Geophysical Abstracts 159 October-December 1954

GEOLOGICAL SURVEY BULLETIN 1022-D

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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 geophysical exploration

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GEOPHYSICAL ABSTRACTS 159, OCTOBER-DECEMBER 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. Lists of abbreviations of journal titles were given in Geophysical Abstracts 156. Additions to those lists will be found in Geophysical Abstracts 157, 158, and on the following page. Unless specifically indicated otherwise, the language in which the article is written is the same as that given in the title. The system of transliteration used by the United States Board on Geographic Names is employed for transliteration of Russian names and titles. Translations of author's abstracts are indicated as "Author's Abstract" followed by the initials of the translator.

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 J. R. Balsley, P. E. Byerly, Henry Faul, Roland G. Henderson, Virginia S. Neuschel, 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*
Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti.	Atti della 7mo Convegno nazionale del metano e del petrolio, Taormina 1952.
Del. Geol. Survey Bull	Bulletin of the Geological Survey of Delaware. Wilmington.
Deutsche Geod. Komm. Veroffentl	Veroffentlichungen der Deutsche Geodatische Kommission. Potsdam. Germany.
Geol. Soc. Australia Jour	Journal of the Geological Society of Australia. Sydney.
Grenoble Univ. Lab. géologie Travaux	Travaux du Laboratoire de Géologie de la Faculté des Sciences de l'Université de Grenoble. Grenoble, France.
Madagascar Bur. geol. Travaux	Travaux du Bureau géologique. Direction des Mines et de la Géologie. Haut Commissariat de Madagascar et Dependances. Tananarive.
Meyniana, Kiel Univ. Geol. Inst. Veroffentl.	Meyniana–Veroffentlichungen aus dem Geologischen Institut der Universitat Kiel. Kiel, Germany.
Mineria y Metalurgia	Mineria y Metalurgia. Servicio de Traducciones Tecnicas. Madrid.
Pacific Sci. Assoc., 7th Cong., Proc	Proceedings of the 7th Pacific Science Congress of the Pacific Science Association. Wellington, N. Z.
R. Acad. Cien. y Artes de Barcelona Mem.	Memorias de la Real Academia de Ciencias y Artes de Barcelona.
Uganda Protectorate Geol. Survey Dept. Records.	Records of the Uganda Protectorate Geological Survey Department. Entebbe.
Ver. Schweizer. Petroleum Geologen u. Ingenieure Bull.	Vereinigung der Schweizerischer Petroleum-Geologen- und Ingenieure Bulletin. A. Schudel Co. Basel.
Zeitschr. Geophysik	Zeitschrift fur Geophysik. Friedr. Vieweg Sohn. Braunschweig, Germany.

GRAVITY

GENERAL AND THEORETICAL PAPERS INCLUDING THOSE ON ISOSTASY

159–1. Grossmann, W. Stand und Künftige Entwicklung der Schweremessungen in Deutschland [Present state and future development of gravity measurements in Germany]: Deutsche Geod. Komm. Veröffentl., Reihe A, Heft 11, p. 5–8, 1953.

By 1945 Germany had a gravity network of more than 100,000 stations, with the accuracy of some individual determinations as high as 0.2 milligal. The most important investigation project is the verification of the Potsdam absolute system. It is planned that three different methods, the standard reversible pendulum, the pendulum with the bob suspended on a string, and observation of a free falling rod, will be used. Measurements will first be made at the three main observatories in Potsdam, Harzburg, and Berchtesgaden, and later made at several secondary stations. At each place gravity determinations will be made by all three methods, and an accuracy of 0.02 milligal is expected. The relative gravity network will be further extended, using chiefly the Graf-Askania and the Worden gravimeters.—*S. T. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

159–2. Haalck, Fritz. Die Genauigkeit eines modernen Gravimeters [The accuracy of a modern gravimeter]: Zeitschr. Geophysik, Sonderband, p. 21–28, 1953.

Further improvement of the accuracy of gravimeters is certainly possible but hardly desirable because the limits of the attainable accuracy of a survey are now set by topographic data, knowledge of the density, and similar factors.

The new gravimeter "Gs9" manufactured by the Askania-Werke is a torsion instrument with its movable system supported by two pairs of twisted springs. The range of the gravimeter is about 4,000 milligals; the drift of the zero point is 0.003 milligal per hour; and the guaranteed accuracy is 0.01 milligal. Ten graphs illustrate the properties of the instrument.—*S. T. V.*

159–3. Werner, Friedrich. Gravimetri per misure regionali [Gravimeters for regional surveys]: Convegno naz, metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 371–375, 1952.

For regional surveys instruments of great precision with low drift constants and small temperature variations are needed. Werner considers gravimeters with metallic springs preferable to those with quartz springs, in spite of some possible effect of the geomagnetic field on metallic springs. In the following discussion Professor Solaini pointed out that one important advantage of the astatic instrument is its low period of natural vibration, which eliminates the interference from microseismic disturbances.—*S. T. V.*

159–4. Solaini, Luigi. Progressi recenti e tendenze attuali reguardanti i metodi gravimetrici e magnetici nella ricerca degli idrocarburi [Recent advances

and present trends of the gravimetric and magnetic methods in the search for hydrocarbons] : Convegno naz. metano e petrolio, 7mo, Taormina 1952, v. 1, p. 377–388, 1952.

The methods most often used in exploration for oil are the seismic methods, but gravimetric and magnetic methods are often used in reconnaissance. The combination of these two methods results in a very effective means of exploration.

The gravimeter has been greatly perfected in recent times and is now characterized by high accuracy, wide range of measurements, and negligible drift of the zero point in instruments provided with metallic springs. In instruments with springs of plastic material the drift is greater, but the natural oscillations are of lower frequency, which is important in case of accidental shocks of an industrial nature, wind, and (or) similar effects. The accuracy of modern gravimeters is greater than our knowledge of constants determining the final reductions, such as the exact elevation and topographic location of stations. Special gravimeters have been designed for subaqueous exploration.

Important improvement in magnetic surveys was made possible by the inductive magnetometers, which permit airborne measurements. Advances have been made in analytic studies of gravimetric and magnetic potential fields.—*S. T. V.*

159–5. Boaga, Giovanni. La gravimetria nella ricerca degli idrocarburi [Gravimetry in the search for hydrocarbons] : Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 397–402, 1952.

As there is a close relationship between the geologic structure of a region and the possible accumulation of oil, and as subsurface structural differences are reflected in the gravity map, the gravimeter is an important exploration tool even though the gravity anomalies cannot be uniquely interpreted. Certain difficulties are experienced in determining the anomaly accurately because the altitude of a station must be known within ±30 cm, if the accuracy of the Fayé correction is to be ±0.1 milligal. Similarly, in computing the Bouguer correction, still greater uncertainty is caused by insufficient knowledge of the underlying geologic formations and their density. Recently suggested methods of improving the accuracy of gravitational data are based on the use of the Laplace equation. The method introduced by Peters and Elkins (see Geophys. Abs. 12620 and 13432) makes it possible to construct curves of equal values of derivatives that are very helpful in the analysis of the results.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

159–6. Tsuboi, Chuji. A new and simple method for calculating the deflections of the vertical from gravity anomalies with the aid of the Bessel Fourier series : Acad. Japan Proc., v. 30, no. 6, p. 461–467, 1954.

The classical approach of determining the deflection of the vertical has been through the method of Stokes. This is not practical, however, because of a paucity of gravity data. Many workers, including Rice, have tried to modify Stokes' method to make it practically feasible, but, in Tsuboi's opinion, do not quite succeed. This failure results mainly from the complexities introduced by considering the curvature of the earth. The new method introduced here neglects the curvature of the earth. It is based on a double Fourier expansion of the gravity potential for a plane surface. The deflections of the vertical are easily obtained by differentiating the potential function, and the unknown coefficients are determined by using the gravity data. After applying the method successfully to gravitational data for the entire United States, it was felt that

the method was not suitable for application at a particular station as this would involve too many terms in the series to be practicable. Instead, through the use of cylindrical coordinates, the gravity potential is expressed as a Bessel Fourier series. The formulas for the deflections of the vertical are derived and are conveniently expressed in the form of a radial integral which is graphically evaluated. The new method of calculation is applied to the point Twin ϕ=36°07′ N, λ= 96°47′ W, which is one of the stations Rice used in his determination of the deflections of the vertical. The results agree almost exactly with those of Rice.—*I. Z.*

159–7. Tsuboi, Chuji. A study of the anomalies in the vertical gradient of gravity with the aid of the Bessel Fourier series: Acad. Japan Proc., v. 30, no. 6, p. 453–461, 1954.

It is common practice to consider the free-air reduction of gravity as a constant. To be precise, however, the vertical gravity gradient at any point is a function of the variation of gravity in a horizontal plane. The vertical gravity gradient is more accurately determined by expanding the function in a double Fourier series. The coefficients are then determined by considering the gravity anomaly at the surface. The method was applied to gravity data covering almost the entire United States. The largest calculated value of $\Delta\delta g/\delta z$ (x) turned out to be approximately 10^{-8} c. g. s. units. However, shorter wave lengths were not considered in the series expansion as the calculations would become too difficult. The added terms would doubtless increase the correction.

To determine the gradient at a particular station, the Bessel Fourier representation of the potential was employed and the coefficients determined for a point in the southwestern United States. The gradient was computed to be 37×10^{-9} cgs units or 1 percent of the normal value.—*I. Z.*

159–8. Haalck, H[ans]. Einige kritische Bemerkungen zur Frage der Analyse gravimetrischer Storungsfelder [Some critical notes on the problem of the analysis of anomalous gravity fields]: Gerlands Beitr. Geophysik, Band 64, Heft 1, p. 16–22, 1954.

The development and practical significance of the problem of analysis of local gravimetric disturbances are critically discussed. Representation by anomaly maps of W_z, W_{zz}, and W_{zzz} in combination is most suitable, as the effect of the different disturbing masses is expressed with different intensities according to their depths. The computation of both W_{zz} and W_{zzz}, however, seems superfluous as the difference between them is not very essential. Determination of W_{zzz} is preferable, for this can be done with less work and with any practical accuracy. In conclusion the purpose of the calculations and the limits of their useful application will be pointed out.—*Author's abstract, S. T. V.*

159–9. Haalck, H[ans]. Die Berechnung von W_{zzz} aus Gravimetermessungen und ihre Bedeutung für die angewandte Geophysik [The computation of W_{zzz} from gravimetric measurements and their significance in applied geophysics]: Zeitschr. Geophysik, Sonderband, p. 46–53, 1953.

For the interpretation of the results of a gravity survey it is very important to have maps of the first three vertical differential quotients of the gravitational potential, that is of W_z, W_{zz}, and W_{zzz}. In the expression for W_z the attraction of an elementary buried mass is proportional to the square of the distance, in W_{zz} to the cube, and in W_{zzz}, to the fourth power; therefore the effect of the masses near the surface is more pronounced in the expression W_{zzz}, the effect

of deep masses in W_z, and that of masses at intermediate depths in W_{zz}. Two procedures are given for the simple determination of W_{zzz}.—*S. T. V.*

159–10. Jung, Karl. Zur Bestimmung der Bodendichte nach dem Nettleton-Verfahren [On the determination of density by Nettleton's method]: Zeitschr. Geophysik, Sonderband, p. 54–58, 1953.

Nettleton's method for determining the density can be put into numerical form by equating to zero the coefficient of correlation between the Bouguer anomalies and the elevations. If σ is the density, σ_1 an assumed approximate density, and σ_2 the difference between them, then an equation may be written in which the Bouguer anomaly is the anomaly calculated assuming σ_1 minus two terms involving σ_2. The correlation coefficient between the Bouguer anomaly and the elevation is set equal to zero and an equation is obtained from which σ_2 may be determined. This procedure is compared with that developed by Parasnis (see Geophys. Abs. 13826) for determining densities. Results are in good agreement.—*M. C. R.*

159–11. Bortfeld, Reinhard. Bemerkungen zur Dichtebestimmung nach dem Nettleton-Verfahren [Remarks on the determination of density by Nettleton's method]: Erdöl u. Kohle, Jahrg. 7, Heft 6, p. 353–355, 1954.

In computing the Bouguer reduction it is necessary to assume the most probable value of the density of the upper layer of the ground. Nettleton has suggested a graphical method of finding this value, which was later expressed in mathematical form by Jung. Certain refinements are now introduced making it unnecessary to assume that gravity has a constant value at all points of the reference horizon. The theoretical computations are presented and also applied to practical cases.—*S. T. V.*

159–12. Haalck, H[ans]. Die Gezeitenbewegungen des festen Erdkörpers und die dadurch für sehr genaue Gravimetermessungen notwendig werdenden Korrektionen [Tides in the solid earth body and the corrections thereby made necessary for very precise gravimeter measurements]: Gerlands Beitr. Geophysik, Band 64, Heft 1, p. 1–15, 1954.

The basic relations of the theory of tides in the solid earth are derived in simplified form. These relations determine the amount of tidal deformation and the disturbances of the force of gravity in intensity and direction. From these relations are derived the numerical values of the corrections that are to be applied to very precise gravimeter measurements if the accuracy of the instruments is to be fully utilized. With the help of a practical example, the use of astronomical almanacs is explained for the practising geophysicist and the computations of the corrections shown.—*Author's abstract, S. T. V.*

159–13. Goguel, Jean. A universal table for the prediction of the luni-solar correction in gravimetry (Tidal gravity corrections): Geophys. Prosp., v. 2, supplement, p. 2–5, 1954.

An explanation of the development and use of the tables of tidal gravity corrections listed in the following abstracts.—*M. C. R.*

159–14. Goguel, Jean. Tidal gravity corrections for 1954: Geophys. Prosp., v. 2, supplement, p. 6–31, 1954.

Two tables give (from March through December 1954) the hourly correction to be added to the gravity readings of instruments in order to find the values

of gravity as they would be without the disturbing influence of the moon and the sun. The factor 1.2, required to take into account the earth's elasticity, has been incorporated. The tables have been calculated for the meridian 15° E. Greenwich and can be used for a wide area on either side of the meridian simply by considering the time difference. It is possible to make the correction practically exact for all longitudes by making interpolations between the values read for the day itself and for the day before (at the same time of day) for the Eastern Hemisphere, or for the next day in the Western Hemisphere, in proportion to the difference in longitude from the 15° E. meridian and to its complement up to 360°.—*M. C. R.*

159–15. Morelli, Carlo. Tidal gravity corrections for 1954: Geophys. Prosp., v. 2, supplement, p. 32–42, 1954.

Graphs showing the diurnal variations of gravity calculated for longitude 15° E. and latitude 25°, 35°, 45°, 55°, and 65° N. for the months of April through December 1954. These are usable in the area 60° either side of the meridian for which they are calculated by using local time.—*M. C. R.*

159–16. Inghilleri, Giuseppe. Campo di validità e calcola generalizzato delle curve di attrazione lunisolare [Region of validity and generalized computation of the curves of lunisolar attraction]: Riv. Geofisica Appl., anno 15, no. 1, p. 1–14, 1954.

The earth-tide curves computed for a particular meridian can be used for any longitude. Formulas which determine the field of validity in latitude of these curves are analytically deduced supposing that the maximum error possible is 10^{-2} milligal. By means of three curves, which are given, the earth tide may be determined at any point on the earth's surface with good precision and by simple computations.—*M. C. R.*

159–17. Schleusener, A[lfred]. Radius der sphärischen Bouguer-Platte bei Benutzung des üblichen ebenen Bouguer-Faktors 0.0419 mgal/m. [The radius of the spherical Bouguer plate in using the usual plane Bouguer factor of 0.0419 mgal per m]: Zeitschr. Geophysik, Sonderband, p. 29–32, 1953.

Errors are possible in computing Bouguer reductions when the coefficient 0.0419 milligal per meter of the plate is used because this value was obtained for plane plates, and in reality we deal with spherical shells. If the ratio of the radius of the plate to its height in meters is 10, the true Bouguer coefficient is 5 percent smaller than that usually assumed; if the ratio is 50, the error in the Bouguer coefficient can be 0.5 milligal, when the differences in the height over the plate are as high as 500 m. The Bouguer coefficient must be chosen in relation to the height of individual plateaus and peaks on the plate. If height is only 100 m, the radius of the Bouguer plate can be only 30 km. A graph shows the radii of the Bouguer plate against its height if the *B*-factor of 0.0419 milligal per meter is used in calculations.—*S. T. V.*

159–18. Schleusener, A[lfred]. Der grösste Ring bei Geländeverbesserungen der Gravimetrie der Lagerstättengeophysik [The greatest zone of terrain corrections in gravimetry in mining geophysics]: Zeitschr. Geophysik, Sonderband, p. 33–36, 1953.

To determine the radius of the farthest zone that must be taken into account in terrain corrections, exact calculations are given for the region around Rosen-

heim-Degerndorf and Staffelsee-Garmish in Bavaria near Zugspitze, the highest mountain in Germany (9,722 feet above sea level), in the form of graphs and tables. The results indicate that if the differences in elevation are not greater than 200 m, the radius can be taken as 5 km, and the final error in gravity will be less than 0.01 milligal. If the greatest difference in the elevation is not more than 800 m, it is necessary to use a 20-km radius, and if higher elevations are to be found, the greatest radius must be 50 km.—*S. T. V.*

159–19. Rosenbach, Otto. Ein Verfahren zur Berechnung des Horizontalgradienten aus Schwerewerten [A procedure for the computation of the horizontal gradient from the gravity values]: Zeitschr. Geophysik, Sonderband, p. 37–45, 1953.

Modern precise gravimeter measurements make possible the computation of horizontal gradients of gravitational anomalies from the Bouguer anomalies if a sufficiently dense network of stations is available. Approximate formulas of different accuracy are derived in the form of series by simple methods of potential theory, and applied to the several examples.—*S. T. V.*

159–20. Baranov, V. Sur une méthode analytique de calcul de l'anomalie regionale [On an analytical method of calculating the regional anomaly]: Geophys. Prosp., v. 2, no. 3, p. 203–226, 1954.

The common notion that the regional anomaly must be as regular as possible can be translated into mathematical language by requiring that the regional anomaly shall be represented, over a not too large area, by a surface of the second or of the third degree. The residual anomaly is commonly defined by the requirement that its horizontal dimensions must be as small as possible. This implies that also its amplitude should be small. This requirement may be moulded into a mathematical form by stating that the square of the difference between the Bouguer anomaly and the regional anomaly, integrated over a certain area, must be a minimum. On these two definitions an analytic method is based for deriving the regional anomaly. Practical computation procedures are presented.—*Author's abstract*

OBSERVATIONS OF GRAVITY SURVEYS

159–21. Tomaschek, R. Variations of the total vector of gravity Winsford (Cheshire). Part I. General results and maritime load influences: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 9, p. 540–556, 1954.

Simultaneous measurements of the vertical component and two perpendicular horizontal components of gravity have been made in the I. C. I. Salt Mine at Winsford (Cheshire) over the period April 16–24, 1951. Apart from the gravitational tide the measurements show a well-developed influence of the variations in the maritime loading, especially in the horizontal components. A common drift in all components indicates the influence of meteorological pressure variations over a large area. Furthermore, diurnal variations of presumably meteorological origin have been observed. The "load tilt" has been determined. It is elliptical with an azimuth of N. 47° W. of the main axis and has an amplitude of 1.65 millisec per foot tide at Liverpool (5.5 millisec per m). The load influences in the vertical component are only 2.4 percent of those in the horizontal direction and indicate the influence of more distant oceanic areas.—*Author's abstract*

159–22. Melchior, Paul J. Application de la methode de Corkan à la discussion des observations des marées terrestres à Freiberg (Saxe) [Application of Corkan's method to the analysis of observations of earth tides at Freiberg (Saxony)]: Acad. Royale Belgique Bull., Cl. Sci., 5° ser., tome 40, no. 4, p. 382–388, 1954.

Corkan's method of tilt-record analysis is applied to the data obtained with two Zollner pendula at Freiberg in Saxony from 1910 to 1915. The method yields a particularly precise determination of the coefficient $\gamma=1+k-h=0.725$. The phase angle of the direct effect is zero. The nature of the indirect effects is discussed and light is shed on the effect resulting from the variation of the potential arising from the bending of the crust.—*Author's abstract, H. F.*

159–23. Goguel, Jean. Levé gravimétrique détaillé du bassin parisien [Detailed gravimetric survey of the Paris basin]: France Bur. Recherches géol. géophys. Pub., no. 15, 31 p. and map, 1954.

Gravimetric surveys in northern France at different times from 1944 to 1954 have included 65,000 stations in a 200,000 km² area. Station density ranged from 1 in 1.4 km² to 1 in 7. The Bouguer map shows, instead of structural trends, a multitude of local anomalies of the order of 20 milligals, 20–40 km wide and sometimes longer. West of the meridian of Meaux, 40 km east of Paris, there are strong anomalies, most often not corresponding to surface geology. East of this line the anomalies are less intense, and the most marked anomalies in Lorraine apparently correspond to prolongation of known structures. Interpretations of anomalies are offered and illustrated.—*M. C. R.*

159–24. Solaini, Luigi. Note sulla esplorazione geofisica della struttura di Bordolano [Notes on the geophysical exploration of the structure of Bordolano]: Convegno naz. metano e petrolio, 7^mo^, Taormina 1952, p. 389–395, 1952.

Gravimetric and seismic reflection surveys were made near Bordolano in the valley of the Po in 1948–49. A Western gravimeter was used in occupying 21 main stations and many secondary stations. The error of the measurement at each station is estimated to be less than 0.03 milligal. On the basis of the results of this gravimetric survey and of the subsequent seismic reflection survey, locations of three control wells were selected; one has been finished and proved to be productive.—*S. T. V.*

159–25. Morelli, Carlo. Rilievo gravimetrico dell'Alto Adriatico [Gravimetric survey of the upper Adriatic]: Annali Geofisica, v. 7, no. 1, p. 45–70, 1954; Osservatorio geofis. Trieste Pubs., no. 37, 16 p., 1954.

A marine gravimetric survey of the northern Adriatic Sea was begun in 1953 starting in the Gulf of Trieste, and then proceeding into the open sea as far as the latitude of the mouth of the Po. The survey was continued near shore until a ten-mile belt had been surveyed as far south as Ancona. A Western gravity meter was used, enclosed in a sphere and dropped to the sea bottom from an anchored ship. All measurements were made in closed loops, and ship positions were determined by radar within ±50 m so that the accuracy of a measurement is ±0.05 milligal. A bathymetric survey was made at the same time with an Atlas echo meter. The results, shown as a Bouguer anomaly map, indicate that the Dinarids extend under the sea with an intense positive anomaly as far as the center of the Adriatic, and that the positive anomaly caused by the Lessini-Berici-Euganei magmatic basin continues under the northern Adriatic.—*D. B. V.*

159–26. Morelli, Carlo. Rete gravimetrica fondamentale in Italia [The basic gravimetric network in Italy]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 451–460, 1952.

