Geophysical Abstracts 150 July-September 1952

(Numbers 13803–14003)

GEOLOGICAL SURVEY BULLETIN 991-C

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

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GEOPHYSICAL ABSTRACTS 150, JULY–SEPTEMBER 1952

By Mary C. Rabbitt and S. T. Vesselowsky

INTRODUCTION

Geophysical Abstracts are issued quarterly by the Geological Survey, U. S. Department of the Interior, to aid those engaged in geophysical research and exploration by providing informative abstracts of current literature dealing with geophysical exploration and with the physics of the solid earth.

Abstracts are grouped in three sections dealing with early physics, exploration geophysics, and patents. The first section has been further divided into sections on gravity, magnetism and electricity, seismology, radioactivity, heat, volcanology, and tectonophysics. The section on exploration geophysics covers gravimetric, magnetic, seismic, electric, electromagnetic, radioactive, thermal methods and well logging. Within each group the order of abstracts is as follows: general papers, bibliographies, and reviews; theory; instruments; methods and techniques; observations.

J. R. Balsley, L. E. Birdsall, P. Edward Byerly, W. J. Dempsey, R. G. Henderson, Elizabeth King, J. L. Meuschke, L. C. Pakiser, F. W. Stead, and Isidore Zietz have prepared the abstracts signed with their initials.

Geographic names used are those approved by the U. S. Board on Geographic Names. Where names in the original material differ from their official usage, both names are given, the latter in brackets.

The system of transliteration used for Russian names and titles is that of the Board on Geographic Names. A table showing this system was printed in Geophysical Abstracts 148 (Bulletin 991–A).

EARTH PHYSICS

GRAVITY

13803. Haalck, Hans. Das physikalische Bildungsgesetz der Figur der Erde [The physical law of the development of the figure of the earth]: Potsdam Geod. Inst. Veröffentl., no. 4, pp. 43-53, 1950.

The problem of figure of the earth is discussed stressing the importance of physical factors in any approximations introduced in mathematical treatment. The known equation for the gravitational potential on the surface of the earth is divided into two parts, one representing the normal terrestrial spheroid, which is a geometric figure produced under the action of hydrostatic law and the centrifugal force of rotation, and the second representing the undulations of the geoid. In the computations, second order terms of the flattening of the earth are taken into account. The normal terrestrial spheroid represents, in the opinion of the author, the final limiting shape of the earth, and existing deviations indicate the direction and intensity of forces acting on the earth's crust.

The surface of the normal terrestrial spheroid is independent of the law controlling the variations of density inside of the earth, whereas the second part of the potential equation is indicative of the distribution of anomalous underground masses.

The article contains extensive computations showing that the normal terrestrial spheroid includes the two-axial ellipsoid of rotation.—*S. T. V.*

13804. Júdice, Antônio. Sobre a utilização das anomalias de Prey na determinaçao da figura da terra [On the use of anomalies of Prey for the determination of the figure of the earth]: Sindicato Nacional dos engenheiros geografos Publicações (Portugal), 1 ser., no. 2, 15 pp., 1951.

It has been suggested by many geophysicists that anomalies of Prey be used in applying the Stokes formula for the determination of the geoid. In a previous publication the author had shown that it is possible to replace the Laplace equation by Poisson's equation, and integrate it, using "complete Bouguer anomalies" or anomalies containing the Bowie corrections. Both methods are based on the development of the Newtonian potential into a power series with negative exponents of the radius vector from the center of the earth, the summation being applied to the space bounded by the greatest and smallest terrestrial radii. In the present study, it is pointed out that in this summation Fayé free-air anomalies, not the Prey anomalies, are to be used. Proof of this statement is based on deductions from potential theory.—*S. T. V.*

13805. Morelli, Carlo. Formule fondamentali per una Geodesia delle superfici isogravitazionali [Fundamental formulas of geodesy based on isogravitational surfaces]: Padova Univ. Ist. geod. e geofis., Nuova Ser., no. 1–5, pp. 189–208, (No date)

The attention of geodesists was recently called to importance of isogravitational surfaces, or those surfaces defined by the condition that gravity remains

constant at all points. The normal at a point of this surface makes with the normal to equipotential surface at the same point an angle δ, determined by the relation: $\text{Cos } \delta = U_{zz}/\sqrt{(U_{xz})^2+(U_{yz})^2+(U_{zz})^2}$. As is suggested by this formula, isogravitational surfaces are important in the interpretation of torsion balance measurements. Several formulas relating isogravitational surfaces to other geodetic and gravitational constants are derived, using methods of differential geometry, and by analysis of related equations the total, the average, and the principal curvatures of isogravitational surfaces are derived.—*S. T. V.*

13806. Haalck, Hans. Die vollständige Bestimmung örtlicher gravimetrischer Störungsfelder aus Drehwaagenmessungen mit Berechnungsbeispiel [Complete determination of local gravitational disturbing fields by measurements with torsion balance, with a numerical example]: Potsdam Geod. Inst. Veröffentl., no. 4, pp. 1–41, 1950.

A simple procedure is given for the numerical determination of higher differential quotients of the gravitational potential, W_{zz}, W_{zzx}, W_{zzy}, and W_{zzz}, from which it is possible to compute the undulations of the geoid and local gravitational anomalies.

As the starting point the readings made with Eötvös torsion balance, giving the values of the gradients W_{xz} and W_{yz}, as well as $W\Delta = W_{yy} - W_{xx}$ and $2\ W_{xy}$, the characteristics of the curvature at the point, are used.

The expression for the gravitational potential is developed into a Taylor series, terms of second and higher order being neglected. Repeated differentiations lead to formulas convenient for numerical computations, with simplifications by the use of Laplace relation $W_{xx}+W_{yy}+W_{zz}=0$. By changing the sequence of differentiation, it is possible to form averages of theoretically identical terms and thus to decrease the importance of errors.

In the process of computations as the first step the readings of the torsion balance are represented as isoanomalies of gravity. This necessitates a dense network of measurements.

The paper contains detailed computations, later applied to a gravitational survey of an area of about 150 sq km.

An analysis of the results obtained is found at the end of the paper, with a discussion of their accuracy, the possible effect of the variations of the density of underground formations on gravitational disturbances.

For the approximate determination of the depth of disturbing bodies use of W_{zzz} is recommended. The depth lies between the limits t_1 and t_2, where $t_1 = a[1.7-0.7\ (La/\sigma)+0.072\ (La/\sigma)^2]$ and $t_2 = a[1.2-0.52\ (La/\sigma)+0.056\ (La/\sigma)^2]$, where L denotes the greatest value of W_{zzz}, a is the distance of the maximum of disturbance from the zero value, that is, from the zero isoanomaly; σ is the excess of the density of the disturbing body over that of surrounding medium; and La/σ is expressed in 10^{-7} cgs units.—*S. T. V.*

13807. Jeffreys, Harold. The free-air reduction of gravity to the second order: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 5, pp. 316–318, 1952.

A second order analysis is given for the free-air reduction in order to include terms in ch and h^2. The pertinent terms involving these expressions may be as large as 6 and 3 parts in a million respectively.

A definition of height is given in terms of the geopotential that will agree to the second order with the height determined by direct measurement along the

vertical where such measurement is possible and where, for constant (ϕ, λ), the potential and g can be expressed as quadratics, in h. Mention is made of the necessity of inclusion of higher harmonics in the potential for sharp topographic features or masses outside the solid surface.—*P. E. B.*

13808. Jobert, G. Marées terrestres d'un globe fluide hétérogène [Terrestrial tides in a heterogeneous fluid globe]: Annales Géophys., tome 8, no. 1, pp. 106–111, 1952.

It is shown that the effect of the heterogeneity of the earth is to increase the value of δ, the ratio of the observed tidal deformation to that theoretically calculated for an unyielding globe, over the same ratio for a homogeneous earth. The proof is valid when the earth behaves as a fluid mass during the deformations and consequently is of interest for long period tides for which this is a satisfactory approximation. The calculations are for the cases in which the density is an analytic function over the range of r and when it is a piecewise continuous function of r, a finite number of discontinuities). This heterogeneity has the effect of decreasing Love's number k and thus increasing δ ($\delta=1+h-3/2k$), which is already greater than unity for constant density. It follows that the factor γ, which affects the deviations of the vertical, is less than the value obtained for a homogeneous earth and is thus still less than unity ($\gamma=1+k-h$). With Bullen's law of density distribution the effect of heterogeneity on δ and γ is expressed by the relations: $\delta>1+.244\ h$; $\gamma<1-.496\ h$.—*P. E. B.*

13809. Tarrant, L. H. Tidal gravity experiments at Peebles and Kirklington: Royal Astron, Soc. Monthly Notices, Geophys. Supp., v. 6, no. 5, pp. 278–285, 1952.

Frost field gravimeters at Peebles and Kirklington were read at half hour intervals from 09^h00^m u. t., May 9, 1949 to 11^h00^m u. t., May 23, 1949. Calculations were made of the expected tide-raising force by two methods and compared with the observed variations. Graphs of the results and contingency tables are included. The results suggest that in Great Britain the predicted tide-raising force is a good practical approximation to the actual gravity variations.—*P. E. B.*

13810. Tomaschek, R. Harmonic analysis of tidal gravity experiments at Peebles and Kirklington: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 5, pp. 286–302, 1952.

A harmonic analysis was made of carefully controlled simultaneous gravity measurements at Peebles and Kirklington. The measurements lasted over a period of 15 days. The analysis for this relatively short period was made by a method incorporated in the Admiralty Tide Tables, Part III (1941). A detailed examination of the data reveals a phase lag for the semidiurnal terms. The relation of tectonic blocks of the crust in England to the sites of the measurements is mentioned, and it is suggested that a secondary effect on these blocks due to sea tides is of importance for these terms. The existence of a 24-hour period of nongravitational origin is confirmed. A review and discussion is given regarding Love's numbers k and h and their significance in terms of the properties of the interior of the earth.—*P. E. B.*

13811. Malone, A. B. A nomogram for the computation of tidal deviations of the vertical: Geophysics, v. 17, no. 3, pp. 615–619, 1952.

A nomogram for the computation of the tidal deviations of the vertical has been constructed from an adaptation of a nomogram devised by Elkins for the compu-

tation of tidal variations in the vertical component of gravity. The computation is for the deviation produced by a single celestial body. The nomogram determinations of three pertinent angles are combined on the same sheet, and there is a considerable reduction in the labor of computation of the deflection and its direction. Pertinent equations and a diagram of the nomogram are included.—*P. E. B.*

13812. Malovichko, A. K. Sposob analiticheskogo prodolzheniya gravitatsionnykh anomaliy [Method of analytic continuation of gravitational anomalies] : Akad. Nauk SSR Izv., Ser. geofiz., no. 1, pp. 35–39, 1952.

The analytic continuation of gravity anomalies in three dimensions is treated, and a process convenient for numerical calculations is presented.

Assuming axial symmetry solutions of the Laplace equation are obtained in cylindrical coordinates in the form

$$V_z(r, z)=\sum_{k=0}^{\infty} A_k e^{-\lambda k^2} I_o(\lambda_k z),$$

where I_o (λk^z) is a Bessel function of zero order. The coefficients A_k are evaluated from the observed anomalous field with the aid of numerical integration. The method is illustrated by a practical example. The suggested method is also applicable to cases not involving axial symmetry.—*S. T. V.*

13813. Bulanzhe [Boulanger], Yu. D. O nekotorykh sistematicheskikh oshibkaikh kvartesvyhk gravimetrov s gorizontal'noy nit'yu [On some systematic errors of gravimeters with horizontally stretched quartz fiber] : Akad. Nauk SSSR Izv., Ser. geofiz., no. 2, pp. 31–37, 1952.

The accuracy of several Nørgaard gravimeters of the geophysical institute of the Akademiya Nauk SSSR was tested and two additional sources of error, often unobserved and not indicated by the manufacturer, were disclosed—one caused by the sphericity of the head of the micrometer screw and the second resulting from the noncoincidence of the axis of rotation of the cylinder and the plane carrying the scale.

For the first error the necessary correction is computed according to the formula $g=2g_z\rho(m+2k)/L.^2$ In the instruments tested, the average value of ρ was 1.004 mm; k, 19.22 mm; and L, 266.14. This correction is always negative; absolute values are given in a table. With this correction applied, the error of the reading can be made less than ± 0.03 mgal.

It is difficult to establish an analytical formula for the corresponding correction for the second source of error and therefore necessary to establish empirical calibration curves for the constants of the instrument. The use of such curves will make the error in the reading smaller than 1/1000 of the measured Δg, the relative difference of gravity.—*S. T. V.*

13814. Worzel, J. L. and Ewing, Maurice. Gravity measurements at sea, 1948 and 1949 : Am. Geophys. Union Trans., v. 33, no. 3, pp. 453–460, 1952.

The long-range program of gravity measurements at sea first reported in Geophys. Abstract 12522 has been continued. During 1948–49, 180 observations were made in the Bahama Islands area, 118 along the east coast of the United States between Key West and Cape Hatteras, 363 in the Pacific Ocean, and 142 along the west coast of Canada, south coast of Alaska, in the Aleutian Islands, and the Bering and Chuckchi Seas.—*M. C. R.*

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13815. Boaga, Giovanni, and Tribalto, G. Il gravimetro "Western G. C." no. 49 del Servizio geologico d'Italia [Western G. C. gravimeter no. 49 of the Servizio Geologico d'Italia]; Servizio geol. Italia Boll., v. 72, anno 1950, fasc. 1, pp. 145–160, 1951.

The Western gravimeter is described in detail, and its operation analyzed including the determination of attainable sensitivity and possible sources of errors. The importance of a very accurate temperature regulation is emphasized. The gravimeter was calibrated by determining the force of gravity at different floors of a tall building. The constant of the instrument was later checked by relative measurements made with a pendulum and two other gravimeters with known characteristics. The results obtained were found to be quite satisfactory. The error of the indication of the instrument is estimated as ± 0.025 milligal.—*S. T. V.*

13816. Bullerwell, W. Gravimeter observations comparing pendulum stations at Cambridge, York, Newcastle-upon-Tyne, Edinburgh and Aberdeen: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 5, pp. 303–315, 1952.

A gravimeter was used in checking the differences in gravity among the pendulum stations at Cambridge, York, Newcastle upon Tyne, Edinburgh, and Aberdeen. The measurements were consistent with the previous pendulum observations. The instrument used was a Frost gravimeter. An adjusted value of the calibration constant for this meter was determined from the pendulum measurements. The Frost gravimeter and a Worden gravimeter were used in examining the departure of the vertical gradient from the free-air correction in Westminster Cathedral. The departure was found to be appreciable below the first three stages of the building. The mass of the building and excavations below ground level are presumably responsible for the discrepancy.—*P. E. B.*

13817. Cook, A. H. A measurement of the difference of gravity between the National Physical Laboratory, Teddington and the Ordnance Survey Office, Southampton: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 5, pp. 319–323, 1952.

The difference in gravity between the National Physical Laboratory and the Ordnance Survey Office was determined with the Cambridge pendulum apparatus. The measurement at the site of Clark's absolute determination was found to be 69.90 ± 0.16 mgal greater than that measured in the Bar Room of the Ordnance Survey Office. The site of the latter measurement is indicated in a diagram and data for the half periods of the pendulums are included. The measurements are in agreement with direct and indirect gravimeter measurements.—*P. E. B.*

13818. Saxov, S. E. The Danish gravity reference stations: Geodaetisk Inst., Meddelelse no. 25, 30 pp., 1952.

A short history of gravity measurements is included with the latitudes, longitudes, elevations and gravity values for the Danish gravity reference stations.—*P. E. B.*

13819. Weiląd ek, Romuald. Podstawowe pomiary gravimetryczne w polochnowschodneiej Poslsce [Gravimetric base measurements in northeastern Poland]: Państwowy Instyt. Geol. Biul. 76, Ser. geofiz. no. 7, 23 pp., 1951.

This is a report on gravimetric base determinations during 1949 in an area of about 35,000 sq km in northeastern Poland. A Nørgaard gravimeter was used and the observatory of the Polish geologic institute in Warsaw served as base station. Sixty-six stations were occupied. Bouguer anomalies were computed and a map of isoanomalies constructed. A detailed description of the Nørgaard gravimeter and its operation is included.—*S. T. V.*

13820. Boaga, Giovanni, Tribalto, G. and Zaccara, Gaetano. Contributo alla costruzione della carta gravimetrica d'Italia, 1° circuito [Contribution to the construction of the gravimetric map of Italy, 1st loop]: Servizio geol. Italia, Boll., v. 72, anno 1950, fasc. 1, pp. 161–181, 1951.

