Geophysical Abstracts 157 April-June 1954

GEOLOGICAL SURVEY BULLETIN 1022-B

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By MARY C. RABBITT, DOROTHY B. VITALIANO, S. T. VESSELOWSKY, *and others*

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

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GEOPHYSICAL ABSTRACTS 157, APRIL–JUNE 1954

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GENERAL INFORMATION

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

The form of the bibliographic reference is believed to be self-explanatory. A list of abbreviations of journal titles was given in Geophysical Abstracts 156. Additions to that list are given below. Unless specifically indicated otherwise, the language in which the article is written is the same as that given in the title. The system of transliteration used by the United States Board on Geographic Names is employed for transliteration of Slavic names and titles. Translations of author's abstracts are indicated as "Author's Abstract" followed by the initials of the translator.

ABSTRACTORS

Geophysical Abstracts are prepared and compiled under the direction of Mary C. Rabbitt with the assistance of Dorothy B. Vitaliano and S. T. Vesselowsky. Other abstracts in this issue have been prepared by P. Edward Byerly, William J. Dempsey, Roland G. Henderson, George V. Keller, L. C. Pakiser, Jr., and Isidore Zietz.

LIST OF JOURNALS

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

Abbreviation	*Publication*
Annales Guébhard-Séverine	Annales Guébhard-Séverine. Institut de géophysique et sciences diverses, fondation Adrien Guébhard-Séverine. Neuchâtel, Switzerland.
Bergakademie	Bergakademie. Zeitschrift für Bergbau, Hüttenwesen und verwandte Wissenschaften. Bergakademie, Freiberg, Germany.
Deep-Sea Research	Deep-Sea Research. Pergamon Press, London.
Indonesia Jour. Sci. Research	Journal of Scientific Research in Indonesia. Published by the Organization for Scientific Research in Indonesia. Djakarta.
Industria Mineraria	Industria Mineraria d'Italia e d'Oltremare. Roma.
Interamericana recursos minerales, Primera convencion, Mem.	Memorias de la Primera Convencion de Recursos Minerales. México, D,
Kakioka Magnetic Observatory Mem	Memoirs of the Kakioka Magnetic Observatory. Kakioka, Japan.
Kyōto Univ. Disaster Prevention Research Inst. Bull.	Bulletin of the Disaster Prevention Research Institute, Kyōto University. Kyōto, Japan.
New Zealand Dept. Sci. Indus. Research, Seismol. Observatory Bull.	Bulletin of the Seismological Observatory, Department of Scientific and Industrial Research. Wellington, New Zealand.
Österreich. Akad. Wiss. Kl. math.-naturw., Erdbeben-Komm. Mitt.	Mitteilungen der Erdbeben-Kommission, Österreichische Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse. Wien.
Rev. Inst. Français du Pétrole	Revue de l'Institut Français du Pétrole et Annales des combustibles liquides. Paris.
St. Louis Acad. Sci. Trans	Transactions of the St. Louis Academy of Science. St. Louis, Mo.
Srbija Zavod. geol. i geofiz. istraživanja Vesnik.	Vesnik Zavoda za geološka i geofizička istraživanja. Beograd.
U. S. Geol. Survey Geophys. Inv	U. S. Geological Survey, Geophysical Investigations, Washington, D. C.

GRAVITY

GENERAL AND THEORETICAL PAPERS, INCLUDING THOSE ON ISOSTASY

157-1. Heyl, Paul R. Gravitation—still a mystery: Sci. Monthly, v. 78, no. 5, p. 303–306, 1954.

This is a review of concepts and experiments concerning the force of gravitation from earliest times to the present, concluding with a brief mention of the practical applications of gravity to geodesy and petroleum prospecting.—*D. B. V.*

157–2. British National Committee for Geodesy and Geophysics. The British Fundamental Gravity Station. New site at the National Physical Laboratory, Teddington, Middlesex: Bull. géod., no. 32, p. 103–105, 1954; and, with no author, Nature, v. 173, no. 4409, p. 794–795, 1954.

The new site of the British Fundamental Gravity Station is on the site of Clark's (1939) absolute determination of gravity in Room No. 11 of the Metrology Division building, National Physical Laboratory, Teddington. The geodetic coordinates are 51°25′13.6″ N. latitude, 0°20′21.4″ W. longitude; height of pillar 9.23 m (Newlyn datum). Two subsidiary sites where the value of gravity is within ±0.02 mgal and 0.04±0.02 mgal greater than at the National Base are also provided.—*M. C. R.*

METHODS OF ANALYSIS AND INTERPRETATION

157–3. Schneider, Oscar. Curvatura de superficies equipotentiales, gradientes y componentes horizontales de la gravedad [Curvature of equipotential surfaces, gradients, and horizontal components of gravity]: Interamericana recursos minerals, primera convencion, Mem., p. 191–199, 1952.

Schneider presents a method of calculating differential curvature of the gravitational equipotential surface from gravimetric (Bouguer) maps. Starting from a corollary of Green's theorem, he shows that the north component of differential curvature can be expressed by the equation

$$U_{\Delta}=\frac{15}{\pi}\int_0^{2\pi}\int_0^{\infty}\frac{\cos 2\theta}{r^2}g(r,\theta)\,drd2\theta,$$

using polar coordinates, where U_{Δ} is the north component in Eötvös units, r is the radial vector from the gravimetric station in kilometers, θ is computed clockwise from north, and $g(r,\theta)$ is the absolute value or the total vertical component of gravity in milligals. The value of U is not affected if the gravimetric value, referred to an arbitrary base, is substituted for the absolute value. The east component is similarly calculated by means of the formula

$$2U_{xy}=\frac{15}{\pi}\int_0^{2\pi}\int_0^{\infty}\frac{\sin 2\theta}{r^2}g(r,\theta)\,drd\theta.$$

The values calculated by these formulas need no latitude correction and are practically free of the regional effect. Charts to aid calculation of U_{Δ} and U_{xy} are included in the paper.

The horizontal gradients of gravity U_{xx} and U_{yx}, and the horizontal components of gravity g_x and g_y can also be calculated from a Bouguer map; latitude and regional corrections must be applied.—*D. B. V.*

157–4. Favre, B., and Dalby, R. Principe des methodes d'interprétation directe en gravimétrie et magnétisme [Principles of the methods of direct

interpretation in gravimetry and magnetism]: Rev. Inst. Français du Pétrole, v. 7, no. 7, p. 217–234, 1952.

In the direct methods of interpretation of potential fields, a field observed at the surface is continued downward by analytical processes involving calculations of the successive derivatives of the vertical component. This is a summary of literature on the subject, drawn mainly from Americans sources—*D. B. V.*

157–5. Andreyev, B. A. V raschety prostranstvennogo raspredeleniya potentsial'nykh poley i ikh ispol'zovaniye v razvedochnoy geofizike, IV [Computations of spatial distribution of potential fields and their utilization in geophysical exploration, part IV]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 49–64, 1954.

This paper is the continuation of previous studies (see Geophys. Abs. 9629, 10745, 11605, 14239) and deals primarily with gravitational and magnetic anomalies and their interpretation by matching the curves obtained in a survey with potential field patterns produced by bodies of different geometric shapes. Several examples of sharply localized anomalies and of anomalies produced by extended horizontal layers are included—*S. T. V.*

157–6. Marussi, Antonio. Sulla riduzione regionale e sul metodo delle derivate seconde in gravimetria [On regional reductions and the second-derivative method in gravimetry]: Annali Geofisica, v. 6, no. 2, p. 155–160, 1953.

Formulas given by Pizzetti in 1909 are recalled which permit determining, by practical procedures, the divergence of the surface gradient of gravity (Beltrami's second differential parameter of gravity at the surface). These are related to the methods of regional reduction and the second-derivative methods which have been recently proposed. Whenever the surface considered is a level surface of the potential field, the second differential parameter may be easily expressed by means of the geometric and dynamic elements of the field itself.—*M. C. R.*

157–7. Simpson, Stephen M., Jr. Least squares polynomial fitting to gravitational data and density plotting by digital computers: Geophysics, v. 19, no. 2, p. 222–270, 1954.

The fitting of an nth order polynomial as function of x and y to gravity data by least squares is discussed. The normal equations are derived and certain simplifications are suggested when a rectangular grid is employed. The method is applied to a gravity anomaly using polynomials of order 2, 3, and 4 respectively. Simpson suggests the use of density plotting as a possible substitute for contouring when only a qualitative analysis is desired. Density plotting as well as the calculation of the residuals is done with a high-speed digital computing machine.—*I. Z.*

157–8. Schneider, Oscar. Calculo de densidades en gravimetria [Calculation of density in gravimetry]: Interamericana de recursos minerales, Primera convencion, Mem. p. 200–201, 1952.

Schneider proposes a method of calculating density which has the advantage of eliminating the personal equation, a source of error inherent in Nettleton's method which is usually employed. For the free-air Bouguer correction he derives the equation: $k=\sum g_r\, h_r - n\,\bar{h}\,\bar{g} / \sum h_r^2 - n\,\bar{h}^2$, where g_r is the value of gravity at a

particular station corrected for latitude, in milligals; h_r is the elevation of the station above datum; n is the number of stations; $\bar{g}$ is the average of values of g_r; and $\bar{h}$ is the average of values of h_r. The density (σ) can then be calculated from the formula $k=(0.3086-0.04185\sigma)$ mg/m. An actual example of these computations is presented.—*D. B. V.*

157–9. Reinhardt, H. G., Porstendorfer, G., and Stelzner, J. Die numerische Berechnung der zeitlichen Schwereanderung fur eine starre Erde [Numerical computation of the variation of gravity with time for a rigid earth]: Bergakademie, Jahrg. 5, no. 5, p. 187–195, 1953.

The complete derivation of the correction to gravity measurements for the tidal effect of the sun and the moon on a rigid earth by the methods of spherical astronomy is given. Numerical results are presented in the form of graphs, and auxiliary tables to facilitate computations are also given. By comparing these corrections with actual values recorded at a station for a sufficiently long period of time, it is possible to determine the additional correction for the deformation of the earth.—*S. T. V.*

157–10. Morelli, Carlo. Variazione diurna della gravità in Europa, Nota 3a [Diurnal variations of gravity in Europe, 3rd note]: Annali Geofisica, v. 6, no. 4, p. 579–583, 1953.

A chart of diurnal variations of gravity for Europe with an accuracy of ± 0.01 mgal has been calculated for central longitude (λ_0) of 15° E. and for latitudes 25°, 35°, 45°, 55°, 65° N. Graphical interpolation for intermediate latitudes is possible. The curves retain their validity in the whole interval of $\lambda_0 \pm 60°$, if the time is expressed as "local time". Graphs for January, February, and March 1954 are included in the paper.—*S. T. V.*

157–11. Pettit, John T. Tables for the computation of the tidal accelerations of the sun and moon: Am. Geophys. Union Trans., v. 35, no. 2, p. 193–202, 1954.

Tables are provided for facilitating the computation of the tidal acceleration of the Sun and Moon at a point on the surface of a rigid Earth. Without interpolation, the tables provide an accuracy of one microgal in the resultant computation. Higher accuracy is readily obtained by interpolation.—*Author's Abstract*

157–12. Gabriel, V. G. Possible maximum variations in the force of gravity as may be observed at the earth's surface: St. Louis Acad. Sci. Trans., v. 31, no. 7, 9 p., no date.

The earth and its ideal mathematical representation, a spheroid of revolution, are briefly defined in terms of radii and other parameters. The force of gravity at the earth's surface is defined by means of Newton's law of universal gravitation, and free-air, Bouguer, and isostatic corrections are briefly explained. By applying generally accepted formulae, the combined effect of theoretical gravity values referred to the International Ellipsoid and the maximum deviations from it due to the necessary corrections are evaluated and plotted as a curve having latitude against possible maximum gravity in gals.—*D. B. V.*

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Tomaschek, R. The tides of the solid earth and their geophysical and geological significance: see Geophys. Abs. 157–180.

OBSERVATIONS OF GRAVITY AND GRAVITY SURVEYS

157–13. Bacon, Lloyal O. Gravity surveys of central Pennsylvania: Am. Geophys. Union Trans., v. 35, no. 3, p. 495–502, 1954.

Gravity surveys in central Pennsylvania were made in an attempt to obtain information which could be related to subsurface structures near the Allegheny Front. Results show no distinct relationship between gravity anomalies and major structural folding; however, they do indicate an intrusion or upthrust of the basement east of the Allegheny Front. It is believed that this basement feature was responsible for the forces causing the northwestward structural salient in the Appalachian Mountain of central Pennsylvania.—*Author's Abstract*

157–14. Cook, A. H. Adjustment of the principal gravity observations in Great Britain: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 8, p. 494–534, 1953.

This is a detailed study of the adjustment of gravity values for certain of the principal gravity observations in Great Britain. Included are a discussion of the normal equations to be solved, diagrams of the nets of gravity stations, and tabulated values of the pertinent data, including calculated gravity values relative to the value at the Pendulum House, Cambridge Observatory, and contributions to chi square for individual differences.—*P. E. B.*

157–15. Duecker, John C. Gravity surveys in northeastern Pennsylvania: Am. Geophys. Union Trans., v. 35, no. 3, p. 503–507, 1954.

A gravity traverse in northeastern Pennsylvania between Millerton and Columbia Cross Roads and thence east to a point about half a mile below Stockport Station on the Delaware River indicated a local anomaly of about 15 milligals near Montrose and a regional Bouguer anomaly of 70 milligals between Milan and Stockport. The local anomaly may be attributed to grabenlike faulting of a shallow layer or a buried intrusion of diabase or peridotite. The regional anomaly fits in well with the Bouguer anomaly maps of the eastern seaboard region compiled by Nettleton and Woollard.—*M. C. R.*

Books, Kenneth G. Geophysical surveys in Salt Lake Valley, Utah: see Geophys. Abs. 157–45.

157–16. Louis J. Comparaison entre une étude géologique et une étude géophysique (par gravimétrie) dans le bassin de Blanzy [Comparison between a geologic and geophysical study (by gravimetry) in the basin of Blanzy]: Soc. géol. France Comptes Rendus, no. 7, p. 141–144, 1954.

A gravimetric study was made in 1952 of the basin of Blanzy, in west-central France, and compared with a geologic study made in 1947. In general, agreement was found to be satisfactory. The gravimetric measurements do not show details such as minor dislocations, and intersections of faults.—*D. B. V.*

157–17. Amadei, Gaetano; Maino, Armando; and Motta, Antonio. Rilevamento gravimetrico della bassa valle dell Aniene [Gravimetric survey of the lower Aniene valley]: Servizio geol. Italia Boll., v. 74, fasc. 1, p. 279–293, 1953.

The plains between Rome and Tivoli were surveyed with an Atlas gravimeter; 60 stations were occupied with 3 serving as base stations. Results are presented in tables and in a map of Bouguer anomalies, and are interpreted as indicating a rapid increase in the positive anomaly noted in the Torre Mastarta area.—*D. B. V.*

157–18. Morelli, Carlo. Rilievo gravimetrica nel Basso Friuli orientale [Gravimetric survey in the eastern Basso Friuli]: Osservatorio geofis. Trieste Pub., no. 43, 7 p., 1954; reprinted from Tecnica Italiana, anno 9, no. 3, 1954.

A detailed gravimetric survey of 333 stations has outlined the bedrock topography between Monfalcone and the Isonzo in the eastern Basso Friuli. The object of the survey was to locate ground water channels. Results are presented in maps of Bouguer anomalies.—*D. B. V.*

157–19. Zaccara, Gaetano. Rilievo gravimetrico del Lazio nordorientale [Gravimetric survey of northeastern Lazio]: Servizio geol. Italia Boll. v. 74, fasc. 1, p. 265–278, 1953.

This is the report on a gravimetric survey of the northeastern part of the Latium. Twenty-four stations were occupied in an area of 460 sq km. The results of the measurements with applied corrections are presented in a table. A map of Bouguer anomalies with a 1-mgal contour interval shows a general trend in a northwest-southeast direction, with a regional horizontal gradient toward the northeast and pronounced positive anomaly in the central part of the surveyed area.—*S. T. V., D. B. V.*

157–20. Tribalto, Giuseppe. Su una ricerca gravimetrica di dettaglio eseguita nella Pianura Pontina [On a detailed gravimetric survey of the Pontine lowland]: Servizio geol. Italia Boll., v. 74 fasc. 2, p. 523–534, 1953.

This is a report on a gravimetric survey of the Pontine lowland. An area of some 400 sq km was surveyed, using a Western gravimeter. The area was divided by 188 stations into small polygons so that the initial station of every loop could be reached in 3 hours, thus allowing the lunisolar effect to be neglected.

The results are presented in a table and on a Bouguer map with 1-mgal contour interval. The map shows a uniform regional gradient increasing from northeast to southwest, attributed to decreasing depth of the basement; and a positive anomaly oriented along the transverse Apeninnes direction and sharply delineated on the west by a negative anomaly which undoubtedly reflects a depression in the basement.—*S. T. V.*

157–21. Morelli, Carlo. Indagini geofisiche per la ricerca del corse sotterraneo del Timavo [Geophysical investigations for the tracing of the subterranean course of the Timavo]: Osservatorio geofis. Trieste Pub., no. 54, 7 p., 1954; reprinted from Tecnica Italiana, anno 9, no. 4, 1954.

A detailed gravimetric survey of 611 stations (average spacing 250 m) on the limestone plateau east of Trieste indicates several series of natural caverns which may represent hitherto unknown underground branches of the Timavo.—*D. B. V.*

157–22. Morelli, Carlo. Rilievo gravimetrico alle foci del Timavo [Gravimetric survey at the mouths of the Timavo]: Osservatorio geofis. Trieste Pub., no. 38–39, p. 3–5, 1954; reprinted from Tecnica Italiana, anno 9, no. 2, p. 111–113, 1954.

A detailed gravimetric survey of 207 stations (average spacing 35 m) indicates the natural channels through which the major part of the underground drainage of the Timavo delta flows.—*D. B. V.*

157–23. Pícha, Jan. Report on the gravimetric measurements in the basic gravimetric network during 1950: Czechoslovak Jour. Physics, v. 1, no. 3–4, p. 210, 1952.

During 1950 the work on the basic gravimetric network of Czechoslavakia was continued. Using the Nørgaard gravimeter, 181 stations of the first and second order were occupied, forming 8 triangles and a loop around the city of Praha. The base stations were Ještěd and Petřín.—*S. T. V.*

Crenn, Y[vonne]. Gravity and magnetic anomalies associated with basic rocks of New Caledonia: see Geophys. Abs. 157–49.

Browne, B. C. Gravity measurements and oceanic structure: see Geophys. Abs. 157–191.

Woollard, G. P. Crustal structure beneath oceanic islands: see Geophys. Abs. 157–188.

MAGNETISM

MAGNETIC FIELD OF THE EARTH

157–24. Darwin, Charles. Electron inertia and terrestrial magnetism: Royal Soc. London Proc., Ser. A, v. 222, no. 1151, p. 471–476, 1954.

The problem is solved of the influence that electron inertia might have on the earth's magnetism. Owing to the retardation of the earth's rotation electric currents will arise from it. Though the direction is correct, it is shown that even for a sphere of the great size of the earth the magnetic effect is entirely negligible. It is also shown that changes of the acceleration rate would have to be extremely slow in order that they should produce any effect at all even on this extremely weak field.—*Author's Abstract*

157–25. Takeuchi, Hitoshi, and Shimazu, Yasuo. On a self-exciting process in magneto-hydrodynamics: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 5, no. 1, 1952; reprinted from Jour. Physics of the Earth, v. 1, no. 1, p. 1–9, 1952.

This is part of a more complete paper published in the Journal of Geophysical Research (see Geophys. Abs. 156–31).—*D. B. V.*

157–26. Mayaud, Pierre-Noël. Le pôle magnétique Sud en 1952 et les déplacements comparés des pôles Nord et Sud de 1842 à 1952 [The south magnetic pole in 1952 and the compared displacements of the north and south magnetic poles from 1842 to 1952]: Annales Géophysique, tome 9, no. 3, p. 266–276, 1953.

This is an extensive discussion of various data on the motions of the magnetic poles in the period 1842–1952. It is found that: the displacements seem to have been more important within the last 40 years, than within the preceding 60 to 70 years; the displacement of the south magnetic pole (south latitude) of 800 km in the past 110 years is practically double that of the north magnetic pole; the displacement is south to north for both poles, and thus does not correspond to a relative variation of the geographical axis and a hypothetical magnetic axis; the south-to-north displacement is distinctly more important than the east-to-west displacement. Thus the displacements of the poles appear to be purely a "regional" phenomenon rather than "planetary" one. The position of the "south magnetic pole" in 1952 is given as 68.7° S., 143° E. with a "probable error" of half a degree in latitude.—*P. E. B.*

157–27. Bhargava, B. N., and Naqvi, Ali M. Very long sequences of geomagnetic activity and its annual variation: Nature, v. 173, no. 4402, p. 498–499, 1954.