As the gravity method is important for initial geophysical exploration of a region as well as in tectonic studies, it is necessary to have within the region under investigation one or more base points, tied to a national network, in which the value of gravity has been determined with utmost precision. Such a network is being established in Italy. Data on the recently established stations of the gravimetric network of Italy are tabulated. Pendulums or gravimeters may be used as the measuring instruments but in general the gravimeters, especially the Worden, are better adapted for the purpose.—*S. T. V.*

159–27. Vecchia, Orlando. Lineamenti geofisici e geologia profonda nella Sicilia ed aree circonstanti [Geophysical features and deep geology of Sicily and surrounding areas]: Riv. Geofisica Appl., anno 15, no. 1, p. 15–46, 1954.

On the basis of a map of isostatic anomalies compiled from the latest gravity measurements in Sicily and surrounding areas, together with numerous available data on the geomagnetism, seismicity, and volcanism of the area, some fundamental features of the deep geology of the region may be inferred.

A belt of gravity maximums, extending along the northern border of Sicily, corresponds to a simatic ridge. The belt continues into the Calabrian peninsula but is not connected with Tunisia. Another positive gravity zone branches from the first and follows the eastern shore of Sicily; it culminates in a simatic bulge in the provinces of Ragusa and Siracusa and extends into the Mediterranean east of Malta. A third simatic zone extends from the Monte di Palermo to Sciacca and then into the sea, as far as the Banchi Terribile-Graham. All simatic zones are seismically active and seem to correspond to nearly vertical fracture zones along which Sicily, the extreme corner of the African continent, is rising.

Between the branches of the π-shaped Sicilian simatic zones there are negative anomalies that, including the deepest central one, can be attributed to a thick accumulation of light sediments. In the seas surrounding Sicily there are many positive gravity anomalies topped by basaltic volcanoes.—*S. T. V.*

159–28. Harrison, J. C. Gravity mesaurements on Malta and at Tunis: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 9, p. 604–609, 1954.

Free-air and Bouguer anomalies are given for 22 stations on Malta. A density of 2.25 g per cc is used for the Bouguer reductions on the basis of density measurements on five samples. In the second part of the paper, discussion is made of the best Potsdam values for No. 3 dock Malta and at Tunis airport. The adopted values are shown to be consistent, within the rather low accuracy of the connections, with values accepted in Sicily.—*Author's abstract*

159–29. Brown, J. M. Gravimetric survey of the east and west banks of the Nile on the site of the Owens Falls hydro-electric scheme, Jinja, Uganda: Uganda Protectorate Geol. Survey Dept. Records, 1951–1952, p. 25–26 and 2 plates.

To assist in the solution of problems arising from the great variation in the thickness of the laterite and decomposed rock overlying solid rock at the site of the Owens Falls dam, a gravimetric survey was made of the east and west banks. The survey was made at 100-foot spacing, using a North American Co.

gravimeter. A contour map was prepared after free-air, Bouguer, and topographic corrections were made. The variations in gravity were considered to be reflections of the variations in the thickness of decomposed amphibolite. Geologic profiles were then computed using the thickness of decomposed rock obtained from the borehole records, and the variation in acceleration in the vicinity of boreholes. From these, theoretical gravity profiles were constructed and both sets adjusted to obtain the best fit with the observed profiles. The survey indicated the general trend of the rock surface and ultimately led to the conclusion that the banks were natural earth dams so that cutoffs were essentially abandoned. Results were confirmed by drilling.—*M. C. R.*

159–30. Cattala, Louis. Gravimetrie à Madagascar. Interpretation tectonique dans le sud et l'ouest [Gravimetric investigations on Madagascar. Tectonic interpretation of the southern and western parts]: Madagascar Bur. geol. Travaux, no. 59, 7 p., 1954.

Since 1948 gravimetric measurements have been made at 1,000 stations in all parts of Madagascar. North American Co. gravimeters were used, and the established network was tied to the Potsdam absolute system. The results are shown as a Bouguer anomaly map of the island contoured at intervals of 10 milligals. Cattala suggests from a study of the anomalies and the geology of the area that the deep basement beneath the island is ruptured along lines corresponding to abrupt changes in the Bouguer anomalies.—*S. T. V.*

MAGNETISM

MAGNETIC FIELD OF THE EARTH

159–31. Troitskaya, V. A. Dva kolebatel'nykh rezhima elektromagnitnogo polya zemli i ikh sutochnyy khod po mirovomu vremeni [Two types of oscillation of the earth's electromagnetic field and their diurnal variation in universal time]: Akad. Nauk SSSR Doklady, tom 93, no. 2, p. 261–264, 1953.

Records of magnetic observatories in the area between 34° and 142° E. long and 39° to 73° N. lat show two different types of oscillations of the geomagnetic field, one characterized by separate trains of oscillations on the generally quiet magnetic background and the other by continuous feeble oscillations that continue for hours. These two types of magnetic disturbances alternate daily at intervals of about 12 hours and occur simultaneously at all stations. The magnetograms show that the peaks of the disturbances occur at the time when the sun passes through the areas of the north and south magnetic poles. These relatively weak geomagnetic disturbances were measured and recorded by continuous observations of telluric currents, a method which is much more sensitive and precise than the observation with magnetometers.—*S. T. V.*

159–32. Chernosky, E. J., Maple, E., and Coon, R. M. Rapid geomagnetic fluctuations at Tucson, Arizona: Am. Geophys. Union Trans., v. 35, no. 5, p. 711–721, 1954.

Oscillatory fluctuations (micropulsations), appearing as trains of waves in the frequency range of ½ to 1/32 cps, were present about 20 percent of the time, with amplitudes of 0.01γ or more, in records of the vertical component of field made at Tucson with a large buried loop in the summer of 1947. The amplitudes of the oscillations were inversely proportional to their frequencies, and 1/20-cps oscillations occurred more often than those of other frequencies. The highest fre-

quencies occurred at night and were related to times of large magnetic disturbance; the lowest frequencies occurred during the day at times of low or moderate activity, and the intermediate frequencies showed a transition of behavior. Random fluctuations, having no characteristic wave forms, had amplitudes which varied as the square root of the fluctuation duration. Average amplitudes of the three largest fluctuations per 15-min scaling interval decrease from 0.08γ at 60-sec duration to 0.01γ at 1 second; maximum amplitudes were about ten times these values. The random fluctuations also showed diurnal variations and a dependence on the degree of magnetic disturbance. A few audiofrequency measurements are also reported.—*Authors' abstract*

159–33. Kazmi, S. A. A. Magnetic observations at Quetta during total solar eclipse of June 30: Nature, v. 174, no. 4432, p. 706, 1954.

To study the effects of the total solar eclipse the magnetograph at Quetta was set to run at 80 mm per hour instead of the normal speed of 20 mm per hour. At $12^h\ 1.6^m$, a full oscillation with a period of 1.3 minutes and amplitude 0.8 gamma appeared in the *H* trace, and the trace remained slightly disturbed until $12^h\ 47^m$. The onset was toward the positive side. A slight increase in declination occurred at the same time.—*R. G. H.*

159–34. Kato, Yoshio. On the secular variation in geomagnetic declination in the historic time of Japan: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 562–564, 1949 (1953).

Kato analyzes data on the horizontal component for the vicinity of Japan. For the period before 1882, when regular observations were begun, data were obtained from measurements of remanent magnetism of five dated lava flows ranging from 865 to 1779 A. D., and from old observations of declination ranging from 1613 to 1882 A. D. He concludes that declination has changed fairly regularly during the last 1,000 years, the most easterly deviation occurring about 1700 A. D., the most westerly probably between 1100 and 1300 A. D. However, the change between 900 and 1400 A. D. is not clear, owing to lack of data. Secular change in inclination, determined from lava flows, was found to be much smaller than that in declination—*D. B. V.*

159–35. Sano, Sigeo. Magnetic observations by Japanese Hydrographic Bureau, Maritime Safety Board, Ministry of Transportation: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 565–567, 1949 (1953).

According to the results of the fourth decennial survey of Japan and station observations, secular variation of declination is stationary in the Ryukyu Islands, easterly in Formosa, but still westerly in Japan proper, Korea, Manchuria, Sakhalin, and Kurile Islands. The annual change is about 1 to 5 seconds in central Honshu and central Korea. Secular variation of dip and horizontal intensity remain stationary.—*D. B. V.*

159–36. Morais, J. Custodio de. Algumas observações do magnetismo terrestre nos Açores [Some observations of terrestrial magnetism in the Azores]: Coimbra Univ. Mus. Mineralog. Geol. Mem. e Noticias, no 37, p. 1–19, 1954.

A brief report is presented of geomagnetic measurements in July 1953 in the Azores. A Schmidt vertical magnetic balance was used in occupying 72 stations on San Miguel, and 32 stations on the other islands. The most interesting feature of this survey was the abrupt variation of the vertical intensity within

only a few feet; in many places the change of the Z-value was 60 gammas per meter. This variation may be explained by the presence of volcanic deposits at the surface.—*S. T. V.*

159–37. Cullington, A. L. A test of the mutual consistency of D and H isomagnetic charts for New Zealand: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 560, 1949 (1953).

Results of the first magnetic survey for epoch 1903.5 and of the resurvey for epoch 1945.5 were analyzed, following Chapman's suggestion that D and H be tested on the assumption that earth-air current density is negligible in accordance with observations of atmospheric electricity. The vertical component of the curl of magnetic intensity and values of i expressed in milliamperes per square kilometer were computed for each of ten districts into which New Zealand has been subdivided. Results show that the distribution of theoretical vertical currents has altered completely in the 42 years between the two surveys. Expected values of di/dt were of the order of 4 with a range from 0 to 10. For 3 out of the 10 districts di/dt was 10 or greater; it is significant that each of the three is subject to widespread magnetic disturbances. Linear expressions for annual secular change of X and Y were computed for the period of the resurvey, 1941–47, but comparison of results is inconclusive.—*D. B. V.*

MAGNETIC PROPERTIES OF ROCKS AND MINERALS

159–38. Bruckshaw, J. M., and Vincenz, S. A. The permanent magnetism of the Mull lavas: Royal Astron. Soc. Monthly Notices, Geophys, supp., v. 6, no. 9, p. 579–589, 1954.

An analysis of the natural magnetic polarization of the basalt flows of Mull shows that many are inversely magnetized, but the mean direction of magnetization of each flow, based on observations of a number of specimens (5 to 11 per flow, with an average of 8), is not always significant. The significance is tested in semiquantitative fashion essentially by seeing whether or not the magnitude of the vector sum of unit vectors representing directions for samples from a given flow is comparable with the most probable magnitude, for a sample of the same size, of unit vectors drawn from a random distribution. In all flows with a significant (nonrandom) direction, this means direction differs from the direction of the present field by at least 133°. Crushing and folding of rocks apparently produce an approximation to randomness of magnetization. Directions and intensities of the natural residual magnetism and the ratio of the natural residual intensity to the induced intensity at the sample site are tabulated. For the flows with significant directions, the mean values of this ratio lie between 2.4 and 4.4, and the standard deviation is about half the mean value. The variability is mainly due to the variation in residual intensity. Laboratory tests of thermoremanence suggest that the intensities of natural magnetization are compatible with thermoremanent magnetization acquired in a field of strength similar to that existing today. Further investigations are in progress to test the possibility of a two-component mechanism or a change in the magnetic properties of the ferromagnetic constituents upon heating.—*P. E. B.*

159–39. Vincenz, S. A. The magnetic properties of some Tertiary intrusives of the Isle of Mull: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 9, p. 590–603, 1954.

In the rocks discussed, which include olivine gabbro, quartz gabbro, granophyre, and felsite, there is in general a qualitative correlation between a high prob-

ability of random distribution of directions of magnetization for a particular intrusion, unusually low or high intensities, and low or high Q_n ratios (natural Koenigsberger ratio), with a large standard deviation for the value of Q_n. Apparently thermal or hydrothermal metamorphism, crushing, and movement were conducive to alteration or destruction of the original magnetization. Movement and crushing seem to be the two main factors. The measurements of thermoremanence of significantly polarized rocks (low probability or random distribution of sample directions) suggest that the original natural intensities, no matter whether normal or inverse, have all suffered a decrease in magnitude. Most of the significantly polarized rocks could have been magnetized by fields of the order of magnitude of the present terrestrial field and by the thermoremanent process of magnetization. None of the observations suggested a behavior that would indicate the occurrence of Nagata's reversed thermoremanent magnetization. Microscopic examination of representative samples showed no correlation between the natural inverse magnetization and any chemical action to which some of the rocks had been subjected subsequent to their formation. In fact, those rock specimens which revealed extensive alteration either by hydrothermal or thermal metamorphism, or by weathering or crushing, were either normally polarized or no significance could be attached to their mean direction of magnetization. The global concentrations of ferromagnetic material in the rocks examined were much too small to agree with Néel's two-component mechanism of reversed thermoremanent magnetization.

The experimental evidence presented apparently supports the hypothesis of major changes in the direction of the Earth's magnetic field.—*P. E. B.*

159–40. Seelis, K. H. Magnetische Untersuchungen au Gesteinen und Erzen der grube "Bayerland" im Zusammenhang mit den dort festgestellten ΔZ- und ΔH- Anomalien [Magnetic studies of rocks and ores from the Bayerland mine, in connection with the ΔZ- and ΔH- anomalies found there]: Geol. Jahrb, Band 68, p. 319–330, 1954.

The density, induced magnetism, remanent magnetism, and susceptibility of a large number of specimens are determined, and the geologic environment described. Owing to the complexity of the ore, one cannot readily recompute the magnetic effect of the whole ore body referred to the surface. The usual assumption of a uniform sheet, however, is apparently not warranted here, because the intensity as well as the direction of magnetization differ greatly from place to place in the ore body. Furthermore, the magnetic properties of the phyllite country rock are such that they severely affect the anomaly at the surface.—*H. F.*

159–41. Asami, Eizo. On the reverse natural remanent magnetism of basalt at Cape Kawajiri, Yamaguchi prefecture: Acad. Japan Proc., v. 30, no. 2, p. 102–105, 1954.

The natural remanent magnetization of 52 specimens of basalt collected along the coast of Cape Kawajiri were measured. The cape is considered to be formed of one basalt eruption thought to be early Pleistocene. Along the western side of the cape the rocks are consistently normally magnetized and have generally a greater intensity of magnetization than the rocks along the northern and eastern side of the cape where the basalt is consistently reversely magnetized. Between these two areas eight specimens have mixed orientations.—*J. R. B.*

INSTRUMENTS AND METHODS OF OBSERVATION

159–42. Haalck, Fritz. Ein Universal-Torsion-Magnetometer zur Bestimmung von D, H und Z [A universal torsion magnetometer for determination of D, H, and Z]: Zeitschr. Geophysik, Sonderband, p. 1–7, 1953.

A universal magnetometer which can be used for direct measurement, without intermediate adjustment, of D, H, and Z is described. The reactive moment for measuring the acting magnetic moments is provided by a torsion wire. A theoretical analysis of the operating instrument is presented and optimum conditions characterizing the different elements are determined. The weight of the magnetic system with mirror and attachment for adjustment is less than 1 gram.

The instrument is characterized by very high precision; measurements of angle can be made with an error of less than ± 3 seconds; and of H and Z with an error of ± 0.3 gammas. For determination of declination, readings are made in two positions of the instrument, similarly for the determination of H and Z; the latter operations take only 10 minutes to perform.

Because of the sensitivity of the instrument, complete temperature compensation could not be attained even with a thermostat. The temperature drift for D- and H-measurements was less than 1 gamma per degree; for Z-measurements a temperature coefficient of about 6 gammas per degree was found.—*S. T. V.*

159–43. Werner, Friedrich. Die Temperaturkompensation bei Torsions-Magnetometern [Temperature compensation of the torsion magnetometer]: Zeitschr. Geophysik, Sonderband, p. 8–11, 1953.

It is impossible in constructing the torsion magnetometer to find material for the springs with the necessary thermoelastic coefficient for good temperature compensation; hence two springs, which can be set either in series or in bifilar arrangement, must be used. In series, each spring produces an effect proportional to its length, and in the bifilar arrangement the springs are differently twisted. The diameter of the springs is about 30μ. A theoretical analysis of instruments with vertical or horizontal twisted axis is given. The graphs shown indicate that variation of the temperature from 15° C to 25° C and back does not affect the readings of the variograph noticeably.— *S. T. V.*

159–44. Kalashnikov, A. G. Opredeleniye magnitnoy vospriimchivosti gornykh porod v polevykh usloviyakh [Determination of the magnetic susceptibility of rocks in the field]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 415–423, 1954.

An apparatus for determination of susceptibility in the field gives an integrated value of susceptibility for a certain portion of the formation rather than the susceptibility for a small sample. The instrument consists of four flat concentrically wound coils mounted in pairs, each pair consisting of a small coil placed inside a large coil. A current passed in opposite directions in the outer coils induces magnetic fluxes of opposite directions in the inner coils so balanced that the resulting flux approximates zero. Formulas are derived for the case when direct current flows through the coils and also for alternating current of low frequency. From these formulas it is possible to determine the susceptibility of the rock on which one pair of coils is placed. Errors of such determinations do not exceed five percent. Description of the instrument is given as well as several graphs characterizing its operation.

The new instrument has been tested in the field in several regions of the U.S.S.R. and found convenient to handle and very precise, especially in measurements of weak susceptibility.—*S. T. V.*

159–45. Morrisey, Norman S. This mobile magnetometer accurately maps these contacts: Oil and Gas Jour., v. 53, no. 19, p. 120, 1954.

This is a description of the United Geophysical Co.'s mobile magnetometer, or "Mo Mag", a version of the airborne magnetometer mounted on a truck.—*L. C. P.*

159–46. Morelli, Carlo. La magnetometria nella ricerca degli idrocarburi [The magnetic method in prospecting for hydrocarbons]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 355–360, 1952.

The magnetic method is the first step in reconnaissance of a region for geologic conditions favorable to the accumulation of oil. Magnetic surveys, supplemented by gravimetric surveys, are much less expensive and yet give much information on the structure of the surveyed area, reducing the amount of subsequent seismic work. In prospecting for oil by the magnetic method, regional surveys are made by establishing a few absolute stations and making relative measurements at many stations around the base stations with magnetometers of high sensitivity. There are great possibilities in airborne magnetic surveying for this purpose.—*S. T. V.*

159–47. Cassinis, Roberto. La magnetometria aerea nelle ricerche di idrocarburi [Airborne magnetic surveying in prospecting for hydrocarbons]: Convegno naz. metano petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 361–369, 1952.

Magnetic anomalies caused by oil-bearing structures are often relatively weak, and, when measurements are made on the surface of the earth, they are often masked by local anomalies, making their interpretation difficult. The great advantage of airborne measurements is their freedom from these difficulties. Two types of instruments are used, the Gulf airborne magnetometer and that of the Naval Ordnance Laboratory. Both are induction instruments of high precision making it possible to attain a precision of ±2 gammas.

Certain conditions must be fulfilled in airborne surveying, such as a constant flight level and a continuous record of the exact position of the plane. Airborne surveying also makes more complete study of the potential field possible by recording the values of magnetic vectors at different heights.

Several airborne-magnetometer surveys made in America are described, and difficulties to be expected in Italy in use of this method are pointed out.—*S. T. V.*

Solaini, Luigi. Recent advances and present trends of the gravimetric and magnetic methods in the search for hydrocarbons. See Geophys. Abs. 159–5.

159–48. Yokoyama, Izumi. Geomagnetic studies of Volcano Mihara. The 4th paper. (A series of geomagnetic dip-surveys and continuous observation of changes in geomagnetic declination): Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 1, p. 17–33, 1954.

By a series of dip surveys, recovery of local anomalous changes which accompanied the 1950 eruption was observed. Decreases and increases in declination related to volcanic activity were observed by continuous observation of declination at a temporary station. Characteristic changes in both declination and dip were observed for the minor eruption of October 1953.—*M. C. R.*

159–49. Minakami, Takeshi, and Sakuma, Shūzō. On geomagnetic studies of Mt. Fuji (Huzi) and other volcanoes in Japan: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 544–557, 1949 (1953).

Geomagnetic surveys of Fuji and other Japanese volcanoes show that the active and dormant volcanoes are magnetized nearly towards the north. Intensity depends on chemical composition of the lavas. The magnetism is partly remanent and partly induced. According to Nagata, the intensity of thermoremanent magnetism is several or 10 times greater than that of the induced. At Kusatu-Sirane, magnetism induced by the present geomagnetic field is more important than the remanent magnetism, but the magnetization of new flows at Miyake-sima (1940) and Sakura-sima (1946) is almost perfectly explained as thermoremanent.

The magnetic anomalies of volcanoes should therefore be explained not only on the basis of magnetic properties of lava specimens, but also by their structure.—*D. B. V.*

MAGNETIC OBSERVATIONS AND SURVEYS

159–50. Murphy, Thomas. The magnetic survey of Ireland for the epoch 1950.5: Dublin Inst. for Advanced Studies Geophys. Mem. no. 4, 27 p., 1953.

Measurements of declination, horizontal intensity, and inclination were made in 1950 at 44 stations, 37 of which were identical or close to those occupied by Walker in 1915. Normal values for all components were deduced by a method of least squares in the form of linear equations involving latitude and longitude. The declination survey is in agreement with a survey of Great Britain in 1948, and the vertical intensity is in good agreement with the vertical magnetic survey in 1945 by the Irish Geological Survey. With three exceptions in declination, the anomalies for each station for the 1915 and 1950 surveys are the same within the limits of experimental error. Maps showing declination, inclination, horizontal and vertical intensity and tables of values are included.—*M. C. R.*

159–51. U. S. Geological Survey. Total intensity aeromagnetic maps of Minnesota: Geophys. Inv. Maps GP 97 and 101, 1954.

The following maps show by contour lines the total magnetic intensity at approximately 1,000 feet above the earth's surface and the geology of the area, as prepared by G. M. Schwartz of the Minnesota Geological Survey: Northeastern Itasca and southeastern Koochiching counties (GP 97) and southern Aitkin and northern Mille Lacs counties (GP 101). Magnetic profiles accompany each map.—*M. C. R.*

159–52. Canada Geological Survey. Aeromagnetic map of New Brunswick: Dept. of Mines and Tech. Surveys, Geophysics Paper 22 (revised edition), 1954.

A revised edition of a map showing by contour lines the total magnetic intensity at about 500 feet above ground level for Point Verte quadrangle, Restigouche and Gloucester Counties.—*M. C. R.*

159–53. Canada Geological Survey. Aeromagnetic maps of Newfoundland: Dept. of Mines and Tech. Surveys, Geophysics Papers 184–195, 198, 201–204, 207, 208, 210, 1954.