Gravity determinations were made along three profiles of a total length of more than 800 km, from Rome as base station to Bologna. Sixty-two stations were occupied at altitudes of 3 to 600 m above sea level, and with gravity differences between —72 and +67 mgal. Logs of the survey and the observed Fayé and Bouguer anomalies are given in tables. In calculating the latter anomalies, density values ranging from 1.6 to 2.5 were assumed in accordance with data from the recently published geologic map of Italy.

Comparison of these results with those of previous determinations of gravity indicates that the Western gravimeter is well adapted to relative gravity measurements.—*S. T. V.*

13821. Boaga, Giovanni, Tribalto, G. and Zaccara, Gaetano. Contributo alla costruzione della carta gravimetrica d'Italia, 2.0 circuito [Contribution to the construction of the gravimetric map of Italy, 2nd loop]: Servizio geol. Italia, Boll., v. 72, (anno 1950), fasc 2, pp. 75–93, 1951.

During a series of gravimetric measurements in Bari province, the geophysical observatory of Rome (g=980.360 gal) was tied to those at Naples, Bari, and Foggia, using some 45 intermediate stations in profiles about 1,200 km long. In selecting intermediate stations an effort was made to include those points where gravity measurements had previously been made, thus obtaining data for comparison of a number of pendulum and gravimeter determinations.

The results of this survey are presented as tables. In computations of Bouguer anomalies the density values of 1.80 to 2.40 were taken from the recently published geological map of Italy—*S. T. V.*

13822. Oulianoff, Nicolas. Gravimétrie et structures géologiques [Gravimetry in relation to geologic structures]: Soc. vaudoise sci. nat., Bull., v. 65, no. 278, pp. 49–61, 1951; Lausanne Univ., Lab. géol., minéralogie, géophys. et Mus. géol., Bull no. 98, 13 pp., 1951.

A brief description is given of pendulum and gravimeter determinations of gravity. The precision of the different methods is discussed, and the usual reductions of readings defined.

Worden gravimeters will be used in planned gravimetric surveys of Switzerland. These surveys will make it possible to determine the thickness of the sial beneath the Alps and to tie the gravitational networks of Zürich, Geneva and Lausanne.—*S. T. V.*

13823. Coron, Suzanne. Compensation isostatique de masses légères situées au-dessous du géoide. Application à l'interprétation des anomalies isostatiques du Bassin Parisien [Isostatic compensation of light masses situated beneath the geoid. Application to the interpretation of the isotatic anomalies of the Paris Basin]: Acad. sci. Paris Comptes rendus, tome 234, no. 9, pp. 977–979, 1952.

To permit a reasonably accurate geologic interpretation of isostatic anomalies, it is necessary to take account not only of differences in density of topographic masses but of terrain at lower levels. A few simple calculations using the Cassinis tables indicate the importance not so much of the total mass of sediments but of their distribution and relative dimensions. Two maps of isostatic anomalies are shown, one calculated according to the Airy hypothesis with depth of compensation of 40 km, and the other assuming a basin composed of sediments of density 2.3.—*M. C. R.*

13824. Coron, Suzanne. Essai d'interpretation des anomalies isostatiques du Bassin Parisien [Attempt at the interpretation of the isostatic anomalies of the Paris Basin]: Acad. Sci. Paris Comtes rendus, tome 234, no. 10, pp. 1075–1077, 1952.

This is a detailed geologic interpretation of anomaly maps discussed in the previous paper.—*M. C. R.*

13825. Cook, A. H. The gravitational attraction of a deposit of clay: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 5, pp. 244–251, 1952.

The results of studies by Skempton and others on the process of consolidation are used to estimate the gravity anomalies over clay deposits consolidated under their own load. Examples of typical clays are discussed, and a procedure given for correcting anomalies, using the intrinsic parameters of the clay, the void ratio and mineral density at the surface, thickness of deposit, and variability of material with depth. The importance of the calculations described lies in the demonstration that the effects of consolidation are sufficient to justify special studies of particular areas. They also indicate that isostatic compensation cannot be considered demonstrated until it has been proved that the observed anomalies cannot be explained as the result of consolidation.—*M. C. R.*

13826. Parasnis, D. S. A study of rock densities in the English Midlands: Royal Astron. Soc: Monthly Notices, Geophys. Supp., v. 6, no. 5, pp. 252–271, 1952.

A method for determining rock densities by gravimetric means is discussed, and examples are given. The regional gravity is eliminated from density profiles by determining the general trends of the anomalies from reductions based upon specimen densities. Stations are then chosen at points of equal Bouguer anomaly. It is shown that for equal Bouguer anomalies a linear function of the specimen density may be employed in calculating a better value. Extensive studies were made of a number of rock samples (apparently 54). Tabulated data for these specimens are included. It is concluded that rock densities in the western Midlands of England do not appear to show any "regional variation."—*P. E. B.*

MAGNETISM AND ELECTRICITY

13827. Yrizar, Pedro de, Mendez de Vigo, Alfonso, Peña, Vicente and Munuera, J. M. Estudio sobre equipos magnéticos para determinación de valores absolutos [Investigation of magnetic instruments for determinations of absolute values]: Inst. Geog. y Catastral Mem., tomo 20, no. 4, 116 pp., 1950.

Because of difficulties in obtaining modern scientific apparatus during the last war, the Servizio de Magnetismo y Electricidad Terrestre made a detailed study of available instruments for magnetic surveys. Not only was the functioning of different instruments tested, but also the methods of measurement of magnetic vectors to eliminate sources of errors and attain the highest precision. A description is given of the testing and adjusting of gimbal suspension, centering of the axis of different instruments, determination of scale value, of the moment of inertia of a magnet, of its coefficients of induction and temperature.—*S. T. V.*

13828. Maino, Armando. Taratura del magnetometro 177 de Kew [The calibration of the Kew no. 177 magnetometer]: Servizio geol. Italia, Boll., v. 73, anno 1951, fasc. 1, pp. 149–159, 1951.

After a brief description of the instrument, procedures for determining its four basic constants are explained. These constants are: the coefficient of induction of the magnets, determined by reduction of the declination to zero following Lamont's method; temperature coefficient of the deflecting magnet, determined by the measurements of the deflection produced at different temperatures of the magnet; moment of inertia of the auxiliary magnet, determined from the period of its oscillations; and scale constants of the instrument and of the collimator.—*S. T. V.*

13829. Haalck, Hans. Über die Ursachen des magnetischen Rindenfeldes der Erde [On the causes of the magnetic field of the crust of the earth]: Gerlands Beitr. Geophysik, Band 62, Heft 3, pp. 208–221, 1952.

It is generally assumed that the observed geomagnetic field is composed of two parts, each resulting from different physical causes. The greater component is that of the magnetism of the earth's core; the other, the magnetism of the crust. The latter can be identified with the portion of the total earth's field which deviates from rotational symmetry. The magnetism of the crust is attributed to two factors: the electromagnetic action of telluric currents flowing in the deeper layers of the crust and the permanent magnetism of certain rocks.

Two systems of telluric currents can be found in the crust: one is the American galvanic vortex, flowing clockwise, the other, the Afro-Australian, circulating in the opposite direction. These two systems coincide with the two geosynclinal zones of the earth—the circum-Pacific and the Mediterranean.—*S. T. V.*

13830. Cullington, A. L. The magnetic secular variation in New Zealand: New Zealand Jour. Sci. Technology, v. 33, Sec. B, no. 5, pp. 355–372, 1952.

From repeat observations between 1940 and 1950 at 62 stations in New Zealand, secular change of D, H, and I were calculated for epoch 1947.5. Charts showing isoporic lines for these components and also change in total, vertical, northerly and easterly intensity were made. Disagreement between these

determinations and Vestine's 1942.5 data shows that for navigational purposes continuation of the secular variation program is necessary.—*W. J. D.*

13831. Gibault, G. Variations rapides du champ magnétique terrestre [Rapid variations of the earth's magnetic field]: Annales Géophys., tome 8, no. 2, pp. 258–259, 1952.

A brief review is given of some previous work on the correlation of the rapid variation of telluric currents with the time rate of change of components of the magnetic field of the earth. Measurements at Chambon-la-Forêt of the short-term variations of the horizontal component revealed that amplitudes are generally greater during the day, and periods greater at night. The times of particular average activity are given and the general nature of the variations described.—*P. E. B.*

13832. Denisse, J.-F. Relation entre l'activité-géomagnétique et l'activité radioélectrique solaire [The relation between geomagnetic activity and radioelectric solar activity]: Annales Géophys., tome 8, no. 1, pp. 55–63, 1952.

Measurements of radiosolar noise at a frequency of 158 megacycles per second, indicate that it is possible to discriminate among solar activity centers of intensity 2 or 3. These are followed one or two days later by an increase in world-wide geomagnetic activity. The study covers the relatively strong period of solar activity lasting from January 1, 1948 to January 1, 1951. The relation between radiosolar noise and geomagnetic activity is expressed by a correlation function, and graphs are included. The detection of the active centers of disturbance on the sun was made by a statistical method, as adequate interferometric data were not available. Magnetic storms of gradual initiation and recurrent storms have no apparent correlation with radiosolar noise. Marked storms with sudden beginnings contribute noticeably to geomagnetic activity.—*P. E. B.*

13833. Bernard, Pierre. Interprétation de la variation undécennale de la composante horizontale du champ magnétique terrestre [Interpretation of the 11-year variation of the horizontal component of the geomagnetic field]: Acad. Sci. Paris Comptes rendus, tome 234, no. 8, pp. 866–868, 1952.

The 11-year component of the horizontal magnetic field at 37 stations exhibits a minimum 1.1 years after the maximum sunspot activity, and a total amplitude of 20 gammas. This variation could be explained by a general circulation of the atmosphere in the region of transition at an altitude of about 75 km where the collision interval of electrons exceeds their gyromagnetic period, which limits their displacement in the direction perpendicular to the lines of force, while the positive ions are carried away in the general movement of their media, the ionization of which varies with solar activity.—*M. C. R.*

13834. Bernard, Pierre. Isolement de la variation undécennale de la composante horizontale du champ magnétique terrestre par combinaisons linéaires d'ordonnées. [The segregation of the 11-year variation of the horizontal component of the geomagnetic field by linear combinations of ordinates]: Annales Géophys, tome 8, no. 2, pp. 248–252, 1952.

Curves of the periodic 11-year variation of the mean annual value of H have been determined by the method of Labrouste, and graphs of the results are

presented. Calculations have been made for data from 37 observatories. Irregularities in the lagging of the general minimum of H (about a 1-year lag) behind maxima of solar activity appear to be associated with areas of tectonic unrest. The curves indicate that less important perturbations were rather irregular during the period 1894–1906, and that the variations flattened during the period 1929–1934 for very many stations. A latitude effect is apparent in the amplitude of the variations, with a maximum around 35°. The greatest amplitude is found at Honolulu. The variations are almost of the same amplitude when calculated using calm days and all days, a result difficult to explain by the post-perturbation effect.—*P. E. B.*

13835. Ryskina, Z. V. Sutochnyy khod magnitnoy aktivnosti po *K*-indeksu v Kelese [Diurnal variation of magnetic activity according to *K*-index in Keles]: Tashkent Geofiz. Observatoriya Trudy, vypusk 4 (5), pp. 10–12, 1950.

Using magnetograms of Keles magnetic observatory for 1941–46, a statistical analysis of diurnal magnetic activity has been made for winter and summer months, with observational data separated into three types: quiet days (variations of magnetic vector less than 40 gammas), moderately disturbed days (variations ranging from 80 to 100 gammas), and very disturbed days (variations over 200 gammas). The results are presented as graphs and tables.—*S. T. V.*

13836. Murphy, Thomas. Provisional values for magnetic declination in Ireland for the epoch 1950.5: Dublin Inst. Advanced Studies, Geophys. Bull., no. 2, 3 pp., 1951.

Results of a magnetic survey of Ireland, carried out during the summer of 1950, are presented in the form of a map. It is believed that values obtained for declination are accurate to 2 min.—*L. E. B.*

13837. Press, Frank and Ewing, Maurice. Magnetic anomalies over oceanic structures: Am. Geophys. Union Trans., v. 33, no. 3, pp. 349–355, 1952.

Computed total magnetic intensity anomalies are presented of two dimensional structures of a volcanic island, (Bermuda), a continental border, (the Continental Shelf south of Long Island), and a crustal fold associated with a negative gravity strip, (north of Puerto Rico). The role of the airborne magnetometer is stressed as a method of investigating oceanic and continual structures.—*J. L. M.*

13838. Beaufils, Y. Répartition spectrale des variations rapides dans les courants telluriques [Spectral analysis of rapid variations in telluric currents]: Annales Géophys., tome 8, no. 1, pp. 100–104, 1952.

Simultaneous measurements of telluric currents were made for a 48-hour period from September 27, 1948 to September 29, 1948, in France, Italy, and Morocco. The currents were detected in 500-meter cables in France and Morocco and with a 1,000-meter cable in Italy. A Fourier analysis was made of the data for the 24-hour period of September 28, the period being divided into 6 intervals. A 10-minute interval was chosen for each of the 6 divisions for which the oscillations were relatively uniform. Significant variations are restricted to daytime. At $5^h\ 34^m$ and $9^h\ 29^m$ the energy was concentrated in the band included by the 21st and 26th harmonics (T=23, 28 sec.). At $14^h\ 02^m$ the band was observed to spread out with limits of the 15th and 23rd harmonics (T=26, 40 sec.). At 16^h

39m the band was displaced toward the higher frequencies with limits of the 23rd and 32nd harmonics (T=19, 26 sec.)—*P. E. B.*

SEISMOLOGY

13839. Altenburg, Kurt. Die Dispersion longitudinaler Raumwellen [Dispersion of longitudinal body waves] : Gerlands Beitr. Geophysik., Band 61, Heft 4, 240–249, 1950.

Absorption and dispersion of longitudinal seismic waves may be produced by inner friction, heat dissipation, and intramolecular vibration. Heat conductivity within the earth's crust is especially important and on this the theory of Kneser on the absorption of ultrasonic waves is cited. The importance is stressed of Kuhn's studies, which showed that when the period of the waves approaches relaxation time, transverse waves cannot be propagated. The variation of absorption with frequency causes anomalous dispersion of the waves so that the radius of the earth's core, according to Kuhn, is greater for longer waves than for short ones. The phenomenon of dispersion to be expected on the core is discussed.

On the basis of his own determinations, the author concludes that Kuhn's theory concerning the physical state of the earth's interior is confirmed, but no conclusions on the chemical composition of the core of the earth are justified. (*See also* Geophys. Abstract 11945).—*S. T. V.*

13840. Takahashi, Takehito and Satō, Yasuo. On the theory of elastic waves in granular substances, pt. 2: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, pp. 37–43, 1950.

In the first paper, (Geophys. Abstract 12533) the solution for a three-dimensional lattice was solved by regarding an aggregate of aelotropic bodies as if the whole were an isotrope. In this paper the aelotropic nature of the lattice structure is considered directly.—*I. Z.*

13841. Homma, S. On boundary shear waves at an inner zone with continuously varying properties and related problems for surface waves: Geophys. Mag., v. 23, no. 1, pp. 25–54, 1951.

Boundary shear waves in an inner zone are discussed assuming the non-existence of discontinuities between the inner and adjacent zones. It is further assumed that the rigidity and density vary with depth in some prescribed manner and that the velocity of the S wave is finite at large distances from the inner zone. If the velocity of the S wave is a minimum in the zone, boundary shear waves whose energy is concentrated chiefly in this zone can be propagated. There are an infinite number of waves of different orders. The velocity increases with increasing wave length reaching an upper limit equal to the maximum velocity of S wave at large distances from the inner zone. The wave length of the greatest velocity is longer when the order of the wave is lower and in the wave of the lowest order, the wave length becomes infinitely long.

The propagation of surface waves in a semi-infinite body of which the density and rigidity vary continuously with the distance are also discussed. The problem differs from other similar investigations in that the density and rigidity at infinite distances from the free surface approach finite asymptotic values. Surface waves of long wave length are found to propagate along the free surface—*I. Z.*

13842. Homma, S. Initial value problem in the theory of elastic waves: Geophys. Mag., v. 23, no. 2, pp. 145–183, 1952.

The boundary-value problem of the generation of elastic waves in spherical polar coordinates is described. The components of displacement are rigorously derived in terms of the known displacement and velocities on the boundary. The problem is divided into two kinds. The first occurs where the radial component of the curl of the generated wave is zero; the second is obtained by equating the divergence of the displacement of the generated wave to zero. In both cases the forms of the generated waves are more complicated than the forms of the distribution of initial values. Unfortunately, formulas are given only for smaller orders of azimuthal symmetry.—*I. Z.*

13843. Satō, Yasuo. Rayleigh waves propagated along the plane surface of horizontally isotropic and vertically aelotropic elastic body: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, pp. 23–29, 1950.