A plot of 3-day running means of the international magnetic character figures, *C*, for the 3-year period 1950–1953 indicates the existence of two very long sequences of 27-day recurrences. One started July 11–12, 1950, and had continued for 40 recurrences at the time of writing; the second began November 21, 1951 and had continued for 21 recurrences. Bhargava and Naqvi conclude that two principal long-lived *M*-regions separated in longitude by about 130° are responsible for the two series; that the single observed yearly maximum for each series (September–October for the first, March–April for the second) indicates the *M*-regions were at heliographic latitudes greater than 7.2°; and that the characteristic annual variation of geomagnetic activity is due to the approach of the earth's projection on the solar disk toward the zones of maximum solar activity.—*M. C. R.*

157–28. Holmberg, E. R. R. Rapid periodic fluctuations of the geomagnetic field. I: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 8, p. 467–481, 1953.

The paper contains a new analysis of observational material, mainly from Eskdalemuir, and describes some unexpected properties of geomagnetic fluctuations. The chief of these are: There is a change of type at sunset from a continuous flux of disturbance to a comparative quiet punctuated by short damped wave trains; and the daytime fluctuations have a spectrum with definite fine structure. The observations for the spring equinoxes on the continuous daytime fluctuations indicate a marked tendency for the hourly mean periods to fall within one of two bands around 20 and 70 seconds. The extent of separation of these bands is much greater in summer than in winter, with the short-period band remaining centered at 20 seconds. The time at which separation begins is also variable, and suggests that the separation is an effect due to sunrise. The nighttime observations show short damped trains of waves of duration between 5 and 10 minutes, with a mean period in the range 30 to 130 seconds. The daytime and nighttime effects could be connected by assuming a resonator, excited by isolated impulses at night and by a continuous flux of wide-band energy during the day.—*P. E. B.*

157–29. Gibault, G[aston]. Sur un décalage entre les micropulsations du magnétisme terrestre et les perturbations ordinaires [On a delay

between magnetic micropulsations and ordinary perturbations of the earth's magnetic field]: Annales Géophysique, tome 10, no. 1, p. 65, 1954.

On October 14 and 15, 1953, several chromospheric eruptions occurred. These were followed on October 15 by a magnetic storm with an abrupt beginning. Because of the exceptional magnetic calm on October 14 it was possible to verify the absence of "micropulsations" before, during, and after the eruptions. The first wave trains of micropulsations at Chambon-le-Forêt began a full ten minutes after the beginning of the magnetic storm. A similar magnetic calm existed on November 10 and was followed by a magnetic disturbances with a progressive beginning, which remained weak the first day. Micropulsations were not noted until the morning of November 12.—*P. E. B.*

157–30. Mayaud, P. N. Sur la forme de la variation *Sa-Sq* du champ magnétique dous les régions polaires [On the variation of the *Sa-Sq* vector in the polar regions]: Annales Géophysique, tome 10, no. 1, p. 89–92, 1954.

Vectorial diagrams are given for the diurnal variation of the *Sa-Sq* vector for the following stations: Port Martin, Cape Dennison, Cape Evans, Thule, Godhavn, Chesterfield, Calm Bay, Fort Rae, Lerwick, and Eskdalemuir. Inside the auroral zone, the trajectory of the extremity of the vector representing the *Sa-Sq* variation remains in a plane normal to the plane ZX^1. The inclination of this plane seems to increase in going from the magnetic pole toward the auroral zone. At local noon and midnight the projection of the vector in the plane ZX^1 is a maximum. Within the auroral zone, the extremity of the vector describes a rather crooked curve (a "figure eight" in the ZX^1 plane because of the semidiurnal fluctuation at this latitude, especially in Z). Outside the auroral zone and near its border, the vector tends to lie in a plane which changes rapidly into coincidence with the ZY^1 plane with decreasing magnetic latitude.—*P. E. B.*

157–31. Nagata, Takes[h]i, and Fukushima, Naoshi. Constitution of polar magnetic storms: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 5, no. 1, 1952; reprinted from Rept. Ionosphere Research in Japan, v. 6, no. 2, p. 85–98, 1952.

Successive instantaneous aspects of the world-wide distribution of polar magnetic storms were examined with the aid of a number of magnetogram copies obtained during the International Polar Year. It is concluded from the analyses of these data that the polar magnetic storms are composed of a number of elementary disturbances which take place successively with duration from 30 minutes to 2 hours.

Although the average of all these elementary disturbances is of the form of S_D-field, the equivalent current system corresponding to each elementary disturbance is generally much simpler, being approximated by the current system produced by an electric dipole which is situated in the auroral zone.

This fact may suggest that each elementary disturbance is caused by the production of e. m. f. in a rather small area in the auroral zone. Sometimes, two or three of such elementary disturbances originated at different localities appear simultaneously.

It is proved then that all these phenomena can be interpreted consistently by assuming the dynamo-action of the highly ionized area in the auroral zone, where the highly ionized area changes time by time.—*Authors' Abstract*

157–32. Kato, Yoshio. On the characteristics of SC* of magnetic storms: Tōhoku Univ. Sci. Repts., 5th ser., v. 4, no. 1, p. 5–8, 1952.

This is a study of the characteristics of the preliminary reverse impulse *SC** of magnetic storms. Kato concludes that the current system during sudden commencement consists of two systems, one a symmetrical part (D_{st}) flowing eastward, and the other an asymmetrical part (S_D) in the auroral zone in the afternoon hemisphere; the term *SC** appears when the intensity of S_D is greater than that of D_{st}. The current systems D_{st} and S_D usually occur at almost the same epoch all over the world, in which case *SC* and *SC** appear simultaneously; but sometimes S_D is a little earlier than D_{st} in which case *SC** appears earlier than *SC*. Kato believes that ultraviolet radiation may be responsible for the formation of D_{st} and S_D during the initial phase of magnetic storms.—*D. B. V.*

157–33. Rougerie, P. Les baies géomagnétiques enregistrées à l' Observatoire du Val-Joyeux [Magnetic bays recorded at the Val-Joyeux observatory]: Annales Géophysique, tome 10, no. 1, p. 47–58, 1954.

This is a presentation of the statistics on geomagnetic bays from the measurements at the Val-Joyeux observatory near Paris for the 35-year period between 1901 and 1936, with the exception of 1922. The diurnal and annual variations of frequencies, magnitudes, and durations are given. The variations of the vertical component are in the opposite senses at Val-Joyeux and Tortosa (Ebro Observatory).—*P. E. B.*

157–34. Bullen, J. M., and Cummack, C. H. The lunar diurnal variations of the earth's magnetic field for all elements at Amberley, N. Z., based on five years' observations: New Zealand Jour. Sci. Technology, sec. B, v. 35, no. 5, p. 371–377, 1954.

From analysis of records of 5 years for lunar diurnal variation, it is found that only the second harmonic of the variation may be considered reliable. The variation in the vertical component is much larger than that computed for northern hemisphere stations at approximately corresponding geographic and geomagnetic coordinates.—*M. C. R.*

157–35. Kato, Yoshio, and Takagi, Akio. Further note on the investigation of the changes in the earth's magnetic field accompanying earthquake or volcanic eruption: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 5, p. 67–74, 1953.

The depth and the magnetic moment of the magnetic dipoles which are used to represent the magnetic disturbances caused by some recent great earthquakes in Japan were calculated. It is revealed that these values are always nearly equal in each disturbance, being 30 km ~ 40 km in their depths and of the order of 10^{16}~10^{17} e. m. u. in their magnetic moments. This fact suggests that the magnetic disturbance accompanying the earthquake is caused by the change in temperature of the underground layer above the Mohorovičić discontinuity where the temperature of the rocks is supposed to be about 600° C~700° C, or nearly [at the] Curie point.—*Authors' Abstract*

157–36. Kato, Yoshio; Ossaka, Justo; and Noritomi, Kazuo. On the change of the earth's magnetic field accompanying the Tokachi earthquake on March 4, 1952: Tōhoku Univ. Sci. Repts., 5th ser., v. 4, no. 3, p. 146–149, 1952.

Earth-inductor measurements of magnetic dip were made at eight localities before and after the Tokachi earthquake. The changes observed are ascribed to the seismic activity. The maximum change was a decrease of 12.2° at Shiramuka.—*D. B. V.*

157–37. Miyakoshi, Junichiro. On the local and anomalous change of geomagnetic declination: Kyōto Univ. Disaster Prevention Research Inst. Bull. no. 6, p. 27–38, 1952.

This is a descrpition of a magnetic declination variometer, together with tables and graphs of secular variations as recorded at Makimine, Ogoya, Yura, and Ikuno observatories. Two local anomalies in the records are related to the Daishoji-Oki and Yoshina earthquakes of March 7 and July 18, 1952, respectively.—*D. B. V.*

Wait, James R. On the relation between telluric currents and the earth's magnetic field: see Geophys. Abs. 157–51.

MAGNETIC PROPERTIES OF ROCKS AND MINERALS

157–38. Lee, E. W. The influence of domain structure on the magnetization curves of single crystals: Phys. Soc. London Proc., Ser. A, v. 66, no. 7, p. 623–630, 1953.

It is pointed out that the lack of agreement between theoretical and experimental magnetization curves found for single crystals in low fields is probably caused, not by residual internal strains, but by neglect of the domain structure of the crystal in the theoretical calculations. Using Néel's model for the domain structure of a single crystal of iron in the form of a strip parallel to the 110 direction magnetization curves have been calculated taking the domain structure into proper account. It is found that the (I, H) curves depend explicitly on the width of the crystal. Comparison is made between the calculated curves and the experimental results of Williams. The agreement between the two is good.—*Author's Abstract*

157–39. Clegg, J. A., Almond, Mary, and Stubbs, P. H. S. The remanent magnetism of some sedimentary rocks in Britain: Philos. Mag., v. 45, no. 365, p. 583–598, 1954.

The remanent magnetism of nine sandstones from the Keuper Marl series was determined, and the polarization was found to be consistent in an approximately northeast-southwest direction with dips significantly less than that of the present earth's field; in some the direction of magnetization was reversed. Samples of the Pennant Sandstone (Upper Coal Measures) and Lower Old Red Sandstone also showed the same general axis of magnetization, the first showing a northwesterly declination with downward dip, and the second polarized in the reverse direction. Tests showed the rocks had a high degree of magnetic stability when exposed to alternating fields, but were easily changed by direct-current fields, suggesting that the rocks contain two magnetic components of different proper-

ties. Experimental deposition of powdered rocks suggests the rocks acquired their magnetization on deposition. The most likely explanation of origin of observed magnetization is said to be that the whole of the land mass which now constitutes England has rotated clockwise through 34° relative to the earth's geographical axis, since deposition of the rocks. The reversed magnetization is attributed to a reversal of the earth's field, although the effect of chemical and physical changes in the rocks since compaction is not ruled out.—*M. C. R.*

157–40. Hospers, J. De natuurlijke magnetizatie van Ijslandse gesteenten [The natural magnetization of Iceland rocks]: Geologie en Mijnbouw, jaarg. 16, no. 2, p. 48–51, 1954.

Study of the natural magnetization of lava flows and associated sediments of Iceland shows that rocks dating from historic times (1729 to 1947–48 A. D.) back to the latter half of the Quaternary are magnetized in approximately the same direction as the present geomagnetic field; early Quaternary rocks show reverse magnetization; and Miocene and Pliocene, normal and reversed magnetization alternating with each other.

The intensity of normal magnetization is about 5×10^{-3} gauss, about 10 times stronger than the present geomagnetic field would account for. Hand specimens heated above their Curie temperature (nearly 580° C) and cooled slowly to room temperature retained the same order of intensity (7×10^{-3} gauss) and direction of magnetization. The direction could be measured except in conglomerates; the mean direction in most rocks corresponds better to the so-called dipole field (the field which would result if the geomagnetic poles coincided with the geographic) than to the present geomagnetic field. Intensity seems to decrease slightly in the course of geologic time. According to the theory of pole shifting, the magnetic poles when averaged over dozens of years correspond to the geographic poles. This is borne out by measurements on 102 samples of Miocene lavas, which give an average declination of N. 1.5° E. and inclination of +77.8°; the dipole field would have a declination of 0 degrees and inclination of +77.0°.

The reverse magnetization of the Quaternary rocks is also remanent; it must have developed in a field stronger than the present, and in the opposite direction. This field must have existed for 250,000 to 500,000 years and must have become reversed within less than 10,000 years.—*D. B. V.*

157–41. Hatherton, T. The magnetic properties of the Whakamaru ignimbrites: New Zealand Jour. Sci. Technology, Sec. B, v. 35, no. 5, p. 421–432, 1954.

Magnetic susceptibility measurements of samples of ignimbrites at Whakamaru, Maraetai, and Waipapa dam sites indicate there is a striking uniformity of magnetite content in the series. Permanent magnetization values helped in locating sheet boundaries and indicate that the series is more complex than previously supposed. The direction is similar to that of the present field of the earth.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

157–42. Gerard, V. B. Note on a proposed three-component aeromagnetometer: New Zealand Jour. Sci. Technology, Sec. B, v. 35, no. 1, p. 1–3, 1953.

For observation by this instrument, flying is restricted to clear nights, and star photographs are taken by a non-magnetic camera mounted on the fluxgate

gimbal mechanism of a total-force aeromagnetometer. The camera's optical axis is parallel to the total-force fluxgate, and, by identifying the stars photographed, the orientation of the total-force fluxgate is determined and the magnetic declination and dip calculated. Tests made on the ground, with an experimental camera, indicated that this proposed method is feasible, and that the expected error would be about ±0.2° in both declination and dip.—*Author's Abstract*

157–43. Burkhart, Kurt. Die magnetische Feldmuhle [The magnetic field mill]: Geofisica Pura e Appl., v. 24, p. 37–53, 1953.

A detailed description is given of a new instrument for exploration of magnetic fields. Operation is based on intermittent opening and screening of horizontally placed coils thus producing electromotive force in them by the vertical component of geomagnetic field. The induced alternating voltage of about 2 volts is electronically amplified. The instrument is well adapted to absolute measurement of the vertical component of the geomagnetic field. The compensation of the vertical vector necessary for the calibration of the instrument is made as usual, by a Helmholtz coil. Using an amplification ranging from 30 to 50 it is possible to measure the minimum intensity of the field with an error of ±0.6 gamma.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

Andreyev, B. A. Computations of spatial distribution of potential fields and their utilization in geophysical exploration, part IV: see Geophys. Abs. 157–5.

Favre, B., and Dalby, R. Principles of the methods of direct interpretation in gravimetry and magnetism: see Geophys. Abs. 157–4.

MAGNETIC OBSERVATIONS AND SURVEYS

157–44. Balsley, J. R., [Jr.], and Kaiser, E. P. Aeromagnetic survey and geologic reconnaissance of part of Piscataquis County, Maine: U. S. Geol. Survey Geophys. Inv. Map GP 116, 1954.

An aeromagnetic survey, followed by geologic reconnaissance of part of Piscataquis County, Maine, was made in an effort to locate masses of gabbroic rock similar to that containing the deposit of massive pyrrhotite at the Katahdin Iron Works. No direct evidence of previously unknown sulfide deposits was found. Thirteen anomalies are discussed and recommendations are made for further work. The most striking feature of the aeromagnetic map is the extraordinarily flat magnetic gradient in the southern half. The granite in the northern part of the area causes the characteristic pattern described by Hurley and Thompson as "bird's-eye maple". Apparently the Onawa pluton and the smaller granitic intrusive body to the south are of different composition and probably of different age or origin than the Mount Katahdin pluton and other granitic intrusive bodies to the west.—*M. C. R.*

157–45. Books, Kenneth G. Geophysical surveys in Salt Lake Valley, Utah: Science, v. 119, no. 3094, p. 513–514, 1954.

Anomalies observed on an aeromagnetic survey in the southern part of Salt Lake Valley, subsequently detailed by ground magnetometer and gravimeter sur-

veys, are attributed to a cylindrical body 500 feet in radius, buried less than 1,000 feet deep, with a susceptibility of 12350×10^{-6} cgs units and a density contrast of 0.25. The source of the anomaly may be an intrusion.—*M. C. R.*

157–46. Agocs, W. B., Rollins, J. C., and Bangs, E. Airborne magnetometer profile from Portland, Oregon to Aubuquerque, New Mexico: Geophysics, v. 19, no. 2, p. 270–280, 1954.

The total magnetic field along a 1,630 mile flight path from Portland, Oreg. to Albuquerque, N. Mex. was observed with the magnetometer detecting element installed in a wingtip nacelle having compensation for the plane's magnetic fields. Flight elevations of 7,000 to 10,000 feet above sea level were used, giving topographic clearances ranging from 900 to 8,500 feet.

A correlation between magnetic features and areas of volcanic rocks, acid intrusive rocks, basic intrusive rocks (ultrabasic phase of the Sierra batholith), sedimentary basins, and pre-Cambrian igneous and metamorphic rocks is shown. A 300-gamma magnetic low 17 miles south of Portland, Oreg., is probably due to inverse polarization. Sharp magnetic highs, due to volcanic rocks, riding on broad magnetic highs, whose sources are 8–16 miles below the plane of observation, also occur in Oregon. In California, the Sierra batholith, another basic intrusive about 3 miles below flight elevation, and surface volcanic rocks cause the major magnetic features. In Arizona, broad but complex anomalies seem to be associated with the pre-Cambrian rocks of the Mexican Highlands while sharp anomalies are due to local areas of San Francisco volcanic rocks. The remainder of the profile across Arizona and New Mexico consists of broad anomalies except where the plane was flying over Tertiary volcanic rocks. The regional gradient is indicated along the profiles and corresponds well with the observed gradient. It is recognized that definite conclusions concerning the relationship between magnetic and geologic features cannot be reached from a single profile.—*W. J. D.*

157–47. Bergeron, Robert, and Harquail, James. Prospecting and exploring of iron ore deposits in Northern Ungava: Canadian Min. Metall. Bull., v. 47, no. 506, p. 276–280, 1954.

The iron formations in the Northern Ungava area are contained in a wide belt of late pre-Cambrian sedimentary rocks that extends in a northwesterly direction across part of Labrador and New Quebec. To find commercial iron ore deposits an integrated program of field geology, drilling, and airborne-magnetometer surveying has been successful. Although the airborne-magnetometer surveys have not yet resulted in the discovery of any specific ore bodies in Ungava, they do provide a rapid and inexpensive method of outlining favorable areas.—*L. C. P.*

157–48. Heezen, Bruce C., Ewing, Maurice, and Miller, Edward Titus. Trans-Atlantic profile of total magnetic intensity and topography, Dakar to Barbados: Deep-Sea Research, v. 1, no. 1, p. 25–33, 1953.

The development of the airborne magnetometer makes possible magnetic surveys of ocean areas without specially constructed non-magnetic ships. Early flights over marine areas indicated that a correlation might exist between topographic features and the character of the magnetic fields. In order to compare magnetic field characteristics with topography and basement structure as deter-

mined by seismic instruments an airborne instrument was incased in a waterproof "fish" and initially towed from the *Atlantis* in 1948. Until an adequate cable was obtained in 1952 repeated failures of the electrical cable had limited the instrument's use in deep water to one trans-Atlantic profile. Until more measurements are made only cursory interpretation of this profile can be made. There is great similarity of the anomaly curve from 170 nautical miles west of Dakar to Barbados. Anomalies of 50 to over 200 gammas, 5–40 nautical miles wide are encountered from the Cape Verde Island region to Barbados. West of Dakar for 170 miles the magnetic field is smooth with anomalies of less than 25 gammas. The topographic contrast between the deep ocean basins and the Mid-Atlantic Ridge is not reflected in the anomaly curve. Large anomalies observed over the submerged parts of the Cape Verde Islands show the effect of known volcanic islands. No anomaly is observed near Barbados or over the continental margin of Africa.—*Authors' Summary*

157–49. Crenn, Y[vonne]. Anomalies gravimétriques et magnétiques liées aux roches basiques de Nouvelle-Calédonie [Gravity and magnetic anomalies associated with basic rocks of New Caledonia]: Annales Géophysique, tome 9, no. 4, p. 291–299, 1953.

A discussion is given of the major gravimetric and magnetic (vertical component) anomalies of New Caledonia. Values are given of specimen densities and susceptibilities. A Bouguer anomaly map with 10-mgal contour interval and a magnetic map with significant anomalies indicated by (+) and (—) signs are presented. On the northwest coast of the island there is a positive gravity gradient of 10 mgal per km. This is interpreted as indicating a large intrusion of peridotite and the source of the apparently thinner peridotites covering the south of the island. A zone of peridotites and basalts extends along the northwest coast of the island. This zone seems to persist in depth, at least to a few kilometers. In one place the peridotite appears to overlie the basalt.

Isostatic balance seems to be realized, on an average, at a depth of 60 km, but there may be a partial local equilibrium under the island at a lesser depth.—*P. E. B.*

157–50. Gerard, V. B. Aeromagnetic observations over the Banks Peninsula area and the Mernoo Bank: New Zealand Jour. Sci. Technology, sec. B, v. 35, no. 2, p. 152–160, 1953.

The analysis of aeromagnetic anomalies in the Banks Peninsula area supports the view that the Gebbies Pass region of Banks Peninsula lies on the eastern flank of the Canterbury Plains syncline, and also shows that about 9 miles west-southwest of Kaiapoi the basement is probably between 4,500 and 5,500 ft below the surface.