The following quadrangles in Newfoundland have been published as blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at

about 1,000 feet above ground level: G. P. 184 (advance edition), West Gander River; G. P. 185 (advance edition), Dead Wolf Pond; G. P. 186 (advance edition), Miguels Lake; G. P. 187 (advance edition), Lake Ambrose; G. P. 188 (advance edition), Noels Paul Brook; G. P. 189, St. Brendans; G. P. 190, Gambo; G. P. 191 (advance edition), Great Gull Lake; G. P. 192 (advance edition), Kepenkeck Lake; G. P. 193 (advance edition), Snowshoe Pond; G. P. 194 (advance edition), Burnt Hill; G. P. 195 (advance edition), Great Burnt Lake; G. P. 198, Bonavista; G. P. 201, Pudops Lake; G. P. 202, (advance edition), Mt. Sylvester; G. P. 203 (advance edition), Meta Pond; G. P. 204 (advance edition), Twillick Brook; G. P. 207 (advance edition), King George IV Lake; G. P. 208 (advance edition), Cold Spring Pond, and G. P. 210, Bay de Verde.—*M. C. R.*

159–54. Canada Geological Survey. Aeromagnetic map of Northwest Territories: Dept. of Mines and Tech. Surveys, Geophysics Paper 218, 1954.

G. P. 218 (advance edition), Magnetic anomaly east of Atzinging Lake, District of Mackenzie, shows an intense anomaly, observed in August 1954, of about 7,000 gammas above "plateau level."—*M. C. R.*

159–55. Canada Geological Survey. Aeromagnetic maps of the Province of Ontario: Dept. of Mines and Tech. Surveys, Geophysics Papers 174, 181, 1954.

The following quadrangles in the Province of Ontario have been published as blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level: G. P. 174, Winchester, in Dundas, Stormont, Carleton, and Russell Counties; G. P. 181, Russell, in Russell, Prescott, Carleton, and Stormont Counties.—*M. C. R.*

159–56. Canada Geological Survey. Aeromagnetic maps of the Province of Quebec: Dept. of Mines and Tech. Surveys, Geophysics Papers 161–163, 167–169, 171–173, 175, 182, 183, 1954.

Blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 500 feet above ground level have been published for the following quadrangles: G. P. 161, Arthabaska, in Arthabaska, Megantic, and Wolfe Counties; G. P. 162, Warwick, in Wolfe, Arthabaska, and Richmond Counties; G. P. 163, Dudswell, in Richmond, Wolfe, and Compton Counties; G. P. 167, Richmond, in Richmond, Shefford, Drummond, and Bagot Counties; G. P. 168, Woburn, in Frontenac County; G. P. 169, Sherbrooke, in Sherbrooke, Compton, Richmond, and Stanstead Counties; G. P. 171, Granby, in Shefford, Brome, Richmond, Rouville, Bagot, St. Hyacinthe, and Missisquoi Counties; G. P. 172, La Patrie, in Compton and Frontenac Counties; G. P. 173, Orford, in Shefford, Sherbrooke, Brome, Richmond, and Stanstead Counties; G. P. 175, Coaticook, in Stanstead, Compton, and Sherbrooke Counties; G. P. 182, Memphremagog, in Stanstead and Brome Counties; and G. P. 183, Sutton, in Missisquoi and Brome Counties.—*M. C. R.*

Thurmond, Robert E., Heinrichs, Walter E. Jr., and Spaulding, E .D. Geophysical discovery and development of the Pima Mine, Pima County, Arizona, a successful exploration project. See Geophys. Abs. 159–78.

Murozumi, Masayoshi. Geophysical prospectings at the Wagasennin iron mine, Iwate prefecture. See Geophys. Abs. 159–83.

ELECTRICITY

GENERAL AND THEORETICAL STUDIES

159–57. Buchheim, W. Das magnetische Feld einer geradlinigen Wechselstromleitung auf homogen leitendem Untergrund und die Messung der elektrischen Bodenleitfähigkeit durch Induktion [The magnetic field of a rectilinear alternating current conductor on homogeneous conducting ground and the measurement of the electrical conductivity of the ground by induction]: Zeitschr. Geophysik, Sonderband, p. 123–135, 1953.

The physical relations between the primary alternating current flowing through a rectilinear conductor on the surface of the earth and the secondary electromagnetic field generated in the ground are discussed by starting from the Maxwell equations, and introducing imaginary functions to derive expressions for the components of electromagnetic field under the special conditions of the problem. These relations can be used for the determination of electrical conductivity of the ground replacing the old Wenner four-point method. The new method has the advantage of being free of galvanic effect. It is also applicable in the case of a parallel stratified medium even if the strata are inclined. In the latter case, the electrical conductivity parallel to stratification can be determined. The field procedure is summarized in the concluding section.—*S. T. V.*

159–58. Kunetz, Gesa, and Richard, Henri. Comparaison des variations rapides du champ tellurique entre stations situées à grande distance [Comparison of rapid variations of the telluric field at stations separated by great distances]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 511–518, 1952.

Similarity of curves obtained in the course of exploration by the telluric method in Europe, Asia, and Africa shows there are variations in telluric currents of a few seconds or minutes extending over vast regions. Examples are shown of observations in Italy and Madagascar on December 5, 1949, in which a relationship can be shown between variations of about a millivolt and period of a few minutes on which are superposed less intense rapid fluctuations of 10–20 second period; in Italy, Gabon, and Madagascar on September 9, 1950, in which there are quasi-sinusoidal variations of about 30-second period; and in Sicily at stations 160 km apart where variations of 0.5 millivolt with 15-second period are superposed on variations of about 1 millivolt and 1–3 minute period.—*M. C. R.*

159–59. Stommel, H[enry]. Exploratory measurements of electrical potential differences between widely spaced points in the North Atlantic Ocean: Archiv Meteorologie Geophysik u. Bioklimatologie, Band 7, p. 292–304, 1954.

Electrical-potential measurements were made at several points in the North Atlantic using existing submarine telegraph cables. The potential differences measured between Halifax and Turks Island and between Horta, Azores Islands and St. Vincent indicate an obvious lunar semidiurnal component, which agrees with that expected from tidal currents deduced from tidal theory. The conductivity of the bottom is apparently low enough to have little short-circuiting effect. On the cables between New York and Horta and Horta and Porthcurno the voltages are less than anticipated from tidal theory. The discrepancy may

be due to inadequacies in tidal theory. Tidal velocities obtained from anchor stations are 2–10 times greater than those obtained from Defaut's tidal theory which in turn are 10 times greater than those indicated electrically.—*M. C. R.*

159–60. Wertheim, Gunther K. Studies of the electric potential between Key West, Florida, and Havana, Cuba: Am. Geophys. Union Trans., v. 35, no. 6, p. 872–882, 1954.

In the Florida Straits, cross-stream potential is a good measure of transport. The major disturbing factor is activity of the geomagnetic field, which prevents correlation of the instantaneous transport with the instantaneous voltage. The effects of bottom conductivity and sloping sea bed also create some uncertainties but are estimated to be small.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

159–61. Dakhnov, V. N. Elektricheskaya razvedka neftyanykh i gazovykh mestorozhdeniy [Electric exploration of the oil and gas deposits]: 425 p., Moscow-Leningrad, Gostoptekhizdat, 1951.

This textbook, written for students in the Russian institutions of higher learning, deals with the electrical properties of rocks; electrochemical activity of minerals; the physicomathematical foundation of the electrical resistivity method; the electrical fields produced in different media; instruments; field techniques and procedures; modifications of electrical profiling; natural phenomena causing difficulties in measurements; and the interpretation of the observations.

Electromagnetic and telluric-current methods are discussed and also special methods applicable to exploration for oil and gas and the investigation of tectonic problems, especially those related to salt domes and intrusions.—*S. T. V.*

159–62. Graf, Anton. Il metodo induttivo ad assorbimento per la ricerca di buoni conduttori estesi nel sottosuolo [The inductive absorption method for search for good extended subsurface conductors]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 495–497, 1952.

A rigid frame supporting an electrical coil is suspended from three helicopters at a height of some 20–25 m and is slowly moved parallel to the ground. If the coil is excited by alternating current, an alternating magnetic flux will be sent into the ground, generating in turn, currents in the underground bodies of an intensity determined by their conductivity. Graf's calculations show that this apparatus will have sufficient sensitivity so that an aquifer under even a thick layer of dry sand will cause a noticeable increase of the current in the coil, and a similar effect will be produced when the coil passes from an oil-bearing formation to another containing saline water.—*S. T. V.*

159–63. Graf, A[nton]. Uber die Moglichkeit der Aufsuchung von Grund- und Salzwasserhorizonten vermittels induktiver geoelektrischer Methoden [On the possibility of finding horizons of ground water and salt water by geoelectric induction methods]: Gerlands Beitr. Geophysik, Band 64, Heft 1, p. 23–82, 1954.

In Graf's earlier paper (1933), the solution of the problem had been reduced to quadratures, but the integral could not be presented in a closed form. By developing the integral into a series, its numerical value could be approximated but only for very great or very small values of $v\sigma a$ (v being the frequency of

the applied alternating current, σ the electric conductivity, and α the thickness of the layer). For intermediate values the series converged too slowly. A rigorous solution is now given for the intermediate region by integrating separately the real and imaginary terms. The procedure is illustrated in detail in an example. The field inside of the emitter is computed by the method of undetermined coefficients; the secondary field was computed for several assumed depths of the layer. The depth of a horizontal or slightly inclined layer can be also found simply by the observation of the field intensity of the horizontal component in the secondary field. The conductive underground body can be delineated by using the method of gradients, which gives sufficiently accurate values.

For small depths it is better to make measurements in the external region, and for great depths better results can be obtained by the measurements in the inner region of the emitter. When prospecting for potable water the measurements in the exterior portion must be used; if the horizon of saline water is being sought, the measurements of the inner region give best results. Frequency variation of the frequency of the feeding current can also be very useful in these investigations.—*S. T. V.*

159–64. Chahnazaroff, D. A. Investigación de las fundaciones en las construcciones de gran peso mediante la aplicación del método geoeléctrico [Investigation of the foundations in heavy construction by the geoelectric method]: Mineria y Metalurgia, no. 156, p. 29–32, and no. 158, p. 39–42, 1954.

A review of the use of the electrical resistivity method in foundation studies. The Wenner electrode configuration and the curves obtained for a homogeneous medium, and for a stratified medium are described. Several practical examples are given in the second part.—*S. T. V.*

159–65. Grigor'yeva, N. P. Metod combinirovannogo profilirovaniya [The method of composite profiling]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 3, p. 10–32, 1950.

The "method of composite profiling" is characterized by the special arrangement of electrodes. Four electrodes *AMNB* are placed in the Wenner configuration, with a fifth electrode *C* on the line perpendicular to the line *AMNB* at a sufficiently great, theoretically infinite, distance. The measurements are made once with the electrodes *AMN*, later with *MNB*, the feeding electrode in either case being *C*. On homogeneous ground the resistivity curves obtained with both combinations of electrodes will be similar, but if the region is underlain by two media of different electrical properties, separated by a vertical boundary, the curves will be distinctly different. Sharp peaks over the boundary make interpretation of the measurements easier. Laboratory experiments were made using different arrangements of models and different combinations of resistivities. Field observations were made in an area containing quartzitic and sericitic slates in various attitudes. The results were in good agreement with the laboratory experiments and with the theoretical expectations.—*S. T. V.*

159–66. Belluigi, Arnaldo. Sviluppi del carotaggio elettrico [The development of electrical well logging]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 581–588, 1952.

The history of electrical well logging is briefly reviewed and the importance of theoretical investigations of related problems—especially the use of low-

frequency alternating current, which has many advantages as compared with direct current—is pointed out.

The use of cylindrical coordinates in the computations of the electric potential around and along a drill hole seems natural and several investigators have already established important relations between the primary and the secondary fields induced by the alternating current. A similar extension of this procedure can be made to such new techniques as the Microlog or induction log, as well as the Matranslog. The last is analogous in many ways with the propagation of telegraphic signals along a wire with uniformly distributed rectifying elements.—*S. T. V.*

159–67. Mathieu, Jean Léon. Quelques applications nouvelles des méthodes Schlumberger [Some new applications of the Schlumberger methods]: Convegno naz. metano et petrolio, 7mo, Taormina 1952, Atti, p. 549–579, 1952.

Logging methods, including electrical, radioactivity, mechanical, dipmeter, and photoclinometer surveys; side wall sampling; and section gage surveys are briefly reviewed and illustrated. These methods have recently been introduced in exploration for coal and lignite, potassium, and underground sources of water. Surveys for lignite in Germany, for potassium in Alsace, for coal in western Europe, and for water are described.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

159–68. Cook, Kenneth L., and Van Nostrand, Robert G. Interpretation of resistivity data over filled sinks: Geophysics, v. 19, no. 4, p. 761–770, 1954.

Solutions of Laplace's equations in prolate and oblate spheroidal coordinates are applied to problems that arise in resistivity surveys over filled hemispheroidal sinks. Comprehensive sets of theoretical curves are presented for both horizontal and vertical profiles in the vicinity of filled sinks. The effectiveness of these theoretical curves is demonstrated not only for the interpretation of resistivity data but also for the planning of proper field techniques in resistivity surveying over such sinks. Excellent correlation between theoretical and observed field resistivity curves is shown over a shale sink in the Tri-State lead-zinc mining district, near Joplin, Mo. It is shown that a filled sink can be approximated in its resistivity edge effects by a vertical dike if the width of the sink is small in comparison with its length and its depth; and a vertical fault if the sink is large in comparison with the electrode separation. A study of the Lee and Wenner configurations indicates that the former gives additional information that more than justifies the extra time and expense involved.—*Authors' abstract*

159–69. Logn, Ö[rnulf]. Mapping nearly vertical discontinuities by earth resitivities: Geophysics, v. 19, no. 4, p. 739–750, 1954.

Following a procedure similar to the method used by Stefanesco et al. (1930) in resistivity computations for a horizontally bedded earth, integral formulas are evaluated for the potential distribution around one current electrode placed in the neighborhood of one vertical plane of discontinuity and two vertical planes of discontinuity. The integral formulas are shown to be identical to the series evaluated by Hedström (1932) using a Maxwell theory of images. The apparent resistivity in the one-current-electrode configuration is defined, and integral formulas are given for planes of discontinuity. Because the evaluation

of apparent resistivity curves across a gangue of small thicknesses is troublesome by these formulas, approximation formulas for a thin vertical sheet are evaluated, and these are found to be of sufficient accuracy in most cases met in the field.

It is suggested that nearly vertical faults, rock boundaries, and breccias in many cases give geoelectrical anomalies which can be assumed to be caused by vertical planes of discontinuity. As an example, resitivity data are presented which were taken across a breccia in Meheia, near Kongsberg, Norway.—*Author's abstract*

159–70. Mooney, Harold M. Depth determinations by electrical resistivity: Mining Engineering, v. 6, no. 9, p. 915–918, 1954.

A summary, with examples, of the empirical, theoretical-curve-matching, and direct methods of interpreting resistivity-depth curves.—*L. C. P.*

159–71. Mooney, Harold M. Effect of a variable surface layer on apparent resistivity data: Mining Engineering, v. 6, no. 12, p. 1210–1212, 1954.

The variations in the resistivity of a surface layer may cause erroneous interpretations of resistivity-depth curves. Such errors in interpretation can sometimes be avoided if the effect of these variations can be recognized and taken into account.—*L. C. P.*

159–72. Wyllie, M. R. J. The fundamentals of electric log interpretation: 126 p., New York, Academic Press Inc., 1954.

This book is designed to "enable the non-specialist worker with electric logs to appreciate the basic principles of log interpretation". The theory and practice of quantitative log interpretation are discussed in simple terms. Conventional resistivity and self-potential logs as well as focussed-current, shallow-current-penetration, induction, and contact logging devices are described.—*M. C. R.*

159–73. Holmes, C. R. Some factors related to the measurement of the electrical properties of porous sandstones: Producers Monthly, v. 19, no. 1, p. 21–27, 1954.

Progress in electric-logging research depends on the ability to make reproducible determinations of the electric parameters of porous rocks under conditions of partial fluid saturation. Surface conductance, the nature of the saturating fluid, and variations in the frequency of the electrical current used to make all measurements materially affect the values of core resistances.—*L. C. P.*

159–74. Hamilton, R. G. Have you any oil fields hidden in the curves of electric logs on file?: Oil and Gas Jour., v. 53, no. 31, p. 180–182, 1954.

New oil and gas pools can be discovered by a proper analysis of electric logs, many of which may be filed and forgotten.—*L. C. P.*

159–75. Hamilton, R. G. Finding oil with electric logs: Oil and Gas Jour., v. 53, no. 32, p. 194–196, 1954.

This is Part 2 of the previous paper by Hamilton. It presents three case histories in which oil or gas were discovered by reexamination of the electric logs from plugged wells.—*L. C. P.*

159–76. White, William E. Here's a new method of interpreting electric logs in shaly sands: Oil and Gas Jour., v. 53, no. 19, p. 106–110, 1954.

A development of formulas representing the general case for electric logging in shaly sands.—*L. C. P.*

ELECTRICAL SURVEYS AND WELL LOGGING

159–77. Groot, Johan Jacob, and Rasmussen, William Charles. Geology and ground-water resources of the Newark area, Delaware: Del. Geol. Survey Bull. 2, 133 p., 1954.

An investigation prompted by the industrial and municipal growth of Newark was undertaken to determine the extent, thickness, and hydrologic properties of aquifers in the area. The investigation included the canvass of existing wells, drilling and logging of test holes, study of surface and subsurface geology, magnetic and electrical resistivity surveys, electrical logging, and sedimentary analyses. The program of test drilling, supplemented by the surface resistivity survey, indicated a new ground-water basin about 2 miles south of the present city well field.—*M. C. R.*

159–78. Thurmond, Robert E., Heinrichs, Walter E., Jr., and Spaulding, E. D. Geophysical discovery and development of the Pima Mine, Pima County, Arizona, a successful exploration project: Mining Engineering, v. 6, no. 2, p. 197–202, 1954.

A commercial ore deposit in the Pima mining district, Pima County, Ariz., was discovered by a combination of electromagnetic and vertical intensity magnetometer surveys. The discovery was followed by the development of the Pima mine. The electromagnetic and magnetic anomalies clearly indicated the presence of the ore body. The ore body is a contact metamorphic deposit. Chalcopyrite is the chief ore mineral, but bornite, chalcocite, and zinc, molybdenum, and tungsten minerals are also present. Magnetite and pyrrhotite are present locally.—*L. C. P.*

159–79. Habberjam, G. M., and Whetton, John T. A resistivity investigation into a washout feature in Coal Measure strata: Geophys. Prosp., v. 2, no. 1, p. 24–37, 1954.

A part of the so-called preglacial valley of the River Wear in County Durham was studied as part of an investigation of the general problem of the possible menace to near-surface mine workings of superficial unconsolidated deposits. Resistivity observations indicated a low resistivity area whose course closely followed the assumed center line of the washout and also showed a possible tributary. However, the apparent resistivities within the preglacial valley overlap the range of resistivities observed in the Coal Measures themselves so that success of the method in tracing the feature is not assured. With the guidance of geology some information on the nature and thickness of the material in the washout was inferred.—*M. C. R.*

159–80. Breusse, J. J., and Huot, G. Hydrological surveys in the Catania area by means of electrical soundings: Geophys. Prosp., v. 2, no. 3, p. 227–231, 1954.

Electrical resistivity surveys for hydrological purposes have been made in the Etna piedmont region. In the Catania and Paterno areas, where the exploration started, the thickness of the overburden has been determined and a contour map

of the blue clays that form the basement has been prepared. Several buried channels, where successful new wells have since been drilled, were discovered.—*M. C. R.*

159–81. Chereau, Jean Yves, and Roger, Albert Henri. Étude électrotellurique sur la dorsale Ferraraise et comparaison avec les résultats apportes par d'autres méthodes [Electrotelluric survey of the Ferraran ridge and comparison with the results obtained by other methods] : Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 589–600, 1952.

In the region surveyed, near Ferrara, the stratigraphic sequence consists of Eocene and Cretaceous limestone, marly at the top but becoming more dense at depth, overlain by Oligocene and younger marls, clays, and sands. The Cretaceous and underlying rocks have resistivities of one hundred to several hundred ohm-meters, the Upper Cretaceous and Eocene rocks of a few tens of ohm-meters, and the post-Eocene formations of 0.5 ohm-meters. The area thus forms the ideal case of a sedimentary basin of conductive sediments lying on a resistant base so that the currents circulate in the basin and changes indicate changes in the basin rather than in the basement. Comparative study of gravity, telluric, and seismic data shows that it is necessary in complex problems to combine results of several kinds of surveys, each providing information to supplement another.—*M. C. R.*

159–82. Fujita, Yoshizo. Three-way geophysical method points up huge pyrite deposit: Eng. Min. Jour., v. 155, no. 12, p. 84–88, 1954.

Apparent-resistivity, resistivity-gradient, and spontaneous-polarization surveys resulted in locating a large pyrite ore body at the Matsuo mine in Japan. A seismic survey also indicated the location of the ore body.—*L. C. P.*

159–83. Murozumi, Masayoshi. Geophysical prospectings at the Wagasennin iron mine, Iwate prefecture [in Japanese with resumé in English] : Geol. Survey Japan Bull., v. 4, no. 10, p. 41–48, 1953.

Magnetic and electrical (resistivity, self-potential, and equipotential line) surveys were made in 1952. The general structure was determined by the resistivity survey; further prospecting was recommended on the basis of magnetic and self-potential anomalies.—*M. C. R.*

159–84. Kaku, Ichiro. Electrical loggings for the well R–1 Kamisuwa, Suwa City, Nagano prefecture [in Japanese with resumé in English] : Geol. Survey Japan Bull., v. 4, no. 9, p. 49–51, 1953.

On the basis of self-potential, resistivity, and lithologic logs, conditions are considered favorable for occurrence of natural gas.—*M. C. R.*

SEISMOLOGY

ELASTIC WAVES

159–85. Stoneley, R[obert S.] Rayleigh waves in a medium with two surface layers (First Paper) : Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 9, p. 610–615, 1954.