Using the expressions derived by S. Homma, the mathematical existence of one and only one kind of Rayleigh wave in a horizontally isotropic but vertically aelotropic semi-infinite elastic medium is demonstrated.—*I. Z.*

13844. Jardetzky, W. S. and Press, Frank. Rayleigh-wave coupling to atmospheric compression waves: Seismol. Soc. America Bull., v. 42, no. 2, pp. 135–144, 1952.

The theory of dispersive Rayleigh waves coupled to atmospheric compressional waves is derived for the case of a solid surface layer. Numerical computation of phase and group velocity curves indicates that an additional branch may be introduced to the dispersion curves as a result of air coupling. This branch corresponds to a train of approximately constant frequency waves beginning with the arrival of the air wave and continuing to a time which depends on the distance and the elastic constants of the layers.—*M. C. R.*

13845. Kanai, Kiyoshi. The effect of solid viscosity of surface layer on the earthquake movements: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, pp. 31–35, 1950.

The propagation of a plane distortional wave vertically upwards in an elastic semi-infinite medium and through the bottom boundary of a superficial layer is discussed. Reflections at the surface and at the bottom of the layer are also considered. Four curves of amplitude against frequency are drawn for cases representing various physical constants. It is concluded that when the surface layer has a large coefficient of solid viscosity and the ratio of the elasticity of the stratum to the subjacent medium is small, a sharp peak occurs in the curve, whereas if the ratio of elasticity is not small, the amplitude-frequency curve is relatively flat. For a small coefficient of solid viscosity in the superficial layer and a small ratio of elasticity of the two adjacent media, resonant peaks of higher order occur whereas for a larger ratio of elasticity, the highs are not clearly defined.—*I. Z.*

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13846. Gassmann, Fritz. Über die Elastizität poröser Medien [On the elasticity of porous media] [In German with English summary]: Zürich Inst. für Geophysik Mitt., no. 17, 23 pp., 1951; Vierteljahrsschrift Naturf. Gesell. Zürich, Jahrg. 96, Heft 1, pp. 1–23, 1951.

This is a detailed report of theoretical studies of the elastic properties of porous media, presented in part to the meeting of the Schweizerische Naturforschende Gesellschaft in 1950. (*See* Geophys. Abstract 13148).

A porous medium consists of a solid phase which may be either a connected frame or an unsolidified aggregate of grains and a liquid or gaseous phase filling the pores. These media are characterized by differential elasticity, that is, they can be treated as perfectly elastic as long as they are subject to sufficiently small variations of stress. The differential elasticity of an isotropic medium is described by two characteristic moduli of elasticity, from which every other modulus can be computed. The elastic moduli of closed porous systems are determined from the moduli of the solid matter of which the frame is built and of the filling of the pores. This makes it possible to calculate the velocities of longitudinal and transverse waves in the porous medium. As an example, the derived formulas are applied to dry sandstone and to sandstone filled with water. Formulas are also extended to the problem of a porous medium with an anisotropic frame.—*S. T. V.*

13847. Vvedenskaya, A. V. Ob opredelenii dinamicheskikh parametrov ochagov zemletryaseniy po nabyudeniyam udalennykh stantsiy [The determination of dynamic parameters of the foci of earthquakes from the records of remote stations]: Akad. Nauk SSSR Doklady, tom 80, no. 4, pp. 591–594, 1951.

This is the extension of the studies of the dynamic characteristics of the initial shock generated in the focus of an earthquake (*See* Geophys. Abstracts 12549, 12934–36). In previous investigations a homogeneous medium with plane boundaries was assumed, but in dealing with the records of remote stations it is necessary to assume a heterogeneous medium. To reduce the influence of heterogeneity the author introduces as basic data only the parameters less affected by it, and chooses as such: the values of the initial displacements of P and S waves; the direction of the initial displacement of the S wave; the character of the initial displacement of the P wave.

The problem is solved geometrically assuming as an approximation for the path of the wave the tangent to the wave ray at the focus. From the geometrical relations it can be concluded that for a simple force and for two forces not producing a moment, only one nodal line is possible, and the approximate equation of this line is given. A double force with a moment gives two nodal lines.

The suggested method is applied to four earthquakes observed in different regions of Central Asia. For three of these earthquakes the results obtained appear probable and compatible with the known geology of the region, but for the fourth the results are of doubtful value.—*S. T. V.*

13848. Gamburtsev, G. A. O glubinnom seysmicheskom zondirovanii zemnoy kory [Deep seismic sounding of the earth's crust]: Akad. Nauk SSSR Vestnik, no. 4, pp. 113–114, 1952.

This is a summary of a paper read before the Division of Physicomathematical Sciences of the Russian Academy of Sciences, in March 1952. During 1950–51 in the region of Tien Shan, mountains in Kirgiz S. S. R., extensive tests were

made on the possibility of increasing the depth of seismic sounding. By producing artificial seismic shocks and recording the resulting waves at distances of as much as 400 km, it was found possible to observe formations at depths to about 50 km. Thus both the thickness of granite and basalt layers beneath this area, as well as the depth of the discontinuity separating them, were reliably determined.

Another problem studied was the determination and continuous recording of seismic volocities in the deeper formations. There are indications that these velocities are influenced by seismic processes preceding and following an earthquake. If this is so, the observed variations of seismic velocity can serve as a means of predicting subsequent seismic shocks.—*S. T. V.*

13849. Gubin, I. E. O prognoze mest vozniknoveniya zemletryaseniy po seysmicheskim i geologicheskim dannym [Predicting of the sites of occurrence of earthquakes from seismic and geologic data] : Priroda, no. 4, pp. 55–65, 1952.

Until recently, evaluation of the seismicity of a region has been made on the basis of statistical data by assuming that the frequency and intensity of earthquakes in the future will be about the same as in the past. But instrumental observations began only about 50 years ago, and in many sparsely populated areas of the U. S. S. R. very little is known about the past seismicity.

For example, in 1890 a map was prepared of seismically endangered areas of Turkestan on the basis of all data available at that time ; and in the last 60 years 25 destructive earthquakes have occurred in parts indicated as free of violent shocks.

It can thus be concluded that the occurrence of earthquakes must be studied in relation to tectonic causes, investigating by geological and geophysical methods subsurface structure, trying to determine from seismologic evidence zones of relative movements along contacts of different formations. Especially important are studies of the dynamic properties of dislocations occurring in the focus, such as those of Keylis-Borok. [*See* Geophys. Abstracts 12549 and 12935.]

This "seismogenetic" method of seismic zoning is said to be much more effective and accurate than the statistical method. An example is cited of a map of Garmskaya Oblast' prepared in 1948, on which earthquakes were predicted in several localities previously free of shocks. Two such predictions have already been fulfilled, with great accuracy as to the position of epicenter, intensity of shocks, and affected area.—*S. T. V.*

13850. Neumann, Frank. Principles underlying the interpretation of seismograms : U. S. Coast and Geodetic Survey, Special Pub. 254, 41 pp., 1951.

This is the first printed edition of a publication first issued in mimeographed form in 1930. It is designed to assist the seismograph station director, the student, or an amateur seismologist. Among the topics discussed are the nature of seismic waves, the response of seismographs to seismic waves, travel-time charts, identification of phases, interpretation of records, earthquake intensity and magnitude, and the nomenclature used in instrumental reports.—*M. C. R.*

13851. Gutenberg, Beno. Waves from blasts recorded in southern California : Am. Geophys. Union Trans., v. 33, no. 3, pp. 427–431, 1952.

Travel times of waves from five atomic explosions in Nevada and a quarry blast of about 120,000 lbs at Corona, Calif., have been determined from records

of stations in the Berkeley, Pasadena, and U. S. Coast and Geodetic Survey groups. From these records and similar data reported previously, the following average velocities of longitudinal waves in southern California have been found: 5.9 kmps below the sediments; a gradual or sudden increase to about 6.5 kmps near a depth of 6 km, and to about 6.9 kmps near 10 km; about 8.2 kmps below the Mohorovičić discontinuity at a depth of 35 to 40 km. There are no clear phases from which the velocity at depths between about 15 and 35 km can be found. The velocity of shear waves below the sediments is about 3.6 kmps. Waves through the air were also recorded.—*M. C. R.*

13852. Officer, C. B., Jr., Ewing, Maurice, and Wuenschel, P. C. Seismic refraction measurements in the Atlantic Ocean, Part IV: Bermuda, Bermuda Rise, and Nares Basin: Geol. Soc. America Bull., v. 63, no. 8, pp. 777–808, 1952.

A series of refraction profiles in the vicinity of the Bermuda Islands and along two traverse lines south and southeast of Bermuda to the northern edge of the Nares Basin [Nares Deep] were made during 1950 and 1951. On profiles near the Nares Deep four layers were identified: unconsolidated sediments with a velocity of 1.70 kmps, consolidated sediments and/or volcanic rocks with a velocity of 4.53 kmps, and crystalline basement rocks with velocities of 6.63 kmps and 8.03 kmps. The discontinuity between the basement layers is at a depth of about 10 km and corresponds to the Mohorovičić discontinuity. Only one basement layer (velocity 7.16 kmps) was found over the Bermuda rise. The thickness of the consolidated volcanic and/or sedimentary rocks and unconsolidated material decreases outward from Bermuda. A depression in the basement about 90 km from Bermuda has been filled with 5.5 km of sediments and volcanic rocks. Two smaller depressions were found at distances of 280 and 560 km. The Bermuda Island profiles indicated an average velocity of 5.25 kmps. Depth calculations from these profiles, the deep boring on Hamilton [Bermuda] Island, and known geology of the islands lead to the conclusion that the volcanic platform was planed to its present depth during a Pleistocene lowering of sea level, thus substantiating the hypothesis stated by Daly in 1910.—*M. C. R.*

13853. Kanai, Kiyoshi. The result of observation of wave-velocity in the ground: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 3, pp. 503–509, 1951.

Velocities of longitudinal waves from explosions were experimentally determined at the Hitachi mine, Ibaraki-ken. Velocity increased with depth to 250 m, beyond which it was constant, 5.5 kmps. The velocity distribution in the upper 130 m seems to be represented by the empirical formula $v=0.6+(1+718\,z)(1+96\,z)$ (where v=velocity at depth z).—*M. C. R.*

13854. Båth, Markus. Initial motion of the first longitudinal earthquake wave recorded at Pasadena and Huancayo: Seismol. Soc. America Bull., v. 42, no. 2, pp. 175–195, 1952.

The geographic distribution of compressions and dilatations recorded at Pasadena and Huancayo have been compiled and results are shown on maps. The distribution indicates that the general tectonic forces are the same within relatively large areas.—*M. C. R.*

13855. Denson, M. E., Jr. Longitudinal waves through the earth's core: Seismol. Soc. America Bull., v. 42, no. 2, pp. 119–134, 1952.

Amplitudes, periods, and travel times of longitudinal waves through the core have been investigated on the records of the Pasadena network stations, Tucson, and Huancayo, and data from La Paz and Jena bulletins. The data indicate that the epicentral distance of the main focal point of longitudinal waves through the core varies with the period, being near 143° for long period waves and 147° for short-period waves. This may be the result of dispersion. Energy relationships in addition to time-distance data and period data suggests a discontinuity at the inner-core transition zone.—*M. C. R.*

13856. Gutenberg, Beno. SV and SH: Am. Geophys. Union Trans., v. 33, no. 4, pp. 573–584, 1952.

From theoretical considerations it is shown that if incident *SV* waves are totally reflected, the reflected *SV* waves show a phase displacement with respect to the incident waves, and the ground particles move in ellipses. Such motion cannot properly be called a surface wave because it does not propagate energy along the surface and has no velocity of its own.

Horizontal and vertical components of ground displacements in *SV* have been calculated as a function of the angle of incidence assuming a Poisson's ratio of 1/4. Near the critical angle, relatively large displacements occur, resulting mostly from the reflected longitudinal wave. If the angle of incidence increases beyond the critical angle and approaches 45°, the horizontal component decreases toward zero. Between the critical distances, roughly 30 and 3,000 km, ground motion produced by *SV* shows complications connected with the total reflection of *SV*. Relatively large horizontal motion is expected near the two critical distances.

Pasadena records of about 60 shocks with epicentral distances between 25° and 80° were used to study the behavior of recorded *S*-waves. Essential data for each shock are tabulated. No evidence is found for a delay of *SV* relative to *SH*.—*M. C. R.*

13857. Dehlinger, Peter. Shear-wave vibrational directions and related fault movements in Southern California earthquakes: Seismol. Soc. America Bull., v. 42, no. 2, pp. 155–173, 1952.

Directions of initial motions of transverse waves from more than 200 small earthquakes in southern California have been determined and related to fault displacements. A theoretical relationship between vibration directions and fault displacements has been derived. Results of the study indicate that horizontal components of faulting in southern California are usually in the same direction, but vertical components vary. The fault pattern deduced from seismic data agrees with the northwesterly trending right-handed transcurrent faults and east-west thrust faults indicated by geologic mapping, suggesting that present-day faulting is similar to that of the recent geologic past. The over-all fault pattern in southern California is consistent with a stress distribution in which a north-south principal stress direction is a maximum and in which the ratio of east-west and vertical stresses to each other differs in different areas.—*M. C. R.*

13858. Heinrich, R. R. and Haill, H. K. On the recorded motion of the *S* phase at Florissant: Seismol. Soc. America Bull., v. 42, no. 2, pp. 145–154, 1952.

Initial motions of *P* and *S* phases for 60 earthquakes in the Aleutian Islands, South America, and Central America have been tabulated. A preferred direction of motion is indicated. Data compiled on the *S* phase show a majority of Aleutian and South American earthquakes recorded a sharp impulsive northeast motion. *S* phases from shocks in Central America had a somewhat indefinite onset.—*M. C. R.*

13859. Coulomb, Jean and Molard, Pierre. Propagation des ondes séismiques *T* dans la mer des Antilles [Propagation of *T* phase waves in the Caribbean Sea]: Annales Géophys., tome 8, no. 2, pp. 264–266, 1952.

Unpublished studies suggest that the *T* phase cannot be considered to be Rayleigh waves modified by the presence of water. The only remaining possibility is propagation in the sofar channel. The *T* phase was examined at the Observatoire de la Martinique on records of earthquakes whose epicentral locations were compatible with those of the U. S. Coast and Geodetic Survey. The arrival times of the initial disturbance and maximum amplitude were examined for consistency of results in the analysis. The different earthquakes and the difficulties in interpretation are discussed in detail. The velocities for the continental portions of the path seem possible only for *S* waves. This fact seems to be supported elsewhere by theoretical studies of refraction at the ocean bottom.—*P. E. B.*

13860. Hayes, R. C. Wave periods in New Zealand local earthquakes: New Zealand Engineering, v. 5, pp. 896–898, 1950.

Combined results of wave measurements in local earthquakes from the records of six New Zealand seismograph stations are given. In general, the results indicate dominant periods of 0.2 to 0.7 sec in *P* waves, and 0.5 to 1 sec in *S* waves. Dominant periods at Wellington are shorter. Periods increase with epicentral distance for shallow-focus shocks but not deep-focus shocks. An increase of period with magnitude is most marked in the *S* waves, especially for magnitudes above 4½.—*M. C. R.*

13861. Koning, L. P. G. Earthquakes in relation to their geographical distribution, depth and magnitude: K. Nederland. Akad. Wetensch. Proc. Ser. B. v. 55, no. 1, pp. 60–77, 1952.

It has been proposed that the foci of deep-focus earthquakes may be arranged on an inclined surface sloping to a depth of about 600 km and dipping toward the continent. To investigate this relationship, with particular reference to the East Indian [Malay] Archipelago, the earth has been divided into layers, at 50- and 100-km intervals, to a depth of 720 km and for each layer a map has been drawn showing epicenters of shocks occurring in it. Epicenters of shocks of the same magnitude have then been connected by isomagnitude lines. Profiles show the relationship of magnitude to depth.

It is concluded that the earthquake foci of all depths in the Malay Archipelago cannot be arranged on one sloping surface. There are two separate seismic zones, one along the west coast of Sumatra, Java, and the Lesser Sunda Islands to New Guinea and a J-shaped belt in the northeastern part. There is more or less regular distribution, both vertical and horizontal, of the centers of relatively

strong seismic activity. There seem to be two groups of shallow shocks, one group of those closely related to intermediate shocks, and the other of those interpreted as local crustal phenomena.—*M. C. R.*

13862. Asada, Toshi, Suzuki, Ziro, and Tomoda, Yoshikumi. Notes on the energy and frequency of earthquakes: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 2, pp. 283–287, 1951.

