is inadvisable to use a plane-earth analysis in a region whose range does not exceed the depth of the nonconducting layer.— *R. G. H.*

14442. Rikitake, Tsuneji. Electromagnetic induction within the earth and its relation to the electrical state of the earth's interior, Pt. II.: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 3–4, p. 263–283, 1950.

In previous studies of electromagnetic induction by geomagnetic variations of various types Rikitake used a "uniform core model" to obtain a first approximation to the distribution of conductivity in the earth. For the second approximation induction is studied in an earth model in which $\sigma = \sigma^1$ for $1 > r/a > q$; and $\sigma = \sigma_o(r/a)^{-1}$ for $q > r/a > 0$, where $a$ and $r$ are respectively the earth's radius and radial distance from the center, $\sigma$ is the conductivity and $q$, $\sigma'$, $\sigma_o$ and $l$ are constants to be determined from the variations $S_q$, $D_{st}$, bay-type disturbances and solar eruption. The most preferable values are found to be $\sigma' = 10^{-15}$ emu, $\sigma_o = 10^{-12}$ emu, $q = 0.94$ and $l = 11$. It is concluded that the upper part of the earth down to a depth of about 400 km is almost nonconducting, the conductivity being of the order $10^{-15}$ emu. The conductivity increases discontinuously at

this level reaching the order $10^{-12}$ emu and then increases according to the inverse eleventh power of the radial distance from the center of the earth.—*R. G. H.*

14443.   Wait, James R.   A conducting permeable sphere in the presence of a coil carrying an oscillating current: Canadian Jour. Physics, v. 31, no. 3, p. 670–679, 1953.

The analysis is carried out for the problem of a current-carrying coil in the neighborhood of a spherical body whose conductivity and magnetic permeability differ from the surroundings.   The case is considered in detail where the frequency is low enough so that the primary field of the coil can be derived from a magnetic scalar potential.   The secondary magnetic fields due to the sphere are then derived.   The "in-phase" and "quadrature" components of the secondary field are discussed numerically and illustrated by graphs.   The results have application to electrical prospecting.—*Author's Abstract*

14444.   Wait, James R., and Campbell, L. Lorne.   The fields of an electric dipole in a semi-infinite conducting medium: Jour. Geophys. Research, v. 58, no. 1, p. 21–28, 1953.

The vertical electric dipole situated in air and just above the surface of a semi-infinite conducting half space is investigated.   The electric and magnetic field components within the conductor are calculated for the case in which the distance from the dipole is much less than a wavelength in free space.   The solutions are expressed in terms of Thomson's functions, which have been conveniently tabulated.   Curves are plotted that show the dependence of the field components on conductivity, frequency, and position of the observer.—*I. Z.*

14445.   Wait, James R.   Propagation of radio waves over a stratified ground: Geophysics, v. 18, no. 2, p. 416–422, 1953.

The propagation of vertically polarized radio waves over a horizontally stratified medium is investigated.   In 1927, Zenneck predicted the existence of a vertically polarized wave guided along the interface between ground and air.   He showed further that the electric vector had a "wave tilt", that is, a horizontal component in the direction of propagation as well as a vertical component.   Calculations are made for a two-layered ground.   It is concluded that the "wave tilt" at a frequency of 125 kc is modified appreciably by discontinuities in the substratum at depths down to 20 m.   For lower layers at depths of 10 m or less the wave tilt is reduced in magnitude and the phase is increased.   The opposite is true if the lower layer is more poorly conducting than the upper layer.   In general a higher frequency or higher conductivity or both will reduce the effect of the lower layers.—*I. Z.*

14446.   Ovchinnikov, I. K.   O vozmushchenii polya postoyannogo toka provodnikami raspolozhennymi v neodnorodnom poluprostranstve [The disturbance of the field of direct current caused by conductors placed in heterogeneous semispace]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, p. 48–60, 1953.

Several areas in the Ural'skiy Khrebet were surveyed by the electric resistivity method, and the results were investigated theoretically by computing the pattern of the electric field around disturbing bodies, (assuming them to be perfectly conductive, as they are mostly sulfide complexes with conductivity 100 to 1000 times greater than that of the surrounding formations).   The ground was assumed to be either a homogeneous semispace with constant conductivity or with con-

ductivity $\gamma$ varying with depth $z$ according to one of the following formulas: $\gamma = \gamma_0$ [cosh $\alpha$ $(K+Z)$/cosh $\alpha$ $K]^{-2}$ or $\gamma = \gamma_0$ [sinh $\alpha$ $(K+Z)$/sinh $\alpha$ $K]^{-2}$ ($\alpha$ and $K$ being constants). Comparison of the field measurements with the computations for a sphere and a flattened ellipsoid shows that in 8 cases the first formula gave satisfactory agreement; in 24 cases the second formula was better. In both cases selection of parameters $K$ and $\alpha$ was made after several trials. Ovchinnikov suggests that the first formula should be further tested.—*S. T. V.*

14447. Van Nostrand, Robert G. Limitations on resistivity methods as inferred from the buried sphere problem: Geophysics, v. 18, no. 2, p. 423–433, 1953.

The solution for the potential of a point source of direct current in the vicinity of a conducting sphere is investigated using a system of bipolar coordinates. The solution is expressed in terms of Legendre polynomials. Assuming a Wenner configuration, a series of curves have been prepared with the ratio of apparent resistivity to the actual resistivity of the country rock as ordinate and the ratio of electrode separation to the radius of the sphere as abscissa. Each curve represents a particular depth of burial. The curves indicate that the maximum depth at which one can expect to locate a spherical mass of material by direct current methods is given by the radius of the sphere. The curves are also useful in horizontal profiling to determine the electrode separation for a particular situation.—*I. Z.*

14448. Belluigi, Arnaldo. Sui campi geoelettromagnetici a bassa frequenza [Electromagnetic fields of low frequency in the earth]: Riv. Geofisica Appl., v. 13, no. 1, p. 1–32, 1952.

A detailed theoretical analysis is presented of the electromagnetic field produced in a homogeneous isotropic medium by a dipole under the action of a low-frequency alternating current, and methods of determining the different parameters of the field are suggested. Emphasis is placed on the "propagation constant," as the quantity which can be conveniently used in investigations of field patterns, of the skin effect, and other phenomena in geophysical prospecting.

An alinement chart is presented for the determination of vertical components of electromagnetic field in homogeneous terrains; the same chart can be used for the determination of anomalies and of topographic corrections in the case of dipoles of finite or infinite extension. These corrections are also discussed in cases of vertical induction phenomena and are computed in several examples.

This is followed by the treatment of infinite horizontal conductive plate subject to induction from a rectilinear transmitter, as suggested by Levi-Civita, and approximate formulas convenient for practical use are derived for this case.—*S. T. V.*

## INSTRUMENTS AND METHODS OF OBSERVATION

14449. Solaini, Luigi. Criteri e problemi costruttivi di strumenti per misure di resistività [Criteria and construction problems of instruments for measuring resistivity]: Annali Geofisica, v. 5, no. 3, p. 357–365, 1952.

Because of the problems arising when great vertical depths are involved in geophysical exploration, Solaini recommends that instruments for measuring resistivity use alternating currents of low frequency and not too high intensity, with the potential electrodes fixed and close together. Possible solutions for the potential measuring circuits are discussed.—*D. B. V.*

14450.  Ward, S. H.   A method for measuring the electrical conductivity of diamond drill core specimens: Geophysics, v. 18, no. 2, p. 434–447, 1953.

Contact resistances and the orientation and distribution of rock and ore particles make the usual conductive methods of measuring electrical conductivity unsatisfactory.   These difficulties may be avoided by an inductive method of measuring the "effective conductivity."   The method consists of measuring the change in the impedance of a solenoid when a core of the material whose conductivity is sought is inserted in it.   The conductivity can be determined from the relationship between this change in impedance and the geometry and physical properties of the core specimen.   This method will be particularly useful in inductive electromagnetic surveys.—L. C. P.

14451.  Szikora, József.   Váltóáramú ellenállásmérőkészülék [Ohmmeter for alternating current] (In Hungarian with summaries in Russian and German): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 1, szám 10, p. 85–88, 1952.

This is a description of an ohmmeter designed for alternating current of 15 cycles per second for use in resistivity measurements.—S. T. V.

14452.  Sebestyén, Károly.   Mérési tapasztalatok alacsony frekvenciás váltóáramú földellenállásmérő alkalmazhatóságára [Experimental measurements on the applicability of low frequency alternating current in earthresistivity apparatus] (In Hungarian with summaries in Russian and German): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 1, szám 9, p. 81–88, 1952.

This is a report on the results obtained by the members of Hungarian Geophysical Institute during experimental measurements, using a specially constructed alternating-current resistivity equipment.   It is concluded that the new instrument is very useful for exploration of shallow geologic structures.—S. T. V.

14453.  Puranen, M[auner], and Kahma, A. A.   Method for inductive prospecting, U. S. patent 2,642,477, granted June 16, 1953.   10 claims.

A radio frequency method of prospecting for ores employing amplitude modulation.

## ELECTRICAL PROPERTIES OF ROCKS AND MINERALS

14454.  Winsauer, W. O., and McCardell, W. M.   Ionic double-layer conductivity in reservoir rock: Jour. Petroleum Technology, v. 5, no. 5, p. 129–134, 1953.

The abnormal conductivity found in shaly reservoir rocks containing an electrolyte is shown to be a consequence of the electrical double layer in the solution adjacent to charged clay surfaces.   This increased conductivity results from a higher concentration of ions in the double layer than in the solution in equilibrium with the double layer.   It is shown that the magnitude of the increased conductivity of a shaly reservoir material is influenced by the concentration and type of ions in the equilibrium solution as well as by the nature of the rock.— *Authors' Abstract*

14455. Rust, C. F. Electrical resistivity measurements on reservoir rock samples by the two-electrode and four-electrode methods: Am. Inst. Min. Metall. Eng. Trans., v. 195, p. 217–224, 1952.

Experimental evidence is presented showing that reproducible formation resistivity factor measurements and resistivity index determinations on reservoir samples may be made utilizing either the two- or four-electrode methods. Equipment is described which permits the application of either technique to the core specimen without loss of time and with a minimum amount of effort. Since electrical resistivity measurements on reservoir rocks are important not only in electric log interpretations, but also in the study of fundamental rock parameters, it was considered desirable to compare the applicability of both techniques of resistivity measurement.—*Author's Abstract*

14456. Wyllie, M. R. J., and Gregory, A. R. Formation factors of unconsolidated porous media: Influence of particle shape and effect of cementation: Jour. Petroleum Technology, v. 198, no. 4, p. 103–110, 1953.

The literature reveals that scant attention has been paid to the systematic experimental determination of the formation factors of unconsolidated porous media. No experiments appear to have been made on the effect of increasing cementation on the formation factor of an initially unconsolidated porous medium. Measurements have accordingly been made of formation factors as a function of porosity for aggregates of spheres in the porosity range 12–56 percent and of cubes, cylinders, discs, and triangular prisms in the porosity range 30–45 percent. The results are examined in the light of the theoretical equations of Clerk Maxwell, Fricke, and Slawinski. Aggregates of unconsolidated spheres and beach sands have been artificially cemented with silica and the formation factor—porosity relationships determined. A theory is outlined which seeks to explain the results obtained and which postulates that formation factor and porosity data for unconsolidated sandstones may be used to determine the original porosity of the unconsolidated sands from which the consolidated sandstones were derived. It follows also that for consolidated sandstones $F = C\phi^{-k}$ where $F$ is formation factor, $\phi$ fraction porosity and $C$ and $k$ are constants.—*Authors' Abstract*

## METHODS OF ANALYSIS AND INTERPRETATION

14457. Trudu, Renato. Curve di resistività per i due strati con contatto piano inclinato rispetto alla superficie del suolo [Resistivity curves for two layers with plane contact slightly inclined with respect to the surface of the earth]: Riv. Geofisica Appl., v. 13, no. 2, p. 95–110, 1952.

The problem of two layers with different resistivities separated by a plane surface and inclined with respect to the surface of the earth is reconsidered, using the method of electrical images. The problem is solved for a general distribution of electrodes at the surface, particularly for the single-pole method. The characteristics and possibilities of different measuring procedures, with a constant base, or by expanding or rotating electrodes, are considered and it is shown that the variables in the problem in each case reduce to two which may be determined by the Tagg method. The extension of the method to electrode configurations other than that with a single pole is considered.—*M. C. R.*

14458. Thiele, H[einrich]. Geoelektrik in Beziehung zur Grundwasserchemie and Hydrologie [Geoelectric methods in relation to ground water chemistry and hydrology]: p. 16–31 *in* Die Wasseraufbereitung als wissen-

schaftliche Aufgabe und ihre praktische Ausführung, of Deutscher Verein von Gas-und Wasserfachmännern, Hannover, 1949.

This paper presents evidence to show that the chemical character of ground water and the underground topography and hydrologic properties of the sediment in which it occurs can be determined regionally from resistivity measurements with the aid of a few check borings and chemical analyses. (The term "sediment" is used here specifically to denote unconsolidated clastics). A fairly accurate estimate of the ground water resources of a given region can thus be made by geoelectric methods, where formerly a great number of borings would have been required for equal accuracy. Comments and questions from a number of individuals, and Thiele's answers to each are included. Many graphs and tables illustrate the arguments.—*D. B. V.*

14459.    Licastro, P. H., and Keller, G. V.    Resistivity measurements as a criteria for determining fluid distribution in the Bradford sand: Producers Monthly, v. 17, no. 7, p. 17–23, 1953.

Bradford sand cores were treated in such a manner as to make them hydrophobic in one case and hydrophilic in another. Experiments showed that above a critical value of water saturation, resistivity is proportional to the inverse square of saturation for water-wetted cores, and is proportional to the inverse tenth power of water saturation for nonwetted cores. Additional measurements on freshly taken cores showed that the Bradford sand in its natural state resembles the cores which had been made artificially non water-wet in the laboratory. It is concluded that the common practice of using the inverse square relationship between resistivity and water saturation to interpret electric logs may result in large errors.—*Authors' Abstract*

## ELECTRICAL SURVEYS AND WELL LOGGING

14460.    Buhle, Merlyn B.    Earth resistivity in groundwater studies in Illinois: Mining Engineering, v. 5, no. 4, p. 395–399, 1953.