The propagation of waves of Rayleigh type in a uniform semi-infinite elastic medium with two uniform surface layers is discussed. The waves are dispersive, and the wave velocity equation is obtained as a determinant of the tenth order. By making infinite the thickness of the surface sheet one can derive the velocity

equation for waves in an internal stratum. By making the thickness of either sheet zero one can retrieve the known equation for the velocity of Rayleigh waves in a medium with a single surface layer. If the wave-length is very small, the determinant reduces to the product of three determinants which, equated in turn to zero, are the velocity equations of very short Rayleigh waves at the free surface and of very short waves of Rayleigh type at the two interfaces. The results of a numerical solution of the wave-velocity equation and the application to the surface waves of earthquakes will be communicated in a later paper.—*Author's abstract*

159–86. Tolstoy, Ivan. Dispersive properties of a fluid layer overlying a semi-infinite elastic solid: Seismol. Soc. America Bull., v. 44, no. 3, p. 493–512, 1954.

The dispersive properties of waves propagating in a system consisting of a fluid layer overlying a semi-infinite elastic body are investigated by means of new formulas for the group velocity. Unattenuated waves are considered, and data for a number of cases were computed with punched cards. A variety of dispersion curves are presented for various modes, including the first five, for certain values of Poisson's ratio, and density and velocity ratios. The distribution of stationary values of the group velocity is examined and illustrated in a number of curves for the normal mode branch of the fundamental mode and for the second and third modes. The minimum group velocity of the fundamental mode may belong either to the normal-mode branch or to the Stoneley-wave branch, depending on the contrast in wave velocities between the two media.—*P. E. B.*

159–87. Babich, V. and Alekseyev, A. Ob ekraniruyushchem deystvii tonkogo uprugogo sloya [Screening effect produced by a thin elastic layer]: Akad. Nauk SSSR Doklady, tom 91, no. 4, p. 763–765, 1953.

If a seismic wave propagating through a medium is incident upon an elastic layer of different elastic properties at an angle greater than the limiting angle, according to the laws of geometric optics, total reflection takes place and no wave disturbance is propagated across the boundary. However, on the basis of dynamic relations of the theory of elasticity it is proved that for a sufficiently thin layer a certain portion of the energy involved in the oscillatory motion will pass over across the layer into the deeper part of the medium. Such propagation will be especially noticeable for long waves and for angles of incidence not too greatly exceeding the limiting value. Such a phenomenon was observed in the results of a seismic survey made by I. S. Berzon and A. M. Yepinat'yeva (see Geophys. Abs. 12636).—*S. T. V.*

159–88. Dix, C. Hewitt. The method of Cagniard in seismic pulse problems: Geophysics, v. 19, no. 4, p. 722–738, 1954.

The essential mathematics involved in the theory of seismic pulse propagation as presented by Cagniard are discussed by considering the simple case of a point source in an infinite medium. The method may be summarized in the following steps:

(1) For a given source and point of observation at time t, there is a particle displacement in the medium at point P, which is denoted by $u\ (P, t)$. (2) The displacement forms a vector field satisfying the relation $u(P, t) = \text{grad}\ \psi + \text{curl}\ U$ where ψ represents the longitudinal wave and U represents the transverse wave. (3) The Newtonian equations describing the motion of the masses can be written in terms of the potentials ψ and U. (4) The conditions of continuity

at the free surface or at the interface can be also written in terms of ψ and U. (5) A particular signal can be put in the center of a cavity corresponding to a unit step function in ψ. (6) The equations of motion, the condition equations at the interface, and the form of the source can all be transformed by the method of Laplace. This involves transformations for both ψ and U. (7) Using the transforms, the equations of motion can be solved by the method of separation of variables and these solutions can be combined so as to satisfy the source condition and the condition of continuity at the boundary. (8) The inverse transformation of the Laplace transform can then be found. (9) The equation of step (2) is employed to find the displacement vector. (10) Using Duhamel's integral, the displacement corresponding to any input pressure can be obtained.—*I. Z.*

159–89. Berzon, I. S. O mnogokratnykh prelomlennykh volnach v vertikal'nosloistykh sredakh [The multiple refracted waves in vertically stratified media]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 424–442, 1954.

In vertically stratified refracting media, seismograms obtained over the sections of the wave path adjoining the boundary surface should show changes in the shape of the multiple waves, which can cause interference of different multiple waves and in certain cases their complete disappearance. The travel times of the refracted-reflected wave (P_{ikiiii}) and of the reflected-refracted wave (P_{iiiiki}) are different, but their travel-time graphs are both parallel to that of the simple wave. This is the main criterion for the identification of multiple waves. If the vertically stratified medium is composed of dissimilar and not too thick layers, the kinematic as well as dynamic conditions are not favorable for the creation of multiple waves. Seismic waves are said to be very seldom reflected more than twice. Experiments over a vertically stratified area gave results which are in good agreement with the theoretical data.—*S. T. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

159–90. Donn, William L., Ewing, Maurice, and Press, Frank. Performance of resonant seismometers: Geophysics, v. 19, no. 4, p. 802–819, 1954.

A group of resonant vertical seismometers, each tuned to cover a part of the spectrum of microseism frequencies, has been operated for about one year.

These instruments clearly distinguish between simultaneous microseisms from two separate sources; show an improved signal-to-noise ratio for microseisms from a single storm, permitting earlier detection of storm onsets; show clearly the increase in period of frontal microseisms as cold fronts move seaward from the east coast of North America; record only the envelope of the oscillations, which greatly facilitates measurement of intensity as a function of time; and appear to be very useful tools in continued attempts at hurricane location by means of microseism amplitude studies.

The performance of the instruments is demonstrated by seven case histories in which microseismic readings of seismometers tuned to different frequencies are related to the meteorological conditions which are apparently responsible for the microseismic activity.—*Authors' abstract*

159–91. Désveaux, E. Sur les séismographes électromagnétiques á deux galvanomètres [On electromagnetic seismographs with two galvonometers]: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 615–621, 1949 (1953).

After establishing the general equation of motion of seismographs, Désveaux describes a filter that eliminates the effect of microseisms from long-period seis-

mographs. The filter employs a suitably chosen galvanometer. The frequency and amplitude of the attenuation band determine the constants of this galvanometer, save for one which remains arbitrary.

A photoelectric earthquake alarm device for seismographs is also described briefly, and recommended particularly for coastal stations for prediction of tsunamis. Instrumental failure is also signaled by the device.—*D. B. V.*

159–92. Ingram, R. E., and Timoney, J. R. Theory of an inverted pendulum with trifilar suspension: Dublin Inst. for Advanced Studies Geophys. Bull. 9, 8 p., 1954.

The theory of small oscillations is applied to the inverted, trifilar suspension pendulum. The potential energy in a small displacement is calculated from geometrical considerations using vectorial methods. The periods of the principal modes of oscillation are found. The theory is applied to the O'Leary seismograph (mass 1¾ tons) at Rathfarnham Castle and gives results in close agreement with the measured values.—*Authors' abstract*

159–93. Pakiser, L. C., Mabey, D. R., and Warrick, R. E. Mapping shallow horizons with reflection seismograph: Am. Assoc. Petroleum Geologists Bull., v. 38, no. 11, p. 2382–2394, 1954.

The United States Geological Survey has successfully tested specially constructed shallow-reflection seismic instruments in two areas in Oklahoma and Kansas. These instruments have high-frequency response, high oscillograph paper speeds, fast-acting automatic gain control, and variable presuppression control. In principle they are straightforward modifications of conventional seismic-reflection equipment.

In Osage County, Okla., the Neva limestone of Permian age has been mapped at a depth of about 200 feet. In Rice County, Kans., the Stone Corral dolomite of Permian age has been mapped at depth of 100 to slightly more than 200 feet. In the Kansas test area the base of the overburden and reflecting horizons within the overburden have been detected in some places.

The shallow-reflection seismic method can be applied to detailed mapping in the depth range of 50–1,000 feet, and may be extended to 4,000 feet or more if desired. The shallower depths are beyond the range of conventional seismic-reflection equipment. A wide variety of shallow-structural and depth-to-bedrock problems may be solved by this new method.—*Authors' abstract*

159–94. Raitt, Russell W. Geophysical measurements: *in* Symposium on Oceanographic Instrumentation, U. S. Natl. Acad. Sciences–Natl. Research Council Pub. 309, p. 70–84, 1954.

Papers presented at a symposium on oceanographic instrumentation held at Rancho Santa Fe, Calif., June 20–23, 1952, sponsored by the Office of Naval Research and the National Research Council included this report on the technique of seismic measurements made by Raitt in the Pacific Ocean. Two lines of development have been followed in improving such measurements under the limiting conditions of work at sea: Improvement of detectability of bottom-refracted waves by reducing noise level, by filtering unwanted noise, by recording several hydrophones, and by proper choice of hydrophone depth; and development of a simple, rapid, and reliable method of firing while under way by dropping TNT bombs fused with slow-burning fuse cut to fire at the desired depth. In the discussion following the paper, Frank Press and J. L. Worzel described earthquake seismology studies and equipment at Lamont Geological Observatory and gravity and magnetic measurements at sea.—*M. C. R.*

159–95. Nersesov, I. L. Signalizator sil'nykh blizkikh zemletryaseniy [A signaling device for local earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 21 (148), p. 16–18, 1953.

When an earthquake, even one of not-too-great intensity, occurs a short distance from a seismograph station, high magnification seismographs start to oscillate with too-great amplitude, and photographically recorded traces are hardly visible, especially in the *S* phase. To eliminate this difficulty, a strip of copper touching, at great amplitudes, two limiting contacts of a relay circuit may be used to insert an additional voltage and produce clearer recording. The distance between the limiting contacts can be adjusted as desired. An alarm bell can be started simultaneously to announce the occurrence of an earthquake more violent than usual.—*S. T. V.*

159–96. Urdaneta, J. R. El sismoscopio electrico [Electric seismoscope]: Acad. Colombiana Cienc. exactas fis. y nat. Rev., v. 9, no. 35, p. 227–232, 1954.

The seismoscope, built on the same physical principles as seismographs, records the time and direction of an earthquake but not the displacement of the ground. The instrument consists of a horizontal pendulum surrounded by a metallic ring that limits the motions of the pendulum but records them through a system of contacts and electric circuits.—*S. T. V.*

Goranson, Roy W. Geophysical methods in volcanism. See Geophys. Abs. 159–192.

159–97. Mintrop, Lüdger. Die Entwicklung der Springseismik [The development of seismic exploration]: Zeitschr. Geophysik, Sonderband, p. 101–122, 1953.

This is a historical review of the development of seismic methods in exploration for natural resources and in geologic investigations. An extensive bibliography is included.—*S. T. V.*

159–98. Milvio, Daniele. Sviluppi del metodo sismico a riflessione nella ricerca degli idrocarburi [Development of the seismic reflection method in the search for hydrocarbons]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 461–463, 1952.

A brief review of the development of the seismic-refraction method since 1930 is presented. Improvements in the design and construction of seismographs, the application of amplifiers with automatic volume control, the use of seismic method in surveys over water-covered areas, and the development of the Poulter method of shooting have made it possible to determine the subsurface structure of an area with an accuracy of ±5 percent. As an interesting illustration on the growing efficiency of the seismic method Milvio cites the surveys of an area repeated several times since 1940, each time adding new and important information.—*S. T. V.*

159–99. Zettel, Werner. La ricerca della strutture petrolifere mediante il metodo sismico [Prospecting for oil-bearing structures with the seismic method]: Convegno naz. metano e del petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 403–415, 1952.

This is a review of the recent improvements in seismic-reflection method, introduced in Germany since the second World War. As typical among German

geophysicists Zettel describes a seismic recording assembly with 24 or 32 traces, provided with amplifiers, filters, automatic volume control, and with means for interlocking different geophones.

To improve reflections, several charges laid out in different geometric patterns on the ground or at a certain height above it are shot simultaneously. Seismograms from northwestern Germany obtained under different shooting conditions and the interpretations of the data were discussed. Reflecting horizons as deep as 4 km have been detected.—*S. T. V.*

159–100. Boccalery, Michael. Aspetti practici nell' esplorazione geofisica [Practical aspects in geophysical exploration]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 443–450, 1952.

Three examples of unusual problems in petroleum exploration, all in the San Joaquin Valley, Calif., are described. In the Wilmington oil field, there were problems in using seismic-reflection methods, because the presence of extensive industrial establishments imposed restrictions on the amount of explosives used and on the location of shot points and geophones. It was nonetheless possible, after only ten shots, to determine the structure and to start drilling. In the Rio Bravo oil field, there were difficulties in interpretation because sand and clay of very different seismic velocities were at the same depth at opposite ends of the field. By applying appropriate corrections it was possible to determine the true geologic profile. In the Raisin City oil field, initially, only a few reflections could be obtained because of the small dimensions of the reflecting structures. After several holes were drilled and the charges exploded in them it was possible, using several seismic profiles, to determine the structure of the area.—*S. T. V.*

159–101. Rummerfield, B. F., McKay, A. E., Hammond, J. W., and Reynolds, F. F. Symposium on current seismic techniques used in pattern shooting: Oil and Gas Jour., v. 52, no. 50, p. 136–146, 195, 1954.

Pattern shooting and multiple-geophone techniques often result in marked improvement in the record quality in areas of bad reflections. The improvement results from better coupling effects, cancellation of unwanted random noise, and reinforcement of the desired reflection signal. In western Oklahoma and the west Texas-New Mexico region, where near-surface high-frequency interference results in poor record quality, combined pattern shooting and multiple-geophone techniques are being widely and successfully used.

Information on the velocity of propagation and frequency of unwanted noise can be obtained from flat-response recording systems. Optimum cancellation of noise can be achieved by the proper grouping of multiple geophones.—*L. C. P.*

159–102. Oil and Gas Journal. Use of dynamite will cut offshore seismic budget: Oil and Gas Jour., v. 53, no. 29, p. 65, 1954.

Dynamite, arranged in small charges and fired progressively, may be used in place of black powder in offshore seismic operations. The number of fish killed is negligible.—*L. C. P.*

159–103. Lawrence, Carl J. New offshore seismic tool spots cork miles away: Oil and Gas Jour., v. 53, no. 32, p. 94–95, 1954.

The Lorac Service Corp. of Tulsa, Okla., has developed a device to help direct ships in offshore seismic work to shot locations. It is called the "zero header" and it is used in conjunction with the Lorac radio-navigation system. The zero

header can be readily adapted to navigate helicopters and to guide commercial ships in harbor areas.—*L. C. P.*

159–104. Leet, L. D. Quarry blasting with short-period delay detonators: Explosives Engineer, v. 32, no. 5, p. 142–148, 154, 1954.

Extensive experiments on the effects of blasts fired with short-period delay detonators indicate the method produces appreciably less vibrations in the ground and results in more effective fragmentation of rock. Several seismograms are included to show the vibrations.—*S. T. V.*

METHODS OF ANALYSIS OF EARTHQUAKE OBSERVATIONS

159–105. Vvedenskaya, A. V. O primenenii setki Vulfa pri opredelenii dinamicheskikh parametrov ochagov zemletryaseniy [Use of Wulff's net in the determination of the dynamic parameters of earthquake foci]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 20 (147), p. 47–50, 1953.

In the graphical construction used in determining the dynamic parameters of earthquake foci, Wulff's net of crystallography may be used. As an example, this chart is applied in the investigation of the earthquake of April 20, 1941. Errors in the angles found by this method are less than $\pm$ 10°.—*S. T. V.*

159–106. Golenetskiy, S. I., and Treskov, A. A. Metod isokhron [The method of isochrons]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 21 (148), p. 91–97, 1953.

The method of isochrons for determination of the epicenter of near earthquakes has several advantages over the methods of Wadati or Mohorovičić. It does not presuppose knowledge of the travel-time curves, but requires only the assumption that they be linear over relatively short sections. A graphical solution may be based on the data at three stations, and a more refined solution obtained when the data of a fourth station are also available. The procedure is very simple, involving only the intersection of straight lines. The method is applied to four recent earthquakes in Central Asia.—*S. T. V.*

159–107. Gayskiy, V. N. K probleme obrabotki blizkikh zemletryaseniy [On the analysis of seismological data from near earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 20 (147), p. 69–74, 1953.

Two methods of analyzing the seismologic observations of near earthquakes are suggested:

If X_o, Y_o are the coordinates of the epicenter, and X_i and Y_i those of the i^{th} station, then $(X_o-X_i)^2+(Y_o-Y_i)^2=V^2(S-P-a)^2$, where V is the velocity of the fictitious wave $(S-P)$, $[V=V_pV_s/(V_p-V_s)]$ and $a=a_s-a_p$, the difference between the initial ordinates of the travel time curves of the S and P waves. This can be written $\Delta_i=V(S_i-P_i-a)$ where Δ_i is the epicentral distance of the i^{th} station. Similarly, for the k^{th} station, $\Delta_k=V(S_k-P_k-a)$ and $\Delta_i-\Delta_k=V[(S_i-P_i)-(S_k-P_k)]$ is the equation of an hyperbola, corresponding to the $S-P$ intervals for stations i and k.

With a third station j, the position of the epicenter for a given V can be obtained from the intersection of hyperbolas (ij) and (ik). By varying V the locus of the possible positions of the epicenter, or the "epicentral" for the stations i, j, k, is obtained. The intersection of two such epicentrals give the epicenter corresponding to four stations for a given V.

The second procedure involves taking a as the variable parameter. Then $\Delta_i = V(t_i - a)$ where $S_i - P_i$ is denoted by t_i and similarly, $\Delta_k = V(t_k - a)$. Then $\Delta_i/\Delta_r = (t_i - a)/(t_k - a)$ which is a circle with a given a. By placing the origin of the coordinates at station k and directing the X-axis through station i, the equation may be written: $s[X + d/(i - q^2)]^2 + y^2 = (qd)^2/(i - q^2)$, where $q = (t_i - a)/(t_k - a)$ and d is the distance between the stations, and the epicentral line is also a circle. The intersection of these circles defines the possible position of the epicenter.—*S. T. V.*

159–108. Kharin, D. A., Keylis-Borok, V. I., and Kogan, S. D. K metodike seysmicheskikh nablyudeniy v epitsentral'noy zone i ikh interpretatsii [On the methods and interpretation of seismic observations in the epicentral zone]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 21 (148), p. 27–48, 1953.

During 1949 five seismic stations equiped with Kirnos electrodynamic seismographs (magnification of 2,500 to 3,000 within the frequency range of 0.3 to 5.0 sec) were operating in the southern Tadzhik S. S. R. as part of an investigation sponsored by the Russian Academy of Sciences to determine the epicenters and the dynamic characteristics of the shocks. The region is one of the most seismically active zones of the U. S. S. R. (for instance, the station of Kalay-Lyabi-Ob recorded during this year about 2,500 seismic shocks, some of them of great violence). The investigations indicated that the methods of Wadati and Ishikawa for epicenter determination give good results only when the stations are in a medium of constant fictitious velocity. Variation of this velocity by 10–15 percent will cause a displacement of the epicenter by 10 km or more. It is thus necessary to find the variation in the fictitious velocity with changing seismic properties of the terrain traversed. The method Keylis-Borok (see Geophys. Abs. 12935 and 14035) makes it possible to determine the dynamic conditions at the focus with an accuracy of 20°–25°. Reliable results can be obtained on the basis of the observational data from 4 or 5 stations. It is important to have the same type of instruments at all stations and to have them carefully calibrated.—*S. T. V.*

159–109. Gayskiy, V. N., and Bichevina, V. N. Ob interpretatsii nablyudeniy nad blizkimi zemletryaseniyam [On the interpretation of the observational data of near earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy no. 21 (148), p. 98–109, 1953.

The graphoanalytic methods of isochrons and epicentrals make it possible to interpret near earthquakes recorded at five or six stations, but the waves used on the seismograms of all stations must be the same phase. A method suggested for selection of the same phases at all stations is based on the following reasoning: The time of travel of any two phases of the P and S waves to any stations i and K are: $t_{pi} = P(i) - t_o = a_p + \Delta/V_p$; $t_{sk} = S(K) - t_o = a + \Delta/V_s$ where Δ is the epicentral distance; V_p and V_s are the velocities of the phases P_i and S_k; a_p and a_s are the initial ordinates of the travel time curves; and $P(i)$ and $S(K)$ the times of arrival of P_i and S_k. From these equations:

$$S(K) - P(i) = a_s - a_p + \Delta/V,$$

where

$$V = (V_p V_s)/(V_p - V_s) = V_p/(K - I)$$

if

$$(K = V_p/V_s)$$

and

$$P(i)=t_o+(Ka_p-a_s)/(K-1)+(S(K)-P(i))/(K-1)$$

Thus for any two P and S phases with linear travel time curves, the function $P=f(S-P)$ is also linear, and therefore data corresponding to the same pair of phases all lie on a straight line.

Good results were obtained in the determination of four epicenters selected as examples. Similarly good results were obtained for the velocities of different waves.

It is concluded that for the southern part of the Tadzhik S. S. R.: $V_p=(7.81\pm 0.08)$ kmps; $V_s=4.42\pm0.05$ kmps; $K=1.766\pm0.004$; and $V=10.18\pm0.05$ kmps.—*S. T. V.*

159.110. Nersesov, I. L., and Rykunov, L. N. K obrabotkė mestnykh zemletryaseniy Garmskoy Oblasti [On the treatment of data of local earthquakes in the Garmskaya Oblast']: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 21 (148), p. 19–26, 1953.

During 1949 and 1950 special seismologic studies were made in the Garmskaya Oblast' of the Tadzhik S. S. R. using, in addition to the two existing permanent seismological observatories, six temporary stations placed so that individual stations were less than 40 miles apart. As the seismic velocities in the region were unknown, epicenters were determined by the methods of Wadati and Ishikawa. Wadati's graphical method was found not sufficiently accurate because of the complicated structure of the Garmskaya Oblast'. Satisfactory results were obtained only when the heterogeneities in the crust were taken into account by introducing different values of the fictitious velocity in the computations K, the fictitious velocity, being equal to $V_p\ V_s/(V_p-V_s)$, where V_p and V_s are the velocities of the longitudinal and transverse waves. Proceeding in this way it was possible to determine for many of the observed earthquakes the coordinates of the epicenters and the depth of the foci with errors not exceeding ±3–5 km.—*S. T. V.*

159–111. Mountier, N. S. Earthquake magnitudes determined from Milne-Shaw records: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 662–666, 1949, (1953).

The construction of a graph of amplitude versus distance, from which it is possible to estimate rapidly if roughly the magnitude of any earthquake recorded at the Dominion Observatory at Wellington, is described in detail. The standard curves were based on Milne-Shaw S-amplitude readings at Wellington for 62 earthquakes during the period 1941–47 for which magnitudes had been determined at Pasadena. The actual amplitude read was always the maximum amplitude of S, SKS, or, in one or two cases, $SKKS$, but never ScS or SS. The accuracy of the method is within half a magnitude, except for very distant earthquakes where smallness of the trace amplitude makes sufficiently accurate reading impossible.—*D. B. V.*

METHODS OF ANALYSIS OF SEISMIC SURVEY DATA

159–112. Hagedoorn, J. G. A practical example of an anisotropic velocity-layer: Geophys. Prosp., v. 2, no. 1, p. 52–60, 1954.