The relation between energy and frequency of earthquakes deduced by Gutenberg and Richter applies only to the magnitude scale devised by Richter. However, it agrees with similar relationships determined by Kawasumi for earthquakes near Japan and by Ishimoto and Iida for small earthquakes.— *M. C. R.*

13863. Murphy, L. M. and Ulrich, F. P. United States earthquakes 1950: U. S. Coast and Geodetic Survey Serial 755, 47 pp., 1952.

This is a summary of earthquake activity in the United States, Alaska, Hawaii, the Canal Zone, and Puerto Rico for the calendar year 1950. Included also are tables of instrumental epicenters for 1949, principal earthquakes of the world in 1950, fluctuations in well-water levels in 1950, and strong-motion data for the year. The strongest shock of the year was that of July 29 in southern California (intensity 8, modified Mercalli scale). Other strong shocks were those of December 14, in northern California (intensity 7), April 14, in Washington (intensity 6), and September 5, in southern California (intensity 5–6).—*M. C. R.*

13864. Byerly, Perry. Pacific Coast earthquakes, 38 pp., Eugene, Oregon State System of Higher Education, 1952.

This is the text of the Condon Lectures. The subjects discussed are the distribution of earthquakes on the Pacific coast of the United States, the causes of earthquakes, instrumental seismology, and the size and effects of earthquakes. A list of earthquakes felt in Oregon between 1866 and 1949 is included.—*M. C. R.*

13865. Schwarzbach, M. Die Erdbehen des Rheinlandes [The earthquakes of the Rhineland]: Kölnische Geol. Hefte, no. 1, 28 pp., 1951.

Geologic considerations of the causes and specific characteristics of the earthquakes of the Rhine valley are presented. These earthquakes are of tectonic nature, and nearly always related to principal faults. In central Europe such tectonic earthquakes usually occur in the lower portion of the Rhine valley, where they are quite numerous, but slight. Earthquakes of great intensity have never occurred here. From the abstract by G. Seidel in Glückauf, Jahrg. 87, Heft 39–40, pp. 945–946, 1951.—*S. T. V.*

13866. Lahn, E. Seismic activity in Turkey from 1947 to 1949: Seismol. Soc. America Bull., v. 42, no. 2, pp. 111–114, 1952.

During 1947–1949, two disastrous earthquakes and 350 minor shocks were recorded in Turkey. Forty-five percent of the latter occurred in the Aegean-Marmara seismic zone, 33 percent in the north Anatolian zone, 15 percent in southeast Anatolia, and 7 percent in secondary zones. The shocks of July 23, 1949, and August 17, 1949, are described.—*M. C. R.*

13867. Monakhov, F. I. Nekotorye resul'taty analiza zemletryaseniy Garmskoy oblasti [Some results of the analysis of earthquakes which occurred in the Garm region] : Akad. Nauk SSSR Izv., Ser. geofiz., no. 2, pp. 46–55, 1952.

Determinations of the foci of several earthquakes in Garmskaya Oblast', Tadzhik S. S. R. [Tadzhikskaya SSR] during 1949–1950 are critically analyzed. The depth determinations were based on the difference in time of arrival of various waves, as recorded on seismograms at epicentral distances ranging from 100 to 800 km. The time intervals are related to the travel-time curves of corresponding waves. This presumes knowledge of the distribution of velocities at depth, and also necessitates a positive identification of the various phases on seismograms. Examples are quoted of travel-time graphs in which the time differences in arrival of waves are undistinguishable, as $S—P$ for focal depth of 100 km and $S_n—P_n$ for focal depth of 30 km or $S^*—P_n$ for the depth of 30 km, and $S'—P_n$ for hypocentral depth ranging from 35 to 55 km.

Sometimes the nature of a wave is determined by using its intensity as criterion; for instance, it is usually assumed that P and S are weaker than P_n and S_n. But, as is shown, this is not always so.

Use of apparent velocity is suggested for determination of focal depth. This velocity is much used in applied seismology for identification of different waves. The method does not give the precise depth of the focus, but does give reliable indication as to the layer in which the focus is located.

A table is given of the apparent velocities of different waves coming from various layers—granite, basalt, ultrabasalt. The coordinates of epicenter can be found without knowledge of travel-time curves by the method of hyperbolas.

By applying the suggested method to seismograms of different earthquakes of central Asia, especially to those occurring in Garmskaya Oblast', the author finds the depth of the corresponding foci. Many of his results differ from data published by other seismologists, especially those of Ye. A. Rozova.—*S. T. V.*

13868. Hayes, R. C. Earthquake origins in New Zealand during the year 1949: New Zealand Jour. Sci. Technology, v. 31, Sec. B, no. 4, pp. 43–45, 1950.

Origin times, epicenters, and maximum reported intensity of earthquakes during 1949 in the New Zealand region are tabulated. A map of epicenters and two isoseismal maps are included.—*M. C. R.*

13869. Hayes, R. C. Earthquake origins in New Zealand during the year 1950: New Zealand Jour. Sci. Technology, v. 33, Sec. B, no. 4, pp. 304–308, 1952.

Origin times, epicenters, and maximum reported intensity of earthquakes during 1950 in the New Zealand region are tabulated. A map of epicenters and two isoseismal maps are included.—*M. C. R.*

13870. Hayes, R. C. The Cook Strait earthquakes: 1950 Jan.–Feb.: New Zealand Jour. Sci. Technology, v. 33, Sec. B, no. 4, pp. 309–317, 1952.

The series of earthquakes which occurred during January and February 1950, in the Cook Strait region, New Zealand, were probably caused by a series of minor upthrusts of tectonic origin, on an existing fault, at depths between 15 km and 30 km. It is believed that the intensity of earthquakes of local origin will be limited to magnitude of about 5½. Maps are included showing the epicenters of all shocks and isoseismals of the January 8 and January 13 shocks.—*L. E. B.*

13871. Koshikawa, Yoshiaki. Seismometrical study of the Imaichi earthquake on Dec. 26, 1949: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 2, pp. 295–299, 1951.

The most probable values of the coordinates of the epicenter of the second shock are 36°43.7′ N. lat., 139°39.4′ E. long. The velocity of P^* is 6.0 kmps. The depth of focus of the first shock was 18–22 km, of the second, 14–18 km.—*M. C. R.*

13872. Kishinouye, Fuyuhiko. Time distribution of felt aftershocks of the Imaichi earthquake of December 26, 1949: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 2, pp. 301–303, 1951.

The ratios of earthquakes felt at Ochiai to those recorded at Utsunomiya for the first year following the main shocks were large during the daytime.—*M. C. R.*

13873. Miyamura, Setumi and Akima, Tetuo. Über die Beobachtung der Nachbeben des Imaichi-bebens am Dorfe Hunyu, Provinz Totigi [On the observation of aftershocks of the Imaichi earthquake near the villiage of Hunyu, Totigi-ken] [In Japanese with German summary]: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 3–4, pp. 421–433, 1950.

After the violent earthquake of December 27, 1949, near Imaichi a temporary seismological station was established in the epicentral region near the village of Hunyu [Funyū]. This station was equipped with three matched components, a precise high-speed recording apparatus, and accurate time control.

Comparison of records obtained by this station with those of others not so well equipped indicates that the arrivals of different waves, even of *P* and *S*, cannot be accurately determined from the seismograms of one-component instruments. Microseismic disturbances, probably produced by industrial causes, were also observed. The character of these suggested anisotropy of the ground, but this was not confirmed by experiments with vibrations produced artificially.

Six facsimiles of seismograms and numerous graphs of various observed phases are included.—*S. T. V.*

13874. Normandin, A. Les tremblements de terre de l'Assam (1950) et leurs conséquences hydrologiques [The Assam earthquakes in 1950 and their hydrologic effects]: Rev. Géographie Alpine, tome 40, fasc. 3, pp. 515–520, 1952.

The earthquake of August 15 caused tremendous slides which may in subsequent years produce river obstructions and increase considerably the turbidity of tributaries on the right bank of the Brahmaputra River.—*M. C. R.*

13875. Lopez de Azcona, J. M. El problema de los microseismos [The problem of microseisms]: Inst. geol. min. España, notas y communicaciones, no. 25, pp. 73–84, 1952.

This is a report of a conference on microseisms on November 19–25, 1951 sponsored by the Pontifical Academy of Sciences. Members of the group were Båth, Bernard, Caloi, Due Rojo, Ewing, Gherzi, Giorgi, Hardtwig, Lehmann, Lopez de Azcona, Macelwane, Menzel, Rothé, Stoneley and Vercelli. Results of the conference are summarized in three parts: those points on which general agreement was reached, those on which no concurrence of opinions could be achieved, and suggestions for needed microseism studies. It was agreed by the conference that microseisms are caused by atmospheric disturbances over oceans. Among

the suggestions for further studies, it was agreed to propose an organization of semiannual "international weeks" from March 25 to 31 and from September 24 to 30. A standardization of methods and the measurement of various elements, such as periods and amplitudes was also recommended.—*S. T. V.*

13876. Kishinouye, Fuyuhiko. On the period and the amplitude of microseismic movement: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 3, pp. 483–486, 1951.

Microseisms are divided into three types; one consisting of regular oscillations with periods of 3 to 4 sec and double amplitude less than 20 μ, the second of regular large oscillations with period about 6 sec, and the third of irregular oscillation and no clear-cut distribution of periods. Microseisms of 4-sec period were observed when cyclonic centers were over the sea south of Tokyo. Period and amplitude became large when the sea to the northeast of Tokyo was very rough.—*M. C. R.*

13877. Donn, W. L. An investigation of swell and microseisms from the hurricane of September 13–16, 1946: Am. Geophys. Union Trans., v. 33, no. 3, pp. 341–344, 1952.

Data on sea swell from records of an underwater pressure unit off Cuttyhunk Island near the southwestern tip of Cape Cod were compared with microseisms at Weston Observatory for the same period. No correlation between the periods of the two phenomena was found, and the time relationships between the two are such as to suggest that the exciting mechanism occurs directly beneath the storm rather than from swell or resulting surf.—*M. C. R.*

13878. Lynch, J. J. The Great Lakes, a source of two-second frontal microseisms: Am. Geophys. Union Trans., v. 33, no. 3, pp. 432–434, 1952.

Microseisms recorded at tripartite stations on both sides of the Hudson River near Poughkeepsie, New York, apparently originate west of Poughkeepsie, possibly in the Great Lakes.—*M. C. R.*

13879. Avershin, S. G. Gornyye udary na shakhtakh K'zelovskogo basseyna [Rock bursts in the mines of Kizel basin]: Ugol', no. 6, pp. 1–5, 1952.

Causes of rock bursts, quite frequent in deeper coal mines of Kizel basin, were studied by a committee of Soviet scientists and mining engineers in the field and in laboratories. Rock bursts frequently produce extensive destruction in the mines and seismic shocks in the surrounding areas, noticeable to a distance of some 5 km.

Laboratory tests showed that the specimens of coal and of surrounding formations taken from deeper coal mines possess great strength and are characterized by an almost complete absence of plasticity, so that, on reaching critical loading limit, specimens break into small pieces with a great detonation.

In the opinion of the author, the potential energy stored in the specimen is abruptly liberated and transformed into a destructive force, often observed in the mines. Conditions favorable for such phenomena can be produced in mines, but can be found also in nature when certain minerals are leached out, exposing the overlying formations to excessive stresses, and finally leading to bursting.—*S. T. V.*

13880. Grigor'yev, S. Ye. Gornyye udary na shakhtakh Kizelovskogo basseyna [Rock bursts in the mines of Kizel basin]: Ogol', no. 6, pp. 5–10, 1952.

The author was a member of the governmental committee studying rock bursts together with S. G. Avershin (*see* Geophys. Abstract 13879), but evidently disagrees with him as to the main causes of these phenomena, emphasizing in his article the formation of vaulted ceilings left in the mines after the removal of coal seams. Exposed to enormous pressure and lateral thrust, these ceilings often collapse with all the effects of an explosion. Most of the article deals with the measures to prevent such catastrophes in the mines.—*S. T. V.*

RADIOACTIVITY

13881. Burling, R. L. Determination of geologic time: Nucleonics, v. 10, no. 5, pp. 30–35, 1952.

This is a review of radioactivity methods of determining geologic age. A bibliography of 76 items is appended.—*M. C. B.*

13882. Hultqvist, Bengt. Calculation of the ionization due to radioactive substances in the ground: Tellus, v. 4, no. 1, pp. 54–62, 1952.

Penetrating gamma radiation from the ground can be expressed by the simple formula $I=C\times S$, where S is the proportion of radioactive element in grams per gram and C is a constant. Formulas for the ionization when the ground is covered with an absorber of greater density than air, or when the radiation travels through air for long distances, are derived. The ionization from various minerals is calculated and is found to agree in magnitude with measured values. Curves showing the decrease in the ionization as a function of the depth of snow cover, are given for three different values of snow density. The decrease in the dose rate with the altitude above the earth's surface is shown graphically.—*F. W. S.*

13883. Ippolito, Felice. Sulla radioattività delle lave del Somma-Vesuvio [On the radioactivity of the lava from the summit of Vesuvius]: Soc. naturalisti Napoli Boll., v. 60, (1951), pp. 53–56, 1952.

The Ra content of lava from the summit of Vesuvius has been studied by several scientists and found to increase regularly in the products of more recent eruptions. A similar study by the author confirmed this phenomenon, which is exceptional among known volcanoes. No explanation is yet known; results of investigations now in progress that are related to this question will be communicated later.—*S. T. V.*

13884. Imbò, G. and Casertano, Lorenzo. Distribuzione statistica delle particelle a raccolte su una lastra fotografica in funzione delle projezione del percorso nell' emulsione [Statistical distribution of alpha particles recorded on a photographic plate as a function of the projection of the depth of penetration into the emulsion]: Annali Geofis., v. 3, no. 4, pp. 475–483, 1950.

To make possible the evaluation of the radioactive content of various rocks by the photographic method, the statistical distribution of alpha particles emanating from a point source and recorded on photographic plate has been calculated. The results are presented in the form of graphs and tables.—*S. T. V.*

13885. Imbò, G., and Casertano, Lorenzo. Deduzione delle concentrazioni di uranio e torio nelle sostanze radioattive con il metodo fotografico [Evaluation of the uranium and thorium content of radioactive substances by the photographic method]: Annali Geofis., v. 5, no. 1, pp. 1–12, 1952.

In a continuation of studies on the measurement of radioactivity of minerals by the photographic method, formulas for the statistical distribution of alpha particles penetrating to a given depth in a photographic plate have been derived. From these formulas, graphs, and tables have been constructed which are applicable to the determination of individual radioactive elements as well as of whole groups, such as uranium and actinium, always assuming radioactive equilibrium. Computations are also made for varying ratios of the uranium and thorium content, as well as for the content of the individual elements.—*S. T. V*

13886. Hée, Arlette, Kleiber, J., Flesch, L., and Jarovoy, Michel. Centres radioactifs et aimantation de deux rockes [Radioactive centers and magnetization of two rocks]: Annales Géophys., tome 7, No 4, pp. 245–253, 1951.

Autoradiographic studies of a granite of Raon-l'Étape and a rhyolite of Rosskopf show a striking correspondence between radioactive centers and iron oxides, magnetite in the granite and hematite and limonite in the rhyolite. The Rosskopf rhyolite has an exceptionally high coefficient of magnetization. This may be explained as the result of the existence in the rock of solid solutions or iron and titanium, giving titaniferous magnetites some of which are ferromagnetic.—*M. C. R.*

13887. Bernert, Traude. Radiumbestimmungen am Tiefseesedimenten [Determinations of the radium content of deep-sea sediments]: Akad. Wiss. Wien, Math-naturwiss. Kl., Sitzungsber. Abt. IIa, Band 160, Heft 1–5, pp. 99–111, 1951.

The results are presented of the determinations of radium content of six samples selected at random from among the core samples taken by the Swedish oceanographic expedition of 1948–49 in different parts of the Atlantic Ocean. The samples were taken in the area between latitudes 14°25′ N and 30°46′ N and longitudes 25°25′ W and 65°55′ W. The depth of sediments from which the core samples were taken ranged from less than 1 meter to 5,067 meters. The amount of radium in these samples ranged from 0.45×10^{-12} to 2.6×10^{-12} grams of radium per gram of substance. The presence of uranium was also established.