An extensive belt of igneous rocks is shown to underlie the Canterbury Plains in the vicinity of Banks Peninsula. A large mass of igneous rock probably exists below Lyttelton Harbour, in contrast to Akaroa Harbour, below which igneous rocks, if present, appear to be either small or of low susceptibility.

The anomalies indicate that Mernoo Bank is dominantly non-magnetic, and therefore quite different from Banks Peninsula, which is composed mainly of andesite and basalt.—*Author's Abstract*

Woollard, G. P. Crustal structure beneath oceanic islands: see Geophys. Abs. 157–188.

ELECTRICITY

GENERAL AND THEORETICAL STUDIES

157–51. Wait, James R. On the relation between telluric currents and the earth's magnetic field: Geophysics, v. 19, no. 2, p. 281–289, 1954.

The work of Cagniard (see Abstract 14645) on the relation between telluric currents and variations in the earth's magnetic field is analyzed. It is shown that Cagniard's derivation is limited either to the case in which there is no significant variation of the magnetic field fluctuations along the surface of the earth, or the case in which the intrinsic propagation constant of the lower layer, which is a function of conductivity, frequency, dielectric constant, and magnetic permeability, is large. Fluctuations in telluric currents and magnetic fields may be local in nature, so that the second condition must be satisfied for Cagniard's approach to be valid. A period of fluctuation of ten seconds is given as the greatest which can be used, assuming reasonable values of the electrical parameters of the lower layer.

The instantaneous relation between the magnetic field and telluric currents should be considered, rather than the harmonic components of the two. Curves are presented showing the change in electric field for a step variation in the magnetic field.—*G. V. K.*

157–52. Wait, James R. Mutual coupling of loops on the ground: Geophysics, v. 19, no. 2, p. 290–296, 1954.

An equation is derived for the mutual impedance of two loops lying on the surface of a homogeneous flat earth. Graphs of the mutual impedance of the loops as a function of conductivity, dielectric constant, and frequency are given for the simplified conditions of no contrast in magnetic permeability from air to earth and a separation between the loops that is large compared to their radii. These curves can be used to determine dielectric constant and conductivity of earth materials from measurements of mutual impedance of two such loops as a function of frequency and separation.—*G. V. K.*

157–53. Buckner, Guy O. Subsurface electrical measurements about two plane interfaces: Geophysics, v. 19, no. 2, p. 297–309, 1954.

An equation is derived for the potential due to a point source along a line perpendicular to two plane interfaces separating a layer of material with resistivity ρ_2 from a material with resistivity ρ_1. The problem is set up in cylindrical coordinates, with a solution expressed in terms of Bessel's functions. These solutions are then expanded in infinite series. Except for one term, the series are the same in each of the three regions. This similar portion of the series was evaluated for reflection coefficients between the two resistivities of from 0.3333 to 0.9980.

Examples are given of the use of these tabulated values for the infinite series in determining the response of electric-logging configurations to the presence of thin beds of high resistivity. The effect of the resistivity of the mud column was not taken into consideration, however.—*G. V. K.*

157–54. Belluigi, Arnaldo. Fondamenti teorici dei geoeltrans [Theoretical foundations of the geoltrans]: Servizio geol. Italia Boll., v. 74, fasc. 1, p. 243–264, 1953.

A summary is given of theoretical work on the electrical and magnetic state of a medium during the transient period, following the application of an electrical

source. Known formulas are supplemented by Belluigi's own analytical deductions, which establish some new relations of importance in practical problems of geophysics. This analysis is applied to homogeneous as well as to heterogeneous ground. The variation of ahe electrical state with time, especially during the initial period or in the final state, can give important indications as to electromagnetic properties of the medium.

The theory developed is applicable to electrical as well as electromagnetic processes and, according to the parameters measured in the fields, is called Eltrans, Matrans, or Matranslog.

The article contains numerous computations of the parameters of electrical or magnetic fields produced in the ground by sources varying with time. Comparison of the computed data with that observed at a given area indicates the electrical properties of this area.—*S. T. V.*

157–55. Belluigi, A[rnaldo]. Campi elettromagnetici vorticosi in lastre infinitamente estese e di dimensioni finite [Vortical electromagnetic fields generated in plates of infinite or finite dimensions]: Annali Geofisica, v. 6, no. 2, p. 251–284, 1953.

This is a brief summary of Belluigi's studies of the electromagnetic vortical field patterns produced in an electrically and magnetically conductive plate for different positions and dimensions of the plate. The exciting source is assumed to be placed on the surface of the earth and the plate buried underground and differently oriented with reference to the source. Numerous graphs are reproduced representing field patterns for different position of the plate. These can be used for the interpretation of the results of a survey made by this method.—*S. T. V.*

157–56. Banno, Noboru. On the earth-current potentials at the Memambetsu Magnetic Observatory [in Japanese with English summary]: Kakioka Magnetic Observatory Mem., v. 6, no. 2, p. 114–118, 1953.

Variations or earth-current potential at Memambetsu Magnetic Observatory mainly are normal to the coastline, as found at other observatories near the coast, although the Memambetsu observatory is 15 km from the Okhotsk Sea. This results from the difference of the conductivity between land and sea and the fact that the electric currents have a tendency to flow toward the sea. Earth-current potentials, which are induced by the changes of magnetic field, must be considered from the standpoint of the electrical characteristics both in the vicinity of the station and in a fairly large area surrounding it.—*M. C. R.*

157–57. Yanagihara, Kazuo, and Oshima, Hiromi. On the earth-current disturbances at Haranomachi caused by the leakage current from the electric railway, Fukushima-Yonezawa [In Japanese with English summary]: Kakioka Magnetic Observatory Mem., v. 6, no. 2, p. 119–134, 1953.

Minor disturbances (called "W-type disturbances"), recorded at nearly constant times on each electrogram at Haranomachi, have been identified as artificial disturbances caused by leakage of current from the electric railway (O-u line from Fukushima to Yonezawa). The first half of the *W*-variation appears when the train runs between Fukushima and Sasakino, the second for the trip between Sasakino and Niwasaka. Earth-current potential gradients were calculated, assuming that the leakage coefficient of the rails is 0.135 km^{-1}, total current

supplied of 1,000 amperes, and electrical conductivity of the ground of 6×10^{-6} $ohm^{-1}cm^{-1}$; numerical values of the *W*-type disturbance were deduced fairly well.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

157–58. Šumi, Franc. O mogućnosti odredjivanja nagiba kontakta izmedju dve geološke formatsije pomoću geoelektrične metode [On the possibility of determining the dip of the contact between two geologic formations by geoelectric method] (in Serbian with German summary): Srbije Zavod geol. i geofiz. istraživanja Vesnik, kniga 10, p. 273–280, 1953.

The problem of determining the inclination of the contact between two geologic formations with different electric properties is discussed, and a procedure is suggested using the Wenner configuration. The measurement is made along the strike of the formations and is repeated with increasing electrode spacings.

Šumi derives formulas for computing the dip from the apparent resistivities obtained, valid for any value of the dip.— *S. T. V.*

157–59. Mosetti, Ferruccio. Su alcune richerche geoelettriche di zone mineralizzate [On some geoelectrical investigations of mineralized zones]: Industria Mineraria, anno 4, no. 12, p. 579–582, 1953; also Osservatorio Geofis. Trieste Pub., no. 35, 4 p., 1953.

Mosetti presents a brief outline of test surveys on the basis of which he concludes that when simple geologic examination indicates the possibility of minerals such as bauxite, blende, galena, or pyrite in a given zone, identification of these minerals is relatively easy by the resistivity method, and horizontal profiles with proper electrode spacing will suffice to outline the deposits.—*D. B. V.*

157–60. Smith, Harold D., and Blum, Harold A. MicroLaterolog versus MicroLog for formation factor calculations: Geophysics, v. 19, no. 2, p. 310–320, 1954.

MicroLaterologs from 3 sandstone sections and 6 limestone sections were used to compute formation resistivity factors. Similar calculations were made from MicroLogs for five of the same sections. These values were compared with formation factors determined on diamond and side-wall cores. In all cases, it was found that the deviations between the formation factors calculated from the electric logs and the formation factors measured on cores was larger for the MicroLog than for the MicroLaterolog. Also, the deviations were greater for both types of logs in limestone than in sandstone. It is shown that the MicroLaterolog can detect border-line oil saturations with a fair degree of reliability while the MicroLog cannot.—*G. V. K.*

157–61. Ruddick, C. K. How to select correct logging method: World Oil, v. 138, no. 5, p. 182–188, 1954.

A logging method should be selected on the basis of the information needed and the probable physical and electrical characteristics of the borehole. The information may be desired to facilitate correlation, or to determine stratigraphy, water saturation, or porosity. Conditions of the hole that may affect a choice include the nature of the fluid, formation types and thicknesses, bit size, caving, and other factors. For salty mud, a combination of gamma ray logs, laterolog, and microlaterolog has given outstanding results. For fresh mud, the

electrical log and microlog are a valuable combination. Gamma ray, neutron, and induction logs are useful when an oil base mud is employed. For cased holes, gamma-ray and neutron logs are employed, with a casing-collar detector.—*L. C. P.*

157–62. Gibbon, Anthony. New oil exploration method developed: World Oil, v. 138, no. 6, p. 99–101, 1954.

A new oil-exploration method ". . . based on the same set of factors as those used in electrical well logging . . ." has been developed by F. W. Lee. An undefined system of electrodes is arrayed along the surface of the ground and undefined electrical measurements are taken. These measurements are then converted to undefined quantities called "polarization index numbers" which are in turn plotted on polarization charts known as "Longcologs."

It is claimed that ". . . experience has shown that any oil or gas field of any consequence is located in an area that exhibits moderate to strong polarization and that when polarization is absent the area is probably dry." It is further claimed that it is possible to determine the approximate depth of potential producing horizons with the method.—*L. C. P.*

METHODS OF ANALYSIS AND INTERPRETATION

157–63. Tikhonov, A. N., and Enenshteyn, B. G. Vliyaniye protsessov stanovleniya elektricheskikh tokov v zemle na polevyye izmereniya pri elektrozondirovanii [The effect of the transient state of ground currents on field measurements during electric sounding]: Akad. Nauk SSSR Doklady, tom 88, no. 5, p. 791–794, 1953.

Errors in deep electric sounding with electrode distances of 10 to 20 kilometers or more often become considerable. Theoretical analysis and experiments lead to the conclusion that the cause of these errors is the deviation of electric impulse sent into the ground, called the "exterior" impulse, from the ideal rectangular wave shape, whereas the "inner" impulse, coming from the battery, remains rectangular. This makes the compensation of impulses impossible. For electrode distance of 10 km, Tikhonov and Enenshteyn recommend switching the galvanometer at least 1 second after the switching in of the current or preferably, using instruments with negligible inertia. Disturbances produced by telluric currents should be avoided.—*S. T. V.*

ELECTRICAL SURVEYS AND WELL LOGGING

157–64. Manfredini, Antonio. Studie geofiscio del Circeo [Geophysical study of the Circeo]: Servizio geol. Italia Boll., v. 75, fasc. 1, p. 311–328, 1953.

A resistivity survey was made of Monte Circeo in the spring of 1953 in order to determine its structure. Two sections are presented showing Mesozoic limestone dipping toward the sea and corresponding in thickness to the dimensions of the mountain, underlain by material characterized by lower resistivity, of the same order as that of the adjacent Pontine plain. Many resistivity curves, two cross sections, and a map are given.—*D. B. V.*

157–65. Mosetti, Ferruccio. Studio geoelettrico dell'idrologia sotterranea del Friuli orientale [Geolectrical study of the subterranean hydrology of eastern Friuli]: Osservatorio Geofis. Trieste Pub., no. 42, 7 p., 1954; reprinted from Tecnica Italiana, anno 9, no. 3, 1954.

Ground-water channels in the area between Pieris and Monfalcone in the Basso Friuli are located by electrical-resistivity measurements. The results of vertical soundings and horizontal profiles are presented in maps and diagrams.—*D. B. V.*

157–66. Mosetti, Ferruccio. Rilievo geoelettrico del delta sotterraneo del Timavo [Geoelectrical survey of the subterranean delta of the Timavo]: Osservatorio Geofis. Trieste Pub., no. 38–39, p. 7–11, 1954; reprinted from Tecnica Italiana, anno 9, no. 2, p. 115–119, 1954.

This is a description of a resistivity survey of the underground course of the Timavo. The method used and difficulties experienced are discussed.—*D. B. V.*

157–67. Mladenovič, Milan. Primena geoelektricne metode otpora na Niksickom Polju [The use of the electrical resistivity method in the investigation of the Field of Nikšić] [in Serbian with English summary]: Srbije Zavoda geol. i geofiz. istraživanja Vesnik, kniga 10, p. 281–289, 1953.

A resistivity survey was made of the site of a proposed reservoir in the Field of Nikšić, in order to determine the depth of the fluviatile and lacustrine deposits and the nature of the bedrock. Well-log data from two previously drilled boreholes were used to aid interpretation of the resistivity data. Resistivity curves and geologic profiles are presented, together with some theoretical curves which were considered in order to interpret the more complex logs.—*D. B. V.*

157–68. Janković, Slobodan. Elektromagnetska ispitivanja nekikh nashikh olovnotsinkovikh lezhishta [Electromagnetic prospecting of some lead-zinc deposits]: Glasnik Prirod. Mus. Srpske Zemlje, Ser. A, kniga 5, p. 159–170, 1952.

Lead-zinc deposits were located at Mazhić, near Trepča, and Ajvalija, near Priština in Yugoslavia in February 1952 by the "Turam" method. In this method the in-phase and quadrature components of electromagnetic fields are measured; the field is induced by a long grounded cable. Important anomalies of phase angles and out-of-phase components of the vertical field vector were found, making possible the exact delineation of ore bodies. The maximum gradient of the phase angle amounts to 3° per 10 m. Where the curves of phase angles and of the quadrature components did not show anomalous changes, the position of ore-bearing masses was determined by the equiphase curves of in-phase components. The results of the measurements are presented on four maps of surveyed areas with characteristic curves traced in.—*S. T. V.*

SEISMOLOGY

GENERAL

157–69. Bullen, K. E. Seismology: 132 p., London, Methuen and Co. Ltd., 1954.

This brief text, one of Methuen's Monographs on Physical Subjects, is designed to give the student of physics, geology, or mathematics an introduction to the problems of present-day seismology. Chapter titles are: The significance of seismology in physics; Macroseismology; Instrumental seismology; *P* and *S* waves (this also includes Rayleigh and Love waves); Fitting elastic wave theory to the earth; Seismology and geology; Seismic rays, phases, and travel-times; Earth models based on seismology; Microseisms: Seismology and meteorology; and Some interesting earthquakes.—*M. C. R.*

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ELASTIC WAVES

157–70. Nomura, Yūkichi, and Takaku, Koshun. On the propagation of elastic waves in an inhomogeneous sphere: Tōhoku Univ. Sci. Repts., 5th ser., v. 4, no. 1, p. 31–41, 1952.

The velocities of elastic waves propagating in a large inhomogeneous sphere are assumed to be functions of distance from the center. From the rigorous solutions of wave equations are calculated various modes of reflection at the free surface, resulting in curved geometrical ray waves and surface waves. From these, intensities of various seismic waves are calculated.—*D. B. V.*

157–71. Honda, Hirokichi, and Nakamura, Kohei. Notes on the problems on the motion of the surface of an elastic solid produced by a linear source: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 5, p. 58–66, 1953.

Integrals involved in Lamb's investigations of the propagation of tremors over the surface of a semi-infinite elastic solid from a vertical force concentrated at a line or point on the surface and in Nakano's investigation of wages produced from a horizontal linear source in the interior of a solid can be evaluated systematically by the method developed by Sakai.—*M. C. R.*

157–72. Slichter, L. B. Seismic interpretation theory for an elastic earth: Royal Soc. London Proc., Ser. A., v. 224, no. 1156, p. 43–63, 1954.

The seismic interpretation problem for an isotropic spherical earth is analyzed on the basis of elastic theory, under the assumption that the three independent elastic parameters are unknown continuous functions of the depth. It is shown that solutions for these functions may be obtained in the form of Taylor's series. The problem is treated for three types of symmetrical excitation conditions on the free surface: (1) a shear source of type $p_{r\phi}$ only; (2) a pressure distribution with vanishing surface shear stress; (3) an excitation consisting of pressure in combination with surface shear stress of type $p_{r\Delta}$. In each case the excitation functions are arbitrary functions of time. It is assumed that the associated components of surface displacement over the sphere are known from available observations, as functions of time. Thus, the complete information contained in seismic records is used in the proposed interpretation process, without need of selecting, identifying and assigning arrival times to specific events on the records. The two static elastic parameters may theoretically be determined from observation at a single frequency, including the frequency zero or static case. The determination of the dynamic elastic parameter requires the use of at least two frequencies.

Algebraic checks are obtained by comparing the general solutions with the corresponding results for two special cases in which the elastic parameters vary in a prescribed manner in the interior of the sphere. In both these cases treatment by the classical ray-path method of interpretation is excluded, because the wave velocity decreases with depth. Furthermore, the ray-path method (which is essentially a method of geometrical optics) would fail to distinguish between the two examples in any case, since the velocity function is the same in both, although the elastic parameters differ. In contrast to the valuable ray-path method, the analytical procedures in the present solution of the elastic problem are prohibitively cumbersome. Practical application of elastic theory to the direct interpretation of seismograms requires further development of the theory with probable utilization of modern high-speed computing methods.—*Author's Abstract*

INSTRUMENTS AND METHODS OF OBSERVATION

157–73. Murphy, L. M., Wilson, Roger M., Burgess, L. R., and Pearce, T. H. Response curves of an electromanetic seismography by sine-wave simulator method: Seismol. Soc. America Bull., v. 44, no. 1, p. 7–19, 1954.

Magnification curves for a Sprengnether horizontal seismometer with galvanometers of various periods are given along with the curves showin the response of the galvanometer to seismometer motions. Simple harmonic motion was impressed on the seismometer boom by applying to a piece of soft iron, fixed to the boom, a variable magnetic force controlled in frequency and intensity by a so-called sine-wave simulator. The experimental arrangement is discussed in detail.—*P. E. B.*

157–74. Gamburtsev, G. A., and Gal'perin, Ye. I. Azimutal'nye seysmicheskiye nablyudeniya s naklonnymi seysmografami [Azimuthal seismic observations with inclined seismographs]: Akad. Nauk SSSR Izv. Ser. geofiz. no. 2, p. 184–189, 1954.

A new arrangement of seismographs to be used in seimological investigations and in seismic prospecting consists of a set of eight seismographs installed in a circle and all inclined at the same angle to the vertical. This arrangement represents a further development of the azimuthal installation described in the preceding article.

The relative amplitude on the seismogram of an inclined instrument is determined by the vector of the displacement of the ground and by the direction of the axis of the seismograph. Graphs are given of the complete record that is obtained for different values of these two vectors from all eight instruments. In the examples analyzed, the angle of inclination is made equal to 30°, 45°, and 60°. With an appropriate choice of this angle a record can be obtained that gives more accurate values of the amplitudes and makes possible the determination of the phase of the incoming wave.

Other applications of the proposed arrangement of seismographs are suggested, such as use of three mutually perpendicular seismographs.—*S. T. V.*

157–75. Gamburtsev, G. A., and Gal'perin, Ye I. Metodika rabot po korreliatsionnomu metodu izucheniya zemletryaseniyi [Procedure to be followed in earthquake studies by the correlation method]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 3–10, 1954.

Three methods are suggested for determining the epicenter and depth of focus of a near earthquake from the observations of a single station. The first, or "angular", arrangement consists of 2 horizontal seismic detectors installed at the point of intersection of 2 perpendicular lines, and 3 vertical detectors placed along each axis, some 250–1,000 m apart. The second, or azimuthal, arrangement consists of seven horizontal detectors distributed in a semicircular arc around the seismic station. The third set-up consists of an azimuthal installation completed by 3 vertical detectors, 1 in the center, 2 others on the coordinate axis at a distance of 500–800 m from the center. These installations can be used only for investigations of local earthquakes, using the direct waves, before interference of these waves with others reflected or refracted on their paths. A master chart, which presupposes knowledge of the law of variation of seismic velocity with depth, is given for interpreting the observed data.—*S. T. V.*

157–76. Pakiser, L. C., and Mabey, D. R. Mapping shallow horizons with the reflection seismograph: Science, v. 119, no. 3099, p. 740, 1954.

In successful tests of specially constructed reflection seismic instruments, the Neva limestone has been mapped at a depth of about 200 ft in Osage County, Okla., and the Stone Corral dolomite has been mapped at depths of 150 to 200 ft in Rice County, Kans. In some places in the Kansas test areas, the base of the overburden at a depth of less than 100 ft has been mapped. Reflecting horizons have been mapped continuously from 200 ft to depths as great as 4,000 ft in the Oklahoma area.