For the past 20 years the Illinois Geological Survey has used resistivity surveys, chiefly in locating and outlining water-bearing sand and gravel to be used as sources of water supplies. Gish-Rooney instruments were used with the Wenner electrode configuration. Approximately 90 percent of the surveys were made in a 200-mile wide belt extending from east to west across central Illinois. Owing to the sharp electrical contrasts between sand and gravel deposits and glacial till, alluvial silt, or underlying shale, much of the work has been of a rather elementary nature. Four specific studies to illustrate the type of work are described.—*M. C. R.*

14461.    Thiele, Siegfried.    Die Geoelektrik in der Wassererschliessung—Eine kritische Stellungnahme [Geoelectrical methods in exploration for water—a critical attitude]: Bohrtechnik-Brunnenbau, Jahrg. 1, Heft 4, p. 98–104, 1950.

Application of geoelectric methods to ground-water exploration is limited because the quantity measured, the apparent resistivity, is actually a composite of at least four independent variables. Mathematically it is valid only if three of these are negligible, and in actual practice such cases are the exception, not the rule. Intensive research on the effects of these factors (textures, degree of saturation, chemical differences between connate water and ground water, resistivity of the rock without ground water) would be highly desirable.—*D. B. V.*

**14462.** Thiele, Heinrich. Erfolge und Grenzen der Geoelektrik in der Grundwasserforschung [Results and limitations of geoelectric methods in ground water prospecting]: Bohrtechnik-Brunnenbau, Jahrg. 2, Heft 7, 9 p., 1951.

The state of geoelectrical methods in ground-water exploration is reviewed, using detailed examples from Frankfurt am Main, north German glacial diluvium, and the North Sea marshes. Thiele then lists eight factors which limit their efficiency.

He concludes that geoelectric methods alone are reliable in determining depth, thickness, and extent of beds bearing or trapping ground water, in finding buried structures favorable for ground-water accumulation, in determining belts where a deposit is protected from contamination by a shallow clay cover, and in locating boundaries between salt water and sweet water. A combination of a few strategically placed borings with geoelectric methods guarantees a complete, trustworthy, and precise, as well as cheap, method of prospecting.—*D. B. V.*

**14463.** Thiele, H[einrich]. Stand der geoelektrischen Methoden in der Grundwassererschliessung—praktische Ergebnisse und Entwicklungsmöglichkeiten [State of geoelectrical methods in ground water prospecting—practical results and possibilities for development]: p. 33–58 *in* "Neuere Methoden der Grundwassererschliessung," Symposium of the Deutscher Verein für Gas- und Wasserfachmännern, in Hohensyburg bei Dortmund June 25–26, 1951, Hannover, 1952.

This is a discussion of the application of geoelectrical methods, in particular the Wenner and Schlumberger methods, to ground-water prospecting. After a thorough theoretical explanation, well illustrated by graphs and tables, Thiele gives very detailed examples of the results obtained in four areas.

These scientifically exact geoelectric methods have supplanted former, more theoretical methods in hydrology. For any particular ground-water occurrence there is a very definite relation between electrical and hydrological values; the specific resistance can be called a "hydrologic coefficient."

Criticisms by F. Hallenbach and E. Schenk indicate they believe that Thiele places too much reliance on geoelectrical data alone. Each cites examples to show how the same measurements can be produced by widely different sets of strata, and discusses the variables involved.

. Thiele, in reply, admits the existence of nine variables influencing specific resistance and permeability, but claims that his discussion is limited to saturated porous sediments, that he does advise control borings, and that such borings give very close agreement with electrical data, thus showing that the influences with which his critics are concerned are of no practical interest.—*D. B. V.*

**14464.** Bubnoff, Serge von. Hydrologie, geologische Struktur und elektrische Leitfähigkeit des Bodens in Norddeutschland [Hydrology, geologic structure, and electrical conductivity of the ground in northern Germany]: Deutschen Akad. Wiss. Berlin, Sitzungsber. Kl. math.-naturwiss., 1951, no. 1, 43 p., 1952.

During the years 1939–1944 numerous surveys using electrical resistivity methods were made in Pommern province, mostly in search of water. An interpretation of the results is presented and compared with the geologic evidence of the region which has been thoroughly studied. Many exploratory holes were drilled to check geophysical interpretations. Many profiles are given and compared with graphs made from the measurements.—*S. T. V.*

14465. Schouppé, Alexander. Elektrische Widerstandsmessungen zur Feststellung der Verbindungswege in Höhlengewässern [Electrical resistance measurements for determination of connecting passages in cavern waters]: Naturwiss. Ver. Steiermark Mitt., Band 81–82, p. 183–186, 1952.

To ascertain the presence or absence of underground connections between several adjacent streams of water in the cavernous region of Semriach, Styria, 800 kg of salt were dissolved in the main stream and the electrical resistivity measured in all of the streams during the following days. A temporary decrease of resistivity in one of the streams showed clearly the presence of such a connection. Difficulties in measurements were caused by the unavoidable polarization of electrodes.—*S. T. V.*

14466. Rao, M. B. Ramachandra. Self-potential anomalies due to subsurface water flow at Garimenapenta, Madras State, India: Mining Engineering, v. 5, no. 4, p. 400–403, 1953.

The occurrence of copper ores at Garimenapenta in Nellore district, Madras State has been investigated several times during the past two centuries, but no ore body has ever been found. The area was resurveyed between December 1949 and May 1950 using self-potential, resistivity, and magnetic methods. In much of the area, electrical-resistivity measurements revealed a highly conductive formation, later found to be the wet clays of the bed of a small reservoir, which had a resistivity of 0.7 ohm-meters in contrast to the resistivity of 20 to 30 ohm-meters of the sandy soil and more or less decomposed granitic gneisses. Self-potentials of +40 to 50 mv which were observed were not related to ore bodies but were caused by subsurface movement of ground water in the sands along the beds of narrow creeks and by the natural potential difference at the contact of wet clays and sands. Detailed measurements indicated that between the clay and sands there is a more or less constant electrical relationship, with the sands always possessing a higher potential. The magnitude of such potential anomaly is variable but small, not more than 20 mv. When the water in the sands occurring over the clays has a marked tendency to flow this potential difference is accentuated, increasing to 50 mv. The effect of streaming or electro-filtration potential then becomes preponderant. Model experiments confirmed this explanation in a qualitative way.—*M. C. R.*

14467. Wantland, Dart. Geophysical investigations for United States Atomic Energy Commission in the Colorado Plateau area: U. S. Bur. Reclamation Geol. Rept. G–119, 141 p., 1952.

Geophysical field investigations using the resistivity method and the potential-drop-ratio method were made from March 17 to May 16, 1952, at two localities, King Tutt Mesa and Bull Canyon, in order to test their usefulness in exploration for uranium deposits. The results indicate that the resistivity method can be advantageously employed in prospecting for uranium deposits in the area, but that subsurface conditions at Bull Canyon were not suitable for the successful use of the potential-drop-ratio method.—*S. T. V.*

14468. Kaneko, Jun. Electrical prospecting in the Shiraoi sulphur mine, Hokkaido [In Japanese with English summary]: Geol. Survey Japan Bull., v. 3, no. 4–5, p. 47–51, 1952.

Sulfur occurs in a pyroxene andesite both as impregnations and replacements. Drilling recommendations are made on the basis of self-potential and resistivity surveys.—*M. C. R.*

## SEISMOLOGY

### ELASTIC WAVES

14469.  Homma, S.  Initial value problem in the theory of elastic waves: Geophys. Mag., v. 23, no. 2, p. 145–182, 1952.

Formulas for the displacements at a time and point of the waves produced by given initial displacements and initial velocities are derived in a spherical coordinate system.  The problem may be divided into two types: one in which the radial component of rotation of the generated wave is zero, and the second in which the divergence of displacement of the generated wave is zero.  In the former there exist some faint movements between $P$ and $S$ though negligibily small.  In both, the forms of the generated waves are more complicated than the forms of the initial displacements.—$M. C. R.$

14470.  Newlands, M[argery].  The disturbance due to a line source in a semi-infinite elastic medium with a single surface layer: Royal Soc. London Philos. Trans., Ser. A, v. 245, no. 896, p. 213–308, 1952.

An investigation is made of the disturbance created by a cylindrical pulse (of $P$- and $S$-type) emitted from a line source in a surface layer of elastic material overlying a semi-infinite medium of different elastic constants and density.  An exact formal description of the motion is obtained in terms of a succession of pulses; the double integrals corresponding to each are evaluated by approximate methods.  It is found that at a remote point (at or near the surface) there should be felt pulses corresponding to travel by each one of the minimum-time-paths predicted by the ray theory, and, in addition, a whole series of diffraction effects.  Ray-path pulses are of the same type as the initial pulse, showing the same "jerk" in the displacements (or in the rate-of-change of these); diffraction pulses are in general "blunt," but certain of them become sharper as the surface is approached until, at the surface, they become part of a minimum-time-path disturbance.  The apparent $S$- and $Sg$-anomalies are considered in the light of these results.  At a certain range interference between pulses becomes important, and at very great range the dispersive Rayleigh wave-train becomes the dominant feature.  A further study of the propagation of free Rayleigh waves shows that an infinite number of modes of vibration are possible.  The degree to which each is excited and the resultant motion is determined; the importance of the Airy phases is demonstrated.  The pulse representation has a natural extension to systems of any number of layers; before the corresponding interference pattern at great range can be determined it will be essential to extend our knowledge of the dispersion of free surface waves to such multilayered systems.—$Author's Abstract$

14471.  Kanai, Kiyoshi.  On the $M_2$-waves (Sezawa waves): Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 1, p. 39–48, 1951.

Dispersion curves and displacement distributions have been calculated for several different assumptions of rigidity, density, and Poisson's ratio.  These indicate that $M_2$ waves can exist in the range of relatively small wave length when $v/v' \geq 1$ but cannot exist when $v/v' < 1$.  $M$ waves exist in all wave lengths when $v/v' \geq 1$.  When $v/v' < 1$, $M$ waves exist when the rigidity ratio $\mu'/\mu \leq 0.39$ and for relatively large wave lengths when $\mu'/\mu > 0.39$.  The motion in the $M_2$ waves is the same as that of gravitational waves; in $M$ waves the motion is that of the usual Rayleigh waves.  The distribution of displacements differs in the 2 waves.  There is a maximum of horizontal displacement having no nodal plane in the layer for $M_2$ waves, except for relatively small wave lengths, but no peculiarity exists for displacements of $M$ waves.—$M. C. R.$

14472.   Satō, Yasuo.   Travel-time of Love-waves *in*   Study on surface waves, pt. 7: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 4, p. 305–317, 1952.

Expressions are derived for the travel times of Love waves as well as for the critical distances of arrival.   Satō investigates the case of a single superficial horizontal layer above a semi-infinite medium when the focus is located respectively in and below the layer.   For the latter case it is shown that the travel time is independent of the depth of focus.   Two numerical evaluations are made resulting in a plot of the critical distance and arrival time as a function of the period.—*I. Z.*

14473.   Horton, C. W.   On the propagation of Rayleigh waves on the surface of a visco-elastic solid: Geophysics, v. 18, no. 1, p. 70–74, 1953.

The propagation of Rayleigh waves is examined for a visco-elastic Poisson solid ($\lambda = \mu$).   The behavior of the waves is characterized by a dimensionless parameter $\delta = \omega\eta/\mu$, where $\omega$ = angular frequency, $\mu$ = shear modulus, and $\eta$ = viscosity.   It is shown that internal friction does not produce a significant change in either the velocity or the shape of the earth-particle path for values of $\delta$ observed in geophysical prospecting.   The attenuation that is predicted is large enough to be observable.—*P. E. B.*

14474.   Duvall, Wilbur I.   Strain-wave shapes in rock near explosions: Geophysics, v. 18, no. 2, p. 310–323, 1953.

The shapes of displacement, velocity, acceleration and strain-wave pulses in solid elastic media near a spherical cavity in which the applied pressure pulse is of the form $\rho = \rho_0(e^{-\alpha t} - e^{-\beta t})$ have been calculated following the theoretical development by Joseph A. Sharpe.   The strain waves were measured by strain gages mounted in solid rock surrounding the charge.   The computed strain-wave pulse shapes at various distances from the cavity are compared with experimentally recorded strain-wave pulses.   As a result of these comparisons it is concluded that: for short distances between the charge and gage, both theory and observation show the radial strain-wave pulse to be nonoscillatory; the shape of the strain-wave pulse is a function of the rock type, applied pressure pulse and distance from the cavity; for distances close to the charge the average theoretical decrease of peak strain with distance is $r^{-1.5}$.   Experimentally the observed decay of peak strain with distance is between $r^{-1.6}$ and $r^{-2.5}$ for different rock types and different explosives; since the shape of the dilatation pulse is independent of distance, that quantity should be measured when considering the absorption properties of the rock.—*I. Z.*

14475.   Förtsch, O[tto].   Das Verhalten von Blattfederseismographen bei Freier und Erzwungener Schwingung [Response of the plate-spring seismograph to free and forced vibration]: Annali Geofisica, v. 5, no. 3, p. 321–356, 1952.

In continuing a work of Rössiger it is demonstrated as well by theory as by experiment that plate-spring seismographs are no simple vibration-system, but have two degrees of freedom and therefore two free vibrations that are very strongly coupled together.   Thereby two coupled frequencies result of the free vibration-periods.   The resonance-curve shows two resonance-points at these frequencies of which only the first one can be damped by the damping apparatus.   The experiments have demonstrated that the behavior of the plate-spring seis-

mograph is strongly influenced by any other charge and by the kind of fastening. By other charge the directive force can be increased or decreased. We approach best the ideal fastening of plate-springs and bars if we use at the analysis of free vibrations and static deflection fastening material with a velocity of sound as low as possible. Opposite, if there is used a fastening material of a velocity of sound as high as possible, the second coupled frequency is widely displaced to higher frequencies, which should be desired.—*Author's Abstract*

14476. Weber, Max. Theorie der Kombinationsseismographen [Theory of the combination seismograph]: Zeitschr. angew. Mathematik u. Physik, v. 4, fasc. 1, p. 57–81, 1953.