It has been demonstrated that radioactive equilibrium does not exist in the sediments; it is also found that at moderate depths the radium content increases with depth.—*S. T. V.*

13888. Arrhenius, G., Kjellberg, G., and Libby, W. F. Age determination of pacific chalk ooze by radiocarbon and titanium content. Tellus, v. 3, no. 4, pp. 222–230, 1951.

Measurements have been carried out on the average radiocarbon activity of a sediment core of eupelagic chalk ooze and the age of the lower boundary calculated by integration of the radiocarbon decay function. In such cores, where constancy of the rate of minerogenous accumulation is indicated and can be checked by lateral control, the titanium content, calibrated in terms of absolute age by means of radiocarbon measurement, can be used for dating as far back in time as the constancy of the rate of minerogenous sedimentation can be proved.—*Author's Abstract*

HEAT

13889. Jeffreys, Harold Problems of thermal instability in a sphere: Royal Astron. Soc., Monthly Notices, Geophys. Supp., v. 6, no. 5, pp. 272–277, 1952.

The theory of thermal instability in a sphere is extended to the case of a viscous sphere with a fluid core. An equation based upon a variational principle is given for approximating the lowest characteristic value for the pertinent equation and boundary conditions for the temperature. The easiest mode to excite probably corresponds to spherical harmonics in the temperature of degree 3 or 4. The case of a fluid percolating through a crystal mesh is considered, and the fourth harmonic is found to be the easiest to excite.

From analogy with other hydrodynamical problems it is pointed out that these results do not offer any objection to the theory of the convective origin of the land and water hemispheres. "The essential point is that, given sufficient time, the most widespread disturbances will become dominant provided only that they can be excited at all, and this condition is satisfied in most cases."—*P. E. B.*

13890. Valle, P. E. Sul gradiente adiabatico di temperatura nell' interno della terra [The adiabatic temperature gradient in the interior of the earth]: Annali Geofis., v. 5, no. 1, pp. 41–53, 1952.

The adiabatic temperature gradient is determined by the equation $(\delta T/\delta h)_s = T g \alpha/c_p$, where T is the absolute temperature, α the coefficient of heat expansion, c_p the heat capacity for constant pressure p, h is depth, and s is the entropy, which is constant. The ratio α/c_p is computed assuming an ideal isotropic body. It can be expressed in terms of the velocities of longitudinal and transverse waves, v_l and v_t, as $\alpha/c_p = (l/v_t^2 - 4/3\, v_t^2)\ (\log\ (\rho v_l v_t^2)\ \frac{1}{3}/\delta \log \rho)$. Using Jeffreys' figures for velocities and Bullen's for density, the thermal gradient was found to be 4.86×10^{-12} g per erg at a depth of 33 km. but only 0.95×10^{-12} g per erg at 2,898 km. near the core boundary. If the temperature at the depth of 33 km is 1,000 K, the temperature at the core boundary will be 1,644. By extending these considerations to the core itself and making $v_t = 0$, the temperature at the center of the core is found to be 2,264.—*S. T. V.*

13891. MacCarthy, G. R. Geothermal investigations on the Arctic slope of Alaska: Am. Geophys. Union Trans., v. 33, no. 4, pp. 589–593, 1952.

Preliminary results of geothermal investigations now in progress near Barrow, Alaska, indicate that, below the level to which seasonal changes penetrate, ground temperatures do not fall below about −10° C. The depth of the 0 C isogoeotherm ranges from 670 to 1,300 feet, increasing with the distance from the nearest large body of water. Thermal disturbances caused by drilling in and through the permafrost persist for many months, so that thermal readings taken in freshly drilled holes appear to have little value. Some correlation between terrain, electrical resistivity of the ground at shallow depths, and ground temperatures is indicated.—*Author's Abstract*

13892. Leith, T. H. Heat flow at Kirkland Lake: Am. Geophys. Union Trans., v. 33, no. 3, pp. 435–443, 1952.

Thermal gradients determined by Misener for the Kirkland Lake region have been used with thermal-conductivity measurements of 37 cores from the same area to calculate a surface heat flow of 1.00 ± 0.02 cal per sq cm per sec. One

conductivity measurement in place was in reasonable agreement with the laboratory determination on the same rock. The heat flow was corrected for the effects of an assumed glacial sequence without changing the value as the differences from the present mean annual surface temperature are small.—*M. C. R.*

13893. Claude, Georges. Sur les anomalies de Péchelbronn [On the Péchelbronn anomalies]: Acad. Sci. Paris Comptes rendus, tome 234, no. 21, pp. 2097–2098, 1952 and Le Génie Civile, tome 129, no. 13, pp. 252–253, 1952.

An alternative explanation of the thermal anomalies in the Péchelbronn region is proposed. Descending ground water passes through the level of critical temperature and is vaporized and then ascends toward the surface, approximating, though for different reasons, the conditions near Larderello. Drilling to resolve the problem is proposed.—*M. C. R.*

VOLCANOLOGY

13894. Martin, G. P. M. Vulkanische Aktivität kein Klima-Faktor [Volcanic activity is not a climate forming factor]: Naturwiss. Ver. Schleswig-Holstein Schr., Band 25, pp. 50–57, 1951.

Volcanic eruptions as meteorological factors influencing climate are discussed with special consideration to them as possible ultimate causes of glacial periods. During violent eruptions enormous masses of volcanic dust are projected into the air to heights of 40–50 km and later carried by winds over great distances. Examples cited are the eruptions of Krakatau, Hekla, and Katmai. The short duration of such meteorological conditions and the fact that the dust affects only atmospheric optics, but does not cause any lowering of temperature during following months, indicate that volcanic phenomena have little effect on climate. Even if more violent volcanic activity in the past is assumed, it cannot be considered as a factor influencing the climate.—*S. T. V.*

13895. Zavaritskiy, A. N. Izverzheniye vulkana Gekly [The eruption of Hekla volcano]: Priroda, no. 4, pp. 104–107, 1952.

The history of Hekla eruptions is summarized and the 1947 eruption described. A change in the character of the erupted material from basalt in 1845 to dacite volcanic froth in 1947 is explained as due to gravitational differentiation of magma during the long period of quiet.—*S. T. V.*

13896. Tazieff, H. L'Etna et son éruption actuelle [Etna and its recent eruption]: Soc. belge géologie Bull., tome 60 (1951), fasc. 3, pp. 320–328, 1952.

A detailed description is given of eruptions of Etna during 1949 and 1950. These eruptions were as always characterized by the effusion of large masses of lava containing a high proportion of sulfuric gases; the maximum temperature of lava was 1,120 C. The velocity of the flow ranged from 25 to 40 km per hour.—*S. T. V.*

13897. Cucuzza-Silvestri, Salvatore. L'eruzione etnea del 1947. [The eruption of Etna of 1947]: Accad. gioenia sci. nat. Boll., Ser. 4, fasc. 2, pp. 135–139, 1949.

This is a condensed version of the article abstracted in Geophys. Abstract 13656.—*L. E. B.*

13898. Fournier d'Albe, E. M. and Lafargue, C. Un ancien cratère volcanique, laboratoire d'étude du rayonnement [An ancient volcanic crater as a laboratory for the study of thermal radiation] : Annales Géophys., tome 8, no. 1, pp. 76–90, 1952.

Air temperatures were measured in the crater of the Puy de Pariou from December 1, 1948 to November 1, 1951. The crater is relatively sheltered and thus the accumulation of a stagnant cold air mass is possible during the night. The radiating walls of the crater cool the adjacent layer of air which sinks to the floor along the walls, mixes with the air below and then migrates upward from the center to a position of equilibrium, until the air mass is sufficiently dense to prevent mixing. Theoretical solutions were determined for the near-surface air temperature, and these checked very well with the observed variation. The presence of a thin layer of snow at one period permitted the neglecting of the surface heat flow exclusive of radiation, and made possible a calculation from a simple formula which checked very well with the observed temperatures. The heat liberated at the dew point and disturbing effects due to winds produced complex temperature variations.—*P. E. B.*

TECTONOPHYSICS

13899. Gallwitz, Hans. Geotektonische Forschungen und geotektonische Hypothesen [Geotectonic research and geotectonic hypotheses] : Forschungen u. Fortschr., 26 Jahrg., Heft. 7–8, pp. 95–99, 1950.

This is a review of the development of tectonic theories since the time of E. Suess.—*S. T. V.*

13900. Fourmarier, Paul. Efforts verticaux et efforts tangentiels dans l'évolution de la croûte superficielle du globe [Vertical and tangential forces in the development of the crust of the earth] : Ciel et Terre, année 67, no. 5–6, pp. 77–87, 1951.

This is a discussion of the different types of deformation of the earth's crust and the relative importance of vertical and horizontal forces in producing deformation. The former are considered more important in the majority of cases. The principal tectonic theories are briefly reviewed.—*M. C. R.*

13901. Ortiz de Villacian, J. R. Teoria fisicomatematica de la tierra (aportación a la geofisica) [Physicomathematical theory of the earth (contribution to geophysics)] : Inst. geol. min. España, notas y comunicaciones, no. 24, pp. 7–70, 1951.

Cosmogonic theories are reviewed from the early speculations of Greek philosophers to Eddington, Jeans, and von Weizsäker. Quoting the statement of Lord Kelvin that no phenomenon is fully known unless measured by a number, the author everywhere tries to introduce the methods of theoretical physics, not only to describe different phenomena but also to explain their casual relations.—*S. T. V.*

13902. Wilson, J. Tuzo. Orogenesis as the fundamental geological process : Am. Geophys. Union Trans., v. 33, no. 3, pp. 444–449, 1952.

It may shortly be possible to discover a fundamental mechanism operating within the earth which would be explicable as a natural consequence of the physical state of the earth and at the same time would explain the geologic

behavior of the earth. Orogenesis is assumed to be the fundamental geologic process acting within the earth, and it with external radiation from the sun is presumed to be the cause of geologic change. Two theories have been proposed, a cooling and contracting earth, and convection currents in the mantle, both arising from the fact that the earth is a heat engine. Estimates of the limits of the rate of erosion since the Mesozoic and of the present rate of volcanism suggest that the continents, like the atmosphere and oceans, have grown in place during the course of geologic time.—*M. C. R.*

13903. Scheidegger, A. E. Physical aspects of the convection-current hypothesis of orogenesis: Am. Geophys. Union Trans., v. 33, no. 4, pp. 585–588, 1952.

Thermal data point toward the probable existence of convection currents within the earth, but the occurrence of deep-focus earthquakes present a serious difficulty to this theory. In order to maintain the observed heat flow through the surface of the earth, the velocity of the convection currents need only be of the order of a few millimeters per year. Computations show that a material with limiting shear stress of 10^8 dynes per cm^2 and a viscosity of 10^{23} poises can participate in such slow movement and still behave as though rigid over periods of time that are short compared to those involved in convection currents.—*J. R. B.*

13904. Escher, B. G. Relation between the mechanism of the formation of fault troughs and volcanic activity: Geol. Soc. America Bull., v. 63, no. 8, pp. 749–756, 1952.

This is the presidential address before the International Association of Volcanology in Brussels, August 1951. The attitude and nature of border faults of typical grabens are described. On the basis of these facts and gravity studies, it is concluded that a tensional origin of grabens is most likely. Analysis of recent work on the products of volcanism in eastern Africa leads to the conclusion that volcanic activity in that region is a consequence of tensional forces in the horizontal direction which have opened the crust in such a way that the material below the crust changes from a latent magmatic state into fluid magma. Multiplicity of rock types would then follow from the assimilation of preexisting rocks in the grabens. Magmatic differentiation seems to belong to areas of compressional folding.—*M. C. R.*

13905. Miyabe, Naomi. Vertical earth movements in Japan as deduced from the results of rerunning the precise levels: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 2, pp. 127–162, 1952.

Because vertical earth movements in a given region cannot be compared directly with movements in other regions where precise levels were run at different times, an attempt has been made to deduce from the vertical displacements of bench marks in different regions and times those which refer to the same datum level and same epoch. These deduced vertical displacements are listed in tables.—*M. C. R.*

13906. Nasu, Nobuji. Block movement along the seismic fault: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 2, pp. 283–287, 1951.

Elevations of triangulation points established in a survey of the Nōbi plain in 1888 have been compared with elevations determined in a 1950 survey. A general upheaval of the eastern part of the area relative to the western part and an up-

lift in the middle part, an N-shaped change, was revealed. The position of the step-wise change agrees with the line "C" of Omori in his report on the Mino-Owari earthquake of 1891. This line when produced northward coincides with the main "Neo Valley" [Neo-dani] fault.—*M. C. R.*

EXPLORATION GEOPHYSICS

GENERAL

13907. Hammer, Sigmund. Geophysical exploration comes of age: Geophysics, v. 17, no. 3, pp. 435–440, 1952; Petroleum Eng., v. 224, no. 4, pp. B–84, 86, 88, 1952; Am. Assoc. Petroleum Geologists, v. 36, no. 7, pp. 1318–1322, 1952.

This is the presidential address delivered before a joint meeting of the Society of Exploration Geophysicists, Society of Economic Paleontologists and Mineralogists, and the American Association of Petroleum Geologists in March 1952. The history of geophysical exploration, especially for petroleum, and of the Society of Exploration Geophysicists is reviewed, and the present technical status and possible future developments are discussed briefly.—*M. C. R.*

13908. Eckhardt, E. A. Geophysical activity in 1951: Geophysics, v. 17, no. 3, pp. 441–451, 1925; Petroleum Engineer, v. 24, no. 5, pp. B–74, 76, 78, 81, 1952.

During 1951 there was a 20.4 percent world-wide increase in seismic exploration for oil, largely in North America. In the United States, the Rocky Mountain states, Louisiana, and Texas accounted for most of the crew months in seismograph operations. Gravity operations showed an increase; magnetometer operation reports do not differentiate between ground party and aeromagnetic crew-months, and comparison on the basis of other activities is impossible. In the mining industry, expenditures for research and development were greatest in the United States, with Canada, India, Australia, Switzerland, and Africa following in order of importance. Charts showing world distribution of geophysical operations in oil exploration and in mining are included.—*L. E. B.*

13909. Houghton, H. M. Geophysical exploration in western Canada: Geophysics, v. 17, no. 3, pp. 452–464, 1952.

This paper is restricted to a statistical study and to operational problems which are peculiar to the bush country of northwestern Alberta. Maps and figures show oil and gas fields, exploration by gravimeter and magnetometer, seismic activity and estimated costs. Pictures of typical locations and equipment for exploration are included. The article is summarized briefly in World Petroleum, v. 23, no. 5, pp. 90–93, 1952.—*L. E. B.*

13910. Swords, H. L. Exploratory activity in the Permian Basin: Petroleum Engineer, v. 24, no. 7, pp. B–50, 52, 54, 1952.

Geophysical exploration and drilling in the west Texas-New Mexico area are summarized. New fields, pools, and extensions are listed in tables.—*M. C. R.*

13911. Umbach, P. H. Exploration expands in the Four Corners region: Petroleum Engineer, v. 24, no. 5, pp. B–58, 60, 63–64, 1952.

Geophysical activity and exploratory drilling in the Paradox Valley, San Juan, and Black Mesa basins of Colorado, New Mexico, Arizona, and Utah are discussed briefly.—*M. C. R.*

13912. Knowles, R. S. Cuba a challenge to wildcatters: World Petroleum, v. 23, no. 3, pp. 52–55, 1952.

Recent exploration (including geophysical) for oil in Cuba is briefly summarized.—*M. C. R.*

13913. World Petroleum. Oil explorations in North Africa, v. 23, no. 3: pp. 48–51, 1952.

Recent exploration (including geophysical) for oil in northern Africa is briefly summarized.—*M. C. R.*

13914. Gold Coast Geological Survey Department. Report for the financial year 1950–51, 8 pp. Accra. Government Printing Dept., 1952.

The geophysics section of this annual report describes the magnetic survey of the area north of Nanwa mine in the Konongo gold belt, an electrical survey at Volta dam site at Ajena, and experimental electrical surveys to locate well sites. Diurnal variations studied from mid-May to the end of July showed that the Konongo district must be south of the magnetic equator.—*L. E. B.*

13915. Uganda Protectorate Geological Survey. Department Records: year ending 31st December 1950, 52 pp., Uxbridge, England, King and Hutchings, Ltd., 1951.