The instruments do not differ radically from conventional equipment. The amplifiers have a frequency range of 75 to 300 cycles per second, the automatic volume-control time constant has been reduced to about one-third its usual value, and a variable presuppression control has been installed to permit a sharp reduction of the first energy arrivals; the oscillograph paper speed is about 25 inches per second; high-frequency galvanometers have been installed; and the timing-line interval has been reduced from 10 to 2 milliseconds.—*M. C. R.*

157–77. Evison, F. F. An improved electromechanical seismic source tested in shattered rock: New Zealand Jour. Sci. Technology, Sec. B, v. 35, no. 1, p. 4–13, 1954.

An earlier moving-coil vibrator, with which useful ranges were attained in fairly homogeneous ground, has been further developed to provide frequencies from 100 c/s. to 800 c/s., and pulse-widths from 5 millisec. to 100 millisec. Appropriate band-pass filters giving high stop-band attenuation have been included in the receiver. Alternating current for the source is derived from accumulators and a commutator, the apparatus being no longer dependent on power mains. The radiated power has been increased about tenfold. Tests in shattered ground suggest the application of seismic scattering measurements to problems in civil engineering. Other proposed applications depend on the observation of shear energy, frictional attenuation, or reflection from shallow interfaces.—*Author's Abstract*

157–78. Evison, F. F. Early arrivals in seismic prospecting: Nature, v. 173, no. 4413, p. 1047, 1954.

An electromechanical seismic source has been used in several series of experiments in underground tunnels and has been tested also at the surface. Confusion normally found in the early part of a seismic record was absent, and arrivals within 50 milliseconds of the first can be distinguished. If the early arrivals can be resolved, the possibility of a shallow-reflection technique is foreseen.—*M. C. R.*

157–79. Sterne, William P. New seismic tool: Oil and Gas Jour., v. 52, no. 46, p. 106–107, 1954.

A new method of seismic prospecting, in which a falling weight replaces the conventional explosive charge, has been developed by the McCollum Exploration Co. of Houston, Tex. Called the "Geograph" method, the system takes soundings from a 6,000-pound weight dropped from a special truck. The recorder integrates the vertically traveling reflections and tends to suppress the undesirable horizontally traveling waves. The method is now being used in the Edwards Plateau

region in west Texas, but it is adaptable to other areas. It is cheaper to operate than the conventional seismic-reflection method.—*L. C. P.*

157–80. Belluigi, Arnaldo. L'avvento dei carotaggi sismici e la loro interpretazione [Introduction to seismic well logging and its interpretation]: Servizio geol. Italia Boll., v. 74, fasc. 2, p. 493–514, 1953.

Seismic logging methods which have recently been introduced are particularly adapted to study of structures discovered by the seismic-reflection method. Belluigi here attempts a theoretical interpretation of seismic logs, based on results obtained by Sharpe (Geophys. Abs. 6630) on seismic waves due to explosions, and by R. M. Mercier on propagation of mechanical waves in an absorbent medium.—*D. B. V.*

157–81. Trudu, Renato. Sul distanziamento transmettitore-rivelatore nel carotaggio sismico [On the spacing between the transmitter and receiver in seismic well logging]: Servizio geol. Italia Boll., v. 74, fasc. 2, p. 515–522, 1953.

Using the formulas derived by Belluigi (preceding abstract), Trudu deduces the optimum spacing between shot point and receiver in seismic well logging.—*D. B. V.*

157–82. Tsuboi, Chuji, and Tomoda, Yoshibumi. Retarded photographic recording of earthquake motions: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 5, no. 1, 1952; reprinted from Jour. Physics of the Earth, v. 1, no. 1, p. 55–56, 1952.

This is a description of an apparatus for recording earthquake motions photographically with a certain time lag. The apparatus is based on the same principle as the instrument constructed by Gane, Logie, and Stephen (Geophys. Abs. 11271) but is purely mechano-optical and therefore is believed to be more dependable in routine observations. Initial motions are always recorded, and speed of recording can be increased as much as desired.—*D. B. V.*

157–83. Hosoyama, Kennosuke. On a mercury tiltmeter and its application: Kyōto Univ. Disaster Prevention Research Inst. Bull., no. 6, p. 17–25, 1953.

This is a report on observations of ground tilt occurring before and after strong earthquakes, as recorded with two different tiltmeters, one of the horizontal pendulum type and the other the mercury tiltmeter. Both instruments are reliable for recording secular changes. Observations at Ogoya and Yura are discussed in some detail.—*D. B. V.*

157–84. Rust, William M. What's new in geophysics?: World Oil, v. 138, no. 5, p. 80–84, 88, 1954.

A summary of recent advances in geophysics, emphasizing seismic prospecting for oil.—*L. C. P.*

157–85. Bradley, R. M. Experimental crews can cut seismic exploration costs: World Oil, v. 138, no. 5, p. 96–98, 1954.

Applying the lessons learned from an experimental seismic crew to routine operations can help reduce costs.—*L. C. P.*

157–86. Clayton, Neal. How to cut seismic exploration costs: World Oil, v. 138, no. 5, p. 92–95, 1954.

This is an analysis of ways of reducing seismic exploration costs.—*L. C. P.*

157–87. Beeman, Keith. What about reproducible seismic recording?: World Oil, v. 138, no. 5, p. 86–88, 1954.

This is an appraisal of magnetic-tape seismograph systems.—*L. C. P.*

METHODS OF ANALYSIS OF EARTHQUAKE OBSERVATIONS

157–88. Carrasco, Luis Esteban. Sobre la determinación de epicentros por el metodo de A. Mohorovičić [On the determination of epicenters by the method of A. Mohorovičić]: Rev. Geofísica, año 12, no. 47, p. 177–181, 1953.

Two graphical solutions to the problem of the intersection of hyperbolas with a common focus are given, one based on homology, the other on polarity. The problem arises in determining the epicenters of near earthquakes by the Mohorovičić method.—*S. T. V.*

157–89. Tsuboi, Chuji. Magnitude-frequency relation for earthquakes in and near Japan: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 5, no. 1, 1952; reprinted from Jour. Physics of the Earth, v. 1, no. 1, p. 47–54, 1952.

By means of formulas previously determined by Tsuboi the magnitudes of 735 shallow earthquakes which occurred in and near Japan during 1931–1950 were determined. The mean annual numbers N of earthquakes having the magnitude M were found to be expressed by

$$\log N = -1.60+1.06\,(8-M), \text{ for area } A,$$
$$\log N = -1.57+0.72\,(8-M), \text{ for area } B,$$
$$\log N = -1.61+0.66\,(8-M), \text{ for area } C,$$
$$\log N = -1.46+1.04\,(8-M), \text{ for the area } (A+B),$$
$$\log N = -1.33+1.01\,(8-M), \text{ for the area } (A+B+C),$$

the class interval of M being taken as 0.1.

It can be seen that while the first constant does not differ much from area to area, the second does, being nearly proportional to the total number of earthquakes which occurred in an area.—*D. B. V.*

METHODS OF ANALYSIS OF SEISMIC SURVEY DATA

157–90. Oliver, Jack; Press, Frank; and Ewing, Maurice. Two dimensional model seismology: Geophysics, v. 19, no. 2 p. 202–220, 1954.

The solutions of many problems in seismology may be obtained by study of ultrasonic pulses propagating in small scale models. Thin sheets, usually one-sixteenth of an inch thick, which serve as two-dimensional models, may be used for such studies. The wave propagation takes place along directions lying in the plane of the sheet and only wave lengths that are long compared to the thickness are employed. The use of thin sheets have the following advantages over three-dimensional models: low cost, availability, ease of fabrication into various configurations, lower energy requirements, and appropriate dilatational-to-shear velocity ratios. The models are usually built in the form of disks.

This is advantageous for the study of surface waves on the edge of the disk because there are no reflections of the surface waves and because a long path may be obtained by using the multiple trips around a relatively small disk. The curvature of the disk may be made small compared to a wave length so that the usual surface-wave equations for flat-lying strata will be applicable with the slight modification of the dilatational wave velocity. Any degree of complexity in the layering of strata may be obtained by gluing together concentric rings of different materials. Good agreement is found between theory and the results of model experiments for the cases of flexural and Rayleigh waves where in the latter the low-velocity layer overlies the high-velocity layer. Experiments were also conducted for the detection of Rayleigh waves in which the low-velocity layer is covered by a high-velocity layer and for body and surface waves in a disk.—*I. Z.*

157–91. Evans, J. F., Hadley, C. F., Eisler, J. D., and Silverman, D. A three-dimensional seismic wave model with both electrical and visual observation of waves: Geophysics, v. 19, no. 2, p. 220–237, 1954.

Many of the problems in seismic prospecting may be solved by analyzing the acoustic wave components in an elastic earth. Because experiments in the ground are difficult to carry out, scaled-down model studies were initiated in the laboratory. Short wave lengths were obtained by using high-frequency sound waves. Piezoelectric crystals were used as sources and detectors primarily because under identical stimuli they are capable of almost perfect duplication. Such duplication is used in displaying (on an oscilloscope), stationary patterns which are characteristic of transient particle motion at a point in the model, and has made possible the direct visual observation of transient wave fronts in transparent models. Techniques for this are described, and sample photographs are given. The waves are "stopped" by illuminating the model stroboscopically with very short and precisely timed flashes of light. Once stopped, the waves are made visible by using either of two well-known optical methods: one, making use of photoelasticity; the other, the so-called schlieren method.

As an example of the quantitative use of the described model techniques, the results are presented showing symmetric and antisymmetric wave propagation in a free elastic plate. Good agreement is found between many features of the experimental record and theoretical predictions. Several problems remain unsolved. One is to provide a point source of acoustic waves. Also, waves of greater intensity must be used to make possible direct visual observation of waves in complex models in which amplitudes may be greatly attenuated by diffraction, multiple partial reflection, or absorption.—*I. Z.*

157–92. Riznichenko, Yu. V. Opredeleniye poley intensivnosti seysmicheskikh voln [The determination of the intensity fields of seismic waves]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 11–25, 1954.

The problem of determining the field pattern of the intensity of seismic waves propagating through a medium is solved under the assumption that the energy spreads along the wave paths as in geometric optics. Thus the spreading of energy is analogous to the laminar flow of incompressible fluid. The properties of the medium, its seismic velocity, density, and the coefficient of absorption are assumed to be known at any point. The intensity E, that is the average value of the stream of energy passing in one second across the cross section of the tube, is given by $E=1/2\ w^2\rho\ VA^2$, where A is the amplitude of the wave, the density of the medium, and $w=2\pi/T$, is the circular frequency of the oscillations.

By the methods of vector analysis and the established relations of the mechanics of continuum, the problem is reduced to Cauchy's problem, with boundary conditions determined by the travel-time curves, known for the points of a definite surface, as for instance, for the surface of the ground. The solution is correct for any harmonic waves on the condition that the length of the waves is sufficiently small in relation to geometric properties of the medium.

The derived formulas are applied to the special cases, when the wave front is spherical, cylindrical, or conical.—*S. T. V.*

157–93. Mota, Lindonor. Determination of dips and depths of geological layers by the seismic refraction method: Geophysics, v. 19, no. 2, p. 242–254, 1954.

In this paper the complete mathematical solution of the dips and depths for 1, 2, 3 and n inclined interfaces from reversed seismic refraction profiles is presented. It is assumed that the velocities increase at each successively deeper interface and that velocities are constant between interfaces. (See also Abstract 12821)—*L. C. P.*

157–94. Vajk, Raoul. Devices for the construction of refracted rays: Geophysics, v. 19, no. 2, p. 237–241, 1954.

Two common problems in seismic computations are: finding the minimum-time path between two points located in media with different seismic velocities separated by a plane interface; and finding the refracted ray where the incident ray to an interface and the velocities of the media on either side are known.

Both problems can be solved graphically by a simple device fashioned from two plastic rules and a plastic triangle. The plastic rules are fastened together to swing about a common axis, with one end of each rule pivoting and sliding freely in a slot along one edge of the triangle. The device is so assembled that the two plastic rules lie along the incident and refracted ray paths and intersect at a point on the interface. The triangle edge is normal to the interface.

The second problem may be solved by use of a simple device constructed from a protractor-triangle, or it can be easily solved graphically.—*L. C. P.*

157–95. Garber, R. Ein Beispiel für die Kennzeichnung multiplier Reflexionen durch die Geschwindigkeit [An example tof the identification of multiple reflections on the basis of the velocity]: Erdöl u. Kohle, Jahrg. 7, Heft 4, p. 197–199, 1954.

Seismic exploration in the province of Limburg, Netherlands, included a region where the subsurface consisted of several parallel, almost-horizontal strata. This made it necessary to distinguish on the seismograms the arrivals of the once-reflected waves from those belonging to multiple-reflected waves. The analysis of seismograms was made in the following manner: Travel times were computed for a number of waves reflected from various layers with increasing depth and on the basis of these times the curve representing the variation of the velocity with depth was drawn. On this curve it was possible to see clearly sharp deviations from the expected shape each time a multiple-reflected wave was picked.—*S. T. V.*

157–96. Krey, Theodore. Bemerkung zu einer Formel für Geschwindigkeitsbestimunungen aus seismischen Messungen von C. H. Dix [A note on the formula of C. H. Dix for the determination of velocity from seismic measurements]: Erdöl u. Kohle, Jahrg. 7, Heft 1, p. 8–9, 1954.

C. H. Dix's formula for the computation of the average velocity $\bar{v}$ in a layer, using the graph of time-delta time-velocity, $\bar{v}^2=\triangle(x^2)/\triangle T(x)$ where x is the distance of the seismograph from the shot point, and $T(x)$ is the corresponding travel time of reflected wave, and the similar formula for the average velocity within the nth layer $v^2_{n,n-1}=(\bar{v}_n^2T_n-v^2_{n-1}T_{n-1})/T_n-T_{n-1})$ can be readily derived from Krey's previously published results. (Geophysics, v. 16, 1951.)—*S. T. V.*

157–97. Berzon, I. S. O razreshayushchey sposobnosti seysmicheskikh metodov pri izuchenii gorizontal'no-sloistykh sred [The resolving capacity of seismic methods in investigations of horizontally stratified media]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 26–48, 1954.

The resolving capacity of a seismic method of exploration may be considered to be the smallest thickness of a layer at depth H which can be located by that method. Berzon here analyzes mathematically the effect of various factors (depth to reflecting or refracting plane, differences in velocity of media, distance from shot point, frequency of the seismic waves) on resolving power for both the reflection and refraction methods. She concludes that difference in depth ΔH affects absolute, and the ratio $\Delta H/H$ the relative, resolving power; that where differences in velocities are small refracted waves in the zone of interference may be extremely retarded; where boundary velocity $V_{g1}>V_{g2}$, the zone of interference decreases inversely with the ratio x/H (x=distance from shot point); in the reflection method resolving power increases with frequency, whereas the effect of wave length is small in seismic refraction. The formulas derived agree with field observations.—*S. T. V.* and *D. B. V.*

OBSERVATIONS OF SEISMIC WAVES

157–98. Girlanda, Antonino. Il terremoto delle Hokkaido del 4 marzo 1952 [The Hokkaido earthquake of March 4, 1952]: Annali Geofisica, v. 6, no. 4, p. 499–509, 1953.

The most probable travel-time curve of the *P* wave between 40° and 105° has been determined, by the method of successive approximations from the data on the Hokkaidō earthquake of March 4, 1952, at 66 seismologic observatories all over the world. The travel times have been compared with those of Jeffreys and Bullen, Gutenberg and Richter, and Macelwane; the best agreement was found with those of Jeffreys and Bullen. Apparent delayed times of arrival at several stations are attributed to the recording of impulses later than the first impulse.—*S. T. V.*

157–99. Nelson, Robert L. A study of the seismic waves *SKS* and *SKKS:* Seismol. Soc. America Bull., v. 44, no. 1, p. 39–55, 1954.

Arrival times, amplitudes, and periods of the seismic phases *SKS* and *SKKS* have been investigated for shallow, intermediate, and deep earthquakes recorded at Pasadena and Huancayo, Peru. New observed time-distance curves are constructed for depths of <60, 100, 200, and 600 kilometers. Travel times for the core have been calculated from shallow-shock time data. Slight modifications of wave velocity just inside the core and of travel times within the core are suggested. Calculated travel times of *SKS*, *SKKS*, and *SKKKS* are in good agreement with observations.

Energy parameters determined from observed amplitude/period ratios are found in only fair agreement with those calculated from theory. Observed energies are too large for most of the phase components and depths considered. The

horizontal components of *SKKS* over the whole distance range, and of *SKS* at $\Delta > 100°$ for all depths, yield observed energies less than those predicted by theory. Both discrepancies are at least qualitatively explained by a proposed non-spherical distribution of shear strain about the fault source, and by abnormal absorption in the outer 700 kilometers of the core. Anomalous observed energies, as functions of epicentral location, are also accounted for by the proposed non-spherical distribution of energy.—*Author's Abstract*

157–100. Ewing, Maurice, and Press, Frank. Mechanisms of *T* wave propagation: Annales Géophysique, tome 9, no. 3, p. 248, 1953.

It is stated that all objections offered by Coulomb and Molard to *T*-phase propagation through water are met by sofar propagation for periods less than about 0.1 sec and by multiple internal reflections of higher normal modes than the first for the longer periods. It seems reasonable to conclude that there will be serious scattering of the short period waves at land boundaries, and this combined with the better response of land seismographs to periods in the range ⅕ to 1 sec accounts for the characteristic differences between *T* phases recorded on sofar hydrophones and *T* phases recorded on land seismographs.—*P. E. B.*

157–101. Evernden, Jack Foord. Love wave dispersion and the structure of the Pacific Basin: Seismol. Soc. America Bull., v. 44, no. 1, p. 1–5, 1954.

By use of the Love-wave dispersion data for the earthquake of September 29, 1946 (epicenter at lat. 5° S., long. 154° E.), a three-layer model of Pacific basin structure has been derived. The periods of the Love waves observed varied continuously from 45 seconds to 7 seconds. The model consists of a layer 2.5 km thick in which V_s is 2.31 kmps; a layer 11 km thick in which V_s is 3.87 kmps; a bottom in which V_s is 4.52 kmps. The thicknesses are in reasonable agreement with Raitt's results for the regions west of Hawaii. Greater thicknesses than those found by Raitt are indicated for the region east of Hawaii.—*P. E. B.*

157–102. Jobert, G., and Jobert, N. Application du principe de Rayleigh à la dispersion d'ondes superficielles [Application of the Rayleigh principle to the dispersion of surface waves]: Annales Géophysique, tome 9, no. 3, p. 250–255, 1953.

Consider the components of particle motion for a Rayleigh wave, $u=U(z)\cos(fct-fx)$, $w=W(z)\sin(fct-fx)$, with the assumption λ/μ=a constant$=h$. Then, for a normal mode, equating the mean kinetic and potential energies during a period, an expression of form $c^2=\int_0^\infty F(\mu,h,f,U,W,U'W')\,dz/f^2 \int_0^\infty G(\rho,U,W)\,dz$ is found for the phase velocity corresponding to wave number "f". The quotient is stationary for small variations of U and W from the actual values, according to the Rayleigh principle, and gives a good upper bound for c^2 for a reasonable choice of approximating functions. The approximating functions $U_0(z_0)$ and $W_0(z_0)$ are chosen as those satisfying the boundary conditions for a half-space, with the conditions

$$\left.\begin{matrix} U_0\ (z_0) \\ W_0\ (z_0) \end{matrix}\right\} = \left\{\begin{matrix} U_1\ (z_1 z_0) \\ W_1\ (z_1 z_0) \end{matrix}\right\} \text{ for } z=z_0$$

with U_1 and W_1 defined by $\rho/\mu=\rho(z_0)/\mu(z_0)$. Taking $\mu'=0$, expressions are derived for U_0 and W_0. Two integral quotients are then presented for c_0^2; one which is stationary, and a second which apparently is not. The first involves substitution of U_0 and W_0 in (1) without altering observed values of the elastic parameters. The second involves the substitution of U_0 and W_0 and also the

replacing of μ, ρ, μ' by μ, ρ, 0 used in the calculation of U_0 and W_0. The second expression is included because of good checks with observation, although it is evidently an abstract quantity.

The remainder of the paper is devoted to obtaining a second-order expression for the square of the phase velocity as a function of the wave number, for small wave numbers, under the conditions that $\mu(z)$ and $\rho(z)/\mu(z)$ can be expressed as uniformly convergent series of terms $a_n z^{nm}$.—*P. E. B.*

157–103. Jobert, N. Dispersion des ondes de surface dans la couche superficielle du glacier du Groenland [Dispersion of surface waves in the surface layer of the Greenland ice cap]: Annales Géophysique, tome 9, no. 4, p. 345–357, 1953.

The method of determining phase velocity, c^2, for Rayleigh waves as a function of wave number is applied to surface-wave data from the "Station Centrale" in the middle of the Greenland ice cap. Data on the elastic properties and density of the ice are used in the calculations. The values of the phase velocity are used to compute the curves of group velocity versus $2\pi/T$. Independent calculations are made of the slope of the dispersion curves at the origin. Of the two distinct phases observed, the second wave train has the properties of Rayleigh waves, and is fitted well by one of the calculated dispersion curves. Unfortunately the data are best fitted by the curve determined from an expression for c^2 which is evidently not stationary with respect to the variations employed in its calculation. The expression for c^2 determined from the Rayleigh principle gives only a fair upper boundary for the group velocities, when compared with observed values.