The combination seismograph consists of a mechanical seismometer combined with an electromechanical transducer and electronic amplifier with recorder. The electromechanical transducer transforms minute displacements of the vibrating element into electric impulses by corresponding changes of electrical capacities or by generation of voltages employing piezoelectric or magnetostrictive effects. Magnification is achieved by electronic amplification. The detailed theory of the mechanical movements of different parts of the seismometer is presented, followed by the discussion of the functioning of the transducer. Possibilities of measuring displacements, velocities, or accelerations with the described instruments are discussed. An extensive bibliography is included.—*S. T. V.*

### INSTRUMENTS AND METHODS OF OBSERVATIONS

14477. Kharin, D. A. O kachestve vibroizmeritel'nykh priborov s mekhanicheskimi i opticheskimi metodami registratsii [Characteristics of vibration-measuring instruments with mechanical and optical recording]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 14 (141), p. 69–78, 1952.

Twelve vibrometers constructed by German, British, American, and Russian manufacturers were tested and calibrated under various conditions. The results of the tests are presented in tables and graphs. This is followed by a critical discussion of individual instruments and analysis of their construction.—*S. T. V.*

14478. Gamburtsev, G. A. O vysokochastotnoy seysmometrii [High frequency seismometry]: Akad. Nauk SSSR Doklady, tom 88, no. 5, p. 787–790, 1953.

In recording earthquakes apparatus with very broad frequency range is commonly used. However, by using seismographs with a narrow band of response tuned to higher than usual frequency and the proper filters, it is possible to register even very weak waves in presence of strong ones of slightly different frequencies. It is also possible to eliminate the disturbing effect of microseisms. This procedure is advantageous both in seismic prospecting and in recording earthquakes at short epicentral distances.—*S. T. V.*

14479. Riznichenko, [Yu.] V., Ivakin, B. N., and Bugrov, V. R. Impul'snyy ul'trazvukovoy seysmoskop [Ultrasonic impulse seismoscope]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, p. 26–32, 1953.

For experiments on models of seismic phenomena an instrument has been designed which produces waves of ultrasonic frequencies in suitable media and makes possible the observation and recording at different points of the medium. The apparatus consists of the following parts: a vacuum tube generator which

produces very short electric impulses (4 to 20 microseconds) ranging in frequency from 2 to 50 cycles per second; and accompanying sinusoidal electric oscillations with frequencies of 100, 250, and 500 kilocycles per second for time marks; several piezoelectric emitters, made of crystals of Seignette's salt, producing mechanical impulses in the model, combined with similarly constructed piezoelectric geoscopes distributed over the body of the model; an amplifier and an oscillograph with photographic recording. A detailed description of the apparatus including an electrical wiring diagram is given. Examples of records obtained with the instrument are shown. (See Geophys. Abs. 13218 and 14317).—*S. T. V.*

14480.   Akima, Tetsuo. A torsion pendulum low-pass filter applied to the study of earthquake waves, Pt. 1: Tokyo Univ. Earthquake Research Inst. Bull., v. 26, pt. 1–4, p. 95–99, 1948.

This paper describes the theory, specifications, and operation of a mechanical filter designed to eliminate waves which mask the surface waves in seismograms of near earthquakes. A schematic diagram and photograph of the apparatus are included.—*D. B. V.*

14481.   Dennison, A. T. The design of electromagnetic geophones: Geophys. Prosp., v. 1, no. 1, p. 3–28, 1953.

Information on the theory and design of both moving-coil and variable-reluctance geophones is summarized. Equivalent electrical circuits used as analogues in the study of theoretical characteristics or as experimental substitutes in the testing of geophones are developed. Types of damping, degrees of damping, voltage sensitivity, choice of natural frequency, and choice of geophone mass are considered.—*W. J. D.*

14482.   Melamud, A. Ya. O kontrole chuvstvitel'nosti seysmicheskoy apparatury [Controlling the sensitivity of seismic equipment]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, p. 33–40, 1953.

When the correlation method is used in seismic prospecting or in seismologic investigations, it becomes imperative to adjust individual channels so that they have the same sensitivity. Discrepancies between various channels must not exceed 5–7 percent. At the same time it is often desirable to decrease the sensitivity because of disturbances caused by microseisms, or to increase it because of the necessity of using smaller charges of explosives.

Methods of changing the constants of the different parts of the equipment are discussed, as well as details of the wiring scheme. The most difficult task is the determination of and changing the constants of a seismograph, usually on a shaking table. Therefore the possibilities are discussed of changing the sensitivity of the setup with or without touching the seismograph.—*S. T. V.*

14483.   Suyehiro, S. Improvement of time accuracy in seismological observations: Geophys. Mag., v. 23, no. 2, p. 183–190, 1952.

Regulators to maintain uniform drum speeds and a system of making time marks from *JJY* time signals have improved the accuracy of observations in the seismological network of the Central Meteorological Observatory, Japan, to 0.1 sec.—*M. C. R.*

14484. Henderson, J. B. H., and Brewer, R. Core hole velocity surveys: Geophysics, v. 18, no. 2, p. 324–337, 1953.

A method of making velocity surveys in core holes has been developed, using a gun perforator with selective firing as the energy source. It is used in conjunction with electric well-logging equipment at a moderate additional cost. As many' as 40 shots can be made before reloading. A 4-channel seismic unit is used, with the automatic gain control removed and with less severe filtering than in conventional seismic equipment. Seismometers are placed at the surface at several distances from the hole. Near-surface velocity variations are determined from which seismic time errors may be easily computed. Data are presented for areas in northern Louisana, southern Arkansas, and North Dakota.—*L. C. P.*

14485. Lawrence, F. L. Time break recording in seismic prospecting, U. S. patent 2,641,749, granted June 9, 1953. 7 claims. Assigned to Standard Oil Development Co.

14486. Cruzan, C. G. Magnetostriction seismometer, U. S. patent 2,643,367, granted June 23, 1953. 6 claims. Assigned to Phillips Petroleum Co.

14487. Piety, R. G. Seismometer, U. S. patent 2,638,578, granted May 12, 1953. 20 claims. Assigned to Phillips Petroleum Co.

A capacitive seismometer.

14488. Doolittle, W. W. Marine seismic surveying, U. S. patent 2,638,176, granted May 12, 1953. 5 claims. Assigned to Stanolind Oil and Gas Co.

A method of lowering seismic detectors into water and detonating a charge while the detectors sink.

14489. Hasbrook, A. F. Seismic surveying, U. S. patent 2,640,186, granted May 26, 1953. 5 claims. Assigned to Olive S. Petty.

An apparatus for transmitting by radio and recording the seismic time break.

14490. Hasbrook, A. F. Seismic surveying, U. S. patent 2,640,187, granted May 26, 1953. 6 claims. Assigned to Olive S. Petty.

An apparatus for transmitting by radio and recording the seismic time break.

14491. Piety, R. G. Rotational seismometer, U. S. patent 2,637,839, granted May 5, 1953. 10 claims. Assigned to Phillips Petroleum Co.

14492. Loper, G. B., and Heaps, S. N. Vertical component low-frequency geophone, U. S. patent 2,636,160, granted April 21, 1953. 13 claims. Assigned to Socony-Vacuum Oil Co.

14493. Piety, R. G. Method of eliminating an undesired component of seismic waves, U. S. patent 2,634,398, granted April 7, 1953. 8 claims. Assigned to Phillips Petroleum Co.

A method of mixing seismic signals.

## METHODS OF ANALYSIS OF SEISMIC SURVEY DATA

14494. Kaufman, H[yman]. Velocity functions in seismic prospecting: Geophysics, v. 18, no. 2, p. 289–297, 1953.

The mathematical relations of 14 instantaneous-velocity—depth functions and 4 instantaneous-velocity—vertical-time functions used in seismic prospecting are described and tabulated. Depth and vertical-time functions are equivalent so a complete tabulation of the instantaneous-velocity—vertical-time functions is not included. Included for each instantaneous-velocity—depth function are corresponding functions for: average-velocity—depth, instantaneous-velocity—vertical-time, average-velocity—vertical-time, travel time from shot point to any point of path, displacement, vertical depth to any point of path, depth—vertical-time, surface-to-surface travel time, range and depth to maximum penetration. Any new function can be analyzed by the system presented.—*L. C. P.*

14495. Faust, L. Y. A velocity function including lithologic variation: Geophysics, v. 18, no. 2, p. 271–288, 1953.

Assuming velocity $(V)$ a function of depth $(Z)$, geologic time $(T)$, and lithology $(L)$, the resistivity log is an approach to the determination of $L$. Since general knowledge of water resistivity values $(R_w)$ is lacking, the values of true resistivity $(R_t)$ against $V/\alpha(ZT)^{1/6}$ were compared for 670,000 feet of section widely distributed geographically. Variations in $R_w$ were presumably averaged out thereby, and the results indicate that statistically $L=[R_t]/T$ and $V=1948\ (ZTL)^{1/6}$. This formula was applied to an additional 270,000 feet of section more localized geographically to observe its accuracy in predicting vertical travel time. If a correction map for $R_w$ variations is applied the results are encouraging but less accurate than good velocity surveys.

Examination of an inconclusively small amount of data with more careful measurements of $R_t$ suggests that accuracy comparable to direct measurement may be attainable. The co-operation of other investigators and of the electric-logging specialists is desired.—*Author's Abstract*

14496. Yepinat'yeva, A. M. Sostavleniye kart granichnykh skorostey seysmicheskikh voln [Construction of master charts for boundary velocities of seismic waves]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 2, p. 124–130, 1953.

The boundary velocity, the velocity of the seismic wave propagating along the boundary plane between two media, can be determined along profiles that are collinear with or perpendicular to the line of shots. The latter procedure is necessary in studying vertical stratification, but greater accuracy can generally be obtained from collinear profiles, especially when reverse travel-time curves are used. Expressions for this boundary velocity have been derived analytically; in the present paper graphic procedures for its determination are suggested and applied to two examples.

Yepinat'yeva points out that sometimes the observed boundary velocity may be not that of the wave refracted by the plane separating the formations, but that of a thin intermediate layer of high seismic velocity embedded in the upper formation. This ordinarily can be discovered by other seismic evidence.—*S. T. V.*

14497. Yepinat'yeva, A. M. Nekotorye voprosy interpretatsii poperechnykh godografov prelomlennykh voln pri nalichii vertikal'nykh granits razdela [Some questions related to interpretation of travel time curves of refracted waves obtained along the profile perpendicular to vertical boundary planes]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, p. 17–25, 1953.

When the medium through which seismic waves are propagated is stratified vertically, the shape of travel-time curves of refracted waves, taken along a line perpendicular to the plane of stratification, is different from the hyperbolic pattern obtained in horizontally stratified media characterized by constant velocities. Old methods for the determination of velocities do not yield accurate values. Theoretical analysis as well as experiments show that the effective values of the boundary velocity $V_b$ and the increase of the depth $\Delta h$ can be computed accurately enough if sections of the travel-time curves sufficiently remote from the boundary plane are used. Otherwise the values obtained are always lower than the true ones. The problem cannot be solved for a medium with several parallel vertical strata.—*S. T. V.*

14498. Richard, H. Réflexions multiples obliques [Oblique multiple reflections]: Geophys. Prosp., v. 1, no. 1, p. 49–63, 1953.

This is a discussion of several examples of the registration of multiple reflections and their possible interpretation. The material is drawn from surveys in Italy and southern France.—*M. C. R.*

14499. Meinhold, R. Über Mehrfach-Reflexionen in der Seismik [Concerning multiple reflections in seismic exploration]: Gerlands Beitr. Geophysik, Band 63, Heft 1, p. 59–70, 1953.

Multiple reflections (echoes) can considerably distort and falsify geologic evaluation. They occur especially at shallow variable surfaces with strong velocity contrasts. Strong echoes were observed during work over a salt dome in northern Germany, where the energy was reflected between the anhydrite cap, lying at a depth of 350 m, and the ground-water table. Formulas are derived for the time factor, for calculating the impulse time of echoes from the arrival time of the original reflection; also for the time gradients of echoes for both horizontal and inclined strata, under the assumption that the energy is multiply reflected between the reflector and the earth's surface. A practical example is calculated.— *Author's Abstract, D. B. V.*

14500. Contini, Camillo. Procedimenti pratici di calcolo delle superfici riflettenti nei rilievi sismici a riflessione [Practical procedures of computing reflecting surfaces in seismic reflection surveys]: Riv. Geofisica Appl., v. 13, no. 2, p. 111–149, 1952.

The equations of the seismic rays and of their transmission times are determined, assuming that the average velocity of the waves vary with depth according to a parabolic law, and that the said average velocity is equal to the ratio of distances to corresponding times. Formulas are developed to calculate the geometrical elements of the reflecting surfaces for two and three dimensions; corresponding charts are given, worked out for such velocities as occur in the middle area of the Po Plain. Formulas are derived to reduce the observed values in connection with the influence exerted by shot point displacement, by inclination of reflecting surfaces at right angles with the profiles and by the move out; charts thus obtained

are represented.   Two special calculating procedures are studied which make it possible to employ the charts with any other value of the constants in the velocity formula, these procedures applying to most formulas practically used.   A slide rule is described which makes it possible to plot the reflections with considerable accuracy and speed, the inclination data being known.—*Author's Abstract*

14501.   Haáz, István Béla.   Mesterséges rezgéshullámokat visszaverő síkfelütet térbeli helyzetének meghatározása [Determination of the reflecting plane in seismic reflection prospecting] (In Hungarian with summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 1, szám 6, p. 50–55, 1952.