One section of this report written by D. J. Gear and J. M. Brown describes the geophysical work of the Uganda Protectorate Geological Survey. Resistivity surveys in connection with ground water investigations and surveys in mining districts by self-potential, magnetic, and gravity methods were made. This section includes a detailed account of results of a gravity survey in the Entebbe area west of Lake Victoria. The downfaulted block of Karroo sediments has an indicated depth of 1,450 feet in the east. A gravity high parallel to the northerly fault plane is interpreted as a basic igneous intrusive of tabular shape at a depth of approximately 150 to 160 feet.—*E. K.*

13916. Mintrop, Ludger. Wirtschaftliche und wissenschaftliche Bedeutung geophysikalischer Verfahren zur Erforschung von Gebirgschichten und nutzbaren Lagerstätten [Economic and scientific significance of geophysical methods for the investigation of mountain structures and mineral deposits]: Schweizer Archiv, angew. Wiss. u. Technik. Jahrg. 16, no. 11, pp. 321–335, 1950.

This is essentially the same as the article summarized in Geophys. Abstract 11788.—*S. T. V.*

13917. Kelly, S. F. Geological and geophysical approach to mining problems: Precambrian, v. 25, no. 7, pp. 13–19, 1952.

This article first appeared in Mining World, and was abstracted as Geophys. Abstract 11995.—*L. E. B.*

13918. Klotz, J. A. Geophysical exploration methods: Jour. Petroleum Technology, v. 4, no. 6, pp. 20–21, 1952.

This is a summary of a talk by R. A. Peterson, presented by the Pacific Technology Forum, on "Elements of Petroleum Production." Seismic, gravimetric, and magnetic methods are reviewed.—*L. E. B.*

13919. Dixey, Frank. A practical handbook of water supply, 573 pp., London, Thomas Murby and Co., 1950.

This is the second edition of the handbook. It contains a short section on geophysical methods used indirectly in the search for water.—*L. E. B.*

13920. Shepard, E. R. Subsurface explorations by geophysical methods: Am. Soc. for Testing Materials Proc., v. 49, pp. 993–1015, 1949.

The principles of the electrical resistivity and seismic methods for use in design and construction of engineering structure are outlined, and the applicability, limitations, time, and cost of operation of each are discussed.—*M. C. R.*

13921. Vance, Harold. Petroleum subsurface engineering, 168 pp., St. Louis, Education Publishers, Inc., 1950.

This book was written for senior students in geology and petroleum engineering. The chapter on well logging and log interpretation and the bibliography on logging of various kinds may serve as reference material for practicing engineers and geologists.—*L. E. B.*

13922. Moore, R. W. Geophysical methods adapted to highway engineering problems: Geophysics, v. 17, no. 3, pp. 505–530, 1952.

The electrical resistivity and seismic methods are the geophysical methods that are most useful in the planning and construction of highways and have been employed in this country for many years with increasing frequency, as well as in other countries. The resistivity method is 10 to 20 times as rapid as drilling, and yields more complete information. Seismic methods, though not quite as rapid, are useful in differentiating materials with similar resistivities, such as a dry sand overlying hard rock. The equipment is designed for maximum portability and ruggedness, and the data are greatly increased in value by a knowledge of the geology in the area gained from road cuts or test pits. Illustrations are given of some of the problems in which geophysical methods are used, such as location of suitable road foundations and gravels for grading; presence of hard rock for tunneling, bridge footings, quarry sites, and dam sites; and for landslide or other grading problems.—*E. K.*

13923. Peltz, Walter. Vierte geophysikalische Arbeitstagung der Deutschen Kohlenbergbauleitung, Gruppe Braunkohle [The fourth geophysical conference of the German Coal Mining Board, Brown coal group]: Braunkohle, Warme und Energie, Band 4, Heft 7–8, pp. 131–132, 1952.

Since the first round table conference on the application of geophysical methods of exploration for coal held in 1949, great progress has been made, primarily in the use of electrical methods. Some difficulty results from the fact that the resistivity of the coal layers is nearly the same as that of the surrounding argillaceous sandstones. More than 2,000 drill holes have been logged by the Schlumberger method. Torsion balance surveys have also been employed.—*S. T. V.*

GRAVITY METHODS

13924. Boaga, Giovanni, Tribalto, G. and Zaccara, Gaetano. Rilievi geo-gravimetrici nella regione nelle grotte di Castellana (Bari) [Geogravimetric surveys in the region of Castellana caverns, Bari province]: Servizio geol. Italia, Boll., v. 72, anno 1950, fasc. 1, pp. 186–202, 1951.

During August 1950, a gravitational survey was made near the city of Castellana over ground containing subterranean caverns of great length and of very regular dimensions. Measurements were made on the surface of the earth and inside of the caverns, 72 stations being occupied in the survey. The results obtained and their interpretation have been previously discussed (*See* Geophys. Abstract 12623.)—*S. T. V.*

MAGNETIC METHODS

13925. Jenny, W. P. Structural correlation of micromagnetic and reflection surveys: World Oil, v. 134, no. 4, pp. 67–72, 1952.

Micromagnetic surveys, the measuring and interpretation of weak anomalies of the order of 2.5 gammas, can locate sedimentary structures favorable to the accumulation of petroleum. Only limited surveys of the required accuracy can be made with ground magnetometer, but with an airborne magnetometer in helicopters large-scale, routine micromagnetic surveys can be made.

It is suggested that the gravity and magnetic field associated with an uplifted positive area can affect the deposition of sediments laid down in a normal sequence after the formation of the original structures. Such change in deposition will affect seismic velocities as well as the magnetic susceptibility of the sedimentary column above the structure. Four hypothetical cases of anticlines with velocity difference over the crests and flanks are shown, and in three cases erroneous interpretation of the reflection results can be obtained.

In four areas where drilling was done on the basis of reflection seismic surveys, micromagnetic evidence, if used in conjunction with the seismic interpretation, would have resulted in better location of the wells.—*W. J. D.*

13926. Whetton, J. T. and Myers, J. O. Geophysical survey of magnetite deposits in Strath, Island of Skye: Geol. Soc. Glasgow Trans., v. 21, pt. 2 (1947–1949), pp. 263–277, 1951.

A vertical magnetometer survey was made with 100-foot station spacing along a 7.5 mile contact between limestone and granite on the isle of Skye. Locations of all readings outside a normal 1,000-gamma range were marked for further investigation, and in these areas profiles were run in an attempt to outline magnetite bodies. Of the 27 magnetite bodies which appear to be indicated, 7 are exposed at the surface.—*W. J. D.*

13927. Scott, H. S. The significance of aeromagnetic data: Precambrian, Pt. 1, v. 25, no. 6, pp. 7–9, 33–34; Pt. 2, v. 25, no. 7, pp. 21–25, 1952.

This is a general review, in nontechnical language, of the use of the magnetometer, especially the airborne magnetometer, in exploration. Examples from total-intensity surveys made by Aeromagnetic Surveys Ltd. are used to illustrate the main points of discussion.—*M. C. R.*

13928. Harper, J. L. Magnetometer surveys in New Mexico areas: Petroleum Engineer, v. 24, no. 9, pp. B–14–16, 1952.

To apply magnetic prospecting effectively to oil-bearing structures, field and instrument techniques capable of distinguishing magnetic sedimentary datum beds as well as the configuration of the basement rocks must be used. A comparison of results of ground magnetic surveys and published aeromagnetic surveys in New Mexico shows a displacement between the magnetic highs which although it shows no characteristic orientation is considered significant. Representative magnetic-contour maps showing sedimentary structures are included.—*W. J. D.*

13929. Canada Geological Survey. Aeromagnetic maps of Northwest Territories: Dept. of Mines and Tech. Surveys, Geophysics Papers 77, 78, 1952.

This is a continuation of the series listed in Geophys. Abstracts 13001, 13212, 13452, and 13705. The following quadrangles in the District of Mackenzie have been published as blue line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 ft. above ground level: G. P. 77, Sandy River; G. P. 78, Hay River. The maps were prepared on a scale of 1 in.=1 mile, and the contour interval of 10 to 500 gammas, depending on the intensity of the anomaly.—*L. E. B.*

13930. Canada Geological Survey. Aeromagnetic maps of the Province of Quebec: Dept. of Mines and Tech. Surveys, Geophysics Papers 89, 91, 1952.

This is a continuation of the series listed in Geophys. Abstracts 13004, 13006, 13454, and 13706. The following quadrangles have been published as blue line areomagnetic maps which show by contour lines the total magnetic intensity at about 1,000 ft above ground level: G. P. 89, Lac Faillon, Abitibi County; G. P. 91, Sabourin, Temiscamingue and Abitibi Counties. The maps were prepared on a scale of 1 in.=1 mile, and the contour interval of 10 to 500 gammas, depending on the intensity of the anomaly.—*L. E. B.*

13931. Canada Geological Survey. Aeromagnetic maps of Province of Ontario: Dept. of Mines and Tech. Surveys, Geophysics Paper 97, 1952.

This is a continuation of the series listed in Geophys. Abstracts 13000 and 13007. The following quadrangles in the Province of Ontario have been published as blue line areomagnetic maps which show by contour lines the total magnetic intensity at above 1,000 ft above ground level: G. P. 97, Mazinaw Lake, in Hastings, Frontenac, Lennox, and Addington Counties. The map was prepared on a scale of 1 in.=1 mile, and the contour interval of 10 to 500 gammas, depending on the intensity of the anomaly.—*L. E. B.*

SEISMIC METHODS

13932. Weatherby, B. B. Some aspects of seismic surveys: World Petroleum, v. 23, no. 3, pp. 44–47, 1952.

This article is based upon and reproduces in part an address before the Society of Exploration Geophysicists. *See* Geophys. Abstracts 13456 and 13708 for previous publication.—*M. C. R.*

13933. Menzel, Heinz. Über das Spektrum sismiseher Wellen, die durch Sprengungen erzeugt werden [On the spectrum of seismic waves produced by explosions]: Annali Geofis., v. 4, no. 3, pp. 301–321; [Italian translation] pp. 433–448, 1951.

In an attempt to explain changes in the spectrum of waves propagating through the upper layers of the crust, two physical phenomena are analyzed: the interference of the direct wave from the shot point with the wave reflected at the free surface of the earth; and the dissipation of energy by reflection, refraction, and diffraction within the upper layer.

In the mathematical analysis of these two phenomena the ground is assumed to be a perfectly elastic medium. The effect of the explosion on the surrounding medium is assumed to follow three phases, as suggested by Morris (*See* Geophys. Abstract 12026). During the first phase the chemical reaction is accomplished without mechanical effects. This is followed by a second phase, the spreading of disintegration of the ground up to the radius where the deformation becomes elastic, beyond which an elastic spherical wave motion is produced. The waves propagating from the point of explosion are assumed to be spherical longitudinal waves. The displacement of a point along the ray is given by the gradient of the stress with respect to the radius vector, with the center of the coordinates placed in that point. The differential equation of wave motion has the shape $\rho(\delta^2F/\delta t^2=(\lambda+2\mu)\Delta F$, where ρ is the density of the ground, and μ and γ are the Lamé constants. By introducing a complex variable, the solution of this equation can be obtained, but numerical evaluation of the results, even under simplifying assumptions, is difficult. It can be concluded, however, that the greatest effect on the incoming seismic wave is produced by the detrital layer, which strongly influences the frequencies of the direct and reflected waves.—*S. T. V.*

13934. Pasechnik, I. P. Metodika eksperimental'nogo izucheniya rezonansnykh yavleniy v kolebatel'noy sisteme pochva—seysmograf [Experimental methods studying resonance phenomena in the system ground—seismograph]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 1, pp. 21–34, 1952.

Natural vibrations which can appear in the mechanical system composed of the ground and a seismograph interfere with the waves coming from a shot and cause difficulties in interpretation. These vibrations are especially pronounced when the seismograph is placed directly on the soil surface or on swampy ground.

Three methods of observation and measurement of these vibrations are recommended. The first, called the impulse method, consists of giving a slight blow to the seismograph placed on the soil and recording the resulting vibrations. These vibrations under certain conditions are the unknown vibrations of the mechanical system soil—seismograph, and can be found from the seismograms obtained either with the same seismograph or with an additional recording cathode-ray oscillograph, if it is running during the whole experiment. The second possibility consists in applying a train of sinusoidal vibrations with abrupt beginning and ending. For this purpose two rigidly connected electrodynamic seismographs are installed on the ground. The electrodynamic system of one instrument, fed from a generator producing electric waves of audio frequency, produces mechanical oscillations, and the other seismograph records them. The third method, called the improved stationary method, was first suggested by Washburn and Wiley in their study of the effect of the placement of a seismometer on its response characteristics (*See* Geophys. Abstract 6174). In the im-

provement suggested by Pasechnik, vibrations are recorded by a cathode-ray oscillograph with electronic commutator. Results of experiments using each of these methods will be given later.—*S. T. V.*

13935. Handley, E. J. Control of variables in the observation of seismic echoes: World Petroleum, v. 23, no. 3, pp. 66–69, 1952.

In the use of the seismic method of exploration, there can be little control over the creation of energy and none over its transmission. By controlling the variables in the recording technique, considerable control may be exercised over the particular wave motions recorded. The factors over which some control may be exercised pertain to the size and type of explosion, the instrument set-up, the use of electric mixing, and automatic volume control.—*M. C. R.*

13936. Baxter, A. J. Continued research improves new exploration tool: World Petroleum, v. 22, no. 7, pp. 40–43, 1951.

This is a description of the Poulter method of surface shooting.—*M. C. R.*

13937. Kokesh, F. P. The development of a new method of seismic velocity determination: Geophysics, v. 17, no. 3, pp. 560–574, 1952.

A method is discussed for determining the velocity-depth relationship in seismic surveys. The shots are fired at varying depths in the drillhole by means of a perforating gun or by the detonation of a length of primacord and the energy recorded by geophones at various points at the surface. Bakelite bullets appeared to give about the same results as lead or steel bullets. Examples are given for three wells and one weathering-correction measurement. The new method appears to be as accurate as the present method of varying the position of geophones in the well, and has the advantage of greater speed, more convenience, and probably lower costs.—*P. E. B.*

13938. Swan, B. G. and Becker, Adrian. Comparison of velocities obtained by delta-time analysis and well velocity surveys: Geophysics, v. 17, no. 3, pp. 575–585, 1952.

A comparison is made of seismic velocities determined from delta-time analyses of reflection profiles and well velocity surveys for 21 wells located in Texas, Oklahoma, Louisiana, Mississippi, Nebraska and North Dakota. A brief description is given of a system of tabulation providing some shortcuts in the handling of data in a delta-time analysis. It is considered a reasonable conclusion that in average reflection areas approximately 100 to 120 delta-T's per point suffice to reduce the average discrepancy between the delta-T and well-velocity curves to 2 to 3 percent. Seven sets of curves for varying qualities of reflection are included as examples.—*P. E. B.*

13939. Eisler, J. D. Studies of a surface seismic disturbance: Geophysics, v. 17, no. 3, pp. 550–559, 1952.

Seismic investigations in a caliche covered area in New Mexico revealed the existence of a prominent surface wave group. A succession of short spreads between two shot points was made with 6 vertical component geophones, and three-component geophone studies were made at a number of points along the profile. The depth of the caliche sediment ranges from about 2 to 130 ft, the beds are underlain to a depth of 230 ft by clays, gravels, and one bed 20 ft thick of crystal-

line limestone. The velocity function indicates velocities of 3,000 fps and 7,800 fps, the latter beginning at a depth of around 30 ft.

The ground motion appears on the vertical component spreads as a complex wave group becoming more coherent at distances from the shot point greater than 1,000 ft. Prominent waves near the shot have periods of 0.03 and 0.1 sec. The energy maximum travels with a velocity of 1,800 fps, and the velocities of individual peaks and troughs in the group range from 1,900 to 2,700 fps. The particle motion in a vertical plane is of a retrograde modified-elliptical form, and the relative progression of peaks and troughs within the wave group indicates a normal dispersive pattern of Rayleigh waves for the two-layer case wherein a high velocity layer is overlain by a low velocity layer. Motion transverse to the line of spread appears to be unrelated to the prominent wave group. Diagrams and records are included.—*P. E. B.*

13940. Burg, K. E. Exploration problems of the Williston basin: Geophysics, v. 17, no. 3, pp. 465–480, 1952.

Intensive exploration has followed the discovery of oil in the Williston basin which covers an extensive area in North and South Dakota, Montana, Manitoba and Saskatchewan. Seismic reflection methods of explbration are most useful but have limitations because the very thick Paleozoic and Mesozoic section often yields multiple reflections, and the overlying Tertiary and younger sediments, which in many places are more than 600 ft thick, include much glacial and other low density material that introduce errors into depth calculations of the older formations. Supplementary refraction and up-hole velocity measurements are recommended for reducing such errors.—*E. K.*

13941. Widess, M. B. Salt solution, a seismic velocity problem in Western Anadarko Basin, Kansas-Oklahoma-Texas: Geophysics, v. 17, no. 3, pp. 481–504, 1952.