The first wave train shows direct motion rather than retrograde, and has periods of the same order as the Rayleigh motion. The waves appear to die out more quickly with distance, and are similar to those observed from blasts. Reference is made to the work of Cagniard and Lapwood on the existence of such waves, propagated with the speed of S, in homogeneous media, and to the M_2 wave of Sezawa and Kanai. If one considers the wave train to be made up of waves propagated along the surface with the speed of S, one may suppose that for a wave of length $\lambda=kh$ $(k\sim 1)$, the waves move with phase velocity

$$c=\overline{V}_s=1/h\int_0^h V_s dZ, \text{ where } V_s=V_s(Z).$$

Then

$$U=C-\lambda dc/d\lambda=\overline{V}_s-hd\overline{V}_s/dh=2\overline{V}_s-V_s(h)$$

if one admits that

$$\overline{V}_p=2\overline{V}_s,\ u=\overline{V}_p-V_s.$$

The dispersion curves for $k=1.5$ are in good agreement with the observed values for the first wave train, provided $2\pi/\lambda<200$.—*P. E. B.*

Gutenberg, B[eno]. Low-velocity layers in the earth's mantle: see Geophys. Abs. 157–184.

Kamitsuki, Akira, and Mikumo, Takeshi. Investigation of the structure of the earth's crust in relation to local earthquakes (preliminary): see Geophys. Abs. 157–181.

Benioff, Hugo. Orogenesis and deep crustal structure—additional evidence from seismology: see Geophys. Abs. 157–173.

Woollard, G. P. Crustal structure beneath oceanic islands: see Geophys. Abs. 157–188.

Laughton, A. S. Laboratory measurements of seismic velocities in ocean sediments: see Geophys. Abs. 157–179.

EARTHQUAKE OCCURRENCES AND EFFECTS

157–104. Tillotson, Ernest. Earthquakes during 1953: Nature, v. 173, no. 4403, p. 531–532, 1954.

This is a brief note on the five earthquakes which caused the most damage in 1953: February 12, in Persia; March 18, in Turkey; August 12, near the island of Cephalonia, Greece; September 10, near Cyprus; and December 12, in Peru.—*M. C. R.*

157–105. Tabuteau, François, and Beaufils, Y. Travaux séismologiques de la première expédition en Terre Adélie (1950) [Seismic studies of the first expedition to Adélie Coast (1950)]: Annales Géophysique, tome 9, no. 3, p. 277–279, 1953.

This is a report on the installation of the seismograph station at Port Martin together with a seismic bulletin from the station for the period July 3, 1950, to October 7, 1950.—*P. E. B.*

157–106. Toperczer, Max, and Trapp, E. Ein Beitrag zur Erdbebengeographie Österreichs [A contribution to the earthquake geography of Austria]: Österreich. Akad. Wiss. Kl. math.-naturw., Erdbeben-Komm. Mitt., no. 65, 59 p., 1950.

A statistical analysis has been made of earthquakes since 1200 A. D. in the area which forms the present Austria. A more detailed study is made of 645 earthquakes between 1904 and 1948. Both studies were based mostly on non-instrumental observations. Only 7 of these earthquakes were of an intensity of 7.0 to 7.5 (Mercalli-Sieberg scale), 529 were of intensities ranging from 3.5 to 5.0, and 78 were of less than 3.5. The area of the greatest seismic intensity is between the northern Dolomites and the Central Alps.

In the whole country 55.5 percent of all earthquakes occur during the winter months, 44.5 percent during the summer months. Toperczer and Trapp relate this to the variation of barometric pressure and give a table of such variation, as observed in Wien between 1851 and 1920, showing the similarity of the yearly variation of atmospheric pressure with the curve of the occurrence of earthquakes.—*S. T. V.*

157–107. Peronaci, Francesco. Il terremoto sardo del 13 novembre 1948 [The Sardinian earthquake of November 13, 1948]: Annali Geofisica, v. 6, no. 4, p. 569–577, 1953.

After more than 80 years of quiet, an earthquake of intensity 7 on the Mercalli scale was felt in the northern part of the island on November 13, 1948. The magnitude was estimated to be 5, and the energy was 10^{20} ergs. The position of the epicenter varied slightly according to the choice of seismograms. The most probable is: $\phi=41°\ 36.8'\pm5.9'$ N., $\lambda=8°\ 24.4'\pm0.5'$ E.; the depth of the focus was 13 ± 0.4 km.

Thus the epicenter is in Vallinco Bay. The velocities of the propagation of seismic waves between Sardinia and Italy are different from those between Sardinia and central Europe, suggesting a difference in geologic structure.—*S. T. V.*

157–108. Andreyev, S. S. Masarskiy, S. I., Rustanovich, D. N., and Kharin, D. A. Issledovaniye slabykh zemletryaseniy yugo-zapadnoy Turkmenii [The investigation of feeble earthquakes in southwestern Turkmen S. S. R.]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 143–152, 1954.

The seismotectonic characteristics of the southwestern part of the Turkmen S. S. R. have been analyzed on the basis of the scientific data gathered since 1912, when the first seismic observatory was established in the region. The records of eleven temporary seismic stations installed within the area most active seismically were especially useful. During 1½ years of the operation of this network, 441 earthquakes were recorded, and 164 were studied in detail. Each temporary station was equipped with 3 Kharin seismographs (1 vertical, and 2 horizontal). These have a magnification of 30,000 to 40,000, natural periods ranging from 0.2 to 0.4 sec, and recording speed of 120 mm per minute. Accurate time was assured by a radio check of the chronometers of each station 6 times daily.

The analysis indicates that there is no relation between the position of the foci of the observed earthquakes and the surface relief; that tectonic causes of individual earthquakes exist in all crustal strata, as shown by the variation in depths of foci; that the zone most active seismically is around Krasnovodsk on the Caspian Sea, where two very active, tectonically independent seismic centers were found.—*S. T. V.*

157–109. Petrushevskiy, B. A., Rezanov, I. A., and Rastvorova, V. A. K seysmogeologicheskoy kharakteristike zapadnoy Turkmenii [On the seismogeologic characteristics of the western Turkmen S. S. R.]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 160–183, 1954.

Seismologic and geologic information about the region east of the Caspian Sea, an area very active seismically, where several earthquakes of destructive intensity have occurred during the last fifty years, has been analyzed. On the basis chiefly of geologic considerations, the observed earthquakes of different intensities and different foci cannot be attributed to one dominant seismotectonic cause, but are the result of many tectonic causes at different geologic times. Corrections to the recent seismoteconic maps of the region and a new map for seismic zoning of western Turkmen S. S. R. are needed.—*S. T. V.*

157–110. Rothé, J. P. La zone séismique médiane Indo-Atlantique [The middle Indo-Atlantic seismic zone]: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 387–398, 1954.

The distribution of epicenters in the Atlantic and Indian Oceans indicates that the line of epicenters associated with the Mid-Atlantic Ridge continues around the Cape of Good Hope and joins a similar line associated with the central ridge of the Indian Ocean. An extensive list of epicenters is included in the paper.—*M. C. R.*

157–111. Ritsema, A. R. New seismicity maps of the Banda Sea: Indonesia Jour. Sci. Research, v. 2, no. 21, p. 48–54, 1953.

The problem of the two-dimensional representation of the five factors (geographic position in latitude and longitude, depth, magnitude, origin time) which determine the seismicity of a given region is discussed in detail. Among the ways considered are: models; maps with open and closed circles of different sizes to show depth or magnitude as well as position; grids showing the number of

shocks, the rebound displacement, and mean depth at which the rebound displacement takes place; maps which show lines of equal numbers of earthquakes per square degree, equal rebound displacement per square degree or equal mean depth at which the rebound displacement took place. Examples are given for the Banda Sea region.—*M. C. R.*

157–112. Hayes, R. C. Earthquake origins in New England during the year 1952: New Zealand Dept. Sci. Indus. Research Seismol. Observatory Bull. S–98, 2 p. and map, 1953.

Times of origin, epicenters, magnitudes, and maximum reported intensity of earthquakes in the New Zealand region during 1952 are tabulated. The epicenters are also shown on a map which includes, as an inset, the isoseismal map of the shock of August 28, 1952.—*M. C. R.*

157–113. Hodgson, J. H., and Storey, R. S. Direction of faulting in some of the larger earthquakes of 1949: Seismol. Soc. America Bull., v. 44, no. 1, p. 57–83, 1954.

Directions of faulting, based on studies of first motion at distant stations, are given for fifteen large earthquakes with different focal depths to a maximum of 600 km. For the first time, data from *PP* and *P′* have been used in obtaining solutions. Seven of the earthquakes considered were in the north Pacific Ocean, four in South America, two in the southwest Pacific, and two in central Asia. The two earthquakes in central Asia apparently occurred on steeply dipping normal faults, but most of the circum-Pacific shocks are due to transcurrent faulting. An attempt will be made to correlate the results with structure when more earthquakes have been studied. Plots of the possible fault planes with strike, dip, and relative displacement, and tables of the first motion at various stations are given for each earthquake.—*P. E. B.*

157–114. Honda, Hirokichi, and Masatsuka, Akira. On the mechanisms of the earthquakes and the stresses producing them in Japan and its vicinity: Tōhoku Univ. Sci. Repts., 5th ser., v. 4, no. 1, p. 42–60, 1952.

The distribution and mechanism of deep, intermediate, and shallow earthquakes occurring in and near Japan during the period 1927–1949 were investigated statistically. The direction of the horizontal component of maximum stresses producing deep and intermediate earthquakes was found to be perpendicular to the deep and intermediate earthquake zones, respectively. The trend of the Japanese volcanic belt is nearly coincident with the intermediate earthquake zone, and perpendicular to the direction of the horizontal stress producing deep and intermediate earthquakes. Most deep and intermediate earthquakes occur on the surface which slopes from the eastern coast of Honshu toward the Asiatic continent, down to a depth of 400–600 km, beneath the boundary of the deep earthquake zone toward the continent. Shallow earthquakes are numerous on the eastern coast of Honshu. Apparently the crustal block bounded by this surface is being forced downward and toward the continent relative to the overlying block—*D. B. V.*

Kato, Yoshio; Ossaka, Justo; and Noritomi, Kazuo. On the change of the earth's magnetic field accompanying the Tokachi earthquake on March 4, 1952: see Geophys. Abs. 157–36.

Miyakoshi, Junichiro. On the local and anomalous change of geomagnetic declination: see Geophys. Abs. 157–37.

157–115. Nishimura, Eiichi. On some destructive earthquakes observed with the tiltmeter at a great distance: Kyōto Univ. Disaster Prevention Research Inst. Bull., no. 6, p. 1–15, 1953.

This is a description of the purpose and use of the tiltmeter, extensometer, magnetometer, and other instruments, together with a brief account of each observation station. In addition, the as yet unexplained phenomenon of ground tilt accompanying distant destructive earthquakes is discussed. The paper serves as an introduction for those which follow in the same bulletin.—*D. B. V.*

157–116. Medvedev, S. V. Issledovaniya v oblasti prognoza zemletryaseniy [Research in the field of earthquake prediction]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 100–103, 1954.

This is a report of a convention of seismologists held in Stalinabad, Tadzhik S. S. R. in October 1953. In papers presented to the congress the following points were emphasized: the prediction of an earthquake is of value if it contains data about the area of the probable shock, the direction, and the time of origin.

To obtain this information it is necessary to continue statistical investigations and to enlarge seismotectonic studies, because only the latter can give information on the probable geologic causes of earthquakes, their direction, and variability or constancy of the foci. It is also important to continue deep geologic sounding over the discovered fault lines, especially with the help of temporary seismologic stations installed at the epicenters. Study of certain phenomena which often precede earthquakes, such as undulatory deformations of the ground, was also emphasized. Such deformation can be observed and measured by photoinclinometers. Some speakers stressed the importance of seismic microzoning because of great differences in the intensities of seismic shocks even within the limits of small towns, because of the local structural difference.—*S. T. V.*

SEISMIC SURVEYS

157–117. Hodgson, John H. A seismic survey in the Canadian Shield, I: Refraction studies based on rockbursts at Kirkland Lake, Ont.: Dominion Observatory Ottawa Pubs., v. 16, no. 5, p. 113–163, 1953.

Rockbursts offer certain unique advantages as an energy source in seismological studies of the earth's crust because of the possibility of precise location and timing coupled with the same energy distribution as earthquakes, so immediately after the World War II steps were taken to set out a refraction profile for detailed studies of the crust. A seismograph was installed at Kirkland Lake to time the bursts at their source, and 14 stations were occupied at distances varying from 8 to 174 km. The stations were occupied one or two at a time, and the instruments being moved to new locations after bursts had been satisfactorily recorded. Stations were housed in portable prefabricated buildings. Several types of instruments were used during the project, those finally selected being of a type designed by Willmore.

In addition to the 14 field stations records at 5 distant stations which recorded the earlier large bursts were used.

First arrivals in the P and S groups suggest that the crust consists of a single layer, and the point at which P_n is first observed confirms this conclusion. Analysis of secondary arrivals suggests that the crust provides several alternate paths for each ray by lateral variations in rock types and by variable thickness, so that groups of phases are obtained rather than single distinct phases.

The records of the distant stations show a very large amplitude for about 10 seconds following the expected arrival time of the direct S waves. This group seems to be identical with that called L_g by Ewing and Press.

Velocities of P and S in the crustal layer are 6.246 ± 0.015 and 3.544 ± 0.023 kmps. The velocity of P below the Mohorovičić discontinuity is 7.913 ± 0.125 kmps if near-station data are used, and 8.176 ± 0.013 kmps if data of near and distant stations are combined. This suggests an increase of velocity with depth. Velocity of S_n, based on the records of the distant stations only, is 4.85 ± 0.10 kmps. The mean thickness of the crust, based on the P waves, is 35.4 ± 5.5 km, the uncertainty being the result of the uncertainties in the velocities and not a true probable error. This uncertainty may correspond to the actual variation in crustal thickness.—*M. C. R.*

157–118. Crary, A. P. Seismic studies on Fletcher's Ice Island, T-3: Am. Geophys. Union Trans. v. 35, no. 2, p. 293–300, 1954.

Seismic studies were made on Fletcher's Ice Island in the Arctic Ocean during June and July 1952, to determine the thickness and elastic characteristics of this ice body. Two types of seismic profiles were made, one using explosives detonated at or near the surface, and one using mechanical impacts. Compressional and torsional velocities were obtained, as well as good flexural waves at the longer distances. A single shot was fired at the surface at a distance of 5½ miles for the generation of an air-ice coupled wave. In addition to these standard types, a constant frequency multi-reflected SV wave showed unusually large amplitudes at the long distances. The ice thickness was obtained independently by seismic energy reflected from the ocean bottom. The arrival times through the island were compared with arrival times to the surrounding ice pack at sea level. The thicknesses obtained by these various types of measurement are quite consistent, giving from 160 to 170 ft, corresponding to an average density of about 0.91 gms/cm^3, as deduced from the elevations. This value of density was also obtained by direct measurements in the upper 50 ft of ice.—*Author's Abstract*

157–119. Oliver, Jack, Crary, A. P., and Cotell, R. [D.] Elastic waves in Arctic pack ice: Am. Geophys. Union Trans., v. 35, no. 2, p. 282–292, 1954.

Experimental studies of the propagation of elastic waves in Arctic ice were made on the Beaufort Sea near Barter Island, Alaska, and on the Arctic Ocean near T–3, the ice island floating near the North Pole. Velocities of observed longitudinal waves ranged from 2,400 to 2,910 m per sec, with one exception. Shear-wave velocities were determined at three places, and for these three elastic constants were calculated using 0.9 g per cm^3 as the density. Air-coupled waves were prominent where shots were fired at or near the ice surface at distances more than 200 times the ice thickness. Ice thicknesses determined from the air-coupled waves were less than measured thicknesses. Flexural waves were also observed. A high-frequency wave with velocity of about 1,700 m per sec was detected, most prominently when the shot was on the surface of the ice or in a dry hole. The method of propagation is not understood.—*M. C. R.*

157–120. Joset, Alain, and Holtzscherer, Jean-Jacques. Étude des vitesses de propagation des ondes séismiques sur l'Inlandsis de Groenland [Study of the velocities of seismic waves on the inland ice cap of Greenland]: Annales Géophysique, tome 9, no. 4, p. 330–344, 1953.

This is an extensive discussion of the results of refraction and reflection shooting on the ice cap in 1949–1951 by the Expeditions Polaires Françaises. Travel-time curves, reproductions of records, computed velocities, and thicknesses are given, as are computed elastic constants for the ice and névé. At camps IV and VI (about 40 and 90 km from the western edge of the ice cap), the following mean P velocities and thicknesses are given (reversed refraction lines and reflections): camp IV, h_1=600 m; h_2=250 m; V_1=3,800 m per sec; V_2=4,750 m per sec; V_3=6,000 m per sec; camp VI, h_1=1,370 m; h_2=300 m; h_3 ÷ 720 m; V_1=3,835 m per sec; V_2=5,000 m per sec; V_3 ≐ 5,450 m per sec; V_4 ≐ 6,650 m per sec.

The second layer is interpreted as something of the nature of a mixture of blocks of crystalline rock and ice. It is presumably too thick to be the usual morainal material. The third layer at station VI is interpreted as crystalline rock and the fourth as basic rock, perhaps basalt. Identical basalts have been found on the eastern and western coasts of Greenland, and as station VI lies on the general line between outcrops (so does station IV apparently), the presence of basalt is not inconsistent with suggestions of east-west dikes or "graben" with associated effusions of basalt.

The central station in the middle of the ice cap is underlain by about 3,000 m of ice, and deep refractions could not be obtained because of length of cable and size of shot necessary. For this station velocity logs are given for boreholes in the ice and névé and compared with the velocity-depth relationship computed from the Herglotz formula. Elastic constants were computed for the ice at the aforementioned 3 stations (6 stations were occupied). Tabulated are ρ, V_p, V_s, $T°C$, σ, μ, λ, E, and K.—*P. E. B.*

157–121. Hill, M. N., and Laughton, A. S. Seismic observations in the eastern Atlantic, 1952: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 348–356, 1954.

Seismic refraction experiments in the Atlantic during the summer of 1952 included 6 in deep water of between 2,000 and 2,600 fathoms and 4 in the approaches to the English Channel. The deep-water stations show a general similarity of structure: a layer of unconsolidated sediments of varying thickness with a mean of about 1 km; a layer in which the velocity of longitudinal waves is between 5.4 and 7.1 kmps; and a layer in which the velocity is 7.8 to 8.2 kmps. Stations on the continental shelf indicate that the basement rocks slope gently seaward.—*M. C. R.*

157–122. Gaskell, T. F. Seismic refraction work by H. M. S. *Challenger* in the deep oceans: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 356–361, 1954.

Seismic refraction work during the world cruise of the *Challenger* was limited by lines no longer than 20 miles and by the small charges used, but nevertheless provided information on many parts of the oceans. In the Pacific the simplest type of structure consisted of a single layer in which the velocity was 6.3 to 6.6 kmps, covered with material probably about 0.5 km thick. This structure was observed seaward of the andesite line. Landward of the andesite line, material with velocity of 5.0 to 5.8 kmps, overlain by layers in which the velocity was 2.5 to 3.3 kmps, was found. Near the Hawaiian Islands an extra layer a few kilometers thick in which the velocity is 4.0 to 5.0 kmps was found between the sediments and the 6.4-kmps layer. This layer is probably volcanic material

although the velocity is also consistent with sedimentary material. Three stations in the Bermuda area gave similar results. Some 3,000 miles north of Bermuda there is evidence for the existence of a layer in which the velocity is 8 kmps, and 5,000 miles southwest of Bermuda the 8-kmps layer may be 18 km below the surface. In the eastern Atlantic the results suggest that the Atlantic and Pacific Oceans have similar form.—*M. C. R.*

157–123. Ewing, Maurice, Sutton, G. H., and Officer, C. B., Jr. Seismic refraction measurements in the Atlantic Ocean, Part VI: Typical deep stations, North Atlantic Basin: Seismol. Soc. America Bull., v. 44, no. 1, p. 21–38, 1954.

Measurements and interpretation are given for 6 deep-sea refraction stations, 3 in the region south of Bermuda (Nares Basin) and 3 in the region northwest of Bermuda. The computed structure includes a sedimentary layer 0.5 to 2.0 km thick with velocity about 1.8 kmps, an intermediate layer 2.3 to 6.0 km thick with velocity about 6.5 kmps, and a lower layer of thickness too great to measure by the methods used with V about 7.9 kmps. The first layer is identified as unconsolidated sediments, the second as the intermediate layer of continental seismology, and the third as the material below the Mohorovičić discontinuity. On the average, the unconsolidated sediment is about twice as thick in the region northwest of Bermuda as in the Nares Basin (1.56 and 0.73 km). The depth to basement is nearly the same in the two regions and the ocean bottom about 0.8 km deeper in the Nares Basin. Travel time curves are included for all stations.—*P. E. B.*

157–124. Press, Frank, and Beckmann, Walter. Geophysical investigations in the emerged and submerged Atlantic coastal plain: Part VIII. Grand Banks and adjacent shelves: Geol. Soc. America Bull., v. 65, no. 3, p. 299–314, 1954.