When the shot-detector spread is perpendicular to the strike of the reflecting plane, the vertical plane containing this spread is perpendicular to the reflecting plane and contains the straight line of its maximum dip.   The reflecting plane is determined by this straight line, that is by its dip and angle $\gamma$, and its perpendicular distance $n$ from the shot point, or by $n$, and by the horizontal distance $d$ from the shot point to the point of intersection of the spread line and the dip line. The author shows that $1 : n^2$ and $1 : d$ satisfy a linear equation system containing as many equations as there are detectors in the spread.   This system gives for $1 : n^2$ and $1 : d$ a normal equation system by the method of the least squares from which these quantities and also their mean errors may be calculated.—*Author's English summary*

14502.   Goguel, Jean [M.].   Une règle pour lesc alculs des ismique-réfraction [A ruler for the calculation of seismic refraction] : Geophys.   Prosp., v. 1, no. 1, p. 44–48, 1953.

This describes the construction of a slide rule to solve problems in seismic refraction where the layers are horizontal or inclined at a small angle.—*M. C. R.*

14503.   de Caleya, Juan F., Closs, Hans, and Dürbaum, Hansjürgen.   Interpretación de resultados en el metodo sismico de reflexión, teniendo en cuenta el efecto de la refracción [Interpretation of the results of seismic reflection method taking into account the refraction effect]:   Minería y Metalurgia, no. 143, p. 22–25, 1953.

This is the Spanish text of the article in Erdöl and Kohle abstracted in Geophys. Abs. 14295.—*S. T. V.*

## METHODS OF ANALYSIS OF EARTHQUAKE OBSERVATIONS

14504.   Kogan, S. D., and Malinovskaya, L. N.   Paletki dlya opredeleniya dinamicheskikh parametrov ochagov zemletryaseniy [Master charts for the determination of the dynamic parameters of the foci of earthquakes]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 2, p. 131–140, 1952.

The dynamic characteristics of the initial shock at the focus of an earthquake have been studied analytically by both V. I. Keylis-Borok and A. V. Vvedenskaya (see Geophys. Abs. 12549, 12935, 13847, and 14035) who derived related formulas.   In view of the cumbersome calculations involved, Kogan and Malinovskaya have worked out a number of master charts and graphs to facilitate the determination of the forces and moments producing the initial shock from the records of surrounding seismograph stations.   Five master charts, corresponding to different positions of the epicenter with reference to the point of observation, are given, as well as auxiliary graphs illustrating the use of the charts.—*S. T. V.*

## OBSERVATIONS OF SEISMIC WAVES

14505. Lehman, I. $P$ and $S$ at distances smaller than 25°: Am. Geophys. Union Trans., v. 34, no. 3, p. 477–483, 1953.

A study was made of the $P$- and $S$-phases of three European earthquakes as recorded at distances up to about 25°. One of the earthquakes occurred at a depth of about 275 km. It was well recorded at distances around 20° where the $P$- and $S$-curves were found to bend gradually and have only one branch. There is, therefore, no abrupt change of velocity at the 20° discontinuity. The second earthquake studied was shallow; the third one probably had its focus at the base of the crust. The behavior of $P$ and $S$ was explained on the assumption of the existence of a "soft," low-velocity layer at some depth below the Mohorovicic discontinuity.—*Author's Abstract*

14506. Caloi, P[ietro], and Marcelli, L. Onde superficiali attraverso il bacino dell'Atlantico [Surface waves through the Atlantic basin]: Annali Geofisica, v. 5, no. 3, p. 397–407, 1952.

The basin of the Atlantic Ocean, at least with respect to the transmission of surface waves, is similar to that of the Pacific. On the basis of Jeffreys' hypothesis, which considers the second layer to be heterogeneous, the dispersion curves of transverse surface waves from the earthquake of April 24, 1947, indicate a thickness of the second layer of 19 km.—*M. C. R.*

14507. Honda, Hirokichi, and Watanabe, Hideo. A remark on the amplitude of the initial motion of very shallow earthquake: Tōhoku Univ. Sci. Repts. 5th ser., v. 4, no. 2, p. 94–97, 1952.

The amplitude of the initial motion to be observed within 1,000 km of an epicenter has been calculated on the basis of Hirono's theoretical investigation and taking into account the heterogeneity of the crust. Observed amplitudes of initial waves from the North Idu and Fukui earthquakes were in good agreement with calculated values.—*M. C. R.*

14508. Imbò, Giuseppe, and Casertano, Lorenzo. Profondità ipocentrali e coefficienti di assorbimento per zone Etnee [Focal depths and coefficients of absorption in the Etna region]: Geofisica Pura e Appl., v. 22, fasc. 1-2, p. 42–52, 1952.

The focal depth and coefficient of absorption have been determined for a number of volcanic earthquakes on the east slope of Etna. By applying a modified Kovesligethy formula to 17 earthquakes observed between 1889 and 1931, Imbò and Casertano find that the focal depths range from 0.1 to 2.5 km and that the coefficient of absorption varies from 0.03 to 0.35. They propose the following equation for the variation of the coefficient of absorption($\alpha$) with depth($x$): $\alpha(x) = 0.27e^{-3.5x}$.—*S. T. V.*

14509. Howell, Lynn G., Neuenschwander, E. F., and Pierson, A. L., III. Gulf coast surface waves: Geophysics, v. 18, no. 1, p. 41–53, 1953.

Records of surface waves were made with a three-component velocity seismometer, a long-period displacement seismometer, six dynamic seismometers, an air-actuated condenser microphone, and a vertical strain seismometer. Wave trains were recorded similar to those obtained by B. F. Howell in California (Geophys. Abs. 11822).

The motion was divided into two trains, the second of which was readily identifiable as a Rayleigh wave from the particle motion. A dispersion analysis of this train shows that it begins with a long period which subsequently beats with a shorter period arrival. The two then begin to unite in phase and period to form the large amplitude train, which has been called the Airy phase by Pekeris and Ewing. An application of the theoretical curves of Kanai to the data, with certain assumptions, suggests that the local surface layer is about 50 feet thick.

The earlier wave train seems to have properties of the $M_2$ wave of Sezawa. The particle motion is direct and the vertical motion falls off with depth. An air-coupled wave immediately following the arrival of the sound wave was associated with the $M_2$ wave. There was a strong contrast in amplitude for the air pressure recording of the $M_2$ wave and the Rayleigh wave, and in fact the air wave was just discernible for the Airy phase of the Rayleigh wave. A large spread in periods of the air-coupled wave was apparent, and there is evidence that air waves are generated over a broad range of phase velocities of ground waves. The data were somewhat limited by the short-period response of the seismometers.—*P. E. B.*

14510.  Howell, Lynn G., and Kean, C. H.   Note on wave-guide propagation over a shallow salt dome: Geophysics, v. 18, no. 2, p. 338–339, 1953.

Tests over the Hawkinsville salt dome show evidence of wave-guide propagation. The first-arriving wave train has a low frequency and a high group velocity. The large amplitude beginning of the high-frequency wave train exhibits a group velocity of about the velocity of sound in water, probably that of the shallow water table.—*L. C. P.*

## EARTHQUAKE OCCURRENCES AND EFFECTS

14511.  Bremner, P. C.   The Dominion Observatory seismic station at Resolute Bay, North West Territories: Dominion Observatory Ottawa Pubs., v. 16, no. 2, p. 63–80, 1952.

During the sumner of 1950 a seismic station was installed at Cornwallis Island, Resolute Bay at 74° 41′ N lat, 94° 54′ W long. The station is equipped with Sprengnether long-period horizontal seismometers and a short-period vertical instrument. A description of the station is given and the scope of immediate investigations, including studies of near earthquakes in the eastern Arctic islands, of microseismic disturbances, and of the properties of permafrost.—*S. T. V.*

14512.  Byerly, Perry.   California earthquakes: New York Acad. Sci. Trans., ser. 2, v. 15, no. 1, p. 6–8, 1952.

This is a philosophical discussion of great California earthquakes and the relation of earthquakes to faulting. Both macroseismic and instrumental observations are considered. The surface layering of the earth and the vicissitudes of ideas concerning it during the past 40 years are also mentioned. — *M. C. R.*

14513.  Silgado F., Enrique.   Datos sismológicos del Perú 1951 [Seismological data for Peru 1951]: Perú Inst. Geol. Bol. no. 8, 30 p., 1953.

In 1951, 86 earthquakes were reported felt in various parts of Peru. The actual number was undoubtedly much greater. The shocks which were recorded are tabulated for each month under the headings of location, time, intensity, and remarks. The earthquake of January 31, one of the strongest, is described in detail.—*D. B. V.*

14514. Silgado F., Enrique, Fernandez Concha, Jaime, and Ericksen, G. E. El terremoto del Cusco del 21 de Mayo de 1950 [The earthquake of Cusco of May 21, 1950] *in* Datos sismológicos del Perú 1949–1950: Perú Inst. Geol. Bol. no. 4, p. 29–46, 1952.

The earthquake of May 21, 1950, was an intensity 7 and caused great destruction in the city of Cusco, where 394 persons were killed and injured. Extensive damage is attributed to the poor condition of buildings; modern structures built of reinforced concrete were not severely damaged. The greatest destruction was to buildings situated on alluvial water-saturated gravel. The earthquake was recorded by many observatories, the nearest being Huancayo. From seismograms the focal depth was found by the Gutenberg-Richter formula to be 8.6 km. The earthquake was of tectonic origin.—*S. T. V.*

14515. Silgado F., Enrique. El sismo del 9 de Diciembre de 1950 [The earthquake of December 9, 1950] *in* Datos sismologicos del Perú 1949–1950: Perú Inst. Geol. Bol. no. 4, p. 47–51, 1952.

The earthquake of December 9, 1950 was felt over an area of about 500,000 sq km. This, together with the absence of surface waves, is an indication of deep focus. The depth was determined by the Pasadena station to be 70–300 km. The magnitude of the earthquake was 7 ($10^{24}$ ergs); the intensity in many localities was 6 on the modified Mercalli scale. The Huancayo instruments recorded only the first phase, being thrown off scale by the violence of following shocks. A map of the region showing isoseismal lines is included.—*S. T. V.*

14516. Berg, Helmut. Das Rheinlandbeben bei Euskirchen vom 14 März 1951 [The earthquake near Euskirchen in the Rhineland on March 14, 1951]: Geofisica Pura e Appl., v. 24, p. 57–67, 1953.

From seismograms of 14 European seismograph stations, the epicenter was determined as 50°47′ N lat, 6°5′ E long, (the same as that of the earthquake of March 8, 1950); origin time as $9^h47^m58.8^s \pm 0.3$; and the depth of focus about 25 km (much deeper than that of the 1950 shock). Two shocks were observed, 7 sec apart. The intensity near the epicenter was 8 on the Mercalli-Cancani-Sieberg scale. The velocity of the $P_n$ wave was found to be 7.64 kmps, of $S_n$ wave 4.49 kmps. Corresponding velocities in the 1950 earthquake were 8.30 kmps and 4.86 kmps. No explanation for these differences can be suggested.—*S. T. V.*

14517. Galanopulos, A. G. Die Seismizität der Insel Leukas [The seismicity of the Levkás Island]: Gerlands Beitr. Geophysik, Band 62, Heft 4, p. 256–263, 1952.

After a brief review of the geology of the island an account is given of 31 earthquakes since 1469 in different parts of the island. Special attention is given to the 2 recent destructive earthquakes of April 22 and June 30, 1948. Seismotectonic considerations on the different earthquakes are presented, and their probable foci and geologic causes indicated. A full analysis of seismotectonic conditions will be undertaken in subsequent studies.—*S. T. V.*

14518. Galanopulos, A. G. Die Seismizität der Insel Leukas II. Die Erdbeben vom 22 April und 30 Juni 1948 [The seismicity of Levkás Island. Pt. 2. The earthquakes of April 22 and June 30, 1948]: Gerlands Beitr. Geophysik, Band 63, Heft 1, p. 1–15, 1953.

This is a continuation of the study of 2 destructive earthquakes on Levkás [see Geophys. Abs. 14517]. Detailed information is given, with photographs, on the

destruction. The intensity, felt area, and epicenter of each are discussed and shown on maps. From isoseismal maps and data from Strasbourg and the Jesuit Seismological Association, the foci are located at intersections of faults. Although according to the Cleveland observatory the focal depth was about 25 km, macroseismic evidence seems to indicate that about 16 km might be more nearly correct.— *D. B. V.*

14519. Poisson, Charles. Une zone séismique de l'océan Indien meridional [A seismic zone in the southern Indian Ocean]: Acad. Malgache Bull., tome 29, p. 94–96, 1952.

From analysis of 14 shocks for which complete data are available from local as well as distant observatories, Poisson concludes that a seismic zone lies under the Indian Ocean between latitude 33° and 34° S. and longitude 57° and 59° E. It was formerly believed that these submarine earthquakes came from a single epicenter. They seem to be of rather shallow origin. Attention is drawn to seemingly systematic retardation of elastic waves from these shocks (about 3 sec in 1,900 km).—*D. B. V.*

14520. Kishinouye, Fuyuhiko, and Kotaka, Mieko. A statistical investigation of conspicuous earthquakes in Japan during the period 1933–1943: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, p. 110–114, 1950.

Geographic and time distributions of conspicuous earthquakes in Japan from 1933 to 1943 were investigated statistically. Using the chi-square test, monthly numbers of earthquakes were shown to be distributed normally or at random. Time intervals and distances between successive shocks were also considered.— *M. C. R.*

14521. Kawasumi, Hirosi. On the energy law of occurrence of Japanese earthquakes: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 4, p. 319–323, 1952.

Kawasumi presents the formulas by means of which he calculated the magnitudes $(M_k)$ of all normal earthquakes occurring in Japan from 1885 to 1943. The magnitudes of those whose epicenters were accurately determined are plotted on a map. Analysis of statistics for magnitudes 4–8 leads to the conclusion that the number of Japanese earthquakes diminishes according to the law $N \propto 10^{-0.5 M_k}$.—*D. B. V.*

14522. Kawasumi, Hirosi. Energy law of earthquake occurrences in the vicinity of Tokyo: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 4, p. 325–330, 1952.

This extends the work of the companion paper [Abs. 14521] to include earthquakes of smaller magnitude in the vicinity of Tokyo, where more complete data were available. A similar law is found to apply, showing that it is not of limited regional validity.—*D. B. V.*

14523. Ikegami, Ryōhei, and Kishinouye, Fuyuhiko. The acceleration of earthquake motion deduced from overturning of the gravestones in case of the Imaichi earthquake on Dec. 26, 1949: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, p. 121–128, 1950.