Evidence from seismic-velocity well-logging, and refraction surveys seems to show that at three places a layer has been observed in which the vertical

velocity is 2,550 meters per second and the horizontal velocity 2,750 meters per second. Most layers are more or less stratified horizontally so that vertical velocities would be mean values and horizontal velocities maximum values, especially in the shaly clays in these examples. It is also possible that low-frequency waves suffer less absorption than high-frequency waves. If the velocity increases with lower frequency, then as a rule higher velocities might be expected from refraction surveys than from well surveys.—*M. C. R.*

159–113. Cholet, Jacques, and Richard, Henri. A test on elastic anisotropy measurement at Berriane (North Sahara): Geophys. Prosp., v. 2, no. 3, p. 232–246, 1954.

Geophysicists who have attempted to evaluate elastic anisotropy of stratified formations have noted that as a rule velocities are higher along the strata than perpendicular to them but have, perhaps, not laid enough stress on the fact that determination of anisotropy is a critical factor, and unless performed under good conditions there are chances of ascribing partially to anisotropy an apparent velocity change caused by other factors. Conditions in the Berriane district of the northern Sahara are favorable for such a study to a depth of 1,250 meters, as the surface corrections are only a few milliseconds, stratification is horizontal, and depth has little effect on velocity. Coherent results are obtained for 0–800 and 0–1,250 meters by using an anisotropy factor of 1.09. When high-velocity layers are not considered, the factor is 1.14, and if the thickness of the high-velocity layers is overestimated, the factor becomes 1.065 or 1.07.—*M. C. R.*

159–114. Rummerfield, Ben F. Reflection quality, a fourth dimension: Geophysics, v. 19, no. 4, p. 684–694, 1954.

Nonstructural geologic information can often be derived from a study of the quality of reflections recorded on seismograms. Such a study requires a good shallow reflecting "control" horizon that can be compared with deeper reflecting horizons for which changes in reflection quality may be significant. Maps of graded reflection quality may show reefs, pinchouts, faults, or buried topography.—*L. C. P.*

159–115. Contini, Camillo. Determinazione della velocita di trasmissione delle onde sismiche nei rilievi a riflessione [Determination of the velocity of propagation of seismic waves in reflection surveys]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 425–434, 1952.

Methods of determining the velocity of seismic waves are reviewed briefly, and a graphical means of determining the velocity is shown. The importance of considering the irregularity of the surface and the weathered layer, and the inclination and curvature of the reflecting surface is stressed. A practical example of the use of the graph in determining velocity in the Po valley is given.—*M. C. R.*

159–116. Dürbaum, H. Zur Bestimmung von Wellengeschwindigkeiten aus reflexionsseismischen Messungen [On the determination of velocity from seismic reflection measurements]: Geophys. Prosp., v. 2, no. 2, p. 151–167, 1954.

A mathematical method for determining velocity, by considering the travel-time curve approximated by the equation for a hyperbola, for the case of n plane parallel layers.—*M. C. R.*

159–117. Schenkel, G. Verfahren zur Bestimmung der wahren Lage und des wahren Einfallens reflexionsseismisch ermittelter Schichtenelemente [Procedure for the determination of the true position and the dip of seismically detected layers]: Geol. Jahrb., Band 68, p. 659–669, 1954.

The interpretation of reflection seismic recordings in steep-dip areas often becomes erroneous by the introduction of the average vertical seismic velocity $\overline{V}$ (t_o) instead of the actual $\overline{V}$-figure, referring to the inclined wave path. The actual figure, however, cannot be stated until the position of the reflecting element is determined. The difficulty is overcome by the described method, using the reflection times recorded at the ends of a cross-spread for the construction of a circle $K=2h''$ $(\overline{V})$, whose intersection with a modified reference curve $TAB-2h'$ $(\overline{V})$ gives the true coordinates of the reflecting element, provided refraction of the wave paths can be neglected.—*Author's abstract*

159–118. Signini, Mario. La determinazione dello strato aerato superficiale nelle prospezioni sismiche a riflessione [The determination of the weathered layer in seismic reflection prospecting]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 417–423, 1952.

In the valley of the Po the weathered layer is in some places 20 to 25 meters thick. The velocity in this layer is about 600 meters per second, and the velocity in the layer immediately below ranges from 1,500 to 2,000 meters per second. Where the upper layer is covered with peat, it presents a great obstacle to the propagation of seismic waves and it is necessary to place explosive charges in deep wells reaching the second layer. To avoid errors caused by the weathered layer Signini suggests a graphoanalytic method of determining its thickness and the corresponding velocity. Several possible configurations are discussed and the necessary formulas derived.—*S. T. V.*

159–119. Krey, Th[eodor]. Extension to three dimensional problems concerning an approximate correction method for refraction in reflection seismic prospecting: Geophys. Prosp., v. 2, no. 1, p. 61–72, 1954.

The formulas derived by the author in a preliminary paper for taking into consideration refraction when dealing with the problem of a vertical plane are extended to the three-dimensional case. Vector analysis is extensively applied. Among others it is shown that in the general case the three horizontal two-dimensional vectors, that is, the gradient of the time of reflection, the direction of true dip, the vector from the shot point to the projection of the reflecting point, point into three different directions.—*Author's abstract*

159–120. Handley, E. J. Computing weathering corrections for seismograph shooting: World Oil, v. 139, no. 6, p. 118–128, 1954.

In some areas the near-surface velocities increase uniformly with depth, causing the first-arrival time-distance data to fall on a smooth curve. Under this condition the usual multiple-layer computations assuming straight-line paths are not applicable. An empirical time-distance equation of simple form can be assumed and the velocity distribution function determined. For any set of data the penetration time can be computed for an assumed "peel-off" depth.—*L. C. P.*

159–121. Flude, John F. Revolutionary new method promises better seismic-reflection computations: Oil and Gas Jour., v. 53, no. 33, p. 146–150, 1954.

The Reynolds Cross-Section Plotter automatically corrects for weathering, elevation, and move-out time and plots reflections from alternate traces on a

reflection seismogram. This makes possible rapid computing of the data from a high-speed offshore crew by a small computing staff. Reflection "picks" are made directly on the plotted cross section from any portion of a record, and from a large number of records at the time time.—*L. C. P.*

159–122. Jones, Hal J., and Morrison, John A. Cross-correlation filtering: Geophysics, v. 19, no. 4, p, 660–683, 1954.

Correlation analysis may be used to study seismic data when additional information, not available from standard methods of analysis, is desired, or as an alternative filtering method. It is essentially a smoothing or filtering operation. Certain parameters, such as the auto-correlation and cross-correlation coefficients, are used to provide a quantitative measure of the correlation between two sets of data, for example, a reflection waveform and a noisy seismic trace. Cross-correlation analysis has been successfully used to identify weak reflections masked by noise. A two-channel analog seismic correlator has been developed.—*L. C. P.*

159–123. Zirkel, N. N. Comparison of break-point and time-intercept methods in refraction calculations: Geophysics, v. 19, no. 4, p. 716–721, 1954.

The break-point (critical-distance) method of refraction calculation is more accurate than the time-intercept method if the weathered layer is ignored and the full intercept time, including the time travel in the weathered layer, is used.—*L. C. P.*

OBSERVATIONS OF SEISMIC WAVES

159–124. Jeffreys, Harold. The times of *P* in Japanese and European earthquakes: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 9, p. 557–565, 1954.

The times of *P* have been studied in six Japanese and five European earthquakes, selected because good determinations of epicenters are possible from stations within 30°. Revised tables for earthquakes in Europe and Japan are constructed. Values of chi square and the number of degrees of freedom are given with computed anomalies. Jeffrey's previous study of the times of *P* at distances up to 30° (Geophys. Abs. 14299) has shown that there are significant differences between those in European and in Japanese earthquakes. From the present study, evidence concerning differences of the times at distances over 30° is somewhat conflicting; if there are any they do not exceed 2^{sec}, but a difference of the order of 1 part in 300 between the velocities under the eastern and western halves of Eurasia is possible.—*P. E. B.*

159–125. Howell, B. F., Jr., and Kaukonen, E. K. Attenuation of seismic waves near an explosion: Seismol. Soc. America Bull., v. 44, no. 3, p. 481–491, 1954.

The energies of the first recorded pulses of seismic waves generated by a series of buried explosions are plotted as a function of distance from the shot point. At short distances the first pulse is a combination of the direct compressional wave, surface waves, and other pulses. Beyond 800 feet, it is a pulse refracted at the bottom of the weathered layer. Absorption, by whatever means it is accomplished, seems to be much greater for the first pulse near the shot than for the refracted pulse beyond 800 feet. The refracted pulse has about 1/600 the energy of the direct pulse. For both the direct wave along the surface and the wave refracted along the bottom of the weathered layer, the attenuation

seems to be greater than would be required for a body wave spreading radially. The large difference in attenuation constants (for exponential attenuation) in the two cases suggests that the rock responds to the refracted pulse as though it were beyond the zone of plastic deformation, but that as far out as 375 feet the direct pulse is not beyond the zone.—*P. E. B.*

159–126. Förtsch, Otto. Beitrage, zur Ausbreitung elastischer Oberflachenwellen [Contribution to the problem of the propagation of surface waves]: Zeitschr Geophysik, Sonderband, p. 59–67, 1953.

Experiments were made on the aviation field at Göttingen, Germany, with vibrations produced in the ground by a vibrating machine and by an explosion. Harmonic analysis of the seismograms indicates that the vibrations are identical. The observed waves were special Rayleigh waves confined to the upper layer. In a homogeneous medium the lower boundary of this layer remains perfectly rigid; in a stratified medium Rayleigh waves appear in pairs, the dispersion curve being also composed of two branches.

Observations of absorption and damping led to the conclusion that in the propagation of elastic waves the same proportional share of energy is absorbed per group wave length (group velocity/frequency). Also it can be readily seen that this loss of energy is caused by sliding friction.—*S. T. V.*

159–127. Dobrin, M. B., Lawrence, P. L., and Sengbush, R. L. Surface and near-surface waves in the Delaware Basin: Geophysics, v. 19, no. 4, p. 695–715, 1954.

Seismic propagation studies made in the Delaware basin of West Texas by the Field Research Laboratories of the Magnolia Petroleum Co. have disclosed several unusual kinds of traveling waves. The near-surface zone in this area is characterized by alternating high- and low-velocity layers, with a thin high-velocity cap. Physical characteristics of the recorded waves have been correlated with this layering.

Five types of waves have been identified: waves refracted along the tops of high-speed near-surface markers which have been multiply reflected, at the critical angle, between the marker beds and interfaces nearer the surface; shear waves refracted at shear velocity along a competent bed several hundred feet deep; compressional waves propagated by normal-mode transmission in the wave guide formed by a low-speed layer situated between two high-speed layers; a single-cycle, apparently nondispersive Rayleigh wave propagated in a thin limestone surface layer and in an underlying low-speed layer of sand and gravel; and an inversely dispersive Rayleigh wave train in which the group velocity appears to decrease with increasing wave length; this type of dispersion, just the opposite of the kind ordinarily recorded, is attributable to the fact that the low-speed surface layer is unusually thick compared with the wave length corresponding to the cutoff frequency of the instrumental system.—*Authors' abstract*

159–128. Ewing, Maurice, and Press, Frank. Mantle Rayleigh waves from the Kamchatka earthquake of Nov. 4, 1952: Seismol. Soc. America Bull., v. 44, no. 3, p. 471–479, 1954.

The new Palisades long-period vertical seismograph (T_o=15 seconds, T_g=90 seconds) recorded mantle Rayleigh waves from the Kamchatka earthquake of November 4, 1952 of orders R_6-R_{15}, the corresponding paths involving as many as seven complete passages around the earth. In a previous study of these waves

(Geophys. Abs. 158–137) Ewing and Press used data for three earthquakes, recorded on the Pasadena linear-strain and Benioff seismographs, on Rayleigh waves in the period range 1–7 minutes involving paths with as many as three circuits of the earth (R_2-R_7). The new dispersion data for periods below 400 seconds are in excellent agreement with the earlier results and can be explained in terms of the known increase of shear velocity with depth in the mantle. All data are combined into a curve of group velocity plotted against period. The new data reaffirm the earlier conclusion that a single dispersion curve represents all the orders and that there is no systematic departure with increasing length of path. Data for periods 400–480 seconds indicate a tendency for the group velocity curve to level off, suggesting that these long waves are influenced by a low or vanishing shear velocity in the core. Deduction of internal friction in the mantle from wave absorption, in terms of the parameter Q, gives $1/Q=370\times10^{-5}$ as a measure of the internal friction in the period range 250–350 seconds. In the previous paper it was calculated that $1/Q=670\times10^{-5}$ for periods of 140 seconds and 215 seconds. Whether the decrease in $1/Q$ is due to the dependence of internal friction upon period, or to the depedence upon depth as the longer waves reach greater depths within the mantle, cannot be decided until other types of evidence are used.—*P. E. B.*

159–129. Omote, Syun'itiro. On the coda waves of earthquake motions: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 666–670, 1949 (1953).

Three types of waves of different periods T_1, T_2, and T_3 are seen in coda waves. T_1 represents the period of waves propagated from the origin, the length of period increasing with epicentral distance because of internal friction in the crust. The two predominant periods T_2 and T_3 remain constant irrespective of their different distances; it is concluded that they represent free oscillation periods of the earth's surface layers.—*D. B. V.*

EARTHQUAKE OCCURRENCES AND EFFECTS

159–130. Rothé, Jean-Pierre, Mary, Jean, and Peterschmitt, Élie. Le séisme "profond" du 29 mars 1954 en Espagne [The deep earthquake of March 29, 1954 in Spain]: Acad. Sci. Paris Comptes Rendus, tome 238, no. 14, p. 1530–1531, 1954.

The epicenter of the violent earthquake of March 29, 1954, at 6^h 17^m G. m. t. has been located by the Strasbourg group at 36.9° N. lat., 3.3° W. long. The depth of focus was apparently 500 to 600 km. This is the first known deep focus outside the circumpacific belt.—*M. C. R.*

159–131. Eiby, G. A. The Waiau earthquakes of May 1948: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 622–628, 1949 (1953).

Series of earthquakes having a common epicenter caused considerable damage in the Hanmer and Waiau area of North Canterbury at the end of May 1948. This activity is supposedly associated with the Hope fault, which is known to have been active at the end of last century. A map showing the location of the fault, the epicenter, and approximate isoseismals for the strongest shock is given, together with an account of the noninstrumental data.

Examination of the records of these shocks has enabled the tentative identification of phases on the records, and the rough evaluation of wave velocities. The phase S^* is shown to be prominent, and P_g to be weak or missing. P_n, P_g, and P^* give velocities comparable with those previously obtained. The value

for S_n is slightly lower, but owing to the nature of the data, this is not thought sufficient to be significant.—*Author's summary.*

159–132. Ketin, I., and Roesli, F. Makroseismische Untersuchungen über das nordwestanatolische Beben vom 18. März 1953 [Macroseismic investigations of the northwest Anatolia earthquake of March 18, 1953]: Eclogae geol. Helvetiae, v. 46, no. 2, p. 187–208, 1953.

The Gönen-Yenice earthquake of March 18, 1953 was a continuation of movement along the active "Pontic" faultline of northern Anatolia, one of the great geotectonic features of the Mediterranean orogenic belt, comparable to the San Andreas fault of California. Except for the fact that no vertical displacement occurred, the 50-km faultline formed by this earthquake resembled other recent faults of the area. In general, horizontal displacements of 3.5 to more than 4 meters and vertical displacements of 0.4 to 1.0 meter have occurred, with the central Anatolian block moving westward with respect to the marginal strip of the Black Sea "Pontic" block and the north in most places being the downthrown side. The total length of recent faults is 800–900 km.—*D. B. V.*

159–133. Tams, Ernst. Über die Wandlungen der Ansichten von der Entstehung der Erdbeben seit Alexander von Humboldt [Changes in opinions on the origin of earthquakes since Alexander van Humboldt]: Forschungen u. Fortschr., Jahrg. 28, Heft 8, p. 225–232, 1954.

This is the text of an address before the Zentralinstitut für Erdbebenforschung of the Deutsche Akademie der Wissenschaften April 28, 1954. Theories of the origin of earthquakes from Alexander von Humboldt to the present are reviewed.—*S. T. V.*

159–134. Montandon, Frédéric. Les tremblements de terre destructeurs en Europe [Destructive earthquakes in Europe]: 195 p., Geneve, 7 Avenue de la Paix, 1953.

This is a catalog of destructive earthquakes in Europe arranged by regions, from 1000 to 1940 A. D. A bibiliography, a map of the centers of diastrous and catastrophic shocks, and a discussion of intensity scales are included.—*M. C. R.*

159–135. Tams, E[rnst]. Uber Gruppenbildung bei Erdbeben in der rheinischen Region nebst Nachbarschaft [The distribution of earthquakes in the region and vicinity of the Rhine]: Zeitschr. Geophysik, Sonderband, p. 92–100, 1953.

Using the data in the recently published catalog of earthquakes in Germany during the years 1800–1899, Tams discusses the earthquakes and seismic character of different parts of the Rhine River region.—*S. T. V.*

159–136. Richter, C. F. Seismicity and structure of the Pacific region of North America: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 671–684, 1949 (1953).

There is abundant and often convincing evidence that local stresses in the crust have altered significantly in relatively short periods of geologic time, perhaps only a few thousand years. As this is considerably longer than any time for which we have reliable seismic data, the present pattern of world seismicity, which appears nearly static from year to year, may nevertheless be changing quite rapidly from the point of view of the geologist or historically minded geophysicist.

The principal features of the geologic structure and seismology of Pacific North America, which include the typical active arc of the Aleutians and western Alaska, a region of block displacements extending from Alaska to Mexico, and the complex arc system of Mexico, Central America, and the West Indies, are described in general terms. This is followed by a discussion of more detailed results for California, which has been more thoroughly investigated than the rest of the region.—*D. B. V.*

159–137. Kawasumi, Hirosi. Map of the origins, meizoseismic areas, and systems of the large earthquakes in Japan since historical times: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 646–648, 1949 (1953).

This paper presents a map of meizoseismic areas (areas in which wooden houses are demolished) of earthquakes in Japan since earliest historic times, based on data from the nearly complete posthumous work of Imamura entitled "General View of Large Earthquakes in Japan." The seismic systems worked out by Imamura are listed.—*D. B. V.*

159–138. Wadati, Kiyoo, and Musya, Kinkiti. Seismic activity in Japan during 1700–1948: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 695–697, 1949 (1953).

Statistical study of past seismic activity in Japan may lead to a method of earthquake prediction. Toward this end, large earthquakes since the 18th century are plotted on a map, with order of occurrence indicated as well as the location of active and dormant volcanoes. The relation of seismic to volcanic activity is shown graphically.—*D. B. V.*

159–139. Wadati, K[iyoo], and Sagisaka, K. Seismic activity in Japan in the period from 1923 to 1948: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 698–702, 1949 (1953).

Reports issued by the Seismological Station of the Central Meteorological Office of Japan in the 25-year period beginning in 1923 are summarized. A total of 237 shallow earthquakes are classified as notable, on the basis of felt area (138 were felt over a 300–400 km radius, 48 over a 400–500 km radius, and 51 over a still wider area.) Notable deep-focus earthquakes included 44 at depths of 100–200 km and 85 over 200 km deep, totalling 129. Maps show the distribution of these shallow and deep earthquakes and the annual mean number of shocks at various places; the time distribution of the shallow earthquakes is presented graphically.—*D. B. V.*

159–140. Hayes, R. C. Some aspects of earthquake activity in the New Zealand region: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 629–636, 1949 (1953).

Three aspects of earthquake activity are discussed with special reference to their application in the New Zealand region: distribution of epicenters (including maps showing all epicenters for 1940–47, epicenters and depths of deeper than normal shocks in the same period, and epicenters of shocks of magnitude 5 or greater); distribution of surface intensity (including an analysis of three isoseismal maps based on noninstrumental data); and correlation of instrumental magnitudes with focal depth, epicentral intensity, and radius of felt area (including a table of the 16 major earthquakes of New Zealand in order of magnitude.)—*D. B. V.*

159–141. Bastings, L., and Banwell, C. J. The future of seismology in New Zealand: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 610–611, 1949 (1953).

New Zealand might be described as specializing in damaging (Rossi-Forel 8) rather than destructive (Rossi-Forel 9 and 10) earthquakes. Its seismicity for all three of these intensities is twice as great as Japan's and three times as great as California's. The practical implications are that the research problem is easier to cope with instrumentally than in most other seismic countries, and that design of earthquake-resistant structures is less exacting.

With suitable equipment, New Zealand should be able to make a substantial contribution in the strong-motion field, and it is recommended that more attention be devoted to this aspect. A network of 80 to 100 instruments, located at intervals of 25 miles throughout the more seismic half of the country, would be required. Several suggestions for carrying out such a scheme economically are offered.—*D. B. V.*

159–142. Mühlhäuser, S. Die Richtung der ersten Bodenbewegung (Kompression oder Dilatation) in Stuttgart fur die Hauptbebengebiete der Erde, als Grundlage fur grosstektonische Betrachtungen [The direction of the initial motion (compression or dilatation) at Stuttgart for the principal seismic regions of the earth as the basis for major tectonic considerations]: Zeitschr. Geophysik, Sonderband, p. 76–91, 1953.

A study has been made of the direction of the initial motion of the longitudinal wave from earthquakes in all parts of the world observed at Stuttgart during the years 1930–43 and 1947–51. Results are discussed for 21 seismic regions and are also shown on maps. In many, especially for focal regions of limited extent, there is a correlation between the geographic position and the direction of the initial motion. This correlation is more often pronounced for foci at the same depth and sometimes changes when an earthquake occurred at a new focus in the same geographic location, but at a different depth.—*S. T. V.*

159–143. Machado, Frédérico. Earthquake intensity anomalies and magma chambers of Azorean volcanoes: Am. Geophys. Union Trans., v. 35, no. 5, p. 833–837, 1954.

A procedure for finding a theoretical earthquake intensity is proposed, and the anomaly is defined as the difference between observed and theoretical intensities. Interpretation of the anomalies is discussed. Application of the method to an Azorean earthquake shows conspicuous negative anomalies, which appear to indicate the probable emplacement of magma chambers of the volcanic system formed by Fayal and Pico Islands.—*Author's abstract*

159–144. Kullenberg, B. Remarks on the Grand Banks turbidity current: Deep-Sea Research, v. 1, no. 4, p. 203–210, 1954.