The solution of salt or other soluble material from a formation by ground water produces lateral changes in velocity distinct from those caused by variations in the original lithology. This is illustrated by the western Anadarko basin, parts of which are underlain by a shallow upper Permian salt-bearing formation which produces over 300 ft of seismic relief in three miles. Drilling revealed that the salt had been dissolved from the areas where this feature is absent, causing 200 ft of slumping in the overlying formation. Core-hole velocity data indicate that at least three velocity provinces are present, and suggest different environments of mineralization pertaining to ground water. A vertical profiling survey in the northern part of the basin by a method designed to eliminate errors caused by bed curvature showed that there were no sudden changes in velocity except near the edges of the salt. In general it is concluded that ground water may cause lowered velocities in the so-called weathered layer and probably in formations at great depths. It may also be the cause of the topographic effect observed on seismic structural maps.—*E. K.*

13942. Linehan, Daniel. Seismology applied to shallow zone research *in* Symposium on surface and subsurface reconnaissance, American Society for testing Materials Special Technical Publication No. 122, pp. 156–170, 1952.

The principles of the seismic refraction method are briefly reviewed, and field methods, equipment, and interpretation procedures are described. Engineering problems which have been studied by the seismic method include those of highway

construction, ground water supplies, and building foundations. Examples drawn from the author's experience are cited.—*M. C. R.*

13943. Helms, Hans von. Refraktionsseismsche Untersuchungen an Salzstöcken im Hamburger Loch [Refraction seismic surveys of salt domes in the Hamburger Loch]: Erdöl u. Kohle, 5th Jahrg., Heft 2, pp. 77–80, 1952.

Seismic refraction surveys were made in a region near the city of Hamburg for salt domes. The procedure consisted of refraction shooting from points as far from the dome as 5 km or more, following profiles directed toward the dome. The article contains five travel-time diagrams with corresponding geologic profiles indicated. Seismic velocities assumed in the construction of travel-time curves are given in a table.—*S. T. V.*

13944. Burke, W. E. Air drilling in seismic surveys: World Petroleum, v. 22, no. 9, pp. 38, 67, 1952.

Field tests in New Mexico and west Texas of the use of compressed air in shot-hole drilling for seismograph surveys are described. The method has not yet proved practical in all areas, but has proved successful in medium and hard formations. Advantages are reduction in time and cost of drilling.—*M. C. R.*

ELECTRICAL AND ELECTROMAGNETIC METHODS

13945. Roman, Irwin. Resistivity reconnaissance *in* Symposium on surface and subsurface reconnaissance: Am. Soc. for Testing Materials Special Tech. Pub. 122, pp. 171–220, 1951.

This is a review of the resistivity method, designed to aid the engineer in evaluating the method as a means for solving problems in road location, foundation conditions, water resources, dam site selections, and mineral exploration. A bibliography of 127 items is included.—*M. C. R.*

13946. Teisseyre, Roman. Metody oporn pozornego oraz metody, normalnego stosunku napięć w geoelektrycznych pracach poszukiwawczych [Methods of apparent resistivity and of potential-drop-ratio in geoelectric prospecting]: Państwowy Insty. Geol. Biul. 63, Ser. geofiz. no. 6, pp. 39–50, 1951.

The Wenner and Lee modifications of the electrical resistivity method and their applications to prospecting for metallic ores and in investigations of dam sites are discussed. This is followed by an account of the potential-drop-ratio and Eltran methods. Theoretical deductions as to the values of standard potential-drop-ratios are presented in the form of two master charts.—*S. T. V.*

13947. Małkowski, Zdzislaw. Elektrychna metoda oporowa przy stosowaniu prądu stałego w badaniach goefizycznych [Electric resistivity method with direct current in geophysical explorations]: Państwowy Instyt. Geol. Biul. 63, Ser. geofiz. no. 6, pp. 5–31, 1951.

The physical basis of the electrical resistivity method in geophysical prospecting and the interpretation of the results are discussed in detail. For the latter, the use of Roman's tables is recommended. Electrical logging of drilling is briefly discussed.—*S. T. V.*

13948. Uchman, Jan and Sobieski, Zenon. Opis aparatury do geofizychnych badań poszukiwawczych metodą oporową [Description of instruments employed in geophysical exploration by resistivity method] : Państwowy Instyt. Geol. Biul. 63, Ser. geofiz. no. 6, pp. 33–38, 1951.

A description is given of instruments and apparatus used in electrical resistivity measurements and in electrical logging by Schlumberger method.—*S. T. V.*

13949. Deutscher Verein von Gas- and Wasserfachmannern. Die Wassererschliessung [Exploration for water], 421 pp., Essen, Vulkan-Verlag Dr. W. Classen, 1952.

This handbook consists of three parts written by different authors. Part one covers hydrology and related engineering questions; part two, by Heinrich Thiele, electrical methods of prospecting for water; and part three, technological questions. Part two includes descriptions of practical surveys with graphs of obtained results and related geologic maps, and an extensive bibliography.—*S. T. V.*

13950. Berel'kovskiy, Ts. Ya and Zubanov, B. G. Ob elektroprofilirovanii nad naklonnym kontakton [The determination of an inclined contact by the electrical method] : Akad. Nauk SSSR Izv., Ser. geofiz. no. 3, pp. 16–30, 1951.

The problem of delineating the inclined boundary between two formations can be solved by the electrical resistivity method if the solution of the corresponding direct problem can be found.

Using the method suggested by A. N. Tikhonov, it is shown that, if the field pattern on the surface of the earth is known for three angles of inclination of 30°, 45°, and 90° made by the boundary plane with the earth's surface, it is possible to compute the pattern for any angle from 0° to 180°. Solutions are given for the angles 30° and 45°.

Analyzing the graphs obtained for the gradients of the potential corresponding to different angles of inclination of the boundary plane, characteristic differences for different values of the angle and different positions of the observer and the point source can be established. This makes it possible to construct approximate, but accurate enough curves of the gradient for every angle of inclination. Having a set of such curves the authors solve the original problem, of finding the angle formed by the boundary plane between the formations and the earth's surface.—*S. T. V.*

13951. Börner, Rudolf. Geophysikalische Bodenuntersuchungen mit dem "Geoskop", "Geostratimeter" and ergänzenden Messverfahren [Geophysical investigations of the ground with the "Geoskop" "Geostratimeter" and some additional measuring procedures] : Braunkohle, Wärme und Energie, Band 3, Heft 15–16, pp. 276–282, 1951.

A brief description is given of instruments for geophysical investigation using radio waves as suggested in 1934 by Ernst Cloos. The "Geoskop" is a combination of a radio transmitter and a receiver, built in such a manner that mutual action of the instruments is reduced to a minimum. When the transmitter is carried over the surveyed area radio waves are partly propagated through the ground, and reception on the receiving apparatus is much influenced by the subsurface structure thus making it possible to establish correlations between the picks of measured indications on the instrument and structural details of the underground. The Geostratimeter represents a further development, less sen-

sitive to conditions in the upper soil layers. A third instrument manufactured by the same company and used for measuring electrical resistivity of the ground, is also mentioned. Neither wiring diagrams of these three instruments nor logs of the cited successful measurements are given.—*S. T. V.*

13952. Grütjen, Karl. Geostratimetermessungen in der rheinischen Braunkohle und Einsatzmöglichkeit des Geostratimeters bei neu aufzuschliessenden Feldern [Geostratimeter measurements in the Rhine lignite and the significance of the impulses of the Geostratimeter for potential new fields]: Braunkohle, Wärme und Energie, Band 3, Heft 15–16, pp. 283–285, 1951.

A report is given on surveys at several places in the Rhine valley in exploration for lignite using the "Geoskop" and "Geostratimeter" procedure. It is pointed out that the graphs obtained had many more peaks than could be caused by structural discontinuities underground, and therefore the interpretation of the results is impossible without knowledge of geologic structure of the area. The author is certain that the Geostratimeter method of exploration may be improved.—*S. T. V.*

13953. Heyll, Hellmuth. Geoskop- und Geostratimeter-untersuchungen in der rheinischen Braunkohle [Exploration with the Geoskop and Geostratimeter in the lignite basin of the Rhine]: Braunkohle, Wärme, und Energie, Heft 15–16, pp. 286–288, 1951.

An area of about 20 sq km in the southern half of the lignite basin was surveyed by the Geoskop and Geostratimeter methods, and results checked in drill holes. Results of the survey are presented as graphs with corresponding geologic profiles. Comparison of the two shows that the curves obtained with Geoskop or Geostratimeter measurements have many peaks, in several places with any relation to structure. Thus often Geoskop measurements instead of clarification bring only confusion.—*S. T. V.*

13954. Zaccara, Gaetano, and Manfredini, Antonio. Analisi geoelettrica di un terreno di fondazione [Geoelectric investigation of a foundation site]: Servizio geol. Italia Boll., v. 73, anno 1951, fasc. 1, pp. 125–146, 1951.

Before the construction of a new airport near the city of Rome, Italy, two sites were explored for their adaptability to this purpose, especially the existence of peat pockets at depths of less than 15 m. The electrical resistivity method with Wenner arrangement of electrodes was used. Fifty stations were occupied on the Ostia site, and thirty on the Fiumicino site. At each station 15 measurements were made with electrode spacing of 2 to 30 m and the results interpreted by the methods of Roman and Tagg. Final results of the survey were confirmed by drilling of six holes to a depth of 15 m. Lithological samples taken from drill holes fully confirmed the results of geophysical prospecting—*S. T. V.*

13955. Zaccara, Gaetano. L'applicazione del metodo geoelettrico alla ricerca dell' acqua [The application of the geoelectric method in prospecting for water]: Servizio geol. Italia Boll., v. 72, anno 1950, fasc. 1, pp. 203–213, 1951.

A report is presented of the application of the resistivity method to prospecting for water over ground consisting of several parallel layers with different electrical resistivity. The survey was made in the volcanic region of Castel di Decima near Rome, Italy.

Six profiles were investigated with initial electrode spacing of 5 m, increased by steps to 100 m. All six profiles showed a low resistivity at short electrode spacing, a substantial increase of resistivity at 40 to 60 m spacing, and again a decrease with greater distances between electrodes.

Using Tagg's graphoanalytic method and Roman's logarithmic procedure the results are interpreted as indicating ground consisting of alternating layers of argillaceous tufa, with electrical resistivity of about 20 ohm meters, and basaltic lava with a small admixture of tufa, with higher resistivity. Only the tufa layers are considered water bearing and their thickness and depth can be accurately determined from the resistivity curves.—*S. T. V.*

13956. Rikitake, Tsuneji, and Kishinouye, Fuyuhiko. Electrical properties of soil at radio frequencies [In Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 2, pp. 423–431, 1951.

The dielectric constant and electrical resistivity of soil at radio frequencies were measured by inserting soil specimens, taken from the grounds of Tokyo University, between two plates of a condenser which was connected with a resonance circuit, composed of a coil, a variable condenser and a thermojunction, loosely coupled with a high-frequency oscillator. By means of a galvanometer connected with the thermojunction, changes in the electric current induced in the resonance circuit were measured and from these, after some reduction, the electrical properties could be determined.

It was found that the electrical properties of soil were greatly affected by water contained in it. The dielectric constant changed from 4 to more than 30 and the resistivity from 500 to 10 kiloohms as the water content changed from 0 to 50 percent. The changes in the electrical properties with frequency were also measured. These facts can be explained in terms of a model consisting of an aggregate of spherical soil particles concentrically surrounded by water.—*M. C. R.*

13957. Barret, W. M. Note on the radio transmission demonstration at Grand Saline, Texas: Geophysics, v. 17, no. 3, pp. 544–549, 1952.

A series of measurements of the output of a receiver located on the 700-ft. level of a salt mine with various locations of a 1,602-kc transmitter on the surface are presented as evidence that in a demonstration radio signals penetrated 700 ft of sediments, salt, and air with low attenuation rather than travelled via the mine shaft, the opinion held by several geophysicists. (*See* Geophys. Abstract 11306 for description of method, 11314 for discussion of original demonstration, and 13755 for contradictory evidence.) A graph of the results shows essentially zero output of the receiver when the transmitter is directly above it and a maximum when the transmitter is 45° above it in the plane including the two parallel antennae. The author states that about 1.5 watts of transmitter power were required.—*J. R. B.*

RADIOACTIVE METHODS

13958. Lang, A. H. Uranium ore bodies. How can more be found in Canada: Canadian Min. Jour., v. 73, no. 6, pp. 57–65, 1952.

This is an analysis of the problems of geologists and prospectors in the search for uranium ore bodies. The use of radioactivity detectors is briefly reviewed and possible future uses of geophysical instruments are presented.—*L. E. B.*

13959. Merritt, J. W. Radioactive oil survey technique: World Oil, v. 135, no. 1, pp. 78–80, 82, 1952.

The use of radiation-intensity surveys in petroleum exploration is described. Because of the movement of gas and water above oil or gas producing zones, a radioactivity high marking the margin of oil or gas occurrence is postulated. However, because of many variables involved, considerable caution is needed in the interpretation of results of radiation surveys.—*M. C. R.*

13960. Lundberg, Hans, Roulston, K. L., Pringle, R. W., and Brownell, G. M. Oil exploration with airborne scintillation counters: Oil in Canada, v. 4, no. 33, pp. 40–42, 44, 46, 1952.

Radioactive data, obtained with airborne scintillation counters, show that radioactive lows generally occur over oil fields and that these lows are commonly surrounded by radioactivity slightly higher than normal. The upward movement of ground waters in oil-bearing regions may explain the anomalous concentration of radioactive substances over oil fields. Should a radioactivity survey show a radioactive low coinciding with other types of geophysical anomalies, the probability of an oil pool is greatly strengthened.—*F. W. S.*

13961. Lundberg, Hans. Radioactivity surveys aid prospecting for oil and gas: Precambrian, v. 25, no. 4, pp. 9, 21, 1952.

The use of airborne-scintillometer surveys in prospecting for oil and the author's theory relating the radioactivity anomalies to the occurrence of oil and gas are summarized briefly. *See also* Abstract 13742.—*M. C. R.*

THERMAL METHODS

13962. Chebotarev, I. I. Hydrological and thermal aspects of petroleum occurrence: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 4, pp. 688–699, 1952.

The problem of oil occurrence has been studied from the point of view of hydrology and geochemistry of subterranean waters and the geothermal environment in connection with the estimation of petroleum potentialities of central Australia.

Three types of waters are typical for oil pools in the world: chloride, bicarbonate, and sulfate. The typical geothermal gradient for the oil-field areas has been found to be 55.2 feet per degree Fahrenheit. Study of subterranean waters and geothermal environment may be particularly valuable in search for oil in deeper parts of the earth's crust.—*M. C. R.*

WELL LOGGING

13963. Stripling, A. A. Well logging instrumentation: World Petroleum, v. 23, no. 6, pp. 55–58, 1952.

Methods of logging and their uses are described briefly. Among the more recent developments mentioned are the magnetic logging devices, acoustic logging, and the dielectric-constant log.—*M. C. R.*

13964. Summers, G. C., and Broding, R. A. Continuous velocity logging: Geophysics, v. 17, no. 3, pp. 598–614, 1952.

A method is described for the continuous recording of formational compressional velocities. The equipment consists of a relaxation oscillator and barium

titanate transmitting and receiving transducers. Some times two receiving transducers are employed for Δt velocity determinations. The transmitting and receiving transducers are separated by 5 ft of acoustic insulator. The instrument is lowered in the hole at a rate of the order of 100 ft per min and gives high-intensity ultrasonic pulses at a rate of 20 to 30 times per sec.

It is possible to obtain relatively low-velocity first arrivals through steel casing under conditions where the amplitude of the casing signal is very weak compared to the formation signal. This depends upon the triggering effect of the arrivals on the timing circuit, and thus presents uncertainties in the interpretation of the records. Normally the log should be run before casing is installed.

Interval velocities for intervals greater than 5 ft are found from velocity logs by integrating the desired interval with a planimeter and dividing by the thickness. The velocity logs check seismic up-hole data within 5 percent. The log appears to be a powerful tool in determining reflection horizons, with some limitations, and in aiding the analysis of surface records. Diagrams showing the comparisons of various logs and a schematic diagram of the amplifying and recording circuit are included.—*P. E. B.*

13965. Vogel, C. B. A seismic velocity logging method: Geophysics, v. 17, no. 3, pp. 586–597, 1952.

A seismic velocity well-logging method that employs a transient sound pulse is described. The transmitter and receiver are 5 ft apart. The pulse is produced by an electric arc from the discharge of a capacitor through electrodes immersed in a fluid; the receiving system consists of a piezoelectric transducer and electronic amplifier. The equipment is lowered into a well and sound pulses are produced at 5 ft intervals. At this spacing the first arrival at the receiver is the refracted *P* wave through the wall of the hole.