Actual dimensions of height and width are important in determining intensity of earthquakes from overturning of gravestones; if merely the ratio between height

and width is used, it leads to underestimation. If $W_G$ is the work done in moving the center of gravity of a column, and $W_D$ work done in motion of the ground, overturning results when $W_G < W_D$ but not when $W_G > W_D$. Applying this to data from the Imaichi earthquake, the acceleration of the main shock is computed as 912 gals at Kawara-machi in Imaichi-machi, and 949 gals in the vicinity of Shimo-Imaichi station. Although these seem high in the light of other kinds of damage, it is explained that wooden houses were spared because the periods of ground motion were short and large amplitudes were damped out quickly.— *D. B. V.*

14524. Hodgson, J. H., and Bremner, P. C. Direction of faulting in the Ancash, Peru, earthquake of November 10, 1946, from teleseismic evidence: Seismol. Soc. America Bull., v. 43, no. 2, p. 121–125, 1953.

From the distribution of first motion at 46 stations, the movement at the focus was along a fault striking N. 45° W. and dipping 71° northeast. The motion was transcurrent, with the Pacific side moving south and slightly underthrusting the continental side. The surface displacements observed by Silgado (see Geophys. Abs. 12757) were apparently a secondary effect.—*M. C. R.*

14525. Toperczer, M[ax]. Zur Definition der Seismizität [On the definition of seismicity]: Archiv Meteorologie, Geophysik und Bioklimatologie, Ser. A, Band 5, Heft 4, p. 377–385, 1953.

Following a short historical survey, Toperczer proposes an absolute definition of seismicity based on seismic energy, which is determined by the magnitude. However, as the values of magnitude are not available for earlier observations, it is suggested that the easily calculated product of intensity and extent of the felt area be used as a measure of relative seismicity. Sources of seismic energy can be calculated from surface density and frequency by Renqvist's method. To predict earthquakes, however, the records of at least 20–25 years must be analyzed; the earthquake risk for a given region can be defined only as the probability that a destructive earthquake will occur within a particular space of time.—*D. B. V.*

14526. Kanai, Kiyoshi. On the damages to buildings due to earthquakes: Tokyo Univ. Earthquake Research Inst. Bull., v. 25, pts. 1–4, p. 61–64, 1947.

By mathematical treatment of the problem, Kanai shows that earthquake damage to buildings is not entirely caused by transient vibrations, but is due partly to a secondary condition caused by the vibrations, namely, unequal settling of the foundation.—*D. B. V.*

14527. Shimozuru, Daisuke. Change of the ground-water level due to the Imaichi earthquake: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, p. 129–132, 1950.

During January 1950, daily observations were made of the water level in a number of wells in the vicinity of Imaichi. Except at Itaga, the water level dropped, reached a minimum, and then began to rise but did not attain preearthquake levels by the end of the month. Data of barometric pressure and rainfall indicate meteorological conditions did not play an important role. No explanation of the phenomena can be advanced at present.—*D. B. V.*

14528. Kanai, Kiyoshi, and Yoshizawa, Shizuyo. Distribution of suffered frequency of earthquake damage to house in Japan [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pt. 1–2, p. 167–173, 1950.

Data on earthquakes in Japan during the 1,350 years from 599 to 1948 show that the damage by earthquakes to Japanese-style wooden houses depends not only on the passive seismicity number but also largely on the nature of the surface layer of the earth.—*D. B. V.*

14529. Miyamura, Setumi. Tertrema movado kaj kvalito de grundo ĉirkaŭ la urbeto de Gobo, Wakayama prefekto [Earthquake movement and character of the ground around the town of Gobo, Wakayama prefecture] (in Esperanto): Tokyo Univ. Earthquake Research Inst. Bull., v. 26, pts. 1–4, p. 101–104, 1948.

Essentially this is a restatement of the paper by Sakuma [Geophys. Abs. 12405] in the same bulletin, with more emphasis on geology of the area, but including less seismographic data.—*D. B. V.*

## SEISMIC SURVEYS

14530. García Siñeriz, José. Memoria General 1951: Inst. geol. y min. España, 79 p., 1952.

Geophysical work during 1951 included seismic prospecting for potassium salts, prospecting for water in two regions and an investigation of a carboniferous deposit. Several gravimetric surveys with the Nørgaard gravimeter were also made.—*S. T. V.*

14531. Baum, Robert B. Oil and gas exploration in Alabama, Georgia, and Florida: Geophysics, v. 18, no. 2, p. 340–359, 1953.

The discovery of the Pollard oil field in southern Alabama in January 1952 sparked a campaign of exploration in southern Alabama, southern Georgia and Florida. The area of these southeastern states compares favorably with that of Texas and, except for the relatively thin sedimentary section in Georgia, there is a large volume of sediments and other conditions favorable to the accumulation of oil and gas. The pace of geophysical exploration is accelerating appreciably; in particular, the reflection seismograph is coming into greater use. Thorough testing of this instrument is just beginning and favorable results are being obtained. In the earlier work, particularly prior to 1948 when the gravity meter was used more extensively, seismograph results were poor in many places because of unfavorable surface conditions. Refraction seismic methods are being used in Florida with some success. Geophysical methods contributed to the discovery of the Sunniland field, Florida, in November 1943; the Gilbertown field, Alabama, in February 1944; and the South Carlton field, Alabama, in May 1950.—*L. C. P.*

14532. Melchior, Louis F. The geophysical discovery and development of the Bayou Couba Dome: Geophysics, v. 18, no. 2, p. 371–382, 1953.

The Bayou Couba salt dome was discovered in March 1928 by refraction fan shooting. Prior to the completion of the discovery well by the Gulf Refining Co. in September 1942, reconnaissance and detailed gravity, reflection-seismograph and refraction-seismograph surveys were conducted to obtain more detailed information on the dome. A radial-refraction seismograph survey, with geophones placed in wells, was conducted following the completion of the discovery well.

The location and size of the dome was shown quite accurately by the earlier geophysical work, but the complex faulting could not be mapped by the reflection work. The outline of the dome as determined from the radial-refraction shooting agreed reasonably well with the outline established by drilling.—*L. C. P.*

14533. Bolinger, John W. History of the Imogene oil field, Atascosa County, Texas: Geophysics, v. 18, no. 2, p. 360–370, 1953.

In September 1942 the discovery well of the Imogene oil field brought in the first Edwards production in southwest Texas. The original lease was taken by the Humble Oil and Refining Co. after a fault was found in 1935 by surface geologic mapping. Although the reflection seismograph cannot be credited with the discovery, it played an important role in the development of the field. The first reflection seismic "spot shooting", in 1940, accurately delineated the subsurface structure. Following the discovery, detailed reflection seismic work was done. It proved to be extremely useful in locating small faults that were not found by drilling.—*L. C. P.*

14535. Gálfi, János. A levegőben robbantás módszerének alkalmazása a hazai szeizmikus kutatásban [Application of airshot-method in seismic explorations in Hungary] (In Hungarian with summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 1, szám 11, p. 89–101, 1952.

Experiments were made in Hungary on different phases of seismic shooting with charges suspended in the air at certain height over the ground. Results obtained are presented in tables and graphs of seismograms. On the whole previous experiences with this method of shooting were confirmed, except that no functional relationship could be found between the frequency of the seismic waves and the distance between the charges.—*S. T. V.*

## MICROSEISMS

14535. Båth, Markus. The problem of microseismic barriers with special reference to Scandinavia: Geol. Fören. Stockholm Förh., Band 74, Häfte 4, p. 427–449, 1952.

Studies of microseisms recorded at Bergen, Uppsala, and Copenhagen show that the fault limiting Fennoscandia in the west along the coast of Norway and west coast of Sweden does not act as a microseism barrier. It is suggested from theoretical considerations that geologic structures with free periods equal to or close to the periods of microseisms may also act as microseismic barriers.—*M. C. R.*

14536. Donn, William L. A comparison of microseisms and ocean waves recorded in southern New England: Am. Geophys. Union Trans., v. 34, no. 3, p. 471–476, 1953.

Records of ocean waves and microseisms were compared for two periods of very high waves off southern New England. Only weak short-period microseisms, slightly above normal background, were observed. In a third period an intense microseism storm developed, following similar conditions, as a cold air mass moved offshore; this suggests that pressure fluctuations in such an air mass are the generating mechanism.—*M. C. R.*

## RADIOACTIVITY

## INSTRUMENTS AND METHODS OF OBSERVATION

14537. Hess, Victor F. On the ionization produced by gamma radiation from the ground and from the atmosphere: Jour. Geophys. Research, v. 58, no. 1, p. 67–72, 1953.

Two methods of determining ionization produced by gamma radiation from radioactive substances in ground and air are discussed: the "absorption method," using lead shielding 1 cm thick of cylindrical shape but open at top around a portable ionization chamber; and the "well method," using annular iron shielding 10 cm thick around the chamber. Empirical measurements do not in general agree with theoretical calculated values but do permit establishing an empirical value for the absorption coefficient for 1-cm lead shielding of $\mu = 0.98$ cm$^{-1}$.— *F. W. S.*

14538. McInnes, D. W. Detection of radioactive minerals: Min. and Geol. Jour., v. 4, no. 6, p. 11–13, 1952.

Descriptions of the Geiger-Müller counter and scintillometer are given, with instructions for their use and maintenance. Wiring diagrams are included.— *S. T. V.*

14539. Eichholz, G. G., Hilborn, J. W., and McMahon, C. The determination of uranium and thorium in ores: Canadian Jour. Physics, v. 31, no. 3, p. 613–628, 1953.

The application of various physical methods to the assay of uranium and thorium in ores is discussed. It is shown how it is possible to determine their uranium and thorium content by means of simultaneous measurement of their beta and gamma activities. Simple working equations are derived which permit this determination to be carried out irrespective of the equilibrium condition of the uranium in the sample. Suitable experimental equipment is described briefly and some typical experimental results are presented.—*Authors' Abstract*

14540. Peirson, D. H. Alpha-particle assay and the measurement of the thorium-uranium ratio in radioactive ores: Phys. Soc. London Proc., ser. B, v. 64, no. 10, p. 876–888, 1951.

The measurement of the alpha-particle activity of a "thick" radioactive source containing the natural radioactive series is discussed critically. Two methods of determining the Th/U ratio are considered for use in ore or mineral assay. The energy discrimination method is simple in procedure and can take account of lack of secular equilibrium between members of a series in the radioactive sample. The beta-alpha coincidence method, making use of the difference in the disintegration constants of radium C' and thorium C', is more complicated. Initial experimental verification of the theory has been obtained. The estimated statistical error in determining the thorium-uranium ratio by the energy discrimination method is $\pm 5$ percent in the region of Th/U $= 1$, with a 4 percent sample ($U_3O_8$ equivalent concentration) in 4 minutes counting. A similar accuracy is obtainable in the coincidence method with a counting period 10 times greater.— *Author's Abstract*

14541. Scotty, C. B. and Egan, E. F. Neutron derived porosity-influence of bore hole diameter: Am. Inst. Min. Metall. Eng. Trans., v. 195, p. 203–206, 1952.

The neutron-gamma log has been used for stratigraphic correlation by the oil industry for a number of years. In the past few years, the quantitative application of the log to provide information with respect to porosity has received considerable attention. The basic concept of quantitative interpretation has been pointed out in the literature. It shall be the purpose of this paper to develop by empirical means a method whereby the relationship of porosity to neutron-gamma deflection may be predicted for various bore hole diameters. This relationship is applicable to the present commercially available neutron-gamma log run in open hole. Data available at present are insufficient to establish similar correlations for cased holes. Through the development of such a correlation, the importance of the various factors which influence the log become evident.— *Authors' Abstract*

14542. Scherbatskoy, S. A. Radiation detecting device, U. S. patent 2,639,390, granted May 19, 1953. 4 claims.

A gas-filled, discharge-chamber type radiation counter.

14543. Jakobson, M. J. Fast counting circuit. U. S. patent 2,636,993, granted April 28, 1953. 6 claims. Assigned to the United States of America as represented by the U. S. Atomic Energy Commission.

An improved electronic scintillation counter.

14544. Shonka, F. R. Pocket radiation meter. U. S. patent 2,634,374, granted April 7, 1953. 7 claims. Assigned to United States of America as represented by the U. S. Atomic Energy Commission.

### ISOTOPE STUDIES AND AGE DETERMINATIONS

14545. Ingerson, Earl. Non-radiogenic isotopes in geology. A review: Geol. Soc. America Bull., v. 64, no. 3, p. 301–374, 1953.

This review "attempts to give a complete account of the significant work that has been done on fractionation in nature of isotopes whose present relative abundance cannot have been affected by production or disintegration of radioactive isotopes." Two parts cover a summary of results to date and a discussion of typical current and future problems. An extensive bibliography is included.— *M. C. R.*

14546. Jensen, Mead LeRoy. The geologic importance of variations in stable isotopic abundances: Econ. Geology, v. 48, no. 3, p. 161–176, 1953.

This is a brief review of the subject of isotopic abundances, particularly the lighter elements and their stable isotopes, and their applications in the field of economic geology. Suggestions of further investigations are made.—*M. C. R.*

14547. Noetzlin, J. La mesure des rapports isotopiques et ses applications possibles à la volcanologie [The measurement of isotope ratios and their possible applications to volcanology]: Bull. volcanolog. sér. 2, tome 12, p. 115–125, 1953.

Isotope ratios of hydrogen and sulfur of volcanic origin were measured spectrometrically. Juvenile water in a Permian retinite from Meissen and 5 hot mineral

waters from Auvergne showed a normal hydrogen/deuterium ratio of 1/5,000. The $S^{32}/S^{34}$ ratio was determined for 3 sulfurs of direct volcanic origin, 2 of hydrothermal origin, and 1 pyrite. Analysis of these results and those of Thode at MacMaster University shows greater deviations from normal in sulfur of nonvolcanic origin, whereas that of volcanic origin gives ratios similar to sulfur in meteorites and thus probably to that of the earth's interior.