The hypothesis is discussed that a turbidity current caused the breaks in the submarine cables lying downslope of the epicentral area of the 1929 Grand Banks earthquake. An inspection of the bottom topography makes it appear impracticable for the turbidity current to have approached from the north and to have caused several of the cable breaks ascribed to it. Though the hypothesis of a turbidity current is able to account for the fact that the cables were broken in sequence from north to south, it is not able to explain why distant breaks on

one and the same cable occurred simultaneously. The direction chosen by the turbidity current indicated by the cable breaks is to the left of the general direction of the slope, whereas it should be slightly to the right of the slope, in view of the action of the deflecting force of the earth's rotation. It is demonstrated that a turbidity current with a limited length should rapidly lose suspension in the rear and become considerably thinner and slower.—*Author's abstract*

159–145. Heezen, Bruce C., Ericson, D. B., and Ewing, Maurice. Further evidence for a turbidity current following the 1929 Grand Banks earthquake: Deep-Sea Research, v. 1, no. 4, p. 193–202, 1954.

Evidence indicates that the top layer of sediment covering the abyssal plain south of the Grand Banks is silt and sand. Two piston-sediment cores show top layers consisting of 130 and 70 centimeters of graded silt and sand overlying foraminiferal clay of abyssal facies. The absence of an overlying abyssal facies indicates the recent deposition of the graded layers.

The presence of the silt and sand layer is further evidence in support of the hypothesis of Heezen and Ewing (1952) that slumps initiated by the 1929 Grand Banks earthquake were transformed into a turbidity current which swept downslope, broke and carried away the submarine telegraph cables, destroyed bottom life, and deposited a large quantity of sediments far out into the ocean basin. The graded silt and sand layers in the cores is near to the 40–100 centimeters thickness predicted by Kuenen (1952).

These layers of silt and sand are also further evidence for the hypothesis that the abyssal plains with their flat gently sloping surface were formed by ponded or otherwise spent turbidity currents.—*V. S. N.*

159–146. Wadati, W., and Hirono, T. A preliminary report on the propagation of tsunami (earthquake tidal waves) in the Pacific Ocean: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 689–694, 1949 (1953).

The travel times and intensity of tsunamis have been investigated geometrically in hopes of finding a method of predicting their arrival at the various coasts and islands. Data from four great earthquakes are used: the Sanriku, of March 2, 1933; the Nankaido, of December 20, 1946; one in the Aleutians on April 1, 1946; and one presumably off the Philippines, date not given. Assuming the velocity of tsunamis to be $\sqrt{9h}$, the successive wave-fronts at intervals of 5, 10, and 20 seconds were calculated after Huygen's principle and presented in seven maps, which also show the energy of the wave at each place (calculated on the assumption that total energy at origin equals 1). Observed and calculated wave heights and travel times from the Sanriku earthquake are given in two tables.—*D. B. V.*

159–147. Macdonald, Gordon A., and Wentworth, Chester K. The tsunami of Nov. 4, 1952 on the island of Hawaii: Seismol. Soc. America Bull., v. 44, no. 3, p. 463–469, 1954.

The strong earthquake that originated near the southeastern coast of Kamchatka on November 4, 1952, was accompanied by a tsunami that caused minor damage in the Hawaiian Islands. The maximum heights at Hilo, Hawaii were about 12 feet. Around most of the island the heights were very much less than for the tsunami of April 1, 1946, and at many places no rise of water level was detected. Damage resulted almost entirely from relatively gentle flooding. Differences between the tsunamis, such as direction of approach, largest wave in

the series, and "screening" effect of islands, indicate that considerable additional observations are needed to strengthen the predictions of effects.—*P. E. B.*

159–148. Miyamura, Setumi. Notes on the geography of earthquake damage distribution: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 653–661, 1949 (1953).

Study of the geographical distribution of damage resulting from the Tokaido (December 7, 1944) and Nankaido (December 21, 1946) earthquakes leads to the conclusion that the nature of the ground is more important than architectural considerations. Although alluvial plains generally suffer more damage than bedrock areas, not all flat plains are equally affected. Most severe damage occurs on mud plains such as deltas, drowned valleys, reclaimed lagoons, muddy alluvium, and artificially made land. On the other hand, gravel plains such as littoral sand dunes, bars, spits, and flood plains of river fans are relatively safer, a fact attributed to the coarser nature of their materials.—*D. B. V.*

159–149. Tayama, Risaburo, and Nakayama, Rurio. Changes of depth in Atumi Bay accompanying Mikawa earthquake in 1945: Pacific Sci. Asso., 7th Cong., Proc., v. 2, p. 682–684, 1949 (1953).

Precise soundings were carried out in Atumi Bay in order to ascertain depth changes due to the Mikawa earthquake of January 13, 1945. Isometric lines of changes of depth are presented on a map. It is concluded that a block east of Hazu Hill was thrust forward in a south-southwesterly direction, and that resistance of opposing blocks produced the resulting pattern of upheaval and subsidence.—*D. B. V.*

159–150. Tayama, Risaburo, and Chino, Sumihiko. Submarine topography in the vicinity of the epicentre of Nankai earthquake in 1946: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 685–688, 1949 (1953).

A bathymetric survey was made of the epicentral region of the Nankaido earthquake of December 21, 1946. Although sea bottom changes as revealed by comparison of the new profiles with those of 1945 are within the limits of measurement error, it is concluded from structural considerations that the Nankaido earthquake accompanied secondary activity on some geotectonic line.—*D. B. V.*

159–151. Belousov, V. V., Gorshkov, G. P., and Petrushevskiy, B. A. Po povodu stat'i I. Ye. Gubina "O seysmicheskom rayonirovanii yugo-zapadnoy Turkmenii" [On I. Ye. Gubin's article "On the seismic zoning of southwestern Turkmen SSR]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 443–450, 1954.

Gubin's studies of the seismotectonic method of seismic zoning (see Geophys. Abs. 13849, 14053) contain many contradictions, as admitted by Gubin, and in the final analysis, his evaluation was based on preceding seismic history or old seismostatistical data.—*S. T. V.*

159–152. Medvedev, S. V. Novaya seysmicheskaya shkala [A new seismic scale]: Akad. Nauk SSSR. Geofiz. Inst. Trudy, no. 21 (148), p. 110–114, 1953.

The proposed scale is based on the amount of elastic displacement produced by an earthquake on a special vibrometer, which is an elastic pendulum adjusted to the same natural frequency as the majority of the buildings in the surrounding area. No details of the instrument are given.—*S. T. V.*

SEISMIC SURVEYS

159–153. Drake, Charles L., Worzel, J. Lamar, and Beckmann, Walter C. Geophysical investigations in the emerged and submerged Atlantic Coastal Plain: Part IX. Gulf of Maine: Geol. Soc. America Bull., v. 65, no. 10, p. 957–970, 1954.

Seismic-refraction measurements were made in the Gulf of Maine in 1948 and 1951 as a continuation of the program of geophysical exploration of the continental margins. Sections from Portland, Maine, to the northwest edge of Georges Bank, from Matinicus Rock, Maine to Cultivator Shoal, and from Cape Ann, Mass., to Yarmouth, Nova Scotia, were observed.

Sediments (with velocities of 5,030 to 6,780 fps) varied in thickness from 0 to 1,020 feet. North and east of Cashes Ledge consolidated sediments (with velocities of 12,000 to 13,000 fps) were detected up to 1,620 feet thick. These are tentatively identified as Triassic and possibly represent an extension of the Fundy Basin. Basement rocks (with velocities of 15,000 to 18,000 fps) thicken under New England and form a troughlike feature off Nova Scotia. Remarkably uniform subbasement rocks (with velocities of 19,000 to 20,000 fps) underlie the Gulf of Maine.—*Authors Abstract*

159–154. Stahl, Pierre. Seismische Messungen der französischen Polarexpedition in Grönland und Island [Seismic measurements of the French polar expedition in Greenland and Iceland]: Zeitschr. Geophysik, Sonderband, p. 68–75, 1953.

Seismic surveys were conducted by the Expeditions Polaires Françaises in Greenland and Iceland from 1936 to 1952. The investigations included determinations of the thickness of the ice in different parts of the region and of the corresponding seismic velocities. Four velocities were distinguished in the ice, varying slightly with the depth, temperature, and density of the ice; in the firn (in the upper layer of half-frozen snow); in the detritus; and in the solid ground under the ice.

The greatest thickness of the ice was 3,050 m in Greenland. The maximum velocity in ice was 3,950 m per sec.; in the firn the velocity ranged from 1,000 to 2,000 m per sec. in the first 10 m depth; and in the rock, velocities were 4,800 to 5,450 m per sec.

Anisotropy in the upper layer of the ice cover was found, with the velocity in the north-south direction 3,300 m per sec., and in the east-west direction 3,600 m per sec. This is explained as the result of numerous crevices in the upper layer, which do not persist into the deeper layers. Tranverse velocities were about 1,925 m per sec. The velocity of Rayleigh waves in ice was about 1,780 m per sec., and in firn 1,600 m per sec.—*S. T. V.*

159–155. Reich, H[ermann]. Über seismische Beobachtungen der Prakla von Reflexionen aus grossen Tiefen bei den grossen Steinbruch-Sprengungen in Blaubeuren am 4. Marz und am 10. Mai 1952 [Observations of reflections from great depths, originating from the large quarry blasts of Blaubeuren on March 4 and May 10, 1952, registered by the Prakla seismograph]: Geol. Jahrb., Band 68, p. 225–240, 1954.

Very good reflections were registered by the modern reflection equipment of the Prakla Company 7.075 and 9.20 seconds after the two large quarry blasts in Blaubeuren on March 4 and May 10, 1952. It is clear that these reflections come from great depths in the crust. Using the velocity values obtained in the Haslach explosion of 1948, one obtains depths of 20.3 km for the first reflecting

surface and 27.6 km for the second. Thus we can think of the first surface as the boundary between the so-called granite layer and the gabbro layer (that is, the Conrad discontinuity) and of the second surface as the boundary of the gabbro layer against the peridotite layer (that is, the Mohorovičić discontinuity). The clarity of the measured reflections is noteworthy and indicates that these boundaries are not transitions from one rock type to another, but sharp boundary surface (discontinuities).—*Author's abstract, H. S.*

159–156. Reasoner, M. A., and Hunt, A. D. Smiley oil field, Saskatchewan: Canadian Min. Metall. Bull., v. 47, no. 509, p. 612–617, 1954.

At the Smiley field, Saskatchewan, draping and compaction of beds of Cretaceous age over the Paleozoic erosional surface has resulted in structure of moderate relief which reflects the valleys and hills of the buried topography. Oil is produced from the Viking sand at depths of about 2,000 feet. The erosional surface, as mapped using the reflection seismograph, agreed remarkably with the drilling results.—*L. C. P.*

159–157. Hodgson, John H. A seismic survey in the Canadian shield: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 637–638, 1949 (1953).

A program of crustal study by means of seismic investigation of rock bursts has been carried on in the vicinity of the gold mines at Kirkland Lake, Ontario. Because distances and altitudes have not yet been accurately surveyed, analysis of results is tentative. Variations of P and S in the granitic layer are explainable in terms of the known geology. The best average values appear to be 6.03 and 3.43 kmps for P and S, respectively, yielding a value of Poisson's ratio of 0.26. Velocities below the Mohorovičić discontinuity are 8.20 kmps for P and 4.75 kmps for S, giving $\sigma=0.25$. No definite values have yet been determined for the intermediate layers. Probably the "granitic layer" in this area is simply the Pre-Cambrian complex.—*D. B. V.*

159–158. Wantland, Dart. Examples of geophysical exploration for uranium: Mines Mag., v. 44, no. 9, p. 26–33, 1954.

A buried Triassic channel system at Nokai Mesa, Navajo County, Ariz. was successfully mapped by the seismic-refraction method.—*L. C. P.*

159–159. Majno, Ciro. Misure nei pozzi della velocita di propagazione delle onde sismiche [Measurements of the velocity of propagation of seismic waves in drill holes]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti. v. 1, p. 435–442, 1952.

Determinations of the velocity of seismic waves were made in the valley of the Po near Cremona by producing explosions on the surface of the earth at different distances from a drill hole in which seismographs were suspended at different depths. The velocity thus determined is closely approximated by the formula $V_z=1{,}700$ m per sec $+0.00439z$, where z is the depth in meters. The same formula is said to be applicable in the valleys of California.—*S. T. V.*

159–160. Kurihara, Shigetoshi. Seismic prospecting at Onahama District in Joban coal field, Fukushima prefecture [in Japanese with resumé in English]: Geol. Survey Japan Bull., v. 4, no. 8, p. 41–48, 1953.

The geologic structure in the Onahama district was determined by seismic refraction and reflection surveys in 1947. The most suitable areas for exploitation were recommended on the basis of the results.—*M. C. R.*

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MICROSEISMS

159–161. Donn, William L. Direction studies using microseism ground-particle motion: Am. Geophys. Union Trans., v. 35, no. 5, p. 821–832, 1954.

Ground-particle trajectories were constructed for Palisades' microseisms originating in storms having various positions and azimuths with respect to the continental margin. It was found that good directional success was obtained for sources on the continental shelf or for deepwater storms on an azimuth normal to the continental margin. The complete lack of directional relationship between particle motion and source direction for deepwater sources having azimuths oblique to the coast is ascribed to simple refraction or interference between waves having multiple refraction paths. Microseisms arriving at Palisades with 8- to 9-second period and 1- to 2-micron ground amplitude have been traced back to North Pacific sources more than 5,000 km away. Very good directional correlation was obtained in these cases between ground-particle motion and source direction. The results of the study appear to explain the original tripartite success of Ramirez in obtaining good locations for Atlantic storms.—*Author's abstract*

159–162. Jones W. M. New Zealand microseisms and their relation to weather conditions (abstract): Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 638, 1949 (1953).

Relative microseismic amplitudes and dominant periods, as recorded principally on the Galitzin-Wilip seismograph at Wellington, have been measured and compared with the courses of 15 cyclonic disturbances. The positions of the storm centres at the times of maximum microseismic amplitudes are varied, sometimes over deep water, at other times on or near land. Strong southerly winds at Wellington are usually accompanied by a microseismic storm, but in other cases large amplitudes are recorded when conditions over New Zealand are calm. The longer periods, 6 to 8 seconds, are usually developed when there is a distant storm centre, but have been observed with storm centres less than 500 miles away.

The passage of cold fronts through Wellington is frequently accompanied by the development of microseismic periods of 3 to 4 seconds. These commence at about the same time as the change to southerly winds, and, with cold fronts coming up from the south, are observed at Christchurch a few hours before Wellington.

A comparison has been made of dominant microseismic periods with periods of "significant" waves observed visually on the coast at Island Bay. For a series of 33 observations, it was found that the average wave period was twice that of the microseismic period, at the same time or 12 hours earlier.—*Author's abstract*

159–163. Bernard, Pierre. Variation annuelle de l'agitation microséismique à Brisbane [Annual variation of microseisms at Brisbane]: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 612–613, 1949 (1953).

The microseismic disturbance at Brisbane shows its maximum in June, and therefore follows the annual variation of southern temperate regions, but, owing to the low latitude of the station, the amplitude of the annual sinusoidal component is small compared to the results of Parc St. Maur. The mean intensity of microseismic disturbance itself seems to be little in the subtropical regions (between the tropics and 35° lat).—*Author's summary*

ISOTOPE STUDIES AND AGE DETERMINATIONS

159–164. Huizenga, J. R., and Stevens, C. M. New long-lived isotopes of lead: Phys. Rev., v. 96, no. 2, p. 547–549, 1954.

The possible importance of Pb^{202} and Pb^{205} in cosmological problems lead to a search for these isotopes by long deuteron bombardments of two samples of thallium. The lead was then separated and one sample analyzed in a mass spectrometer, the other in a scintillation spectrometer. The half life of Pb^{202} was calculated to be about 3×10^5 years. It is more difficult to set a lower limit on the half life of Pb^{205}; the *K*-capture half life is greater than 6×10^7 years and the *L*-capture half life is certainly as long as that of Pb^{202} and probably much longer.—*M. C. R.*

159–165. Lopez de Azcona, Juan Manuel. Procedencia del A^{40} de nuestro planeta [Origin of A^{40} of our planet]: Inst. geol. min. España, notas y comunicaciones, no. 34, p. 17–26, 1954.

Most A^{40} is probably radiogenic, evolved from potassium or even uranium. The atmosphere is a secondary, planetary phenomenon. Most of the degasification of the lithosphere took place in preerosional times; the amount of A^{40} liberated between the time of the formation of the earth and that of the oldest known formations is of approximately the same order as the present A^{40} content of the atmosphere and hydrosphere, the contribution during the last 2,000 million years being of little importance. Only the same few kilometers of rock have been involved in the erosion cycle, being constantly reworked, and hence there has been no important addition of A^{40} from this source.—*D. B. V.*

159–166. Wetherill, George W. Variations in the isotopic abundances of neon and argon extracted from radioactive minerals: Phys. Rev., v. 96, no. 3, p. 679–683, 1954.

Large excesses of Ne^{21}, Ne^{22}, and A^{38} have been found in uranium and thorium minerals. These abnormal abundances are ascribed to (α, n) and (α, p) reactions in the minerals. It is shown that it is possible that a part of the atmospheric Ne^{21} originated in this way.—*Author's abstract*

159–167. Holmes, Arthur, and Besairie, Henri. Sur quelques measures de géochronologie à Madagascar [On some measurements of geochronology at Madagascar]: Acad. Sci. Paris Comptes Rendus, tome 238, no. 7, p. 758–760, 1954.

Ages have been determined for seven samples from Madagascar, four analyzed at Teddington and three at the Billingham Division of Imperial Industries, Limited. Four events in pre-Karroo geologic history are thus dated: about 255 million years, 485 million years, 700(?) million years, and still older granites and pegmatites.—*M. C. R.*

159–168. Kröll, Viktor S. On the age-determination in deep-sea sediments by radium measurements: Deep-Sea Research, v. 1, no. 4, p. 211–215, 1954.

The possibility of dating deep-sea sediments by radioactive measurements is discussed. The vertical distribution of radium is mainly influenced by three factors, namely the rate of accumulation of ionium, the total rate of deposition, and the diffusion and adsorption of radium or ionium. Hence a knowledge of the geochemistry of the radioactive elements is necessary to obtain the dating.—*Author's abstract*

159–169. Naughton, John J., and Terada, Kazuji. Effect of eruption of Hawaiian volcanoes on the composition and carbon isotope content of associated volcanic and fumarolic gases: Science, v. 120, no. 3119, p. 580–581, 1954.

Samples of gas secured at Sulfur Bank solfataric fumarole and from a lava flow before it cooled were analyzed by a low-pressure technique capable of analyzing samples of 0.01 cc and detecting components present to the extent of 0.2 percent by volume. Some carbon dioxide was retained and purified for use in carbon isotopic analysis. Great differences in the composition of the gas between times of eruption and quiescence were noted, especially in the CO_2, O_2, and N_2 contents. During the quiet period, there is strong indication of air contamination from the presence of nitrogen and oxygen in the gas. In three samples from the Sulfur Bank fumarole, constant C^{12}/C^{13} ratio was obtained, despite the eruption or dormancy of the adjacent volcanoes, and in general the fumarolic carbon dioxide was "heavier" than gas extracted from the lava or above the active lava flow.—*M. C. R.*

RADIOACTIVITY

RADIOACTIVITY CONSTANTS

159–170. Suttle, A. D., Jr., and Libby, W. F. Natural radioactivity of rhenium: Phys. Rev., v. 95, no. 3, p. 866–867, 1954.

On the basis of new and lower measurements of the energy of beta radiation, the half life of rhenium 187 must be 10^{11} years or less. The natural radioactivity of rhenium may correspond to a half life as short as a few billion years in which case the accumulation of osmium 187, the daughter isotope, in old rocks should be observable.—*M. C. R.*

159–171. Beard, George, and Wiedenbeck, M. L. Natural radioactivity of Sm^{147}: Phys. Rev., v. 95, no. 5, p. 1245–1246, 1954.

The half life of Sm^{147} has been measured to be $1.25 \pm 0.06 \times 10^{11}$ years with an energy distribution corresponding to the emission of monoenergetic alpha particles.—*Authors' abstract*

159–172. Herr, W., Hinterberger, H., and Voshage, H. Half life of rhenium: Phys. Rev., v. 95, no. 6, p. 1691, 1954.

A specimen of molybdenite was analyzed and 0.32 percent rhenium and 0.00161 percent osmium found. The half life is then obtained from $T(Re^{187}) = 91.7t$ where t is the age of the mineral. The age of the mineral is unknown but cannot be less than 50 million years or more than 2,500 million years, and the half life is therefore between 5×10^9 and 2.5×10^{11} years. A reasonable age of 500 million years for the mineral would indicate a half life of 5×10^{10} years.—*M. C. R.*

159–173. Hinterberger, H., Herr, W., and Voshage, H. Radiogenic osmium from rhenium-containing molybdenite: Phys. Rev., v. 95, no. 6, p. 1690–1691, 1954.

To 139 grams of molybdenite containing 0.32 percent rhenium, 0.147 milligram of ordinary osmium was added, and 2.26 milligrams of osmium was recovered. A 0.28 milligram sample was analyzed in a 60° mass spectrometer, and the mass spectogram of osmium identified in five places. In each, the line corresponding

to the isotope of mass 187 was greatly enhanced compared with that of ordinary osmium. According to the isobar rule, the radioactivity of rhenium must be attributed to the 187 isotope. From the measured abundances of the isotopes and the quantities of added and recovered osmium, it follows that at least 99.5 percent of the osmium originally present in the mineral is radiogenic.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

159–174. Wilson, E. E., Rhoden, V. C., Vaughn, W. W., and Faul, Henry. Portable scintillation counters for geologic use: U. S. Geol. Survey Circ. 353, 10 p., 1954.

A small, light portable scintillation counter designed primarily for geologic field use embodies a very fast trigger amplifier and a compact relaxation-oscillator power supply. The circuit takes full advantage of the high counting rate that can be obtained from a sodium iodide crystal. The counter can be used in automobiles and small aircraft without modification. The basic circuit has also been modified for gamma-ray logging of holes as deep as 1,000 feet. A smaller and lighter scintillation counter of the total intensity type is being tested.—*M. C. R.*

159–175. Blanc, Daniel. Le comportement des compteurs de Geiger-Müller à graphitage externe aux taux de comptage élevés [Behavior of Geiger-Müller counters with external graphite cathodes at high counting rates]: Jour. Physique et Radium, tome 15, no. 10, p. 693–694, 1954.

Counters of the Maze type with external cathodes, originally made for cosmic-ray studies, are suitable for higher counting rates as well. As the counting rate increases, the Geiger threshold rises and the semiproportional region widens. The slope and length of the plateau both increase but stability remains good up to several hundred thousand counts per minute.—*H. F.*

159–176. Wright, Robert J. Prospecting with a counter: 68 p., Washington, U. S. Atomic Energy Commission, 1954.