A reconnaissance refraction survey was conducted on the Grand Banks, St. Pierre Banks, Cabot Strait Trough, and Banquereau. Three stations on the Grand Banks indicate sedimentary layers ranging from 2,300 to 10,700 feet in thickness. The sediments are underlain by basement rocks having velocities of 16,150–18,200 ft/sec.

A striking feature, existing on a profile running from St. Pierre Bank across Cabot Strait Trough to Banquereau, is the occurrence under the trough of a prism of sediments that thickens to almost 14,000 feet near the northeast margin where it is almost entirely truncated by basement rock.

The sequence of subsurface layers found on the banks south and southeast of Newfoundland is not unlike that reported for the submerged shelf off the northeast coast of the United States and the banks off Nova Scotia. The seismic results and the recent results from dredging and coring operations support the hypothesis that the shelf off eastern North America is a depositional feature dating back to at least Lower Cretaceous time. The physiographic differences north and south of Cape Cod are believed to be due to erosion. The data suggest a structural origin for the Cabot Strait Trough, although the possibility of subsequent modification by glaciation is not ruled out.—*Authors' Abstract.*

157–125. Caloi, Pietro. Osservazioni sismiche e clinografiche presso grandi dighe di sbarramento [Seismic and clinographic observations around large retaining dams]: Annali Geofisica, v. 6, no. 3, p. 321–366, 1953.

Extensive observations were made with sensitive seismograph and photo-inclinometers of the deformations of large dams and of the movements of the ground on which the dams are constructed. Caloi found that the dams are noticeably deformed every time the level of the water in the reservoir changes, and when the exterior surface of the dam is heated by the sun, while the inner surface remains at constant temperature, being cooled by water. To these static deformations must be added slow movements of the ground. These movements may be such that the entire surrounding area moves as one rigid mass, but sometimes the opposite hills on which the ends of the dam are anchored move in different directions that can be dangerous to the very stability of the structure.

This question of the movement of the ground in separate blocks, evidently separated by some deep fractures, must be studied by geophysicists before the construction work begins because the neglect of this phenomenon can be as dangerous as a defective foundation.

Oscillatory movements also take place, caused by remote earthquakes, by microseismic disturbances, and by industrial installations. Minute cracks produced in the structure by inner stresses can be observed with sufficiently sensitive seismographs. The article contains many graphs of observed data and oscillograms illustrating the text.—*S. T. V.*

157–126. Fabian, H. J., and Helms, H. von. Geologisch-geophysikalische Untersuchungen im Raume Meppen, westlich der Ems [Geologic and geophysical investigations in the Meppen region, west of the Ems]: Erdöl u. Kohle, Jahrg. 6, Heft 10, p. 601–604, and Heft 11, p. 726–729, 1953.

This is a discussion of the geophysical investigations of the area between the border of the Netherlands and the Ems in northwestern Germany made before 1949. In this region of about 300 sq km, geophysical exploration for oil was begun in 1935; the first surveys were by magnetic and gravity methods, and since 1946 seismic reflection and refraction methods have been used. The results are presented as parallel seismic and geologic profiles.

Results of the investigations since 1949 by seismic reflection and refraction methods are presented in the second paper. Several sites were explored and geologic profiles constructed on the basis of the travel-time curves.—*S. T. V.*

MICROSEISMS

157–127. Bernard, Pierre. Recherche de l'origine des microséismes enregistrés à Port-Martin [Research on the origin of microseisms recorded at Port Martin]: Annales Géophysique, tome 9, no. 3, p. 280–283, 1953.

The origin of the microseismic activity recorded at Port Martin in 1950 can, in several cases, be shown "with some probability". Evidence is found against the hypothesis that microseisms arise only from isobaric depressions whose velocity of displacement exceeds the group velocity of the swell.—*P. E. B.*

ISOTOPE STUDIES AND AGE DETERMINATIONS

157–128. Reynolds, John H. The isotopic constitution of silicon, germanium, and hafnium: Phys. Rev., v. 90, no. 6, p. 1047–1049, 1953.

The isotopic constitutions of silicon, germanium, and hafnium have been measured with a mass spectrometer by techniques which are described. Results for silicon are in good agreement with certain of the earlier determinations but

are in poor agreement with the values adopted in the recent compilation by Bainbridge and Nier (1950). Results for germanium do not differ significantly from earlier determinations. Results for hafnium differ only slightly from the one previous determination in which electrical detection was used, but in such a way as to suggest that determinations on hafnium which has been fractionally purified with respect to zirconium may not be faithfully representative of the true abundances. An upper limit of 0.003 per cent has been placed on the abundance in nature of Hf^{182}.—*Author's Abstract.*

157–129. Landergren, Sture. On the relative abundance of the stable carbon isotopes in marine sediments: Deep-Sea Research, v. 1, no. 2, p. 98–120, 1954.

The ratio C^{12}/C^{13} has been determined in about 200 samples of marine sediments under different geologic conditions. In some cases the ratio has been determined both in organic and carbonate carbon, so that the isotope exchange could be discussed. The isotope ratio variations in marine limestone are affected by the water conditions prevailing during the deposition. In limestone deposited in circulating and aerated surface water the ratio tends to a value indicating isotope exchange equilibrium with carbon dioxide. Where the water-air system is restricted and deposition takes place in stagnant water, there is enrichment in the light isotope; where water conditions are very stable, for example in the alum shale milieu, the isotope exchange between carbon dioxide and carbonate tends to attain equilibrium.

The paper includes an appendix by A. Parwell describing the conversion of organic carbon to carbon dioxide and the preparation of barium carbonate for mass spectrometric determination.—*D. B. V.*

157–130. Imbò, G[iuseppe], and Gaeta, F. S. Considerazioni sui metodi di Holmes e di Jeffreys per la determinazione dell'età della crosta terrestre [Considerations on the methods of Holmes and Jeffreys for the determination of the age of the crust of the earth]: Annali Geofisica, v. 6, no. 3, p. 417–425, 1953.

On the basis of isotopic analysis of 13 samples of lead ores, the age of the earth crust was determined, using the method of discrete values and that of intersections. The disagreement in the results, as well as the diversity of values obtained with the second method, are attributable to various causes among which are the possibilities of escape or adsorption of volatile elements, thus altering the basic conditions of the problem. These considerations would exclude on one hand the possibility of applying the method of Jeffreys and, on the other hand, in order to apply the method of Holmes, would require the introduction of particular corrections to the original data or a number of isotopic analyses notably greater than that actually obtained.—*S. T. V.*

157–131. Patterson, C. [C.], Brown, H., Tilton, G., and Inghram, M. [G.]. Concentration of uranium and lead and the isotopic composition of lead in meteoritic material: Phys. Rev., v. 92, no. 5, p. 1234–1235, 1953.

The cosmic abundance of lead and uranium have been determined by studying the lead and uranium contents of meteoritic materials. Lead is found to be present to 8×10^{-3} atom/10,000 atoms of silicon, and uranium to 1×10^{-4} atom/10,000 atoms of silicon. The new value for lead removes the hump in the cosmic

abundance curve in the 206–208 mass region. The relative primordial abundances of lead isotopes of mass 204, 206, 207, and 208 are found to be 1 : 9.4 : 10.3 : 39.2, respectively.—*Authors' Abstract*

157–132. Kulp, J. Laurence, Broecker, Wallace S., and Eckelmann, Walter R. Age determination of uranium minerals by the Pb–210 method: Nucleonics, v. 11, no. 8, p. 19–21, 1953.

Ages may be calculated from the ratio of Pb^{210} to PB^{206} in a mineral. The Pb^{206} is determined by mass spectrometric analysis. Pb^{210} is determined by determining the alpha activity of Po^{210}, after allowing sufficient time for the decay of other interfering isotopes. Results of measurements on 10 samples are given in a table. Agreement between ages by this method and the "best" age determined from an analysis of available radioactive age determinations is good.—*M.C.R.*

157–133. Kulp, J. Laurence, Bate, George L., and Broecker, Wallace S. Present status of the lead method of age determination: Am. Jour. Sci., v. 252, no. 6, p. 345–365, 1954.

The available results on the age of radioactive minerals as determined by the various isotopic ratios Pb^{206}/U^{238}, Pb^{207}/U^{238}, Pb^{207}/U^{235}, Pb^{207}/Pb^{206}, Pb^{206}/Pb^{210}, and Pb^{208}/Th^{232} are summarized. The probable sources of error are radon leakage, leaching and alteration, uncertainty in the isotopic composition of any common lead, chemical analysis, and instrumental techniques. With sufficient isotopic analyses on the common lead of an area, it is usually possible to make a precise correction for the common lead contribution to the isotopic composition of a radioactive mineral. Radon leakage can be measured under laboratory conditions and extrapolated to the integrated thermal history of the mineral. Chemical and instrumental errors are generally of second-order importance. The occurrence of leaching and alteration can be estimated from the comparison of the lead-lead with the lead-uranium ages. In the most ideal conditions, the uncertainty of the half-life of U^{235} may be significant error.

It is concluded that the 207/235 and 206/210 ages are the most reliable over the greater range of geologic time. The 206/238 age is generally correct to 5–10 percent and supersedes the 207/235 age in accuracy for young minerals. The Pb^{208}/Th^{232} age is considered usable for minerals high in thorium content. The 207/206 age is the least reliable of all.

Nomographs are presented which simplify the calculation of the age of a mineral from the isotopic ratio.—*Authors' Abstract*

157–134. Russell, R. D., Farquhar, R. M., Cumming, G. L., and Wilson, J. Tuzo. Dating galenas by means of their isotopic constitutions: Am. Geophys. Union Trans., v. 35, no. 2, p. 301–309, 1954.

Two distinct classes of common leads are recognized which may be distinguished by their isotopic abundances: "ordinary", and "anomalous" characterized by very high Pb^{206} and Pb^{208} abundances. Ordinary leads may be dated by comparing their isotopic abundances with average lead abundance-time curves if a possible error is assigned that is sufficiently large to include the effects of irregularities in the distribution of uranium, thorium, and lead in the crust. The expected possible errors have been calculated by assuming that the maximum percentage deviations in the average uranium/lead and thorium/lead values

have been constant during geologic time and have been growing linearly since the crust formed. The errors are similar, and become rapidly smaller with increasing age of the sample so that useful ages can be obtained for samples older than 1,000 million years and for samples older than 2,000 million years. The errors are comparable to those for standard radioactive age determinations.

Anomalous leads can be explained by large additions of radiogenic leads and ordinary lead, and the lead abundance ratios can be used in a least-squares calculation to provide a limit to the time of separation of the leads from the source of the radiogenic additions.

Both anomalous and ordinary leads from the Sudbury Basin area have been dated by these methods and consistent ages of 1,200±200 million years obtained. These ages are cited as supporting the view that the Sudbury galenas were brought in along faults associated with the Grenville orogeny.—*M. C. R.*

157–135. Holmes, Arthur. The oldest dated minerals of the Rhodesian Shield: Nature, v. 173, no. 4405, p. 612–614, 1954.

Determinations of the ages of three monazites from Rhodesia (from the Bikita District and from north of Salisbury, Southern Rhodesia and from the Irumi Hills, Northern Rhodesia) indicate a period of pegmatite formation 2640±40 million years ago. These are the oldest dated samples in Africa. As Macgregor has detected algal structures in limestones in the Bulawayan system which is older than the pegmatites, this is evidence of the existence of life for at least 2,600 million years.—*M. C. R.*

157–136. Rafter, T. A. The preparation of carbon for C^{14} age measurements: New Zealand Jour. Sci. Technology, Sec. B, v. 35, no. 1, p. 64–89, 1953.

The paper describes the techniques used for the production of carbon from carbonaceous material. The carbon samples produced are free from detectable radioactivities other than C^{14}, contain 1 per cent or less of ash, and the carbon percentage varies within limits that cannot affect the counting rate. A full description is given of technical difficulties associated with carbon preparation and its deposition as a uniform layer on the inside of copper cylinders.—*Author's Abstract*

157–137. Fergusson, G. J. Activity measurement of samples for radiocarbon dating: New Zealand Jour. Sci. Technology, Sec. B, v. 35, no. 1, p. 90–108, 1953.

The equipment and procedure that have been developed for the measurement of the low radioactivity samples involved in radiocarbon dating are described. An internal-sample Geiger-Müller counter, 22 inches long and 3½ inches in diameter, fitted with an automatic sample changer, is used with automatic voltage control. The counting rates are continuously recorded by a method that allows a statistical analysis of each run, and also provides a continuous overall check on the operation of the equipment.—*Author's Abstract*

157–138. Deevey, Edward S. Jr., Gross, Marsha S., Hutchinson, G. E., and Kraybill, Henry L. The natural C^{14} contents of materials from hard-water lakes: Natl. Acad. Sci. Proc., v. 40, no. 5, p. 285–288, 1954.

In the ordinary procedure of radiocarbon dating it is assumed that the carbon before entering the material under investigation has achieved isotopic exchange

equilibrium with the carbon dioxide of the air. This assumption may be false for material formed in hard waters. Samples from Queechy Lake, N. Y. (lying on the Stockbridge marble), and Lake Zoar, Conn. (receiving water from the Housatonic River which drains a limestone area) were studied with vegetation of soft-water lakes as controls and modern wood samples as standards. A spurious "age" of 2,200 years was indicated by the carbon content of Lake Queechy. The Lake Zoar samples, though somewhat richer in C^{14}, were still deficient in C^{14} when compared with modern wood. Radiocarbon dating of marl, shell, or water plants that developed in an ancient lake geochemically similar to Lake Queechy may indicate ages as much as 2,000 years more than true ages.—*M. C. R.*

157–139. Fergusson, G. J., and Rafter, T. A. New Zealand C^{14} age measurements: New Zealand Jour. Sci. Technology, Sec. B, v. 35, no. 1, p. 127–128, 1953.

Ages are given for six samples as determined by the radiocarbon method, using the Fergusson and Rafter equipment.—*M. C. R.*

157–140. Te Punga, M. T. Radiocarbon dating of a Rangitikei river terrace: New Zealand Jour. Sci. Technology, Sec. B, v. 35, no. 1, p. 45–48, 1953.

Radiocarbon dating of fossil wood from the Ohakea terrace in the Rangitikei Valley indicates that this terrace was formed 3,050±200 years ago. This indicates that at the place where the sample was collected, the river has in about 3,000 years cut a trench 100 feet deep and 1 mile wide. Twenty miles upstream the river has cut during the same interval a trench 200 feet deep and a quarter of a mile wide.—*M. C. R.*

157–141. Lowenstam, H. A., and Epstein, S[amuel]. Paleotemperatures of the post-Aptian Cretaceous as determined by the oxygen isotope method: Jour. Geol., v. 62, no. 3, p. 207–248, 1954.

The initial investigations of paleotemperature by the isotope method (Geophys. Abs. 12778) are carried further in this study. The factors which must be taken into account in such determinations are: whether the temperature record (oxygen isotopic composition) is preserved in the remains through geologic time; whether the variation in isotopic composition in sea water is sufficient to be reflected in the oxygen isotopic composition of $CaCO_3$ and thus introduce a large error; whether a "vital effect" could cause an animal to secrete shell material not in isostatic equilibrium with the surrounding water; and whether the animal might secrete shell material during a portion of the total temperature range.

Different types of fossils—belemnite guards, *Inoceramus*, brachiopod and oyster fragments, chalk, and bioclastic matrix materials—were used in these determinations. Since subjective factors must be introduced in interpreting temperature determinations, emphasis in this paper is on trends in temperature, both geographical and chronological, rather than determination of absolute precise temperatures.

The results indicate a progressive rise in ocean temperatures from the Cenomanian, climaxing in the Comacian-Santonian, followed by a general decline to the Maestrichtian. During the Comacian-Santonian temperature climax, marginal subtropical ocean temperatures extended northward into the present cold-temperature belt.—*D. B. V.*

RADIOACTIVITY

GENERAL

157–143. Voytkevich, G. V. Geokhimicheskoye i geologicheskoye znacheniye radioaktivnosti [The geochemical and geological significance of radioactivity]: Akad. Nauk SSSR Izv. Ser. geol., no. 3, p. 17–33, 1953.

Voytkevich examines the constancy of radioactive disintegration and concludes that the radioactive elements were synthesized shortly before formation of the earth.—*D. B. V.*

RADIOACTIVITY CONSTANTS

157–143. Hée, A[rlette], Coche, A., Keller, P., Jarovoy, M[ichel], and Wack, M[onique]. Remarques sur la constante de désintégration β du K^{40} [Notes on the disintegration constant for the β decay of K^{40}]: Annales Géophysique, tome 10, no. 1, p. 19–40, 1954.

This is a detailed description of a determination of the disintegration constant for the β decay of K^{40}. Discussions are given of the problems of self-absorption of radiation in the source, back-scattering by the support of the source, and the determination of the relation between the disintegration rate in a hypothetical source and the counting rate in the G. M. tube, using the β activity of RaE (Bi^{210}) as a comparison. Other factors are discussed. Purified KCl was used as the source of potassium. The results are: specific activity of ordinary potassium is $42\pm3\beta$ per sec per g; constant of partial disintegration of K^{40} is $\lambda_\beta = (7.2\pm 0.6)10^{-10}$ per year; energy produced by combined β disintegration and "K" capture in one gram of ordinary potassium is $(41\pm3)10^{-6}$ cal per year.—*P. E. B.*

157–144. Russell, R. D., Shillibeer, H. A. Farquhar, R. M., and Mousuf, A. K. The branching ratio of potassium 40: Phys. Rev., v. 91, no. 2, p. 1223–1224, 1953.

This was measured by determining the argon and potassium content of potassium feldspar of accurately known ages. The results obtained for five samples differing in age by more than a factor of five are all consistent within the limits of error with a branching ratio of 0.060 ± 0.006 when a total decay constant of 0.54×10^{-9} $year^{-1}$ is assumed. The results indicate that loss of argon from these samples during geological time is unlikely.—*Authors' Abstract*

INSTRUMENTS AND METHODS OF OBSERVATION

157–145. Picciotto, E. [E.], and Wilgain, S. Thorium determination in deep-sea sediments: Nature, v. 173, no. 4405, p. 632–633, 1954.

Thorium has been measured in samples of red clay from the Pacific Ocean, using a nuclear emulsion method. Concentration of thorium was calculated from the 5-branched star production, assuming the thorium to be in equilibrium with radiothorium and ascribing all 5-branched stars to radiothorium. Absence of appreciable amounts of radioactinium which also produces five-branched stars was indicated by the measurement of length of α tracks of thorium C′ on 2 samples and by the independence of the number of stars on the depth in the sediments. Although the number of samples is insufficient for definite conclusions, the thorium contents were grouped around the value 5×10^{-6} g Th per gram of dried red clay. The uranium-content measured by Hecht in other samples

from the same cores was between 1.5 and 2.5×10^{-6} g uranium per g. The Th/U rate is thus a little lower but of the same order of magnitude as the average in continental rocks.

A method of age determination of deep-sea sediments based on the ionium-thorium ratio would be valid if the ratio has remained constant in the time interval considered (maximum about 350,000 years) and if thorium is precipitated from sea water in same proportion as ionium. Such a ratio will be independent of rate of total sedimentation and rate of precipitation of thorium and ionium—*M. C. R.*

157–146. Bilicke, Walt. New devices for finding ores: Mines Mag., v. 44, no. 3, p. 119–120, 1954.

Bilicke summarizes uranium-prospecting methods and instruments, including Geiger counters, scintillation counters, logging devices, and ultraviolet-ray lamps.—*L. C. P.*

157–147. Ito, Yoshiro. The measurement of radioactivity at and below the ground surface: Kyōto Univ. Disaster Prevention Research Inst. Bull., no. 6, p. 49–63, 1953.

Measurements of radioactivity were made with the Geiger counter and Lauritsen electroscope at various places on the surface and in a mine, in preparation for a detailed study of minor fluctuations and secular variation, if any, of ground radiation which may be related to earthquakes, volcanic eruptions, crustal deformation, and similar phenomena. The results of these preliminary measurements show a considerable amount of penetrating radiation (3 cm-lead) in the rock at depths uninfluenced by cosmic radiation, and minor fluctuation of ground radiation over a period of several days. In addition, it was found that the Geiger counter could be used in some places to detect slight differences in rock formations, for prospecting in mines.—*D. B. V.*

157–148. Moraschinelli, E. Misura della radioattività atmosferica con emulsioni nucleari [Measurement of the atmospheric radioactivity with nuclear emulsions]: Annali Geofisica, v. 6, no. 4, p. 561–567, 1953.