Noetzlin recommends systematic study of the isotope ratios of sulfur and other light elements, such as carbon, boron, and chlorine. As the phenomenon of volcanic eruption is too rapid for the isotopic exchange in an element to reach equilibrium, a geologic thermometer for eruptions on this basis is not feasible, but data obtained should provide information on the state of matter in deep magmas.—*D. B. V.*

14548.    Craig, Harmon.   The geochemistry of the stable carbon isotopes: Geochimica et Cosmochimica Acta, v. 3, no. 2/3, p. 53–92, 1953.

New mass spectrometric determinations of variations in the $C^{13}/C^{12}$ ratio of several hundred samples of carbon from various geologic sources confirm previous work with a few exceptions. The chief differences are the marked division of organic carbon samples into marine and terrestrial groups and the heavier results for atmospheric $CO_2$. Carbonates show a range of isotopic composition greater than any other group except the graphites, but do not show an age effect. The origin of graphite cannot be determined from $C^{13}/C^{12}$ ratios. Data on the dolomite problem are insufficient, but the use of carbon isotope studies does not seem promising.—*M. C. R.*

14549.    Aldrich, L. T., Herzog, L. F., Doak, J. B., and Davis, G. L.   Variations in strontium isotope abundances in minerals.   Pt. 1, Mass spectrometric analysis of mineral sources of strontium: Am. Geophys. Union Trans., v. 34, no. 3, p. 457–460, 1953.

Procedures have been devised to permit isotopic analysis of strontium samples of 50 micrograms with a precision of the order of 0.5 percent. Variations in the ratio $Sr^{86}/Sr^{88}$ in celestite, feldspar, and micas range from 0.1160 to 0.1220. It has not been possible to correlate this variation with either inferred geologic age or any component in any of the minerals.—*M. C. R.*

14550.    Herzog, L. F., Aldrich, L. T., Holyk, W. K., Whiting, F. B., and Ahrens, L. H.   Variations in strontium isotope abundances in minerals.   Pt. 2, Radiogenic Sr [87] in biotite, feldspar, and celestite: Am. Geophys. Union Trans., v. 34, no. 3, p. 461–470, 1953.

Mass spectrometric analysis of Sr concentrates from biotites, phlogopite, muscovites, feldspars, and celestites show that variations exist in the relative abundance of Sr [87]. Biotites contain up to 12 percent radiogenic Sr and should prove useful for geologic age determinations. Certain ancient feldspars, of age greater than 1,500 million years, containing negligible amounts of Rb, yield Sr [87]/Sr [88] ratios less than 2.5 percent smaller than that for a geologically young strontium standard. The celestite samples analyzed show even smaller deviations from the standard Sr [87] abundance. These analyses strongly indicate that the source material from which these crystalline rocks were derived had a Sr/Rb ratio larger by factors of five and ten, respectively, than those now accepted for average surface igneous rock or granite, but similar to those found for basalt, or chondritic material. The present limited data favor a basalt-like ratio; further work using well-dated samples is planned to narrow the permissible range of compositions and make a choice of source material possible.—*Authors' Abstract*

14551. Kulp, J. L., and Volchok, H. L. Constancy of cosmic-ray flux over the past 30,000 years: Phys. Rev., v. 90, no. 3, p. 713–714, 1953.

The constancy of cosmic-ray flux can be proven roughly over the past 4,000 years by comparing $C^{14}$ age measurements with historical data. Kulp and Volchok have dated layers of mud in a deep-sea core by the $C^{14}$ method and then redated the same specimens by the $Th^{230}$ (ionium) method. They show that the cosmic-ray flux has not varied by more than 10–20 percent over the past 35,000 years.—H. F.

## RADIOACTIVITY OF ROCKS, WATER, AIR

14552. Barbera, L., Curatolo, M., Indovina Addario, M. M., and Santangelo, M. Studio della radioattività delle lave dell' Etna col metodo delle emulsioni nucleari [Study of the radioactivity of Etna lavas by nuclear-emulsion method]: Annali Geofisica, v. 5, no. 4, p. 603–611, 1952.

The radioactivity of 4 specimens of lavas from different eruptions of Etna (a prehistoric eruption, and eruptions of 1351, 1669, and 1928) was determined by the photographic method. It is concluded that the average radioactivity of the samples does not change with the date of eruption, and is about 5 to $6 \times 10^{-4} \alpha$ per cm² per sec.—S. T. V.

14553. Hurley, P. M. and Fairbairn, H. W. Alpha-radiation damage in zircon: Jour. Applied Physics, v. 23, no. 12, p. 1408, 1952.

Studies of zircons of ages from 3 to 1,500 million years that had suffered alpha-particle irradiation up to $10^{16}$ alphas per mg show that the intensity of x-ray diffraction by the zircon decreased progressively with total alpha-irradiation becoming immeasurable above background after dosages of about $6 \times 10^{15}$ alphas per mg. A more accurately measurable criterion was found to be the diffraction angle from the 112 plane. Evidence indicates that the disordering is produced by knock-on atoms at the end of the alpha track and by the recoiled parent, rather than by disturbances of the electronic structure during the ionizing part of the track. Of interest in studies in earth heat is the fact that zircon becomes "half-metamict" after a radioactive energy release of 685,000 calories per gram, indicating that only a fraction of a percent of the energy can be stored in the structure as disordered atoms, the rest being lost as heat.—M. C. R.

14554. Cooley, R. A., Martin, A. V., Feldman, C., and Gillespie, J. The hafnium to zirconium abundance ratio and specific radioactivity of some ores: Geochimica et Cosmochimica Acta, v. 3, no. 1, p. 30–33, 1953.

The hafnium to zirconium abundance ratio and the specific radioactivity of ore samples from North America, India, South America, and Australia were measured spectroscopically and by Geiger counter respectively. The Hf/Zr ratio ranged from 0.0078 to 0.068. The few determinations of radioactivity do not indicate that the specific radioactivity of the ore in general can be correlated with hafnium content, although if consideration is limited to zircons there is a 75 percent correlation.—M. C. R.

14555. Norinder, Harald, Siksna, Reinhards, and Metnieks, Arvids. Radon and thoron contents of the soil-air at Almunge: Geol. Fören. Stockholm Förh., Band 74, Häfte 4, p. 450–454, 1952.

Measurements of the radioactivity of soil air were made at the Institute of High Tension Research of Uppsala University. Air from the soil was sucked

into an ionization chamber through a pipe driven into clefts in a pegmatitic facies of thorite-containing canadite.    After collecting the air in the ionization chamber, the chamber was connected with a bifilar Wulf electrometer and the radioactivity of the air in the chamber determined by the electrical leak produced.    Radon and thoron activities were distinguished by the difference in the disintegration periods. The shape of the ionization curve may indicate the presence of thorium minerals but the relation of the primary sources cannot be calculated from the emanations because of the various uncertainties involved.—*M. C. R.*

14556.    Norinder, Harald, Metnieks, Arvids, and Siksna, Reinhards.    Radon content of the air in the soil at Uppsala: Arkiv Geofysik, Band 11, Häfte 5–6, p. 571–579, 1953.

Measurements of the radon content in the soil air, carried out at the Institute of High Tension Research of Uppsala University from August 1950 to October 1951, were made to determine if the locality was very rich in emanation.    All measurements were made with an ionization chamber and electrometer of the Wulf bifilar type, the calibration of which was determined by calculation rather than by use of a radium standard; without absolute values, the radon measurements at Uppsala cannot be compared directly with the values found by investigators in other countries.    The measurements verified an abnormally high radon content from 1 to $6 \times 10^{-12}$ curies/cm$^3$ at a depth of 90 cm.    Air in basement rooms of the Institute had radon content as high as $0.5 \times 10^{-12}$ curies/cm$^3$.    Thoron measurements showed a Rn/Th ratio between $1.5 \times 10^3$ and $10 \times 10^3$.—*F. W. S.*

## RADIOACTIVITY EXPLORATION SURVEYS

14557.    Kunori, Shoichi, and Saito, Tomosaburo.    Geophysical prospecting of Yugashima gold mine [In Japanese with English summary]: Geol. Survey Japan Bull., v. 3, nos. 4–5, p. 28–34, 1952.

Gold and silver occur in veins with gangue minerals of quartz, calcite, and rhodochrosite.    Gamma-ray and geochemical methods gave most satisfactory results, though resistivity surveys were sometimes used.—*M. C. R.*

## THERMOLUMINESCENCE

14558.    Daniels, Farrington, Boyd, Charles A., and Saunders, Donald F.    Thermoluminescence as a research tool: Science, v. 117, no. 3040, p. 343–349, 1953.

Thermoluminescence is the emission of light produced by heating a solid to a temperature below that of incandenscence and is exhibited by crystals that have been exposed to x-rays or radioactivity and then heated rapidly.    As a result of the radiation, electrons may be removed from ions in the crystal lattice and move around in a crystal.    The released electrons may then go into an electron trap from which the extra energy may be released as visible light on heating.    Thermoluminescence is measured by glow curves in which the intensity of light is measured with a phototube and the temperature by a thermocouple.    The property of thermoluminescence may be useful in studies of dosimetry, in identification and control of substances with definite heat treatments and physical histories, in research on catalysts, and studies of radiation damage, and in geologic studies in stratigraphic correlation and age determinations.—*M. C. R.*

# HEAT

## GENERAL AND THEORETICAL STUDIES

14559. Blackwell, J. H. Radial-axial heat flow in regions bounded internally by circular cylinders: Canadian Jour. Physics, v. 31, no. 3, p. 472–479, 1953.

Two radial-axial transient heat flow problems have been solved for regions bounded internally by circular cylinders. They are not of the simple "product-solution" type, and it is considered that they may have application in other fields of physics where the Diffusion Equation applies. The problems arose during investigation into "end effect" in cylindrical thermal-conductivity probes. The solutions are obtained by integral-transform methods, two different types of transform being used in each solution.—*Author's Abstract*

## INSTRUMENTS AND METHODS OF OBSERVATION

14560. Stegena, Lajos. Kísérleti mérések egy termális mérőberendezéssel [Experimental measurements with a thermal measuring arrangement] (In Hungarian with summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 1, szám 12, p. 102–108, 1952.

The use of geothermal measurements in prospecting is considered. Two solutions of the Fourier differential equation of heat conduction are given, one when the temperature of the medium is assumed to be a linear function of all three coordinates $x$, $y$, $z$, that is when $T = A + Bx + Cy + Dz$ and the other when temperature is a harmonic function of time. Instruments and methods for measuring temperatures are also described. The method has been successfully used to determine the depth of a limestone layer and an inclined layer filled with thermal waters.—*S. T. V.*

## OBSERVED TEMPERATURES IN THE CRUST AND HEAT FLOW

14561. Balyi, Karoly, and Papp, Ferenz. Közeteink hővezetőképessége, or, La conductibilité calorique des roches hongroises [Thermal conductivity of Hungarian rocks]: Földtani Közlöny, v. 80, no. 10–12, Hungarian text, p. 390–391, French text p. 391–394, 1950.

Thermal conductivity was measured on 25 rocks from different places in Hungary, using Eucken's simplification of Lees' method. The rocks were then studied microscopically. The results are presented in a table. In eruptive rocks, conductivity is influenced by mineralogical composition, structure and degree of crystallization; in sedimentary rocks, by pore space and crystallinity (in sandstones, by ratio of matrix to quartz grains); in volcanic tuffs, by structure and mineralogical composition.—*D. B. V.*

14562. Higashi, A. Thermal conductivity of frozen soil: Hokkaido Univ. Fac. Sci. Jour., ser. 2, v. 4, p. 95–106, 1952.

The thermal diffusivity of frozen soil was measured with samples which were artificially prepared under conditions similar to the natural frost formation. Thermal conductivity was computed from the diffusivity thus obtained and the

volume specific heat of the soil. Moisture relationship of the thermal diffusivity $k$ and the thermal conductivity $K$ is represented by the following empirical formulae: $k = ae^{br}$, $K = ce^{dr}$. In these formulae, $r$ is the moisture ratio of frozen soil and $a$, $b$, $c$, and $d$ are constants. These formulae hold only in the range of moisture content below the saturation moisture ratio. Two modes of segregation of ice are usually observed in the frozen soil: an ice plate of considerable thickness and a dispersion of innumerable thin layers. The soil samples of these two types of freezing contain usually more water than the saturation amount. In these cases the rate of increase of $k$ with respect to $r$ is smaller than that expressed by the former empirical formula. The variation of the thermal diffusivity in relation to the direction of heat flow is comparatively small.—*Author's Abstract*

## VOLCANOLOGY

14563.  MacGregor, A. G.  Eruptive mechanisms: Mt. Pelée, the Soufrière of St. Vincent and the Valley of Ten Thousand Smokes: Bull. volcanolog. sér. 2, tome 12, p. 49–74, 1952.

A review of the evidence shows that a dome (tholoid) rose in the crater of Mt. Pelée in the 1902 eruption. Erroneous statement to the contrary has been responsible for controversy regarding the origin and kinetics of nuées ardentes in the West Indies. At Mt. Pelée, the explosions originated in dome magma that was not fully consolidated and produced self-explosive avalanches of varying degrees of magnitude and initial energy, whose speed and momentum were due mainly to gravity. They were directed by a weakness on the flank of the dome. At Soufrière nuées ardentes were initiated by vertical explosion in a domeless crater, were distributed radially on the slopes, and owed their speed and momentum entirely to gravity.

Modification of Fenner's hypothesis of the eruption of Katmai in 1912 is also suggested. Hybridization of rising rhyolitic magma with old basic lava took place at moderate depth at the source; moraine was not assimilated. Eruption occurred at Novarupta and possibly in two or three other fissures. The contaminated magma eventually reached the critical explosion level, and mobile incandescent tuff flowed down the valley under the influence of gravity, pure rhyolitic tuff following the hybridized material. Most of the fumaroles are from contemporaneously formed fissures. Cold "ashfall" types of deposit followed.