Information on field counters, their operation, use, abuse, and application in prospecting, mining, and geologic problems is summarized in this booklet. A list of manufacturers and distributors of portable radiation detection instruments suitable for prospecting is included.—*M. C. R.*

159–177. Lobdell, David S., Buckley, E. F., and Merritt, John W. Gamma ray exploration comes of age: World Oil, v. 139, no. 2, p. 107–112, 1954.

Oil accumulations may be outlined by detecting surface radiation associated with buried hydrocarbons. A greater radiation intensity is found on the edges of pools with a low level of radiation over the main body. Differences may be small. Reconnaissance by helicopter is feasible but conventional airborne surveying equipment is too fast and tends to smooth out marginal bands.—*M. C. R.*

159–178. Foote, Royal S. Airborne exploration for uranium: Mines Mag., v. 44, no. 10, p. 29–30, 1954.

Airborne radiation surveying, using a scintillation-type counter mounted in a light aircraft, has proved to be a rapid, cheap, and effective method of exploration for uranium. The actual size and grade of deposits that can be detected depends upon the altitude of the survey, the speed at which the aircraft flies,

and the type of instruments used. Several hundred square feet of 0.1 percent U_3O_8 ore may be detected from an altitude of 100 feet. At higher altitudes (200 to 500 feet) all outcrops larger than 1,000 square feet with a grade of 0.2 or 0.3 percent U_3O_8 should be detected (the ore must be exposed at the surface). There are two types of flying: "rim" flying for local geologic features, and "grid" flying for surveying larger areas. Contract costs for airborne radiation surveys range from $2.00 to $9.00 per surveyed mile. If airborne facilities are established by the operator, costs should run between $1.50 and $3.00 per surveyed mile.—*L. C. P.*

159–179. Trudu, Renato. Metodi e carotaggi radioattivi [Radioactivity logging methods]: Convegno naz. metano e petrolio, 7mo, Taorimina 1952, Atti, v. 1, p. 487–493, 1952.

Methods of radioactivity logging, both gamma ray and neutron, are briefly discussed, their physical bases explained, and instruments used are described. The applications of these methods in practical cases are described, and the advantages and drawbacks indicated. One of the greatest advantages is the possibility of using these methods in cased drill holes.—*S. T. V.*

159–180. Muratori, Giovanni. Metodi e strumenti di carotaggio radioattivo [Methods and instruments of radioactivity logging]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, p. 475–486, 1952.

Physical bases of radioactivity logging, both gamma and neutron, are discussed and instruments used are described. Several parallel profiles obtained by radioactivity logging and by electric methods are shown. Interpretation is shown by practical examples.—*S. T. V.*

Mathieu, Jean Léon. Some new applications of the Schlumberger methods. See Geophys. Abs. 159–67.

RADIOACTIVITY OF ROCKS, WATERS, AND AIR

159–181. Mawdsley, J. B. Radioactive, pronouncedly differentiated pegmatite sill, Lac La Ronge district, Northern Saskatchewan: Econ. Geology, v. 49, no. 6, p. 616–624, 1954.

Five miles east of Hunter bay, Lac La Ronge, is an irregular pegmatite sill, about 40 feet thick, intruding metamorphosed sediments. It is composed of three facies: an upper margin 2 inches thick of fine-grained (¼ to ½ inch) oligoclase and quartz; next is 10 feet or more or coarse (4 to 6 inches) crystals, chiefly salmon-pink microcline with some peach-colored oligoclase, both graphically intergrown with quartz; and, a central band 4 feet, or more, thick of salmon-pink microcline-perthite crystals up to 2 feet long with interstitial glassy quartz. The same two outer zones are repeated below the central zone.

The central band is not radioactive, but monazite is found in one area in the upper band of the intermediate facies, and uraninite is found in the upper marginal facies, and in the immediately adjacent, coarse mica schist. At a gablelike part of the upper contact of the sill, over a length of 8 feet, and across a width of 1 to 4 inches, numerous crystals of uraninite up to 1 inch in diameter have been obtained. Along the same contact is a similar, but less rich occurrence, and a scintillometer survey obtained a number of above-background readings elsewhere near the inferred upper contact of the sill.

The concentration of the uraninite on the hanging wall of the sill may have occurred partly at the time of consolidation of the marginal facies and partly during the final solidification of the skill.—*Author's abstract*

159–182. Sarrot-Reynauld de Cresseneuil, Jean. Essai d'application des méthodes de la radiocristallographie et de la radioactivité à la geologie [Attempt at application of the methods of X-ray crystallography and radioactivity to geology] : Grenoble Univ. Lab. geologie Travaux, tome 30, p. 37–41, 1952 [1953].

A combination of field work, X-ray powder analysis of samples, and radioactivity measurements is more effective than any one of these methods alone in study of the complex structure in the Montgirod-les-Chapelles coal mine, near Bourg-Saint-Maurice, on the Isère near Landry.—*D. B. V.*

159–183. Sarrot-Reynauld de Cresseneuil, J[ean]. Étude des propriétés radioactives du Houiller alpin [Study of the radioactive properties of the Alpine coal basin] : Grenoble Univ. Lab. geologie Traveaux, tome 30, p. 43–54, 1952 [1953].

This paper presents the results of beta-radiation measurements made on samples taken along the walls and roof of galleries in three coal mines—Montgirod-les-Chapelles, near Bourg-Saint-Maurice; Boutière, near Laval; and La Mure (Villaret). A thin-walled Geiger counter was used. Such data should prove useful to the coal industry as a supplement to gamma-ray measurements in working out problems in the Alpine coal basin.—*D. B. V.*

159–184. Kimura, Kenjiro. Geochemical studies on the radioactive springs in Japan : Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 485–499, 1949 (1953).

Geochemical studies have been made of a number of strongly radioactive springs in Japan. The highest radon content, 12,000 Mache units, was recorded at a small spring at Masutomi; another in the same area maintains a radon content of 5,000 Mache units. A spring in the Misasa region contains about 450 Mache units of thoron. Springs containing unusually high amounts of polonium, thorium X, actinium X, and other radioactive products have also been recorded in the mineral spring regions of Japan.

The study of the equilibrium relationships of these radioactive elements indicates that the sources of radon are not too deep in the earth. Tables are given listing the most strongly radioactive springs of the world; depth of radon source estimated from equilibrium relationships; and the radium and thorium X content of 10 springs, the thoron content of 17 springs, and the radium A, B, C, F, and thorium B content of 10 springs.—*D. B. V.*

159–185. Kamada, Masaakira. Radioactivity of volcanic gas : Tōhoku Univ. Sci. Repts., 1st ser., v. 37, no. 1, p. 117–124, 1953.

Presence of radon, radium A, radium B, radium C, thoron, thorium A, and thorium B has been identified in volcanic gases in Japan but actinon has not yet been confirmed. Measurements with an I. M. fontactoscope indicate that the radioactivities of volcanic gases are not negligible and are often comparable to those of gases issuing from strongly radioactive mineral springs. The thoron content of as much as 11,300 Mache units for the Shiratori fumarole gas in the Kirishima volcanic region is the world's largest known value. Studies of samples

from the Kirishima region indicate that the radon contents of fumarole gases are almost constant, unlike those of the radioactive springs. All fumaroles issued from eruptive rocks. In fumaroles accompanied by hot waters, there was an abnormal partition of radon and thoron, indicating that the origin was in the volcanic gas rather than in the hot water or in ground water near the surface. The Tn/Rn ratio did not differ much from one fumarole to another; their origin then is presumably near the surface. If it is possible to determine An in volcanic gases, the actinon may be used as a tracer to determine more accurately the movement of the gases.—*M. C. R.*

159–186. Anderson, W., Mayneord, W. V., and Turner, R. C. The radon content of the atmosphere: Nature, v. 174, no. 4427, p. 424–426, 1954.

A series of measurements at the Royal Cancer Hospital in London indicates that the radon content of air samples taken on the roof of the building is on the average $2\text{–}3\times10^{-12}$ curie per liter. This amount is some twenty times that found early in the century by investigators in Montreal, Cambridge, and Chicago. The activity during smog may be 400 times that on a clear sunny day. The burning of coal and coal gas contributes to the atmospheric radon content; however, it is not possible at present to assess with accuracy the fraction attributable to this process.—*R. G. H.*

159–187. Hess, Victor F., and Parkinson, W. Dudley. On the contribution of alpha rays from the ground to the total ionization of the lower atmosphere: Am. Geophys. Union Trans., v. 35, no. 6, p. 869–871, 1954.

The contribution of small ions produced by alpha particles near the ground to the total ion content 1 meter above the ground is estimated to be in general, rather small, about 5 to 10 per cent. The coefficient of eddy diffusion was assumed to be 0.5 cm^{-1} g sec^{-1} but is not critical.—*M. C. R.*

HEAT

159–188. Jacobs, J. A. The time factor in geological problems: Geol. Assoc. Canada Proc., v. 6, pt. 2, p. 83–86, 1954.

In examining the significance of radioactivity in geophysical problems, most investigators have assumed (for simplicity) a constant rate of heat generation, although its decrease during the Earth's lifetime is approximately 50 percent. A detailed study of the thermal history of the Earth is being carried out, particular regard being paid to this time factor. A graph has been obtained of the total surface heat flow as a function of time. This graph depends on the age of the Earth, although its broad features are independent of this factor. A particular feature of the graph is the rather sudden slowing up of the decrease in the heat flow about 1,500 million years after the Earth was born. With our present estimate of the age of the Earth (3,500 million years), this decrease occurred about 2,000 million years ago. The oldest rock (of a greenstone facies) in at least three continents (North America, Western Australia, and South Africa) have been dated as at least 2,000 million years, and there is evidence that they are of the same peculiar petrological type. It is suggested that these greenstone volcanic areas represent the original nuclei of the continents and are the remains of the tectonic disturbances of this early phase in the Earth's history.—*Author's abstract*

159–189. Birch, Francis. The present state of geothermal investigations: Geophysics, v. 19, no. 4, p. 645–659, 1954.

At present, the emphasis in geothermal studies in nonvolcanic areas is on the flow of heat to the surface, a quantity of much theoretical importance. The number of reliable determinations of heat flow is still small, with few of the oil-producing regions represented. While thermal gradients range from about 5 to 70° C per km, most of the measurements of heat flow fall within the range 1.2×10^{-6} cal per cm^2-sec ±50 percent, including the most recent values for the deep ocean basins. There are suggestions of regional variations, but many more measurements reliable to 10 percent or better will be needed for further progress. The study of regions or provinces, rather than single localities, is especially desirable, and should be feasible in areas extensively drilled for oil. The principal requirements, which are difficult to meet, are approximate thermal equilibrium, which may require an undisturbed period of many months, and availability for laboratory study of cores representing the major formations penetrated by the well. A renewal of interest in this subject among oil geologists, with recognition and exploitation of opportunities as they arise, could greatly advance its development.—*Author's abstract*

159–190. Swartz, J. H. A geothermal measuring circuit: Science, v. 120, no. 3119, p. 573–574, 1954.

A multiconductor cable for geothermal measurements in drill holes in northern Alaska makes use of thermistors as thermal measuring elements. The circuit was designed to permit maximum accuracy with a minimum number of conductors. All conductors are connected at the bottom end of the cable, and one conductor used as a common return lead. A thermistor is then inserted at the desired position in each of the others save one which is reserved for a test lead. This allows accurate determination of the circuit resistance for each thermistor circuit with only one conductor for each thermistor and without regard to the nature of the temperature distribution along the cable. By using a four-decade Wheatstone bridge and a sensitive galvonometer with this circuit it has been found possible to obtain a precision of measurement in the field with a probable error of less than ±0.01° C.—*M. C. R.*

VOLCANOLOGY

159–191. Beringer, Carl Chr[istolph]. Vulkanismus und andere Tiefenkräfte der Erde [Volcanism and other deep forces of the earth]: 54 p., Stuttgart, Kosmos Gesellschaft der Naturfreunde, 1953.

This is a brief review of volcanism and related processes. The first part begins with descriptions of two historic eruptions, of Vesuvius in 79 A. D. and Krakatoa in 1883, followed by a description of the various products of eruptions, structure of volcanoes, and eruption phenomena. The section concludes with a geographical list of active volcanoes and brief discussion of the distribution. The second part deals with plutonic forms and processes, the internal constitution of the earth, and the relationship between tectogenesis and volcanism.—*D. B. V.*

159–192. Goranson, Roy W. Geophysical methods in volcanism: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 506, 1949 (1953).

Electrical and magnetic measurements around volcanoes have not proved very diagnostic in determining subsurface structures, but seismic methods have great potentialities. Phases of the form *PmS*—which are shear waves converted from

compressional waves incident on the surface of discontinuity, *m*, and then reflected from this surface—have proved very useful in the delineation of underlying structures and in showing up small deviations from the general structure outlined by refraction shooting.

The seismic method thus appears to have sufficient resolution to determine underlying volcanic structure; furthermore, if the viscosity in the magma chamber is low enough, shear waves will not be propagated through it, and a shadow zone results. Observational points must be spaced close enough together that the change from one type of seismogram to another can be followed by easy transitional steps, necessitating either a very large number of seismometer stations or an equally large number of shots.—*D. B. V.*

159–193. White, Donald E., Sandberg, C. H., and Brannock, W. W. Geochemical and geophysical approaches to the problems of utilization of hot spring water and heat: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 490–499, 1949 (1953).

In the course of this discussion on possibilities of developing geothermal power in the United States, the role of geophysical surveys is mentioned. Four methods have been used at Steamboat Springs, Nev. The self-potential method is useful in identifying centers of chemical action, particularly where oxidation of sulfur or hydrogen sulfide is taking place. Resistivity surveys can be used to determine the center as well as borders of a thermal area if there are not too many complicating factors. Other factors being equal, resistivity anomalies depend on temperature and salinity; but complications arise in areas containing spring deposits because siliceous sinter has high apparent resistivity, especially if dry, which opposes the effect of temperature and salinity. Surface magnetometer surveys seem to be helpful in identifying thermal centers. Low magnetic susceptibilities associated with the centers are probably due to rock alteration caused by the thermal waters. These lows are not to be explained as Curie-point effects, for such high temperatures are not to be expected at shallow depths. Finally, airborne magnetometer surveys have been made to determine whether anomalies exist that could be attributed to a Curie-point effect at depth; although preliminary examination of the field records failed to show evidence of such effect, final decision must await compilation of a finished map.—*D. B. V.*

159–194. Byers, F. M., Jr., and Barth, T. F. W. Volcanic activity on Akun and Akutan Islands: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 382–397, 1949 (1953).

A study of volcanic activity on Akun and Akutan Islands in the Aleutian Islands was carried out in the summer of 1948 by the U. S. Geological Survey. Historic activity on Akun, solfataric in character, ceased between 1942 and 1945; in contrast, Akutan volcano is one of the most active cones in the Aleutians. Major pyroclastic eruptions accompanied by basalt flows have taken place at intervals of approximately 20 years, the most recent being in January 1947. Minor ash eruptions are frequent between major eruptions. Analyses of hot spring waters on Akutan show considerable boron, presumably magmatic, as do the springs on Umnak Island, 100 miles to the southwest.—*D. B. V.*

159–195. Foshag, William F. The development of Parícutin volcano: Pacific Sci Assoc., 7th Cong., Proc., v. 2, p. 398–403, 1949 (1953).

The development of Parícutin volcano can be divided into three periods: the Quitzocho period, during which the cone developed and grew (February 20 to

October 18, 1943); the Zapicho period, covering the life of the adventitious cone Zapicho (October 19, 1943 to January 8, 1944); and the Taqui period, the volcano's activity as a mature volcanic edifice (not yet ended when this paper was presented). During the first period, average daily emission, chiefly bombs and ash, amounted to about 2 million tons per day, during the second, 500,000 tons per day, and during the third, 100,000 tons per day. The climax of activity was apparently reached in April and May of 1943. The structure of the volcano was that of a cinder cone partly drowned in its own lavas.—*D. B. V.*

159–196. Macdonald, G. A., and Eaton, J. P. The eruption of Kilauea volcano in May, 1954: Volcano Letter, no. 524, p. 1–9, 1954.

Following the eruption of November 1952, Kilauea was quiet until October 1953 when seismic activity began and continued intermittently until the eruption that began May 31, 1954. The eruption was immediately preceded by spasmodic tremor and a series of sharp quakes at the rate of about one a minute. Less than one minute after the beginning of strong harmonic tremor, Kilauea was in eruption. It was one of the shortest on record for Kilauea, ending in three and one-half days.

Lava fountains erupted along fissures in Halemaumau crater and in Kilauea caldera northeast of Halemaumau. The early flow into Halemaumau produced a fill of 63 feet which shrank rapidly to a final thickness of 31 feet with a volume of 7 million cubic yards. Some of the new lava presumably drained back into the fissures through which it had risen. The basaltic flow on the caldera floor covered 139 acres with a volume of 1.5 million cubic yards.

The last two eruptions of Kilauea have resembled the eruptive habit of Mauna Loa more than those of Kilauea in the 19th and early 20th centuries. The geologic structure and formations at prehistoric vents indicate, however, that throughout most of the growth of Kilauea it has closely resembled Mauna Loa.—*V. S. N.*.

159–197. Ishikawa, Toshio. Eruption of Usu volcano, Hokkaido, Japan, 1943–45: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, 368–375, 1949 (1953).

Activity of Usu volcano was preceded by a long preliminary period of strong earthquakes beginning on December 28, 1943, and ending with maximum elevation of the dome in September 1945, with a new roof mountain completed. The three stages of the eruption (earthquake, explosion, and dome-building) are described. These phenomena, characteristic of Usu eruptions, are rarely observed elsewhere.—*D. B. V.*

159–198. Minakami, Takeshi. On the geophysical studies of the volcanic activities in Japan during 1939–1948: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 530–544, 1949 (1953).

Brief descriptions are given of volcanic activity in Japan during 1939–48, and an outline of geodetic and geophysical studies (seismological, magnetic, and gravimetric) of the volcanoes during that period. The most important eruptions were those of Usu, Miyake-sima, Tori-sima, Asama, and Sakura-sima.—*D. B. V.*

Minakami, Takeshi, and Sakuma, Shūzō. On geomagnetic studies of Mt. Fuji (Huzi) and other volcanoes in Japan. See Geophys. Abs. 159–49.

Machado, Frédérico. Earthquake intensity anomalies and magma chambers of Azorean volcanoes. See Geophys. Abs. 159–143.

159–199. Dietz, R. S., and Sheehy, M. J. Transpacific detection of Myojin volcanic explosions by underwater sound: Geol. Soc. America Bull., v. 65, no. 10, p. 941–956, 1954.

Submarine volcanic eruptions 200 nautical miles south of Tokyo appear to have come from the central cone of a caldera lying along the Fuji volcanic zone. A series of great explosions was recorded from the time of the discovery by a fishing boat, the Myojin Maru, on September 17, 1952, to the end of the main series on September 26, 1952. A few visual observations of Myojin were made, but additional data were obtained from a tsunami recorder on Hachijo Island, 130 km north of Myojin; from an atmospheric electricity recorder at Tokyo; and from the U. S. Navy sofar stations at Point Sur and Point Arena, Calif., about 8,600 km from Myojin, where more than 100 explosions were detected. Explosions recorded on sofar equipment agree in time with those observed visually or inferred from tsunami and atmospheric data. This is believed to be the first time signals on sofar records have definitely been identified as of volcanic origin and, as some of the signals were distinctive, installations similar to those of sofar stations may prove of value for monitoring oceanic volcanic activity.—*V. S. N.*

159–200. Pelaez, Vinicio R. The behaviour and characteristics of volcanoes in the solfataric and fumarolic stage of activity: Pacific Sci. Assoc. 7th Cong., Proc., v. 2, p. 364–368, 1949 (1953).

From the history of Catarman volcano in Camiguin Island, northern Mindanao, Philippine Islands, it is inferred that volcanoes upon entering solfataric and fumarolic activity are characterized by explosive, mainly gaseous, eruptions along lateral vents which develop pyroclastic cones; that fissure eruptions along the main crater or on its flank may develop and give rise to solfataras; that the energy released at this stage is dominantly gaseous and unaccompanied by lava; that a "volcanic trench" is developed by gas eruptions and fissure eruptions; and that all these activities tend to destroy the cone rather than build it up. Philippine volcanoes are classified in four groups: active valcanoes, with historic eruptions; volcanoes in solfataric or fumarolic stage with known activity; those in solfataric or fumarolic stage with no known activity; and extinct volcanic mountains, peaks, or cones. Examples in each group are described briefly.—*D. B. V.*

Kamada, Masaakira. Radioactivity of volcanic gas. See Geophys. Abs. 159–185.

Naughton, John J., and Terada, Kazuji. Effect of eruption of Hawaiian volcanoes on the composition and carbon isotope content of associated volcanic and fumarolic gases. See Geophys. Abs. 159–169.

159–201. Wilson, Stuart H. The chemical investigation of the hot springs of the New Zealand thermal region: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 449–469, 1949 (1953).

On the basis of work on steam and gases at White Island, it has become possible to criticize Jaggar's engulfment theory of volcanism, and, by relating this work to hot springs areas on the mainland, to suggest an extension of Day's theory of hot springs. It is postulated, first, that the magmatic steam is not being continuously evolved from the magma, but comes from a reservoir of steam originally separated as another phase of the solidifying magma. This concept allows a better explanation of the varying ratios of chlorides and sul-

fates in hot springs. Second, the occurrence of "mixed areas" characteristic of the New Zealand region suggests the further hypothesis that hydrogen sulfide may be held underground as ferrous sulfide as soon as slight alkalinity develops, but penetration of ground water with oxygen in solution causes oxidation of the sulfide and development of acid conditions, releasing hydrogen sulfide again. Acid areas are thus of two types, primary and secondary origin. A program of further work is suggested.—*D. B. V.*

159–202. Avais, Jacques. Note sur les sources thermales de Nouvelle Calédonie [Note on the thermal springs of New Caledonia]: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 482–484, 1949 (1953).

The generally sulfurous hot springs of New Caledonia emerge from the serpentines of the peridotite massifs, or from the surrounding sedimentary formations, and are alined either along the major structural axis of the island (N. 120° E.) or in a north-south direction. The springs are moderately hot, with a maximum temperature of about 40° C, or more or less tepid owing to admixture with surface water, and probably represent the end stages of the peridotite intrusion. Detailed physicochemical studies are in progress.—*D. B. V.*

159–203. Collins, B. W. Thermal waters of Banks Peninsula, Canterbury, New Zealand: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 469–481, 1949 (1953).