For limestones, a *P* wave, *S* wave, water wave, and surface wave have been recorded. The *S* wave is of small amplitude or lacking for shales. Modifications of the apparatus have been employed when the hole diameter varies in order to increase the accuracy of velocity determinations. Figures are included giving comparisons among seismic, electric log, and velocity log data.—*P. E. B.*

13966. Pirson, S. J. Review of quantitative methods of electrical-log interpretation: Am. Petroleum Inst., Drilling and Production Practice 1951, pp. 369–379, 1952.

This is the same paper as that abstracted in Geophys. Abstract 13048, but with larger diagrams. The discussion that followed the presentation of the paper is included.—*L. E. B.*

13967. Morris, T. S. Investigating ground water supplies with electric well logs: Water Well Jour., v. 6, no. 3, pp. 12, 32, 34, 36, 1952.

This is a nontechnical article describing the use of electrical well measurements in the search for water supplies. From log data it is possible to determine formation thickness and depth of formations, and in combination with previous knowledge of a given locality to estimate the yield of a well; but the use of logging information cannot give any indication of the permeability of formations, nor can sand beds be distinguished from gravel.—*L. E. B.*

13968. Doll, H. G. The MicroLog—A new electrical logging method for detailed determination of permeable beds: Am. Inst. Min. Met. Eng. Trans., Tech. Paper 2880, v. 195, pp. 155–164, 1950.

The MicroLog has been developed primarily as a means for the accurate determination of permeable beds where the self-potential log alone does not give a satisfactory answer. A MicroLog is a resistivity log recorded with electrodes spaced at short distances from each other in an insulating pad which is pressed against the wall of the drill hole. Measurements are recorded simultaneously with two different electrode spacings. The method provides a detailed record of formations, particularly the permeable beds, traversed in the borehole. Permeable beds are indicated by a positive separation between the two microresistivity curves. The interpretation is at present qualitative but refinements may permit quantitative determinations.—*M. C. R.*

13969. Howard, R. C. and Winn, R. H. Guarded electrode system improve log interpretation of Lower Wilcox: World Oil, v. 135, no. 1, pp. 170–172, 174, 176, 178, 1952.

Reasonably accurate interpretations of Lower Wilcox stratigraphy in the upper Gulf Coast of Texas have been made possible by use of automatic current focusing or the guarded-electrode system of electric logging. Typical logs are shown.—*M. C. R.*

13970. Wyllie, M. R. J. An investigation of the electrokinetic component of the self-potential curve: Am. Inst. Min. Met. Eng. Petroleum Trans. Tech. Paper 2940, v. 192, pp. 1–18, 1951.

Eight laboratory-prepared aqueous-base drilling muds representing common mud types, and 15 aqueous-base drilling muds sampled in the field, have been used in an experimental investigation of the relationship between the streaming potential developed across a mud filter cake and the differential pressure causing filtrate flow. It has been established that the relationship is of the form, $E_s=kP^y$, where E_s is the streaming potential, P the differential pressure and k and y are constants for any particular mud system at constant temperature. Beyond a certain minimum thickness this relationship is independent of the thickness of the filter cake. Experiment has shown that both k and y are temperature dependent parameters and that in certain mud systems there is a critical value of P above which the simple relationship $E_s=kP^y$ ceases to hold. The constant k tends to be a function of the mud resistivity at 77 F, but the exponent y has not been found to be related to any commonly measured mud property.

Field experiments in a midcontinent well show that the total self-potential developed opposite a formation may be quantitatively accounted for as the algebraic sum of an electrochemical and an electrokinetic potential. A chart is given to permit use of mean solution activities in the interpretation of electrochemical self-potential data. Field methods of computing the electrokinetic component are complicated and inaccurate. Low resistivity muds are essential if optimum accuracy is desired in computing connate water salinities.—*M. C. R*

13971. Doll, H. G. The *SP* log in shaly sands: Am. Inst. Min. Met. Eng., Petroleum Trans., v. 189, pp. 205–214, 1950.

A theoretical analysis is given of the effects of different parameters on the value of the pseudostatic self potential of shaly sands as compared to the static self

potential of clean sands under similar conditions. Formulas, current diagrams, and theoretical and actual self-potential logs and resistivity logs are included. Formulas for the pseudostatic self potential of shaly sands are given for the cases in which the diffusion follows an exponential law and therefore the resistivities of the connate water and of the mud filtrate are connected by an exponential relation. A graph is included to show the comparative difference for a linear variation of sand resistivity in the invaded zone.

"The pseudostatic self potential of a shaly sand is not only a function of the shale content but is also influenced, to a very large extent, by the relative resistivities of the sand and shale, so that the corresponding self potential deflection decreases in a large measure when oil saturation increases." It is essential not to use muds that are a great deal more resistive than the connate water.—*P. E. B.*

13972. Wyllie, M. R. J., and Rose, W. D. Some theoretical considerations related to the quantitative evaluation of the physical characteristics of reservoir rock from electrical log data: Am. Inst. Min. Met. Eng. Trans., Tech. Paper 2852, v. 189, pp. 105–118, 1950.

Logging parameters, such as the cementation factor, formation factor, and resistivity index exponent, are shown to be related to the rock textural parameters in the Kozeny equation and expressions of capillary pressure phenomena. From a strictly theoretical standpoint, it is at present impossible to make accurate estimates of reservoir rock parameters from electric-log data alone, but combinations of electric-log and core-analysis data may yield widely applicable expressions for some of these parameters.

If the tortuosity, T, applicable to fluid flow of the wetting phase in a porous medium is the same as the tortuosity affecting electrical conductivity through the fluid in the same medium, then the formation factor F takes the form $F=T^{1/2}/\phi$, where ϕ is the porosity. With the same assumption regarding the equality of the hydraulic and electrical tortuosities of the wetting phase in partially saturated porous media, the resistivity index I in terms of saturation and the ratio of the wetting liquid tortuosities at 100 percent saturation and the saturation Sw considered is $I=(Te/T)^{1/2}\ Sw$.

Thus in the relationship $I=Sw^{-n}$, n depends on the texture and wetting liquid saturation and is not universally 2. In practice n seems to lie between 1.7 and 2.5.

Accurate determinations of porosity from log data alone are not possible.

The empirical relationship between permeability and log data proposed by Tixier has been expanded and a more general relationship defined. A correlation between irreducible saturation, permeability, and formation factor is proposed for those places where an estimate of capillary pressure is unobtainable.—*M. C. R.*

13973. Puzin, L. A. Connate water resistivity in Oklahoma—Its application to electric log interpretation: Petroleum Engineer, v. 24, no. 9, pp. B-67–70, 73, 74, 76, 78, 1952.

A connate-water resistivity chart of Oklahoma formations, made by compiling resistivity values measured or calculated from connate water samples, is presented. Resistivity values of a given horizon can be plotted on a map to show the geographical variations of connate water salinity within that particular horizon. Such equiresistivity maps prepared for eight horizons in Oklahoma, are included.—*M. C. R.*

13974. Owen, J. E. The resistivity of a fluid-filled porous body: Jour. Petroleum Technology, v. 4, no. 7, pp. 169–174, 1952. Am. Inst. Min. Met. Eng. Petroleum Trans., Tech. Paper 3352, v. 195, pp. 169–174, 1952.

Correlations between electrical resistivity and porosity have been made empirically, notably by Archie who obtained a relation $F=\phi^{-m}$ where F is the formation factor, or the ratio of the resistivity of a fluid-saturated porous body to that of the saturating fluid, ϕ is the porosity, and m the so-called cementation factor. Experimental values of the formation factor higher than expected from simple pore geometry have been explained as the result of tortuosity of uniform pore paths. Variations in cross-sectional area of the conducting paths also affect the resistivity. A model of a porous body is presented in which the pore space consists of a system of voids and interconnecting tubes, and equations for the flow of electric current through such a network are derived. These equations show how constriction effects can result in high formation factors. Constriction and tortuosity may be combined to give model pore systems exhibiting to a first approximation porosity and resistivity properties similar to those of natural porous bodies.—*M. C. R.*

13975. Bush, R. E., and Mardock, E. S. The quantitative application of radioactivity logs: Am. Inst. Min. Met. Eng. Trans., Tech. Paper 3075, v. 192, pp. 191–198, 1951.

Quantitative interpretation of radioactivity logs is based on core data within the same well for both cased-hole and open-hole conditions, thereby establishing reference lines for instrumental zero and for type lithologies. An interrelation factor called the neutron-productivity number, can be used to estimate productivity from sandstone as well as limestone formations.—*F. W. S.*

13976. Russell, W. L. Interpretation of neutron well logs: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 2, pp. 312–341, 1952.

Recent improvements in gamma-ray and neutron logging permit, under limited conditions, the making of quantitative interpretation of the neutron log as a measure of the porosity of rocks, particularly limestones and dolomites. The paper is a review of various methods of logging and of interpretation and discusses the accuracy, errors, and limitations of natural gamma-ray and neutron well logs.—*F. W. S.*

13977. Basham R. B. and Macune, C. W. The delta log, a differential temperature surveying method: Jour. Petroleum Technology, v. 4, no. 5, pp. 123–129, 1952; also Am. Inst. Min. Met. Trans., Tech. Paper 3317, v. 195, 1952.

Very small anomalies in oil-well temperatures may be detected and measured by recording the difference in temperature between two thermally sensitive elements spaced a known distance apart on a carrier and lowered into a borehole. In the instrument described, the thermal elements, of the electrical-resistance type, are enclosed in a steel tube to prevent contamination from well fluids and are spaced 6 ft apart on a carrier tube 1½ in. in diameter. The elements operate in a balanced electrical circuit, which sends only a reference signal to the surface while the logging device passes through normal-gradient temperatures but produces large recorder deflections when it is unbalanced as either element enters a temperature disturbance. Differences in temperature between the elements may be recorded on a scale of 0.02° per inch and differences of 0.001° can therefore be detected.—*M. C. R.*

PATENTS

GRAVITY METHODS

13978. Boucher, F. G. Gravity meter, U. S. patent 2,610,507, granted Sept. 16, 1952. 4 claims.

MAGNETIC METHODS

13979. Brattain, W. H., Klein, N. E. and Richardson, M. S. Magnetometer head, U. S. patent 2,605,344, granted July 29, 1952. 2 claims. Assigned to the United States of America as represented by the Secretary of the Navy.

13980. Brewer, A. W. and Jarman, C. A. Apparatus for the measurement of magnetic fields, U. S. patent 2,606,229, granted Aug. 5, 1952. 8 claims.

Apparatus for determining the magnitude and direction of the earth's magnetic field in a moving vehicle.

13981. Klaasse, J. M. and Jensen, Homer. Method and apparatus for conducting geophysical surveys from an aircraft, U. S. patent 2,610,226 granted Sept. 9, 1952. 10 claims.

Airborne magnetometer with shoran ground control. Pilot indicator shows deviation from circular arc around one shoran station and fiducial marker indicates concentric circles around second station.

13982. Jensen, Homer. Method and apparatus for magnetic exploration, U. S. patent 2,611,802, granted Sept. 23, 1952. 6 claims.

Airborne magnetometer and combined aerial camera and recording devices to indicate value of magnetic field and plum point beneath the aircraft.

13983. Rumbaugh, L. H., Jensen, Homer, and Balsley, J. R. Jr. Method and apparatus for conducting geophysical surveys, U. S. patent 2,611,803, granted Sept. 23, 1952. 6 claims.

Airborne magnetometer and combined aerial camera and recording camera to photograph dials and number counters showing value of magnetic field and plumb point beneath the aircraft.

SEISMIC METHODS

13984. Mann, R. W. Seismic exploration method, U. S. patent 2,604,954 granted July 29, 1952. 3 claims. Assigned to Standard Oil Development Co.

A method of preventing generation of secondary impulses when the explosive charge is fired beneath the surface of a body of water.

13985. Hawkins, J. E. System for analyzing seismographic records, U. S. patent 2,604,955, granted July 29, 1952. 14 claims. Assigned to Seismograph Service Corp.

13986. Reid, A. C. Marine seismometer spread, U. S. patent 2,607,842, granted Aug. 19, 1952. 10 claims. Assigned to Stanolind Oil and Gas Co.

Marine seismic surveying assembly to be towed by a vessel through a body of water.

13987. Winterhalter, A. C. Seismic exploration apparatus, U. S. patent 2,609,438, granted Sept. 2, 1952. 3 claims. Assigned to Sun Oil Co.

Seismic exploration apparatus consisting of a series of detectors, frequency-modulated oscillators, high-frequency radio transmitters, and receivers.

13988. Silverman, Daniel. Seismic-wave generator, U. S. patent 2,609,885, granted Sept. 9, 1952. 4 claims. Assigned to Stanolind Oil and Gas Co.

A source of seismic waves for seismic-reflection surveying consisting of an elongated vertical helix of explosive material, the pitch of the helix being such as to produce an effective velocity of detonation in the direction of the helical axis substantially equal to the velocity of seismic waves in the surrounding formation.

13989. Pottorf, Newell. Marine seismometer spread, U. S. patent 2,610,240, granted Sept. 9, 1952. 7 claims. Assigned to Stanolind Oil and Gas Co.

A seismometer spread adapted for towing through a body of water.

13990. Hawkins, J. E. Seismic signal amplifying system, U. S. patent 2,611,024, granted Sept. 16, 1952. 2 claims. Assigned to Seismograph Service Corp.

ELECTRICAL AND ELECTROMAGNETIC METHODS

13991. Brant, A. A. Geophysical exploration, U. S. patent 2,611,004, granted Sept. 16, 1952. 13 claims.

A method of detecting sulfides by measuring transient potential up to 0.5 second.

13992. Muffly, Gary. Detecting device, U. S. patent 2,608,602, granted Aug. 26, 1952. 15 claims. Assigned to Gulf Research and Development Co.

Means for detecting an object by its disturbing effect upon an electromagnetic field.

RADIOACTIVITY METHODS

13993. Simpson, J. A. Jr. Radiation device and method of construction, U. S. patent 2,602,904, granted July 8, 1952. 11 claims. Assigned to the United States of America as represented by the U. S. Atomic Energy Commission.

13994. Neufeld, Jacob. Radiation detector, U. S. patent 2,604,600, granted July 22, 1952. 9 claims. Assigned to Well Surveys, Inc.

13995. Herndon, H. V. and Hoff, R. G. Portable radiation survey instrument, U. S. patent 2,605,429, granted July 29, 1952. 7 claims. Assigned to the United States of America as represented by the U. S. Atomic Energy Commission.

13996. Krasnow, Shelley and Test, M. J. Construction of Geiger-Muller tube, U. S. patent 2,605,435, granted July 29, 1952. 14 claims. Assigned to Schlumberger Well Surveying Corp.

13997. Scherbatskoy, S. A. High-efficiency ionization chamber, U. S. patent 2,606,-295, granted Aug. 5, 1952. 3 claims. Assigned to Well Surveys, Inc.

13998. Simpson, J. A. Jr. Radiation counter, U. S. patent 2,606,296, granted Aug. 5, 1952. 19 claims. Assigned to the United States of America as represented by the U. S. Atomic Energy Commission.

LOGGING AND BOREHOLE METHODS

13999. Swift, L. M. Casing collar locator, U. S. patent 2,602,833, granted July 8, 1952. 3 claims. Assigned to Well Surveys, Inc.

A permanent magnet and elements connected in circuit with it, defining with the well casing a magnetic circuit in which the reluctance is varied by traversing a casing collar.

14000. Basham, R. B. and Macune, C. W. Apparatus for locating binding areas around well casing, U. S. patent 2,604,181, granted July 22, 1952. 6 claims. Assigned to Westronics, Inc.

Apparatus consists of vibrator and pickup and means of indicating variations in amplitudes of vibrations in casing.

14001. Purcell, W. R. Method and apparatus for measuring capillary pressure, U. S. patent 2,604,779, granted July 29, 1952. 6 claims. Assigned to Shell Development Co.

14002. Owen, J. E. Electrical well logging apparatus, U. S. patent 2,605,321, granted July 29, 1952. 6 claims. Assigned to Geophysical Research Corp.

14003. Angona, F. A. Apparatus for measuring interstitial water content of well cores, U. S. patent 2,612,036, granted Sept. 30, 1952. 4 claims. Assigned to Socony-Vacuum Oil Co.

Apparatus for determining interstitial water content of a well core sample by the restored-state method.

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