Two tables show present classifications of volcanism involving gas-generating eruptive avalanches or tuff-flows and MacGregor's amended classification (corresponding closely to Lacroix's but more precise), which also includes the kind of magma associated with each type of eruption.—*D. B. V.*

14564.  Brügger, Juan.  El volcanismo in Chile [Volcanism in Chile]: Univ. Chile Facultad Cienc. fis. y mat. Anales, 1950, v. 7, p. 61–71, 1951.

Chile is a country of intensive volcanic activity past and present, with 37 active volcanoes and numerous volcanic islands. Volcanism played an important role in its geologic history and in shaping its tectonic features. Tertiary rhyolites alone cover an area of over 110,000 sq km. The amount of lava erupted in northern Chile is estimated to be some 50,000 cu km. The more important eruptions of several active and inactive Chilean volcanoes are described.—*S. T. V.*

14565. Philippine Geodetic and Geophysical Institute. A preliminary report on the recent eruptions of Hibok Hibok Volcano, Camiguin Island, Philippines: Bull. volcanolog., sér. 2, tome 12, p. 215–225, 1952.

This report includes brief quotations from reports of activity of Hibok Hibok in September 1948, June 1949, September 1950, and December 1951; the text of a formal proposal to create a Commission on Volcanology to investigate Philippine volcanoes; and the memorandum report on the September 1950 eruption. The last recommends complete aerial photograph coverage of Camiguin Island, establishment of a seismic station at Mambajao, periodic determination of changes in elevation, and expansion of weather reporting to include photographing the volcano in different phases.—*D. B. V.*

14566. Sarcia, J., and Sarcia, J. A. Volcanisme et tectonique dans le Nord-Est Adamaoua (Cameroun français) [Volcanism and tectonics in Northeast Adamawa (French Cameroun)]: Bull. volcanolog., sér. 2, tome 12, p. 129–143, 1952.

This is a preliminary study of the geology of part of the Adamaoua plateau. The geomorphologic, volcanologic and tectonic features are outlined and a geologic history suggested. The volcanic rocks consist of three series, the thick, widespread older andesites and basalts, later (probably Neocene) trachy-phonolites, and Quaternary andesites and basalts. The first series appears to be the result of forces set in motion by the disjunction of Africa and Brazil in early Cretaceous time; the second is related to subsidences within the block; and the latest, to renewed activity along ancient faults.—*D. B. V.*

14567. Omote, Syun'itiro. Precise leveling at the eastern foot of volcano Usu: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, p. 133–142, 1950.

Bench marks placed along the road traversing the rising area along the eastern foot of Mt. Usu (Usu-dake) in March 1944, were resurveyed in April and July of the same year. Tilting of the ground in the active area was measured during the same period on pond surfaces, and to the north of the area from the level of Lake Toya. From the evidence it is inferred that the center of seismic activity, observed first on December 27, 1943, at the northwestern foot of the mountain, shifted two months later to the eastern foot, at which time upheaval began to be conspicuous in the epicentral region. Then the center of elevation migrated northward. The first eruption occurred on June 23, 1944, in the area of most rapid elevation.—*D. B. V.*

14568. Minakami, Takeshi. Topographical deformations during the 1943–1945 eruption *in* Recent activities of Volcano Usu (V): Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, p. 143–152, 1950.

Leveling surveys along the civil road through the rising area on the eastern foot of the mountain showed the vertical deformation developed in the form of a dome, and amounted to 20–30 cm per day during the period of maximum rising. Measurements of horizontal movements were not as systematic but indicated that the movements were always outward or in a radial direction from the active craterlets. During the initial stage of the activity the vertical movements were predominant, but the horizontal movements became more prominent as the lava approached the surface.—*M. C. R.*

14569.   Minakami, Takeshi, Sakuma, Shūzō, and Okada, Atsushi. Precise
        levelling around Mt. Usu in 1949 *in* Recent activities of Mt. Usu (VI):
        Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, p. 153–160,
        1950.

In 1949 precise leveling surveys were made along the western and southern
bases of Usu-dake and compared with the results of the 1919 survey. A conspic-
uous rise of 8.0 cm and 16.2 cm along the western foot and southern skirt respec-
tively were noted, corresponding to the epicentral area of the earthquakes which
initiated the activity. Surveys along the route from Sobetu to the base of the new
mountain in October 1948 and July 1949 indicated no marked change in height
took place between the 2 surveys. This is in contrast to the 1910 eruption after
which the area subsided.—*M. C. R.*

14570.   Miyamura, Setumi. Vermessung der Deformation der Erdoberflächen
        bei der Eruption eines neuen Flankenvulkans von Usu-dake, Hokkaido,
        1944 [Measurements of the deformation of the earth's surface by the
        eruption of a new parasite-volcano on Usu-dake, Hokkaido, 1944]
        (In Japanese with German summary): Tokyo Univ. Earthquake
        Research Inst. Bull., v. 28, pt. 3–4, p. 321–331, 1950.

To measure the horizontal deformation of the surface around the new crater
2 rhombuses with sides of about 30 m were marked and accurately surveyed.
At one of these sites, a contraction of about $2 \times 10^{-2}$ in the direction of the crater
was noted after 13 days, and a displacement of less than $10^{-2}$ by collapse. The
latter figure approximately corresponds to the experimental compressive strength
of argillaceous soil in the laboratory, according to Terzaghi.—*M. C. R.*

14571.   Yagi, Kenzo. Recent activity of Usu Volcano, Japan, with special
        reference to the formation of Syowa Sinzan: Am. Geophys. Union
        Trans., v. 34, no. 3, p. 449–456, 1953.

This is an illustrated account of the seismic and volcanic activity at Usu-dake
from December 1943 to September 1945. The new lava is a hypersthene dacite,
similar to the lavas of the other domes of Usu-dake. Except for the extrusions
of the lava dome, the activity at Usu-dake in 1910 was similar to that in 1943–45.
Older domes of O-usu and Ko-usu were probably formed in the same way.—
*M. C. R.*

## TECTONOPHYSICS

### FORCES IN THE CRUST AND OROGENESIS

14572.   Rittmann, Alfred. Orogénèse et volcanisme [Orogenesis and volcanism]:
        Archives des Sci. (Génève), v. 4, fasc. 5, p. 274–314, 1951.

In this paper, Rittmann presents in detail his theory which explains how
volcanism, petrogenesis, and epeirogenesis are all genetically related to orogenesis
The earth is assumed to consist of a solid crust about 70 km thick, composed
of sial and sima, resting on a viscous magma core of approximately the composition
of sima. The mechanical properties of the earth's crust, particularly sima,
being similar to those of the magma, the crust will react tectonically approxi-
mately as an extremely viscous body. Limitation of large tectonic movements
to orogenic zones therefore must be due to the birth of tectonic forces in themselves
or immediately subjacent regions.

The fundamental difference between the tectonically passive continental and suboceanic zones of Pacific type is that in the former, isostatic, hydrostatic, gravitative, thermal, and physicochemical equilibria are well established, whereas in the latter, because of rapid changes of thickness, at least some equilibria are disturbed. The horizontal thermal gradient of an active zone causes subcrustal magmatic currents, whose acceleration causes compression toward the anterior passive zone (continent) and the opposite toward the posterior passive zone (ocean basin). The result is epeirogenic uplift of the interior of the continent and depression of the marginal zones. This disturbs isostatic equilibrium.

If sedimentation is heavy and prolonged, the marginal depression becomes a geosyncline. The acceleration of the underlying current is shown to lead to volcanism in the geosynclinal area, whereby magma from the subcrust is intruded along fractures. The weight of sediments and volcanic material and withdrawal of magma from below cause the area to sink. When the base of the geosynclinal crust reaches the level of the base of the sima underlying the continent, the horizontal gradient becomes zero and the geosynclinal phase of the orogenic cycle ends. It is during the geosynclinal phase that the caloric energy is stored which accomplishes the mechanical and thermodynamic work of orogenesis.

Continued sinking disturbs the thermal gradient in such manner that a descending current underlies the geosyncline. The bottom part becomes engulfed in the magma. At the same time, the upper beds are compressed into mountains. Also at this time, conditions favor volcanism in the anterior part of the continent. The withdrawal of magma from below leads to epeirogenic subsidence, which upsets isostatic and hydrostatic equilibrium.

The engulfed sial becomes heated and metamorphic changes occur, increasing with depth until the lower parts are transformed into anatectic magmas, granitic or granodioritic, or even noritic, in character. Sima is assimilated without much change.

The anatectic magmas and metamorphic rocks are lighter and tend to rise, upsetting the dynamic equilibrium, and inaugurating the phase of uplift. The anatectic magmas penetrate the rocks above and form batholiths; sometimes they reach the surface and give rise to explosive volcanism. On the surface, uplift is accompanied by secondary tectonic movements which cause further deformation of the earlier compression. At an advanced stage of uplift, after the anatectic magmas have solidified, conditions again permit fracturing and intrusion in part of the geosynclinal area. The orogenic cycle ends with reestablishment of equilibrium. Following uplift and complete peneplanation, an orogenic zone usually acquires the characteristics of a nonorogenic zone and becomes part of the sial shield of the growing continent. Before this ultimate stage is reached, the new marginal marine basin may itself have become a geosyncline, a new orogenic cycle thus commencing before the old is ended. It is only the extremely long duration of the geosynclinal phase which makes orogeneses appear to occur in separate paroxysms; in reality, they constitute a continuous series of causes and effects, of disturbances and restablishments of equilibria.—D. B. V.

14573. Vening Meinesz, F. A. Convection currents in the earth and the origin of the continents, Pts. 1, 2, and 3: K. Nederland. Akad. Wetensch. Proc., ser. B, v. 55, no. 5, p. 527–553, 1952.

A curve representing the mean values of the 16 spherical harmonic terms of the thickness of the sialic layers is shown to be nearly proportional to that based on the actual topography. In former papers [Geophys. Abs. 10138, 13186, 14076],

Vening Meinesz has advanced the theory that convection currents occurring in the mantle of the earth have dragged together the sialic matter floating on it in large shields above the sinking currents thus creating the continents. This paper is intended to prove that the distribution of these current systems corresponds to a distribution of these shields according to a series of second to seventh order spherical harmonics with amplitudes as given by the new curve. Equations are derived for stable convection currents in a spherical shell, and while actual conditions in the earth could not have been as stable, this investigation shows that it is reasonable to suppose that currents in the mantle were governed by similar equations. Comparable equations are then derived for spherical coordinates.

Part II continues with solutions of equations derived in Part I, with special reference to the earth. The results are summarized in tables and analyzed mathematically for different assumptions of temperature distribution, pressure, and boundary conditions. The similarity of stationary convection and of the supposed pseudoperiodic convection in the earth seems to imply that for the latter we cannot neglect the temperature conduction.

Part III deals with stresses and derives equations for these for plane and spherical cases. Two conclusions are drawn: if deep and intermediate earthquakes are caused by shearing-stresses in turn caused by convection currents, their way of occurring must depend on the subterms as well as the order $n$ of the spherical harmonic according to which the current is distributed; the distribution according to which these currents originate also depends on these subterms.

A tentative history of the earth's crust based on the convection-current hypothesis closes the paper. A map of the zero to the fifth order spherical harmonics of world topography is included, and an appendix gives formulae for $\theta_o$ (excess above temperature for no current) and $w_o$ (vertical speed in the axis of the sinking column) in the mantle and in the whole earth.—*D. B. V.*

14574.  Hills, G. F. S.   The spread of the continents: Geol. Mag., v. 90, no. 1, p. 41–47, 1953.

It is generally accepted that the continents contain more radio-activity than the Pacific floor. The two continents, Laurasia and Gondwanaland, would therefore expand the rocks below, relative to that floor. The plastic substratum under the continents would be forced higher in their centres than at their Pacific margins. It would creep towards those margins and would carry part of the overlying granite to them, piling it high at their margins and thinning it at their centres. The plastic substratum would continually carry its heat to the cold Pacific substratum and render it plastic into which the continents would be impelled.—*Author's Abstract*

14575.  Fardin, R.   Sur la théorie orogénique de M. Matschinsky [On the orogenic theory of Matschinsky]: Rev. géomorphologie dynamique, 3e année, no. 6, p. 294–299, 1952.

Fardin discusses some points of Matschinsky's theory (Geophys. Abs. 13419) of the formation of terrestrial relief, being opposed to the principle involving breaking and subsequent plastic flow due either to compressive forces caused by the shrinking brought about by cooling or to the forces of inertia implied by Wegener's theory. Those principles originate in a certain analogy between the macroscopic behavior of the globe and the physical behavior of metal alloys at high temperature. But the layers in which deformation takes place are so thin compared to the globe, tectonic evolution should be compared with the behavior of surface conditions in metallurgy. A thin membrane exposed to a system of

forces applied locally and at varying times would assume an equilibrium figure represented by a Bessel or Mathieu function which in three-dimensions would be similar to certain systems of folded mountains.— *M. C. R.*

14576. Egyed, L. The formation of deep sea troughs and related geophysical phenomena: Acta Geol. Acad. Sci. Hungaricae, tomus 2, fasc. 1–2, p. 33–50, 1953.

Egyed presents a new concept of the formation of deep-sea troughs as the result of horizontal compression originating in the crust. Horizontal forces at the margin of oceanic and continental areas form a couple and produce warping of the crust with the deep being formed at the contact line. There are also developed as a consequence a row of islands, a shallow sea behind it, and at the place of greatest tensional stress the volcanic belt. Pressure causing deformation produces a shearing stress in the crust and underlying magma so a system of stress trajectories is formed. Stress is relieved at the weakest point in the system, producing earthquakes. The depressed part of the continental area is of a geosynclinal character. The origin of the horizontal forces is believed to be closely connected to the rotation of the earth.— *M. C. R.*

14577. Krames, Karl. Sind das Rote Meer und der Golf von Aden Einbruchsgräben oder Kontinentalrisse? [Are the Red Sea and the Gulf of Aden grabens due to downwarping, or continental rifts?]: Geofisica Pura e Appl., v. 22, fasc. 1–2, p. 53–56, 1952.