Consideration of known data on the thermal springs of South Island raises some interesting questions, such as the significance of apparent temperature changes in springs and wells measured more than 40 years ago (in two springs, in the Lyttleton tunnel and at Rapaki, present temperatures are higher; in the Motukarara well, temperatures are lower); and the possible development of geothermal power.—*D. B. V.*

159–204. Waring, Gerald A. The occurrence and distribution of thermal springs: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 439–448, 1949 (1953).

This is a preliminary summary of an annotated bibliography on thermal springs of the world. The most important reports on the principal thermal areas are listed geographically.—*D. B. V.*

TECTONOPHYSICS

159–205. Carey, S. Warren. The rheid concept in geotectonics: Geol. Soc. Australia Jour., v. 1, p. 67–117, 1953.

The rheidity of a substance is defined as that property which determines whether it will behave as a fluid or solid for a particular experiment. It may be measured for given conditions of temperature, pressure, and shear stress, by that time for which the shear must be maintained for the deformation by viscous flow to exceed by one thousand times the elastic deformation. When loads are maintained for longer than the rheidity, the substance deforms as a fluid, and the elastic terms of the deformation equation may be neglected as insignificant. The rheidity of ice, salt, gypsum, and serpentine are respectively of the order of a fortnight, a year, ten years, and ten thousand years. Glaciers, salt domes, gypsum extrusions, and postmagmatic reintrusion of serpentine are examples of rheid behaviour. Geological and astronomical evidence indicates that the rheidity of the mantle of the earth varies from tens of thousands of years at the top to hundreds of years at the base. Since tectonic loads are maintained from

ten thousand to ten million years, the mantle of the earth behaves as a fluid for all geotectonic phenomena. The rheidity of the crust varies from 10^5 to 10^9 years, and hence the crust behaves as a solid for many tectonic processes. Geosynclinal materials and orogenic zones have, in general, shorter rheidities, and many fluid phenomena occur. Crystalline schists undergo rheid folding in the cores of orogens. Rheid folding, in spite of its appearance of extreme complexity, obeys simple geometrical laws, the understanding of which allows the complexly attenuated and contorted folds to be projected and extrapolated from fragmentary data. The universal contortion of the Archaean gneisses, which is usually regarded as evidence of intense shortening, does not necessarily imply much shortening or intense diastrophism.—*Author's abstract*

159–206. Gurevich, G. I. K voprosu v mekhanizme razdeleniya plastov gornykh porod na bloki [On a problem in the mechanism of dividing of plastic layers into blocks] : Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 411–414, 1954.

The problem of mechanical stresses produced in different parallel layers by compressive forces perpendicular to the plane of stratification is discussed. The strength of the different layers varies as well as the rate of plastic flow of the material in the direction perpendicular to the compressive force. Obviously a more rigid layer will be exposed to tensile stresses from the adjoining more plastic layers. This stress is computed as the function of the length of the layer and of the difference of the plastic flow of the layers. For a certain length of the contact between adjoining layers this stress reaches the critical value and the more rigid layer will be fractured, and thus form disconnected blocks.—*S. T. V.*

159–207. Gzovskiy, M. V. Tektonicheskiye polya napryazheniy [Tectonic fields of stresses] : Akad. Nauk SSSR Izv. Ser. geofiz. no. 5, p. 390–410, 1954.

By tectonic field of stresses Gzovskiy means the totality of stresses produced at different points in a formation by the development of a tectonic process resulting from the application of certain forces and moments, and, in turn, producing a whole set of mechanical reactions at different points of the area studied.

Knowledge of the tectonic field of stresses, that is, of the correlations between mechanical causes and geologic consequences, facilitates the interpretation of geologic and geophysical observations. In general it makes possible the solution of two kinds of problems: determination from the known stresses the position and the kind of resulting fractures; and reconstruction from the observed fractures the direction and the position of the applied stresses. Study of the tectonic field of stresses must be based on long established relations of the theory of elasticity and the strength of materials. The mathematical computations are developed; in the analysis of more complicated cases, use of model experiments is recommended.—*S. T. V.*

159–208. Hess, H. H., and Maxwell, J. C. Major structural features of the south-west Pacific: a preliminary interpretation of H. O. 5484, bathymetric chart, New Guinea to New Zealand: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 14–17, 1949 (1953).

The region covered by the U. S. Navy Hydrographic Office chart H. O. 5484 is an interesting example of progressive outward belts of orogeny over a long period of geologic time, with at least four and possibly six epochs of island arc type of deformation. The oldest of these belts lies off the western edge of the chart, extending north and south through Western Australia. The youngest, and

still active, series includes the arcs of Northern New Guinea–New Britain, Solomons, New Hebrides, Tonga, and Kermadec. The Solomons arc shows the most advanced stage of development and the Tonga-Kermadec arc the least. On the outer or convex side of each arc are found deep narrow trenches which no doubt lie over, and are the topographic expression of, crustal downbucklings (following Vening-Meinesz), though the presence of large negative gravity anomalies has not yet been ascertained.—*D. B. V.*

159–209. Gutenberg, B[eno]. Geophysical and geological observations in the Pacific area and tectonic hypothesis: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 7–9, 1949 (1953).

There is a growing accumulation of evidence—geophysical, geological, and petrographic—that the Pacific basin shows features not duplicated in any other oceanic or continental area. There is no feature on the earth's surface comparable in dimensions or importance with the Marshall line, within which the younger eruptive rocks are basaltic rather than andesitic; this discontinuity is here called the "boundary of the Pacific basin."

Earthquakes with foci deeper than 300 km have been found only in the tectonic belts related to this boundary. In addition, about 80 percent of all earthquake energy is released in narrow belts bordering the Pacific, whereas active belts of other oceans follow ridges inside those oceans. The lack of granitic layer under the Pacific seems to be the reason for its unique processes and features.

In addition to the tectonic processes which produce sequences of gravity anomalies, shallow earthquakes, and volcanoes in the arcuate structures, there is a different group of active tectonic belts characterized by shallow earthquakes but lacking the other phenomena. In several of these, shearing along zones more or less parallel to the Pacific boundary has been found. Whether these stresses are a byproduct of the processes involved in the former sequence, or related to an independent source, is an open question; nor are the sources of energy well understood. Many more observations and more even distribution of all types of data over the Pacific are needed before any conclusions can be presented with confidence.—*D. B. V.*

159–210. Fourmarier, P[aul]. Quelques reflections au sujet de la symétrie du Pacifique et de la symétrie Eurafricaine [Some reflections on the subject of the symmetry of the Pacific and of the Eurafrican symmetry]: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 9–14, 1949 (1953).

Fourmarier reaffirms his belief in a bilaterally symmetrical arrangement of the superficial features of the earth's crust, about a great circle passing through the poles and bisecting the Pacific Ocean and Africa and Europe, and, in answer to criticisms by Escher, suggests that both views may be reconciled.

The axis of symmetry is traced systematically. Its presence through the geological ages is opposed to the idea of polar wandering. Problems still unexplained are the difference between the Atlantic and Pacific coasts, and the sigmoid curvature of the axes of the oceans and major continents, which affects the great circle line of symmetry under discussion. Future geophysical and astronomical investgiations may throw light on these features.—*D. B. V.*

159–211. Gutenberg, B[eno]. Postglacial uplift in the Great Lakes region: Archiv Meteorologie, Geophysik u. Bioklimatologie, Band 7, p. 243–251, 1954.

The hypothesis of postglacial uplift has been largely accepted for Fennoscandia, but the uplift in the Great Lakes region is considered by some to be no longer

the result of processes connected with the removal of ice. Discrepancies between results found by various authors do not alter the fact that the Great Lakes region is tilting, that the hinge line is somewhere across the Great Lakes, and that the uplift increases northeastward towards Hudson Bay. Details and absolute values are less reliable in the Great Lakes region than in Fennoscandia, but the dimensions of the process are of the same order of magnitude. A reasonable explanation is that the uplift in both areas is due to the mass deficit remaining from the melting of the ice and to a tendency to restore the equilibrium by subcrustal flow with a time of relaxation of the order of 8,000 years.—*M. C. R.*

159–212. Danjon, André and Guinot, Bernard. Sur une singularité du mouvement des poles terrestres survenue en 1926 [On a singularity of the movement of the poles in 1926]: Acad. Sci. Paris Comptes Rendus, tome 238, no. 10, p. 1081–1083, 1954.

In 1926 the amplitude of the Chandlerian component of the motion of the pole became zero, the curves which represent the corresponding variation of the coordinates of the pole changing abruptly by a half-cycle at the same time. From 1890 to 1924 the period of the oscillations was 435±2 days; from 1928 to 1953 the period has been 428±2 days.—*M. C. R.*

159–213. Stoyko, Anna, and Stoyko, Nicolas. Les variations périodiques de la rotation de la terre pendant les annees 1947–1952 [Periodic variations of the rotation of the earth during the years 1947–1952]: Acad. Royale Belgique Bull., Cl. Sci., 5° sér. tome 39, no. 6, p. 543–551, 1953.

Studies of the seasonal changes in the length of the day indicate a marked fluctuation in the seasonal amplitude. The observations at Washington indicate the amplitude of the 14-month term is of the same order as the annual term.—*M. C. R.*

159–214. Dungen, F. H. van den, Cox, J. F., and Meighem, J. Van. Sur les déplacements par rapport aux étoiles de l'axe de rotation instantané de lithosphère sous la solicitation des vents meridiens [On the displacements with respect to the stars of the axis of instantaneous rotation of the lithosphere caused by meridional winds]: Acad. Royale Belgique Bull., Cl. Sci., 5° sér. tome 39, no. 7, p. 590–611, 1953.

The effect of meridional winds can result in a displacement of the axis of rotation of the lithosphere with respect to the axes of reference of celestial mechanics.—*M. C. R.*

INTERNAL CONSTITUTION OF THE EARTH

159–215. Dalta, A. N. On the energy required to form the Moon: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 9, p. 535–539, 1954.

The energy in various model primitive Earth-Moon bodies containing a normal phase *X* and two high-pressure phases *Y* and *Z* has been examined. In each model, the first high-pressure phase *Y* has been taken to be in agreement with the data for the outer central core of Bullen's Earth model *B*. With certain simplifying assumptions, fifteen models are presented and with them fifteen corresponding values of the pressure at which the second transformation occurs. The possibility of the transition of the primitive three-phase body to a two-phase body in which phase *Z* is no longer present is considered, and the number of

models is reduced to six. A consideration of the change in energy involved in the transition suggests that, for a body of the Moon's size to be ejected from a three-phase model of the type considered, it is necessary that the density of *Z* is at least about 18 grams per cubic centimeter and that the radius of the region occupied by *Z* was at least about 1,500 km. This result gives some quantitative support to Bullen's theory of the origin of the Moon, provided that his suggested mechanism of resonance could lead to sufficient distortion to take the primitive body over a potential barrier into the state in which the phase *Z* has disappeared.—*P. E. B.*

159–216. Mir Amorós, Jesús. Sobre la hipotesis Kuhn-Rittmann [On the Kuhn-Rittmann hypothesis] : R. Acad. Cienc. y Artes de Barcelona Mem., v. 31, no. 9, p. 277–303, 1953.

A discussion of the Kuhn-Rittmann hypothesis on the internal structure of the earth as well as the deductions which follow from this theory on the origin of terrestrial magnetism, the chemical composition of terrestrial matter and terrestrial atmosphere, the composition of the sun, probable variation of pressure and temperature in the earth with increasing depth, and other problems of geophysics.—*S. T. V.*

159–217. Bullen, K. E. On the homogeneity, or otherwise, of the earth's upper mantle: Am. Geophys. Union Trans., v. 35, no. 5, p. 838–841, 1954.

The question of the extent of inhomogeneity between the earth's crustal layers and a depth of 1,000 km is discussed. On the basis of the author's Model A, inhomogeneity would be spread over a range of several hundred kilometers below a depth of 200 km, while with Model B there could be homogeneity between depths of 200 and 2,700 km. Thus Model B is less compatible with cyclic convection current theories than Model A. If reliable evidence for convection currents in the mantle should ever emerge, this would give some support to Model B, and, indirectly, to the existence of a solid inner core. Also should Model B prove to be nearer the truth than Model A, this would reduce certain of the difficulties in the way of convection current theories.—*Author's abstract*

159–218. Bullen, K. E. Composition of the Earth's outer core: Nature, v. 174, no. 4428, p. 505, 1954.

Recent revisions of astronomical data indicate a reduction in the estimated diameter of Mars and Venus, and a reduction in the estimated ellipticity of Mars. On the assumption that the terrestrial planets have a common primitive composition, these revisions indicate that the Earth's outer core is composed of a mixture of uncombined iron and a material with an atomic number less than that of iron. Investigations of Birch and of Knopoff and Uffen support this conclusion.—*R. G. H.*

159–219. Dietz, Robert S., Menard, Henry W., and Hamilton, Edwin L. Echograms of the Mid-Pacific expedition: Deep-Sea Research, v. 1, no. 4, p. 258–272, 1954.

The Scripps Institution of Oceanography—U. S. Navy Mid-Pacific Expedition of 1950 obtained about 12,000 nautical miles of echograms along straight runs between San Diego and the Marshall Islands that reveal much new topographic information. The Pacific sea floor profile reveals the large-scale roughness of the Pacific floor, the great size of the seamounts, and presence of broad low

swells. The Hawaiian Islands are developed on one of these broad swells. Along the northeast side of the islands at the base of Oahu and Hawaii is a deep with a well defined arch on its seaward side. A mountainous region with many guyots, called the "Mid-Pacific Mountains", was discovered between Hawaii and the Marshall Islands. Recovery of volcanic rock and a Cretaceous reef coral and rudistid fauna from the mile-deep tops of two guyots indicated them to be deeply drowned basaltic platforms on which coral reefs grew. Exclusive of the Mid-Pacific Mountains, thirty seamounts were crossed, many of them new discoveries. Most are probably of volcanic origin. Three ridged scarps were crossed. They mark abrupt regional changes in sea-floor level and probably are formed by faulting. Three U-shaped depressions discovered were thought to be grabens. Much of the sea floor, particularly between the United States and Hawaii, is rough in topographical detail. Sediment is apparently accumulating largely in the topographic lows forming flat basins over about 37 percent of the track. It is assumed that there are currents along the sea floor competent to erode sediment after it has once been deposited and move it into the lows.—*V. S. N.*

159–220. Fisher, Robert L., and Revelle, Roger. A deep sounding from the southern hemisphere: Nature, v. 174, no. 4427, p. 469–470, 1954.

In December 1952–January 1953, the Scripps Institution of Oceanography research vessel, *Horizon*, found in the Tonga Trench, 180 miles south of Tonga Tabu Island, a depth of 5,814 fathoms from first echoes. Second echoes indicate, with a large uncertainty, a greater depth of 5,900 fathoms at the center of "masked zone". Measurements with a narrow beam echo-sounder are needed to tell whether or not the Tonga Trench is deeper than the Marianas Trench, heretofore believed to contain the greatest oceanic depth.—*R. G. H.*

159–221. Northrop, John, and Frosch, Robert A. Seamounts in the North American Basin: Deep-Sea Research, v. 1, no. 4, p. 252–257, 1954.

Recent bathymetric surveys of the North American Basin have shown that numerous seamounts exist off the northeastern United States' continental shelf as far south as Bermuda and eastward to the foothills of the Mid-Atlantic Ridge. The three seamounts described in this report show typically their conical shape, isolated position, mountainous proportions, 15°–20° sloping sides and abrupt rise from the flat abyssal plain of the deep-sea floor. The seamounts' location, morphology, and association with the Bermuda volcanics indicate that they are extinct volcanoes which probably erupted during the Early Tertiary along lines of weakness set up by previous tangential stresses on the earth's crust.—*Authors' abstract*

GENERAL GEOPHYSICAL EXPLORATION

159–222. Eve, A. S., and Keys, D. E. Applied geophysics in the search for minerals, 4th edition: 382 p., New York, Cambridge University Press, 1954.

The fourth edition of this book, first published in 1929, has been revised to include developments during the past fifteen years such as airborne exploration methods, gravimeters, seismic reflection techniques, and methods of locating deposits of radioactive ores. About one half the book is devoted to the magnetic, electrical, and electromagnetic methods. Problems are included to aid in usage as a textbook.—*M. C. R.*

159–223. Matschinski, Matthias. Certitude des résultats de la prospection géophysique [Certainty of the results of geophysical prospecting]: Geophys. Prosp., v. 2, no. 1, p. 38–51, 1954.

The fundamental concepts on which the methods of determining the certainty of geophysical data, described in a previous paper (see Geophys. Abs. 158–218), are discussed by examples.—*M. C. R.*

159–224. Scull, B. J. Oil and more gas promised in North Arkansas: World Oil, v. 139, no. 5, p. 117–119, 1954.

A summary of oil and gas possibilities and exploration methods used in northern Arkansas. Seismic, gravity, and airborne-magnetometer geophysical methods have been employed.—*L. C. P.*

159–225. McCarver, Holland C. Geophysical history of the Good field, Borden County, Texas: Geophysics, v. 19, no. 4, p. 791–801, 1954.

The Good oilfield was one of the first west Texas Pennsylvanian reef fields looked for and discovered as such. No seismic reflections from the reef itself were observed, but the seismic anomaly was interpreted as a Permian "structure" caused by differential compaction and draping over a reef mass. This was later confirmed by drilling. Close cooperation between geologic and geophysical programs is obviously necessary in exploration of such features.—*M. C. R.*

159–226. Pluta, J. S., and Rummerfield, Ben F. Texas poses tough geophysical problems: Oil and Gas Jour., v. 53, no. 17, p. 70–72, 1954.

In certain segments of the oil provinces of Texas it is difficult to obtain usable seismic data. Results can often be improved by the use of multiple holes, multiple geophones, long in-line offsets, right angle offsets, surface shooting, and variable seismic playback units. Gravity anomalies may be caused by the same near-surface variations which cause velocity changes.—*L. C. P.*

159–227. Foote, Royal S. How geophysics helps find uranium: Eng. Min. Jour., v. 155, no. 9, p. 96–97, 109, 1954.

Practical application of geophysics on the Colorado Plateau is restricted to radiation detection methods. These include airborne reconnaissance, ground reconnaissance, drill-hole logging, and carborne reconnaissance. Scintillation counters are in general use. The seismic refraction method has been used successfully by the U. S. Atomic Energy Commission and the U. S. Geological Survey to outline ore-bearing channels in the Moenkopi formation, but real savings over subsurface geologic methods have not yet been demonstrated. Electric logging research has also been successful and is expected to come into general use within the next year. Combined gama-ray and electric log equipment is being built.—*L. C. P.*

159–228. Heermann, O. Erdölgeologische Grundlagen der Aufschlussarbeiten im ostbayerischen Molassebecken [Petrolelum geology foundations of the exploratory work in the east Bavarian Molasse basin]: Ver. Schweizer. Petroleum Geologen u. Ingenieure Bull., v. 21, no. 60, p. 5–22, 1954.

Exploration in the east Bavarian Molasse basin in search for oil was begun in 1935 and was continued by both geophysicists and geologists in spite of many discouragements. In 1950, two drill holes at Ampfing and Isen (near Munich)

proved to be discovery wells. Several geologic profiles with parallel presentation of the results of seismic investigations are included.—*S. T. V.*

159–229. Cantos Figuerola, José. La interpretación geologica de la mediciones geofisicas aplicadas a la prospección, Tomo V [The geologic interpretation of geophysical measurements applied to prospecting, volume 5] : Inst. geol. min. España, 371 p., 1953.

Nineteen investigations of the Sección de Geofisica Aplicada in the Institute Geologico y Minero are reported. Work of the section is based on a close relationship between geology and geophysics. Investigations reported on include hydrologic studies in Alicante, Ciudad Real, Logroño, Fiñana, Los Monegros, Los Llanos del Marquesedo, San Javier, and Almeria by electric and gravimetric methods, as well as other investigations, using gravimetric, magnetic, seismic, and electric methods, of geologic and mining problems.—*M. C. R.*

159–230. Andres, Jakob. Der Beitrag der Geophysik zur Erforschung des tieferen Untergrundes in Schleswig-Holstein [The contribution of geophysics to the deep subsurface exploration in Schleswig-Holstein] : Meyniana Kiel Univ. Geol. Inst. Veröffentl., Band 2, p. 7–14, 1954.

Almost all of Schleswig-Holstein is covered by a thick layer of drift so that subsurface exploration must be by geophysical methods. Strong magnetic anomalies observed in the first extensive surveys made about 1925–26, were attributed to crystalline rocks at depths of 5,000–6,000 m. Extensive geophysical surveys of 1935–45 comprising gravimetric, torsion balance, and seismic refraction and reflection investigations, were directed by the Reichsamt für Bodenforschung.

Some exploratory drilling has also been done. The results of these investigations are summarized and illustrated by profiles. In the northern part of the province thick deposits of salt and some salt domes were found, and at least in one place, near Boostedt and Plön, traces of oil were found.—*S. T. V.*

159–231. Petrucci, Giuseppe. Applicabilità dei metodi geofisici alla ricerca degli idrocarburi [The applicability of geophysical methods in prospecting for hydrocarbons] : Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 465–474, 1952.

In determining the most efficient methods of exploration for oil in Sicily, topographic conditions, as well as geologic conditions, must be taken into account. Thus magnetic methods are better than gravimetric, especially when combined with airborne transportation for rapid reconnaissance. To delineate particular structures, seismic reflection surveys are needed and logging studies are used for depth, thickness, and correlation of layers. Several gravimetric and magnetic maps and tables of related physical constants are included.—*S. T. V.*

159–232. Ward, H. J. The search for Australia's uranium : Mining Engineering, v. 6, no. 12, p. 1169–1173, 1954.

Airborne and ground radiometric, self-potential, and airborne and ground magnetometer surveys are being used to locate uranium in Australia. Radioactivity logging of drill holes is also employed. The geophysical surveys are closely coordinated with geologic studies.—*L. C. P.*

159–233. Migaux, Léon. Vue d'ensemble sur les travaux de géophysique appliqués aux recherches de pétrole en Afrique du Nord [General review of

applied geophysical studies in exploration for oil in Northern Africa]: Convegno naz. metano e petrolio, 7mo, Taormina 1952, Atti, v. 1, p. 499–509, 1952.

A review is presented of geologic conditions and of the geophysical exploration for oil in northern Africa. The results are of interest to Italian geophysicists because of the geologic similarity of northern Africa and Sicily and of especially great interest in view of the proposed petroleum exploration in Sicily. Several seismic, electric, and gravimetric maps of parts of northern Africa are shown and discussed, and detailed studies by telluric currents are described.—*S. T. V.*

159–234. Gardner, Frank J. Point of no return: Oil and Gas Jour., v. 53, no. 33, p. 145, 1954.

A discussion of the declining ratio of success and profits of the seismograph industry.—*L. C. P.*

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