A method of measuring atmospheric radioactivity by the employment of nuclear emulsions is described. The radioactive components are separated from the air by electrostatic separation into an electrode plate, following which the plate is placed on the sensitive emulsion in order to obtain a registration of the emitted alpha particles. From a microscopic examination of the emulsion one determines the relative amount of the atmospheric radioactivity, and it is also possible to discriminate the elements of the thorium family from those of the uranium-radium family.—*Author's Abstract*

157–149. Barbera, L., Curatolo, M., Indovina Addario, M. M., Palumbo, D[onato], and Santangelo, M[ariano]. Radioattività di una lava etnea; studio quantitativo [Radioactivity of a sample of Etna lava; quantitative investigation]: Annali Geofisica, v. 6, no. 2, p. 161–172, 1953

By comparison of the theoretical and experimental spectra of alpha tracks in a nuclear emulsion, the presence of radioactive equilibrium in a sample may be determined. Assuming equilibrium it is then possible to determine the ratio of uranium to thorium.—*M. C. R.*

RADIOACTIVITY OF ROCKS, WATERS, AND AIR

157–150. Santomauro, L., and Cigna, A. Prime misure sulla radioattività delle precipitazioni atmosferiche [The first measurements of radioactivity of atmospheric precipitation]: Annali Geofisica, v. 6, no. 3, p. 361–387, 1954.

During 1951 and 1952 the radioactivity of atmospheric precipitation was measured, chiefly at Milano. The results of 42 measurements, given in a table, show the average radioactivity is about 10^4 times greater than that of the air. This activity was not constant: it became greater after atomic experiments at Las Vegas, Eniwetok, and Montebello Islands. The activity increased about 8 days after experiments at Las Vegas, 2 weeks after those at Eniwetok, and about 3 weeks after explosions at Montebello Islands. Gamma rays and beta particles of the precipitates were measured with Geiger-Müller counters and the background of cosmic radiation was taken into account when computing the final data.—*S. T. V.*

157–151. Garrigue, Hubert. Recherches sur la radioactivité de l'atmosphère [Studies on the radioactivity of the atmosphere]: Acad. Sci. Paris Comptes Rendus, tome 238, no. 21, p. 2074–2075, 1954.

This is a continuation of reports on radioactivity in the atmosphere observed at Puy-de-Dôme. Traces of radioactive dust were observed in the air on April 24; weak radioactivity was found in snow which fell on May 3–4, 1954.—*M. C. R.*

157–152. Eugster, J. Neutron measurements at great underground depths: Rev. Sci. Instruments, v. 25, no. 1, p. 5–7, 1954.

A preliminary report on our first extensive measurements of the cosmic-ray intensities at medium underground (5,880m equivalent) is given. In these experiments, carried out during 1951 and 1952, two identical portions of photographic plates, one bare and one shielded with Cd, were exposed at identical temperature. For the controls, which were exposed at the surface of the earth, there was found a good agreement between our results and those obtained by Yagoda and Kaplan for slow neutrons. The Cd difference counts obtained at the underground station were much higher than the controls.—*Author's Abstract*

157–153. Damon, Paul E., and Kuroda, P. K. On the natural radioactivity of rainfall: Am. Geophys. Union Trans., v. 35, no. 2, p. 208–216, 1954.

Natural radioactivity of rainwater during two December 1952 storms at Fayetteville, Ark., ranged from 1 to 60 millimicrocuries per liter of rainwater. Radioactivity was primarily due to radium B+C, that due to thorium-B and radium-D being less than 10^{-10} and 10^{-11} curie per liter each, respectively. The mechanism of accumulation in rainwater proposed is that decay products of radon in the atmosphere become attached to aerosols and condensation droplets and are swept downward by growing raindrops during precipitation. The total activity per unit area and time increases toward the limiting value determined by the supply of radium-A from radon. An average of $0.2+10^{-13}$ curie per liter of radon within the cloud system is sufficient to supply the rainwater with the observed radioactivity.—*M. C. R.*

RADIOACTIVITY EXPLORATION SURVEYS

157–154. Moxham, R. M. Airborne radioactivity surveys for phosphate in Florida: U. S. Geol. Survey Circ. 230, 4 p. and 8 plates, 1954.

Airborne radioactivity surveys totaling 5,600 traverse miles were made in 10 areas in Florida, which were thought to be geologically favorable for deposits of uraniferous phosphate. Abnormal radioactivity was recorded in 8 of the 10 areas surveyed. The anomalies are located in Bradford, Clay, Columbia, De Soto, Dixie, Lake, Marion, Orange, Sumter, Taylor, and Union Counties.

Two of the anomalies were investigated briefly on the ground. One resulted from a deposit of river-pebble phosphate in the Peace River valley; the river-pebble samples contain an average of 0.013 percent equivalent uranium. The other anomally resulted from outcrops of leached phosphatic rock containing as much as 0.016 percent equivalent uranium. Several anomalies in other areas were recorded at or near localities where phosphate deposits have been reported.—*Author's Abstract.*

157–155. Cross, W. H. Airborne scintillometer survey of Radium Hill area, South Australia: Canadian Min. Metall. Bull., v. 47, no. 505, p. 348–350, 1954.

An airborne scintillometer survey of the Radium Hill area in South Australia indicated a number of areas with higher-than-normal radioactivity. These will be checked on the ground for possible radioactive ore. Areas found to have lower-than-normal radioactivity may now be dismissed from further prospecting. The contact between the Archean (higher-than-normal radioactivity) and Proterozoic (lower-than-normal radioactivity) rocks was outlined in a general way as a result of the survey. The scintillometer measurements were made from an aircraft traveling at a speed of 80 miles per hour, at a height of 250 feet. Traverses were spaced 500 yards apart.—*L. C. P.*

HEAT

GENERAL AND THEORETICAL STUDIES

157–156. Rosenblatt, D. B. Effects of a primeval endowment of U^{236}: Phys. Rev., v. 91, no. 6, p. 1474–1475, 1953.

The effects of a primeval endowment of U^{236} upon theories pertaining to the evolution of the elements, the thermal history of the earth and geochronology are considered. It is shown that the present thorium to uranium ratio, early volcanism on the earth and on the moon, as well as corrections to the dating of rocks and meteorites may be related to an initial abundance of the isotope, if certain assumptions are made.—*Author's Abstract*

OBSERVED TEMPERATURES IN THE CRUST AND HEAT FLOW

157–157. Bullard, E. C. Heat-flow through the floor of the ocean: Deep-Sea Research, v. 1, no. 2, p. 65–66, 1954.

The average heat flow from 6 stations in the Pacific was found by Revelle and Maxwell to be 1.2×10^{-6} cal/cm^2/sec [Geophys. Abs. 14355], and from 6 stations in the Atlantic to be about 1.0×10^{-6} cal/cm^2/sec. It is possible that at sea the after effects of climatic change rather than heat flow are measured; however, this possibility requires a change of several degrees in the bottom temperature during

the last few thousand years, and the temperature of this water cannot have changed greatly so long as there has been ice in the polar seas.

If the quantity measured is a genuine estimate of the equilibrium heat flow from the rocks beneath the ocean, it raises an interesting problem. Although there are very few reliable measurements of the radioactivity of oceanic rocks, it seems most unlikely that their radioactivity can be high enough to account for the observed heat flow without assuming that the heat is derived from a thickness of rock measured in hundreds of kilometers; if this heat were conducted to the surface it would involve temperatures reaching the melting point at a depth of a few hundred kilometers, which is contradicted by seismological evidence. A possible escape from this difficulty is to assume that the heat is brought from great depth by convection currents in the mantle. This mechanism presents all the difficulties that have been urged against the convection theories of orogenesis; it differs in that the rising currents would lie beneath the oceans and the sinking ones beneath the continents. The need for more observations is obvious before far-reaching conclusions can be drawn.—*D. B. V.*

157–158. Bullard, E. C. The flow of heat through the floor of the Atlantic Ocean: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 408–429, 1954.

The measurement of the temperature gradient and thermal conductivity in the sediments beneath the floor of the North Atlantic Ocean is described. Measurements were made at five stations. The mean heat flow and conductivity were found to be 0.98×10^{-6} cal/cm²s and 25×10^{-4} cal/cm° Cs. The heat flows at the individual stations range from 0.58 to 1.42×10^{-6} cal/cm²s. The high heat flow is an unexpected result, and it is difficult to find a source for so much heat.—*Author's Abstract*

157–159. Marler, George D. Does the cold of winter affect the thermal intensity of the hot springs in Yellowstone Park: Am. Jour. Sci., v. 252, no. 1, p. 38–54, 1954.

The Yellowstone National Park geyser basins are subjected to extreme seasonal climatic changes. In order to test the hypothesis that these changes produce variations in thermal intensity, quantitative determinations were made of temperature and function of most of the important hot springs in the Upper Geyser Basin.

To date, no significant differences between thermal intensity of summer and winter have been found that could be explained as a result of surface cooling; frequency of geyser activity does not seem to be adversely affected by low atmospheric temperature. Possible explanations for this include voluminous character of the storage basins, which leaves their discharge unaffected from season to season; almost complete lack of seepage of colder waters from the surface during winter; underground structure which prevents convection down to the seat of eruption. In fact, if these suggestions are valid, thermal intensity may actually be greater in winter, rather than less, but more data are needed before this possibility can be verified.—*D. V. B.*

VOLCANOLOGY

157–160. Williams, Howel. Problems and progress in volcanology: Geol. Soc. London Quart. Jour., v. 109 pt. 3, p. 311–332, 1953 (1954).

Volcanoes are, and always have been concentrated chiefly along continental edges and within ocean basins. Volcanism is most nearly continuous in orogenic

belts, other than those of Alpine-Himalayan type, and in the oceans; it is intermittent and short-lived adjoining orogenic belts and ceases for very long periods only in continental nuclei. More information is needed concerning the shapes and depths of volcanic reservoirs. Wedging, stoping and fluxing rather than explosive churning are the chief means by which vents are opened. The source and maintenance of heat are largely unsolved problems, but much of the requisite thermal energy probably comes from ascending juvenile gases. Among the factors that control volcanic behaviour one of the chief is the rate of vesiculation; magma composition, degree of crystallization, retrograde boiling and depth of magma chambers appear to be relatively unimportant. The origin of the water vapour given off by volcanoes remains in dispute, but in certain kinds of eruptions groundwater plays an important part. Many calderas and volcano-tectonic depressions owe their formation chiefly to large-scale subterranean migration of magma. Methods of prediction are being improved; seismic and tilt measurements now offer the most reliable information, but magnetic and electric methods merit further trial.—*Author's Summary*

157–161. Powers, H. A. Current activity of Aleutian volcanoes: Volcano Letter, no. 522, p. 6, 1953.

There has been slight activity at most Aleutian volcanoes during the fall of 1953. Trident Volcano erupted lava during July and August that flowed for about 3 miles, starting from the northwest side of the original vent and following the west margin of the June flows. The flow was still steaming in December; the vent is sporadically erupting small bursts of ash and constantly fuming and steaming. Mount Spurr has been steaming, but has not erupted since July; Shishaldin erupted hot ash during the first week of October; Pavlov was seen glowing on November 25.—*D. B. V.*

157–162. Wentworth, Chester K. A suggested explanation of the alternation of activity between two vents at Kilauea volcano: Volcano Letter, no. 522, p. 1–2, 1953.

In the 1952 eruption of Kilauea, lava flowed from two vents in the Halemaumau pit. At first, both vents were active, but in late August and early September activity alternated between the two; the quiescent vent remained crusted over and almost dead while the other showed vigorous action for several hours to a day or more.

This paper suggests the following explanation for the alternation: the two vents were branches from the same source at no very great depth. When one of such vents became inactive, cooling of the lava and surrounding rock resulted, the liquid parts became less mobile and presently lost capacity for quick hydraulic response to an opening. On the other hand, cooling eventually results in shrinking and possible production of openings; if stresses are transmitted, the response is by rupture rather than by flow. If arm *A* has chilled and entered the rupture stage while arm *B* continued active, the latter can at some common point apply stress in the form of liquid pressure to part of arm *A*, resulting in breaking through of liquid and renewal of activity of *A*. At the same time the hydraulic and thermal activity of vent *B* are sapped and *B* in turn cools toward the rupture state. Then the time may come when the hot, swelling hydraulic phase of conduit *A* will develop sufficient boundary stress to invade the rupturing realm of conduit *B* and bring that vent to a renewed phase of liquid activity, completing a cycle. The period of such a cycle depends essentially on volumes and cooling rates.—*D. B. V.*

157–163. Fries, Carl, Jr., and Gutierrez, Celedonio. Activity of Parícutin Volcano during the year 1952: Am. Geophys. Union Trans., v. 35, no. 3, p. 486–494, 1954.

Lava emission at Parícutin came to an abrupt end early on February 25, 1952. Explosive activity in the crater also declined abruptly on the same day and continued only as intermittent weak, noiseless puffs until March 4, when all activity came to a complete halt. Final activity had little effect on the outward appearance of the cone. The two peaks of the cone rise about 410 m above the level of the original surface of Polido's cornfield, where eruption first began on February 20, 1943. The base of the cone is oval with a diameter of 650 m from northeast to southwest and 900 m from northwest to southeast, but the crater rim is nearly round with a diameter of about 280 m.—*M. C. R.*

157–164. Penta, Francesco. Sulle possibilita offerte dal territorio della repubblica di El Salvador nell'America Centrale nel campo delle "forze endogene" [On the possibilities offered in the territory of the republic of El Salvador in Central America in the field of "endogenous forces"]: Annali Geofysica, v. 6, no. 3, p. 209–314, 1953.

The fumarolic and solfataric emanations in the very active volcanic region of El Salvador are similar to those of other volcanic areas such as Italy, Japan, and New Zealand. Some are related to subterranean waters. The possibility of admixture with marine waters is excluded. Further study of the emanations, including their sulfur, arsenic, and rare gases, radioactivity, and heat, is urged in the hope of finding economic applications. It is probable also that there are important deeper sources of thermal energy along the dislocation on which the active volcanoes lie.—*D. B. V.*

157–165. Perozzi, Adolfo. Su alcune manifestazioni fumaroliche e solfatariche nel El Salvador (Centro America) [On some fumarolic and solfataric manifestations in El Salvador (Central America)]: Annali Geophysica, v. 6, no. 3, p. 389–403, 1953.

The most important solfataric and fumarolic activity in the volcanic belt of El Salvador is described briefly. Temperatures of 125.5° C (at Cuyanausul) and 107.0° C (at El Tronador) were recorded, higher than any previously reported. This may indicate an increase in thermal activity; but it is also possible that the hottest vents were overlooked by previous investigators, for they produce almost dry steam and are therefore less showy.—*D. B. V.*

157–166. Morais, J. Custodio de. Furnas dos Açores [Furnas of the Azores]: Coimbra Univ. Mus. Mineralog. Geol. Mem. e Noticias, no. 35, p. 48–75, 1953.

"Caldeiras" (caldrons), boiling springs of water or mud, are found in the islands of San Miguel, Terceira, and Graciosa of the Azores archipelago. The two most important localities are on San Miguel, near Furnas village and at Furnas lagoon. (The term Furnas is used to designate a place where there are many caldeiras. Although classified as geysers, caldeiras do not erupt intermittently but boil constantly, with jets not exceeding 1 m in height. Temperatures of as much as 100° were measured.

This paper gives temperature measurements and chemical analyses of the waters and mud of many caldeiras, compares the Azores phenomena with those

of Yellowstone National Park, Iceland, and New Zealand, and reviews theories of geyser formation.

The Furnas region is unstable, with frequent earthquakes; destructive volcanic eruptions occurred on San Miguel within historic times.—*D. B. V.*

157–167. Foster, Helen L. Eruptions of Mihara-yama, O-shima, and Asama-yama, Japan: Volcano Letter, no. 522, p. 6, 1953.

Mihara-yama on O-shima began to erupt on October 5, 1953, and has continued intermittently into January 1954. All the new activity is on a small scale compared with the eruptions of 1950 and 1951. Only small quantities of lava and ejecta have been emitted, nearly all of which have been within the 1951 cinder cone crater.

A series of small explosions began at Asama-yama on December 27, 1953; about 10 occured between that date and January 7, 1954. The latest and most violent of these sent an ash cloud to a height of 700 m.—*D. B. V.*

TECTONOPHYSICS

FORCES IN THE EARTH AND OROGENESIS

157–168. Scheidegger, A. E. On some physical aspects of the theory of the origin of mountain belts and island arcs: Canadian Jour. Physics, v. 31, no. 5, p. 1148–1155, 1953.

It is shown that a physical explanation can be given within the framework of the contraction hypothesis of orogenesis for the four types of junctions of island arcs and mountain belts observed by geologist.—*Author's Abstract*

Tillotson, Ernest. The constitution of the earth to a depth of 750 kilometers: see Geophys. Abs. 157–183.

157–169. Nikolayev, V. A. O nekotorykh chertakh stroyeniya i razvitiya podvizhnykh poyasov zemnoy kory [On some features of the structure and evolution of active zones of the earth's crust]: Akad. Nauk SSSR Izv. Ser. geol., no. 2, p. 19–36, 1953.

This is a review of the question of structural development of the active zones of the earth's crust. The characteristics of the major structural elements of active zones—geosynclines and geanticlines—are described briefly, together with the principles of their development in time and space.—*D. B. V.*

157–170. de Sitter, L. U. Gravitational gliding tectonics—an essay in comparative structural geology: Am. Jour. Sci., v. 252, no. 6, p. 321–344, 1954.

Gravitational gliding tectonics explains certain folded and faulted structures by superficial gliding of relatively large and coherent masses down slopes under the influence of gravity rather than directly by lateral compression, though lateral compression is a possible cause of the slope. Examples of such tectonics have been described from all the continents except perhaps Australia. Study of these examples suggests certain distinctive features by which gravitational gliding tectonics may be recognized; among them are the existence of suitable slope,

the preservation of an unthinned inverted limb, and in certain cases chaotic structure showing little relation to recognizable trends. The evidence clearly demonstrates, however, the close relation between lateral compression and gravity structures.—*Author's Abstract*

157–171. Hales, A. L. The thermal contraction theory of mountain building: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 8, p. 486–493, 1953.

In an earlier paper Hales suggested that it was failure in the region at depths of 250–600 km which determined the periodicity of orogenic phenomena, and estimated that the interval between successive periods of failure of this "tension" zone should be between 50 and 300 million years. With the assumptions of the previous analysis, he shows that the cross-sectional areas of ocean deeps indicate that times of the order of 50 million years are to be associated with failure in the tension zone. If the troughs are formed in the manner described in the earlier paper, a regression of sea level of about 70 meters will occur as a result of their formation. The association between vulcanism and orogenically active areas may be due to heat generated in plastic flow in a thin layer in association with readjustment from the deformations produced by cooling.—*P. E. B.*

157–172. Pavlovskiy, Ye. V. O nekotorykh obshchikh zakonomernostyakh razvitiya zemnoy kory [On some general principles of development of the earth's crust]: Akad Nauk SSSR Izv. Ser. geol., no. 5, p. 82–89, 1953.

The initial structures of the earth's crust were primary simatic platforms, remnants of which are found today under the Pacific Ocean. Since the beginning of Archean time, elevated portions of this primary simatic crust seem to have been the seat of development of the discontinuous "granitic" sial layer. The sequence of development is: geosynclines, secondary sialic platforms, present continental masses. The general trend of geotectonic processes since the beginning of the Archean has been a decrease in area of the primary simatic platforms and expansion of the secondary continental platforms.—*D. B. V.*

157–173. Benioff, Hugo. Orogenesis and deep crustal structures—additional evidence from seismology: Geol. Soc. America Bull., v. 65, no. 5, p. 369–384, 1954.

Seismic evidence indicates that the principal orogenic structure responsible for each of the great linear and curvilinear mountain ranges and oceanic trenches is a complex reverse fault. A study of eight regions in which orogenic activity is in progress reveals that these great faults occur in two basic types, here designated oceanic and marginal. Oceanic faults, situated within the oceanic domain, extend from the surface to depths of 550 to 700 km. They exhibit an average dip of 61°. Their elastic strain-rebound characteristics show that these faults are composed of two separate mechanical units—a shallow component extending from the ocean bottom to a depth of roughly 60 km, and a deeper component extending to the 700 km crustal boundary. The marginal faults situated along the continental margins occur in dual and triple forms. The dual faults comprise a shallow member extending from the surface to a depth of approximately 60 km and an intermediate member extending to a depth of 200 to 300 km. The average dip is 33°. The dip changes abruptly to 60° to form a third component extending down to the 650± crustal boundary. The elastic

strain-rebound characteristics of the marginal faults indicate that the components of these structures also move as separate units, although in South America the two lower elements exhibit some evidence for mechanical coupling. In the continental domain the 300 km level thus represents a tectonic discontinuity not as yet revealed by seismic wave-propagation studies but which is apparently the lower boundary of the continents. Since the oceanic faults and the deep components of the marginal faults have the same average dip (61°) it may be assumed that both are fractures in a single, continuous mechanical structure subject to a single stress system. The different average dip (33°) of the marginal intermediate fault components suggests that they occur in a structure mechanically distinct from the deep oceanic and continental layer and that they are activated by a different stress system. A hypothesis offered for the origin of the volcanoes associated with the faults assumes that the source of volcanic energy is heat produced in the fault rocks by the inelastic components of the repeated to-and-fro strains involved in the generation of the sequences of earthquakes and aftershocks.—*Author's Abstract.*

157–174. Lees, G[eorge] M[artin]. The geological history of the oceans: Deep-Sea Research, v. 1, no. 2, p. 67–71, 1954.