Krames believes that the Red Sea and Gulf of Aden are clear indications of continental drift. As evidence, he cites the parallelism of their opposite coast lines, their great width, and the alinement of positive gravity anomalies parallel to their length. Another manifestation of similar horizontal forces is the Rhine graben.—*S. T. V.*

14578. Escher, B. G. Sur le rapport entre le mécanisme de la formation des fossés tectoniques et le volcanisme [On the relation between the mechanism of formation of rift valleys and volcanism]: Bull. volcanolog. sér. 2, tome 12, p. 33–47, 1952.

This is the presidential address to the International Association of Volcanology in Brussels, August 1951. For previous publication see Geophysical Abstract 13904.— *D. B. V.*

14579. Pettit, J. T., Slichter, L. B., and LaCoste, L. Earth tides: Am. Geophys. Union Trans., v. 34, no. 2, p. 174–184, 1953.

The residual, $D(t)$, of the vertical component of gravity has been evaluated at four stations in three widely separated areas. It is given by the expression: $D(t) = g(t) - g_o(t) = \epsilon(t) \, g_o \, [t - \alpha t]$ where $g(t)$ is the observed vertical component of gravity, $g_o(t)$ represents the computed vertical component due to the gravitational attraction of the sun and moon, $\epsilon$ and $\alpha$ are the amplitude and phase factors, and $D(t)$ represents the contribution from the deformation of the earth. Of the four observed stations, those at Los Angeles, Pasadena, and Hawaii yield most reliable results. Here, $D(t)$ yields values of $\alpha$ and $\epsilon$ which are nearly constant in time for a given station. The phase shift is large; furthermore, the difference between the phases at the California stations and the other two stations is also large. There are indications that the amplitude factor also changes with geographic position. When the phase and amplitude parameters are constant in time, the classic harmonic tidal components are easily computed. Comparisons are made between

the results using this method and the classic procedure of harmonic analysis as used by the U. S. Coast and Geodetic Survey and British Admiralty. The discrepancies found were small.—*I. Z.*

14580.    Melchior, P. J.    Nouvelles recherches théoriques sur les marées de l'écorce et les variations des latitudes [Recent theoretical studies on earth tides and the variations of latitudes]: Bull. géod., no. 23, p. 59–66, 1952.

Among possible causes of periodic irregularities in the displacement of the earth's axis, is a resonance effect depending upon the value of the Chandler period.    Possible explanations of this are displacements of masses in the interior of the earth and elastic deformations of the crust.— *S. T. V.*

14581.    Polli, Silvio.    Gli attuali movimenti verticali delle coste continentali [Actual vertical movements of the continental coasts]: Annali Geofisica, v. 5, no. 4, p. 597–602, 1952.

By averaging data from 110 stations for the period from 1871 to 1940, a universal rise of sea level of 1.1 cm during the 70 years, was established. This may be explained as the result of melting of polar ice masses during this period. In contrast to this figure, the average uplift of Fennoscandia during one decade was 4.7 cm. Measurements of sea level variations in United States reveal a lowering of Atlantic Coast at a rate of 2 cm per decade.

The article contains a world map indicating variations of different shore lines over the sea level.    In general, subsidence of the areas between the latitudes 20° S. and 45° N., and a rising of those above 45° N. lat are noted.— *S. T. V.*

## ELASTIC CONSTANTS AND STRENGTH OF ROCKS

14582.    Marx, J. W., and Sivertsen, J. M.    Temperature dependence of the elastic moduli and internal friction of silica and glass: Jour. Applied Physics, v. 24, no. 1, p. 81–87, 1953.

The dynamic Young's moduli and the internal friction of fused quartz, Pyrex glass, and soft glass rods were measured at a frequency of 37 kc/s, in longitudinal vibration, within the temperature range 170° to 1000° C.    The moduli of Pyrex and quartz increased with rising temperature, up to the softening point of the glass, while that of soft glass decreased.    All three moduli were approximately linear with respect to the temperature over most of the measurement interval. Internal friction maxima were noted at high temperatures, while at the lowest measurement temperatures a significant increase in background damping occurred. A brief recapitulation of existing theory is given and employed to interpret the internal friction data.    It is suggested that, in microscopically inhomogeneous media, the diffusion measurement by internal friction methods is not equivalent to the determination by other techniques.—*Authors' Abstract*

14583.    Hughes, D. S., and Cooke, C. E., Jr.    The effect of pressure on the reduction of pore volume of consolidated sandstones: Geophysics, v. 18, no. 2, p. 298–309, 1953.

Changes in pore volume of jacketed dry cores of Steven sand from the Paloma field, Kern County, Calif., and Berea sandstone from Berea, Ohio, were measured under hydrostatic pressures ranging from 50 to 1,000 bars.    The total measured

changes of pore volume correspond to a change from 19.35 to 18.84 percent in the porosity of the Berea sandstone, and from 18.45 to 17.31 percent in the porosity of the Steven sand. These would correspond to changes in total available fluid capacity per acre-foot of 213.4 ft³ in the Berea and 496.6 ft³ in the Steven sand. The coefficient of change of pore volume with pressure decreases rapidly with increasing pressures to about 500 bars, so that pressure changes are more important when the original static load on the rock is small.—*M. C. R.*

## INTERNAL CONSTITUTION OF THE EARTH

14584. Berlage, H. P. On the composition of the bodies of the solar system: K. Nederland. Akad. Wetensch. Proc., ser. B, v. 56, no. 1, p. 45–55, 1953.

Berlage attempts to arrange into one coherent picture the current aspects of the constitution of the bodies of the solar system. This he does by means of a graph on which are plotted as a function of the logarithm of their masses the mean densities of all the bodies in the solar system for which this quantity is known with fair accuracy. This graph is similar to one published in a previous paper but has been revised on the basis of more recent data. He then discusses a number of different theories, particularly Urey's, in the light of this diagram, and shows to what extent it confirms or contradicts them.—*D. B. V.*

14585. Berlage, H. P. The masses of planets and satellites derived from the disc theory of the origin of the solar system: K. Nederland. Akad. Wetensch. Proc., ser. B, v. 56, no. 1, p. 56–66, 1953.

The disk theory of the origin of the planetary system, as adopted by Berlage, leads to a formula for the masses of the planets and for the masses of the bodies of any secondary system that is easily adaptable to the observed values.

Berlage is convinced that we must distinguish between two periods in the evolution of the planetary system: first, the nebula lost about 99 percent of its mass by escape of free H and He in a comparatively short time; then the cloud flattened out into a toruslike disk in which large scale turbulence had died out. He returns to the idea that all planets were created from the disk in one phase, abandoning his 1940 suggestion of two stages. He concludes that the disk remained a totality for a long time during its transformation, with mutual exchange of material between rings and protoplanets up to the final action.—*D. B. V.*

14586. Rikitake, Tsuneji. The electrical state of the earth's interior and the origin of the earth's main magnetic field: Geofisica Pura e Appl., v. 22, fasc. 1–2, p. 37–41, 1952.

Elsasser-Bullard's theory concerning the origin of the earth's main magnetic field is discussed under the assumption that electrical conductivity in the earth varies in accordance with the law of electro-magnetic induction as developed by the methods of theoretical physics. Rikitake shows that the variations of magnetic field will reach the earth's surface because of the very long period of these variations (100 years and more). Thus the Elsasser-Bullard theory seems to be in agreement with our knowledge of the electric state of the earth's interior as inferred from both geophysical investigations and the deductions of theoretical physics.—*S. T. V.*

14587.   Coulomb, J[ean].   La constitution physique de la terre [Physical constitution of the earth]: 284 p., Paris, Éditions Albin Michel, 1952.

This is one of the volumes in the Sciences d'Aujourd'hui series.   The subjects discussed are seismology, gravity, the figure of the earth, and slow deformations of the earth.—*M. C. R.*

14588.   Urey, H. C.   The abundances of the elements: Phys. Rev., v. 88, no. 3, p. 248–253, 1952.

The cosmic abundances of the elements were estimated by Goldschmidt (1937) from a study of terrestrial and meteoritic abundances and a comparison of these with Russell's data on the sun.   More recently Brown has prepared a table weighting the proportions of the iron and silicate phases according to an estimated proportion of these phases in the earth.   The writer has recently proposed that the chondritic meteorites themselves may represent an average sample, and has shown that this assumption is consistent with the density of the moon, which on the basis of his recent discussion in regard to the origin of the solar system should also be approximately a sample of non-volatile materials.   A table of abundances is prepared assuming that these meteorites do represent such a mean sample.   This table does not differ markedly from Goldschmidt's, but is distinctly different from Brown's, both because of a different weighting of the phases in meteorites and because of a different choice of data from the literature. Iron is much less abundant than estimated by Brown and somewhat less abundant than Goldschmidt's estimate.   There is some indication for markedly low abundances of Se and Te and Br and I, which may indicate some escape of these elements during the formation of the meteorites.   Hg is low, almost certainly because of its loss as a volatile substance during the formation of the meteorites.— *Author's Abstract.*

14589.   Di Filippo, D[omenico], and Marcelli, L.   Struttura della crosta terrestre in corrispondenza dell'Italia centrale [The structure of the earth's crust in relation to central Italy]: Annali Geofisica, v. 5, no. 4, p. 569–579, 1952.

From data of the earthquake of September 5, 1950, in Gran Sasso, Italy, the thickness of the granite layer in central Italy has been calculated as 25 km, and that of the basalt layer as 36 km.   The Mohorovičić discontinuity is at a depth of about 60 km.   It was also found that the bottom surface of the granite layer is inclined at a small angle.—*S. T. V.*

## GENERAL GEOPHYSICAL EXPLORATION

14590.   Coolbaugh, D. F.   The recent trend in mining geophysics in the United States: Mines Mag., v. 43, no. 4, p. 41, 56, 1953.

There has been a great increase in mining geophysics in the United States since World War II.   Excluding U. S. S. R., this country now accounts for 25 percent of the world total of mining geophysics; 20 percent of the activity of the United States is government operated.   Canada leads with 30 percent of the world total.   Airborne magnetic, radioactivity and induced magnetic measurements are among the advanced techniques being employed.   The resistivity, natural potential, and radioactivity well-logging methods common in the petroleum industry are now being employed by mining companies.   The expanded search for uranium is the motivating force for much of the recent increase in mining

geophysics. Seismic and electrical methods, in addition to radioactivity methods, are used to find uranium. Only recently have even the larger mining companies attempted the large scale use of geophysics in the United States. They are now beginning to realize that the "actual development of mining geophysics will have to come through their own organizations."—*L. C. P.*

14591. Lahee, Frederick H., and others. Exploratory drilling in 1952, and Developments in the United States and Canada: Am. Assoc. Petroleum Geologists Bull., v. 37, no. 6, p. 1193–1522, 1953.

This entire issue of the Bulletin of the American Association of Petroleum Geologists is devoted to a review of exploratory drilling for oil in 1952 and to developments in exploratory activity in all areas of the United States, Canada, and Mexico. Nearly 50 authors participated in writing this annual review. Geophysical activity is summarized in the reviews of developments in each of the major areas in the United States, Canada, and Mexico, and the role of geophysics in drilling successful and unsuccessful wildcat wells is tabulated in the introductory review by Lahee. An increase in geophysical activity is noted throughout the entire North American continent. The reflection seismograph accounts for most of this activity, but there was considerable gravity work during the year. Some ground and airborne magnetometer work was done and, in the Tampico area of Mexico, electrical-resistivity methods were used.

In the United States, 179 successful new field wildcat wells and 1,155 dry holes were located on the basis of geophysics, for a success ratio of 13.4 percent. On the basis of geology, 359 producing wells and 2,959 dry holes were located for a success ratio of 10.8 percent. A combination of geological and geophysical methods accounted for 143 producing wells and 705 dry holes, for a success ratio of 16.9 percent. A total of 680 wildcat wells located on the basis of technical information were producers and 4,818 were dry holes, for a success ratio of 12.2 percent. Only 16 wildcat wells located on a nontechnical basis were producers and 466 were dry holes, for a success ratio of 3.3 percent.—*L. C. P.*

14592. Clewell, D. H., Broding, R. A., Loper, G. B., Heaps, S. N., Simon, R. F., Mills, R. L., and Dobrin, M. B. Instrumentation for geophysical exploration: Rev. Sci. Instruments, v. 24, no. 4, p. 243–266, 1953.

This is a review of the methods of geophysical exploration for petroleum and the instruments used therein. Included are discussions of seismic equipment, gravity meters (including the Magnolia instrument), electrical and radioactivity well logging, and magnetometers, including the airborne magnetometer.—*M. C. R.*

14593. Komarov, S. G. Geofizicheskiye metody issledovaniya neftyanykh skvazhin [Geophysical methods of exploration of oil wells]: 360 p., Moscow-Leningrad Gostoptekhizdat, 1952.

This is a textbook of geophysical methods in the exploration of oil wells written for use in industrial schools for oil field foremen.—*S. T. V.*

14594. Horvath, Josef. Geophysikalische Schurfverfahren [Geophysical methods of prospecting] p. 166–217 *in* Granigg, B., Die Lagerstätten nutzbarer Mineralien [The deposits of economic minerals]: Vienna, Julius Springer, 1951.

This section contains a review of the gravitational, magnetic, seismic, electric, and electromagnetic methods of prospecting and electric well logging.—*S. T. V.*

14595.    Iida, Kumizi.  Recent developments in geophysical exploration [In Japanese with English summary]: Jour. Geography (Tokyo), v. 61, no 4, p. 27–31, 1952.

A review of recent developments throughout the world.—*M. C. R.*

## MISCELLANEOUS  PATENTS

14596.    Young, E. T.    Well surveying instrument, U. S. patent 2,633,645, granted April 7, 1953.    3 claims.    Assigned to Sperry-Sun Well Surveying Co.

An inclination and direction indicator.

14597.    Green, P. M.    Well-surveying inclinometer, U. S. patent 2,635,349, granted April 21, 1953.    7 claims.    Assigned to Socony-Vacuum Oil Co.

14598.    Lundberg, M. T. F.    Method of geophysical exploration, U. S. patent 2,636,924, granted April 28, 1953.    2 claims.    Assigned to Lundberg Explorations Ltd.

A general method of making geophysical measurements from the air.

# INDEX

**119**