The geophysical conception of permanence of oceans conflicts with observed geology. The compression zones of continents strike boldly into the oceans in many cases and the complex pattern resulting from repeated phases of compression makes it unlikely that oceanic floors and continents can be fundamentally different. There is abundant evidence of mobility within and along the margins of the oceans. Downwarps of continental margins since early Cretaceous of 35,000 and perhaps 50,000 ft are known. The layered structure of continents suggested by seismic results is quite unacceptable geologically and the Mohorovičić discontinuity must have some other explanation.—*Author's Abstract.*

157–175. Polli, Silvio. L'attuale deformazione della crosta terrestre [The present deformation of the crust of the earth]: Annali Geofisica, v. 6, no. 4, p. 555–560, 1953.

From data for the period 1891 to 1940 from mariographic stations throughout the world, Polli concludes that the crust of the earth is rising in the polar regions and sinking in the equatorial regions. The average rising and sinking is about 0.3 mm per decade, the maximum about 0.5 mm per decade. The polar diameter is thus increasing about 1 mm every 10 years, while the equatorial diameter is decreasing by about the same amount in the same time. The earth is approaching a more spherical shape.—*S. T. V.*

157–176. Guyot, Edmond. La rotation de la terre et ses variations [The rotation of the earth and its variations]: Annales Guébhard-Séverine, 29e année, p. 117–141, 1953.

This is a comprehensive historical review of knowledge about the earth's rotation. Variations of the position of the axis of rotation in space and with respect to the earth are considered, as well as variations in velocity. Results of modern measurements are summed up, concluding with the recommendation of an international symposium on fundamental constants of astronomy in 1950, that the second of mean solar time be discarded as the unit of measurement in favor of the "Time of the Ephemerides", measured by means of the sidereal year for 1900; and that the conversion of mean solar time into "Time of the

Ephemerides" be obtained by the following correction: $t=24.349$ sec$+72.3165\ T+29.949\ T^2+1.821\ B$, where T is counted in Julian centuries beginning with January 0, 1900, at midnight and B is a constant. This same formula defines the second of "Time of the Ephemerides".—*D. B. V.*

157–177. Young, Andrew. The effect of the movement of surface masses on the rotation of the Earth: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 8, p. 482–485, 1953.

In investigating the effect of surface mass movements on the general rotation of the earth, the change in the length of the day may be treated independently of the variation of latitude. A detailed discussion is presented for the case of seasonal variations in the distribution of atmospheric air masses. The seasonal variation of latitude is described by the equations usually formulated, but account may have to be taken of corrections for the angular momentum of the atmospheric masses. The fact that sudden fluctuations in angular momentum of the atmosphere occur may account, in part at least, for the irregularities of the observed variation of latitude. The equations presented in this article remain valid for secular changes in mass distributions provided such changes persist for periods of decades. For periods of centuries, the equations possibly need modification.—*P. E. B.*

157–178. Eardley, A. J., Tectonic relations of North and South America: Am. Assoc. Petroleum Geologists Bull., v. 38, no. 5, p. 707–773, 1954.

The Pacific and Atlantic marginal belts of orogeny in Paleozoic time are believed to merge in central and southern Mexico and then as a single belt to swing eastward through Central America approximately to Jamaica and Hispaniola. Veering sharply southward from Hispaniola the belt includes the present submerged Beata Ridge and connects with the metamorphic core of the Venezuelan and Colombian Andes.

The major Mesozoic belt of orogeny is believed to extend down the peninsula of Baja California, through the Sierra del Sur of Mexico to the Costa Rica-Panama Isthmus and the Colombian and Ecuadorian Andes. It is marked throughout by great granitoid batholiths. Another belt of late Jurassic and Cretaceous orogeny branches eastward in Central America from the main belt in Colombia. This belt makes a tight U-shaped pattern and is believed to mark two tectogenes for the most part, both of which formed in the late Mesozoic time and probably in succession one after the other. A third tectogene from Puerto Rico around the Lesser Antilles to the Leeward Islands is active today and probably had a beginning in Eocene time. It lies outward from the late Mesozoic tectogenes. The available geophysical data in the form of gravity anomalies and seismic observations are related to the geological information in making the analysis of the tectogenes. The eastern Caribbean Basin is believed to be due to middle and late Tertiary subsidence, and the western Caribbean Basin is believed to be due to Cretaceous and early Tertiary subsidence. The Gulf of Mexico is postulated to have begun to subside in Permian time.

From the sequence of events described for each of the basins in the Mexican-Caribbean region, as well as for the Banda Sea of the Dutch East Indies, an orogenic cycle is postulated as follows: (1) general epeirogenic uplift of a central region for a long time, and the shedding from it of large amounts of debris to partly surrounding basins; (2) compressional deformation in the partly surrounding basins to form a belt of major orogeny; and (3) subsidence of the

former region of uplift, with the creation of a basin having deep water in places. The marginal areas of the new basin soon become sites of heavy sedimentation.

From this tectonic setting a theory of orogenesis is devised which proposes asymmetrical convective flow in the mantle as the causative mechanism. The theory is applied to the Dutch East Indies and the Peruvian Andes as well as the mediterranean region between North America and South America.—*Author's abstract*

Tillotson, Ernest. The constitution of the earth to a depth of 750 kilometers: see Geophys. Abs. 157–183.

ELASTIC CONSTANTS AND STRENGTH OF ROCKS

157–179. Laughton, A. S. Laboratory measurements of seismic velocities in ocean sediments: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 336–341, 1954.

Laboratory measurements were made of compressional wave velocities in samples of globigerina ooze and a grey claylike material collected in the north Atlantic in 1952. In uncompressed samples, the velocity in the ooze was 1.54 to 1.67 kmps and the mean density 1.58 g per cm^3; in the claylike material, which is less calcareous, velocity ranged from 1.47 to 1.52 kmps and the mean density was 1.55 g per cm^3. The variation of velocity with compaction pressure was determined experimentally; the work indicates the existence of a gradient of velocity in the sediment which is of the same order of magnitude as that observed at sea.—*M. C. R.*

INTERNAL CONSTITUTION OF THE EARTH

157–180. Tomaschek, R. The tides of the solid earth and their geophysical and geological significance: Nature, v. 173, no. 4395, p. 143–145, 1954.

Tidal changes in the solid earth are measured by gravimeters and pendulums capable of measuring tilts of 0.001 second of arc and changes of gravity 10^{-8} to 10^{-9}. Experimental values for tidal elastic factors are not compatible with theoretical values for a homogeneous earth. With the aid of seismic information, Takeuchi calculated layered earth models with elastic behavior in close agreement with experimental values. The sensitive instruments reflect both the constitution of the earth's interior and activity in the upper strata.—*R. G. H.*

157–181. Kamitsuki, Akira, and Mikumo, Takeshi. Investigation of the structure of the earth's crust in relation to local earthquakes (preliminary): Kyōto Univ. Disaster Prevention Research Inst. Bull., no. 6, p. 39–47, 1953.

Preliminary observations of local earthquakes of frequent occurrence in the Wakayama District were made with a vertical seismograph of short period and high magnification. It was confirmed by the reflected seismic wave that there exist some distinct surfaces of discontinuity in the earth's crust in the Wakayama District.—*Authors' Abstract*

157–182. Valle, P. E. Sulle proprietà elastiche del mantello interno della terra [On the elastic properties of the interior mantle of the earth]: Annali Geofisica, v. 6, no. 3, p. 373–380, 1953.

The velocities of elastic waves in the *D* layer of the earth at zero pressure and at the temperature of the top of the layer were calculated by means of the

classical theory of solids and were found to be 9.67 kmps for longitudinal waves and 5.59 kmps for transverse waves. None of the common silicates can account for such a high velocity. The results are in excellent agreement with those of F. Birch.—*Author's Abstract*

157–183. Tillotson, Ernest. The constitution of the earth to a depth of 750 kilometres: Royal Astron. Soc. Occasional Notes, v. 3, no. 15, p. 14–27, 1953.

This is a summary of recent data and theories on the constitution of the upper 750 km of the earth and its origin, the formation of mountains, and the cause of volcanic action.—*M. C. R.*

157–184. Gutenberg, B[eno]. Low-velocity layers in the earth's mantle: Geol. Soc. America Bull., v. 66, no. 4, p. 337–348, 1954.

New data confirm the hypothesis that in the outer 600 km of the earth there are two low-velocity layers, one between 10 and 20 km (the "lithosphere channel"), and the other between 60 and 150 km for *P* and between 60 an 250 km for *S* (the "asthenosphere channel"). There is some doubt whether the former is in or below the granitic layer; Gutenberg is inclined to believe, with others, that the depth of the granitic material has been overestimated.

At present, the best explanation for the lithosphere channel seems to be phase changes in the material; such phase changes may also be the reason for the difficulty in finding reasonable rock types with required velocities. Present data are insufficient to prove that no similar layer exists under ocean basins, where ultrabasic material exists at the corresponding depth.

The asthenosphere channel, now well established, is probably due to a greater effect of increase of temperature with depth than that of increase of pressure at depths where the melting point of the material is approached, whereas above and below this channel the effect of increase in pressure with depth prevails. Below the channel the material retains a greater value of Poisson's ratio, indicating a relatively smaller increase in rigidity than in bulk modulus with depth.

Many earthquakes seem to originate in the lithosphere channel. The relatively small elastic constants there are probably paralleled by relatively small breaking strength. In addition, phase changes now going on may account for some of the earthquake energy. If an earthquake occurs in the channel, possibly 50 percent of the total released energy may go into the channel. Earthquakes originating above the channel would show much more energy than those originating within it; this would explain the unusually great damage observed in some relatively small shallow shocks.—*D. B. V.*

157–185. Shimazu, Yasuo. Density distribution and concentration of heavy materials in the mantle of the earth: Tokyo Univ. Geophys. Inst. Geophys. Note, v. 5, no. 1, 1952; reprinted from Jour. Physics of the Earth, v. 1, no. 1, p. 11–17, 1952.

Shimazu investigates the possibility of an earth model with no density discontinuity in the mantle and a linear increase of metallic materials with depth. The main results obtained are: the density at the bottom of the mantle may be between 6.289 and 7.970; the total metallic content in the mantle may be between 11.4 and 22.9 percent; and the atomic ratio of iron to silicate in the whole earth is 1.559, regardless of distribution of the iron phase between mantle and core.—*D. B. V.*

157–186. Kropotkin, P. N. Sovremennye geofizicheskiye dannye o stroyenii Zemli i problema proiskhozhdeniya basal'tovoy i granitnoy magmy [Modern geophysical data on the structure of the Earth and the problem of the origin of basaltic and granitic magma]: Akad. Nauk SSSR Izv. Ser. geol., no. 1, p. 38–62, 1953.

Kropotkin presents a new hypothesis of the origin of magmas, based on geophysical evidence on the internal constitution of the earth and on the assumption that the earth was formed from old cosmic dust. According to this theory, the various eutectic magmas are melted from the solid ultrabasic substratum. Direct fusion gives rise to the ultrabasic rocks; "selective fusion" gives rise to silicate melts, from which the majority of igneous rocks are developed by differentiation and hybridization, or to metallic melts producing compounds similar in composition to meteorities (mesosiderite, pallasite, and nickel-iron plus sulfides). This polyphletic origin of magmas contrasts with Bowen's and Daly's idea of differentiation from a single primary magma.—*D. B. V.*

157–187. Bullard, E. C. A comparison of oceans and continents: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 403–407, 1954.

The geophysical results obtained at sea are compared with those on land. It is concluded that there is a basic difference between the structure of oceans and continents, and that the deep ocean basins can never have been parts of continents. The possibility of the gradual growth of the continents is considered. This hypothesis suggests that there may be differences between the material below the Mohorovičić discontinuity on land and at sea—*Author's Abstract*

157–188. Woollard, G. P. Crustal structure beneath oceanic islands: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 361–387, 1954.

The difficulties and ambiguities in the interpretation of seismic, gravity, and magnetic observations are discussed. The results obtained near the islands of Oahu, Bermuda and Bikini are summarized. On all these islands there is evidence of the presence of basaltic lava flows. Gravity and magnetic surveys are incomplete but are sufficient to show that there are considerable anomalies probably associated with the volcanic rocks. The velocity of compressional seismic waves in the coral cap is 2.5 to 3.1 km/s, while the volcanic rocks give 4 to 5½ km/s. Measurements in the surrounding deep water give a velocity of about 8.1 km/s at a depth of 10 km near Bermuda, and 13 km near Bikini. Over this velocity of 6.9 km/s (Bermuda) and 6.5 km/s (Bikini) were found.

All the results appear to be consistent with the view that the islands have a volcanic core which constitutes a load on the sea floor. This load and the necessity of filling the space vacated by the lava causes a gradual sinking of the crust to produce a regional isostatic adjustment.—*Author's Abstract*

157–189. Lees, G[eorge] M[artin]. The geological evidence on the nature of ocean floors: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 400–403, 1954.

A study of the geological structure of continental margins makes it extremely difficult to accept geophysical deductions that there is an important difference in character between continents and the adjacent ocean floor. The continents are areas of great complexity and have been subjected to intense compression;

their known structures shows no resemblance to the "sialic" and "simatic" layers postulated by the geophysicist. The continental structures frequently strike out into the ocean and it seems most improbable that they do not continue far out to sea.

There is no positive geological evidence of the permanence of the ocean or that the ocean floors are structurally different from the continents. The seismic results may well be explained by extensive submarine lava floors or in some other way. A worldwide peridotite layer at such a depth seems most improbable.—*Author's Abstract.*

Lees, G[eorge] M[artin]. The geological history of the oceans: see Geophys. Abs. 157–174.

Gaskell, T. F. Seismic refraction work by the H. M. S. *Challenger* in the deep oceans: see Geophys. Abs. 157–122.

157–190. Hess, H. H. Geological hypotheses and the earth's crust under the oceans: Royal Soc. London Proc., Ser. A, v. 222, no. 1150, p. 341–348, 1954.

Recent work has determined that the depth of the Mohorovičić discontinuity beneath the oceans is about 5 km, and has made it likely that the peridotite xenoliths in basaltic volcanic rocks are samples of material from below the discontinuity. An idealized section of the crust, based on seismic and gravity results consists of a continental section, 35–40 km thick, and an oceanic segment of basalt and sediments 5 km thick, both overlying the peridotite.

If the continental and oceanic sectors have always been in isostatic equilibrium, as they seem to be today, then the depth to the Mohorovičić discontinuity under continents has been directly related to sea level. Deformation, erosion, and isostatic readjustment would result in the same depth of discontinuity if the amount of water remains unchanged; and it is likely that if the volume of water in the oceans increased, these processes would thicken the crust enough to bring it back to equilibrium with the water level. If the oceans were much shallower in the Archean, then the continents were much thinner. Similarity of some of the oldest Archean rocks of Southern Rhodesia and the sections below the ocean floor suggests that the Mohorovičić discontinuity may represent the original solid surface of the earth, a much disturbed remnant of which is preserved in Rhodesia.

Three hypotheses are suggested for the origin of oceanic ridges: one involving extrusion of basalt along a line of fractures in the crust; another, brecciation of the peridotite substratum by great masses of basaltic magma, perhaps over an upward convection current; and the third, thickening and buckling of the upper basaltic crust with partial fusion of the downbuckled portion resulting in andesitic volcanism and diorite intrusion.

Serpentization of olivine by water rising from the interior of the earth may produce local changes of level in the ocean floor and anomalies in heat flow.—*M. C. R.*

157–191. Browne, B. C. Gravity measurements and oceanic structure: Royal Soc. London Proc. Ser. A, v. 222, no. 1150, p. 398–400, 1954.

The observed isostatic balance between continents and oceans is consistent with the seismic results and depends mainly on the shallowness of the Mohorovičić discontinuity under the oceans.

The gravity anomalies over flat parts of the ocean floor show a greater scatter than do those over flat continental areas. This is believed to be due to varying thicknesses of sediment which conceal the underlying topography.—*Author's Abstract*

157–192. Northrop, John. Bathymetry of the Puerto Rico Trench: Am. Geophys. Union Trans., v. 35, no. 2, p. 221–225, 1954.

The Puerto Rico Trench extends for about 400 mi in a generally east-west direction 80 mi north of Puerto Rico and has a five to ten-mile wide "flat" floor 4350 fm deep. The trench is separated from the Nares Basin to the north by a 2900-fm divide, and is roughly paralleled to the south by a series of seamounts which form an interrupted ridge 2700 to 3700 fm deep. South of this ridge are basins, 4000 to 4100 fm deep, which may drain into the Trench through San Juan Canyon. The Trench floor has two kinds of sediment in alternating layers up to several meters thick: (1) layers of abyssal red clay with low carbonate content, which is "normal" at this great depth, and (2) anomalous layers of highly calcareous sands showing excellent graded bedding and shallow water benthonic fossils. The layers of anomalous sand are attributed to the action of turbidity currents, which may have transported the sediment from neighboring island platforms down submarine canyons and deposited it in the Trench, rather than to former shallow water conditions in the Trench.—*Author's Abstract*

157–193. Mitchell, Raoul C. Submarine landslips off the coasts of Puerto Rico and Barbados, West Indies: Nature, v. 173, no. 4394, p. 119–121, 1954.

Unusual heavy seas were observed during calm weather in Puerto Rico or Barbados December 2 and 5, 1951, August 17, 1952, and December 3–4, 1952. On three of these occasions microseism activity recorded at San Juan was low, and a study of weather maps rules out meteorological conditions as the cause. Earthquakes and submarine volcanic activity could not be correlated with the high seas. Submarine landslips in the Brownson Deep or from the Barbados Ridge could cause such stormy seas without causing sudden shocks which would be recorded at seismological stations.—*M. C. R.*

157–194. Luskin, Bernard, Heezen, Bruce C., Ewing, Maurice, and Landisman, Mark. Precision measurement of ocean depth: Deep-Sea Research, v. 1, no. 3, p. 131–140, 1954.

This is a description of new echo-sounding equipment which can record ocean depth to an accuracy better than 1 fathom in 3,000. Among its applications is the detailed exploration of the relationship between the seaward extension of submarine canyons and the gradients of the abyssal plains. Data provided by this instrument greatly aid interpretation of data obtained from other instruments of oceanographic research.—*D. B. V.*

GENERAL GEOPHYSICAL EXPLORATION

157–195. Lahee, Frederic H., and others. Exploratory drilling in 1953, Developments in North America: Am. Assoc. Petroleum Geologists Bull., v. 38, no. 6, p. 971–1291, 1954.

The entire June issue of the Bulletin of American Association of Petroleum Geologists is devoted to a review of exploratory drilling and developments in

oil exploration in the United States, Alaska, and Canada during 1953. In the United States 221 new field wildcats located on the basis of geophysics were producers and 1,086 were dry holes; 100 wildcat wells located on the basis of both geology and geophysics were producers and 745 were dry; geology alone accounted for 368 producing wells and 3,227 dry holes. Only 21 producing wells were located without technical advice as against 426 dry holes. New field wildcats located on the basis of technical recommendations were 2½ times as successful as those located without such advice.

In the articles by region on developments in oil exploration, geological and geophysical exploration and exploratory drilling are reviewed and tabulated.—*L. C. P.*

157–196. Macelwane, James B. What differentiates the geophysical engineer?: Mining Engineering, v. 6, no. 4, p. 390–392, 1954

All engineering professions have developed out of the needs of an advancing civilization. The geophysical engineer joined these professions during World War I because there was a "need for a new approach to the problem of exploration" and for a new type of engineer "able to devise economical applications of the geophysical sciences to exploration" for oil, mineral deposits, construction materials, water, as well as other applications.—*L. C. P.*

157–197. Smith, Cecil W. Geophysical costs go up as profits sag: World Oil, v. 138, no. 5, p. 90, 1954.

Increasing salaries have boosted costs and cut profits in geophysical contract operations.—*L. C. P.*

157–198. Walstrum, J. N. Highly skilled professionalism: World Oil, v. 138, no. 5, p. 100 and 104, 1954.

This article describes the results an oil company wants from a geophysical contractor.—*L. C. P.*

157–199. Green, Cecil H. Confidence and patience: World Oil, v. 138, no. 5, p. 101–104, 1954.

This is a discussion of the work a geophysical contractor can give an oil company for its dollar.—*L. C. P.*

157–200. Rieke, R. R. Logging services playing vital role in exploration: World Oil, v. 138, no. 5, p. 207–214 and 225, 1954.

This is a general summary of the 20 different logging services that are now available to aid in the search for oil. These services have been developed during the past 21 years.—*L. C. P.*

157–201. Barber, R. C. Development of logging methods applied to secondary recovery problems: Producers Monthly, v. 18, no. 6, p. 36–37, 1954.

Laterolog, microlaterolog, gamma ray, neutron, induction, and conventional resistivity-logging methods can be used to advantage in problems of secondary recovery. The problems of applying these logging methods are so varied that each must be worked out separately. Selection of the proper method depends upon such factors as the salinity of the mud and hole condition as well as the type of information sought.—*L. C. P.*

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ERRATUM

In Bulletin 1022–A, Geophysical Abstracts 156, page 38, line 26 should read: 156–88. Carrasco, Esteban L[uis]. Demonstración de un teorema de

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