Geophysical Abstracts 158 July–September 1954

GEOLOGICAL SURVEY BULLETIN 1022–C

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

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

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GEOPHYSICAL ABSTRACTS 158, SEPTEMBER–JUNE 1954

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

GENERAL INFORMATION

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

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

ABSTRACTORS

Geophysical Abstracts are prepared and compiled under the direction of Mary C. Rabbitt with the assistance of Dorothy B. Vitaliano and S. T. Vesselowsky. Other abstracts in this issue have been prepared by J. R. Balsley, P. Edward Byerly, Roland G. Henderson, George V. Keller, 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*
Acta Cuyana de Ingenieria	Acta Cuyana de Ingenieria. Facultad de Ingenieria y Ciencias Exactas Fisicas y Naturales, Universidad Nacional de Cuyo, San Juan, Argentina.
Akad. Nauk SSSR Vestnik	Akademii Nauk SSSR Vestnik. Moskva.
Bol. Radiactividad	Boletín de Radiactividad. Instituto Nacional de Geofisica. Madrid.
Explosives Engineer	Explosives Engineer. Hercules Powder Co. Wilmington, Del.
Garcia de Orta	Garcia de Orta. Revista da Junta das Missões Geograficos e de Investigacões do Ultramor. Lisboa.
Great Britain Geol. Survey Bull	Bulletin of the Geological Survey of Great Britain. London.
Industria Mineraria	L'Industria Mineraria. Associazione mineraria italiana. Roma.
Maden Tetkik ve Arama Enstitüsü Mecmuasi.	Maden Tetkik ve Arama Enstitüsü Mecmuasi. Mining Research and Exploration Institute of Turkey.
Meteoros	Meteoros. Revista de meteorologia y geofisica. Servicio Meteorologico Nacional. Buenos Aires.
Okayama Univ. Balneological Lab. Repts.	Reports of the Balneological Laboratory, Okayama University. Misasa Hot Springs, Tottori-ken, Japan.
Pennsylvania State Univ. Min. Industries Expt. Sta. Bull.	Bulletin of the Mineral Industries Experiment Station. Pennsylvania State University. State College, Pa.
Tōhoku Univ. Research Inst. Sci. Repts.	Tōhoku University Research Institute Science Reports, Sendai, Japan.
Tokyo Natl. Sci. Mus. Bull	Bulletin of the National Science Museum, Tokyo.
U. S. Natl. Bur. Standards Jour. Research.	U. S. National Bureau of Standards Journal of Research. Washington, D. C.
Vses. nauchno-issled. inst. razved, geofiz. Trudy.	Vsesoyuznyy nauchno-issledovatel'skiy institut razvedochnoy geofiziki, Trudy [Transactions of the All-Soviet Scientific Research Institute for Geophysical Exploration]. Moskva.
Zisin	Zisin. Seismological Society of Japan. Tokyo.

GRAVITY

GENERAL AND THEORETICAL PAPERS INCLUDING THOSE ON ISOSTASY

158–1. de Graaff-Hunter, J. The use of Stokes' formula in geodesy: Bull. géod., no. 32, p. 148–153, 1954.

The calculation of the elevations and inclinations of the geoid in relation to a unique international reference spheroid should be pursued by means of Stokes's formula at survey origins. Such results are required to enable detached geodetic surveys to be properly related and so fulfill their comprehensive functions. Errors likely to arise from incompleteness of gravity data should be examined regionally so that supplementary observations of gravity may be planned and carried out with greatest effect for the aim in view.—*Author's summary*

158–2. Hirvonen, R. A. The gravimetric method for determination of the form of the geoid: Tellus, v. 6, no. 1, p. 84–88, 1954.

Hirvonen discusses the various gravity anomalies and their defects with regard to use in computing the undulations of the geoid or deflections of the vertical from Stokes' or Vening Meinesz' formulas. Estimates are made of the number and distribution of stations required to yield certain accuracies in computed undulations and deflections of the vertical.—*P. E. B.*

158–3. Kaula, William M. Gravimetrically computed deflections of the vertical in Ohio: Am. Geophys. Union Trans., v. 35, no. 4, p. 549–557, 1954.

Deflections of the vertical were computed for five points over a range of 100 km in central Ohio, using free-air anomalies out to 1,500 km and isostatic anomalies, with corrections, for the rest of the Earth. For ξ at all five points, and for η at three points, agreement with the astronomically observed deflections was obtained to within 0.67″; errors in astronomic longitude are shown to cause disagreement in η at two points. The probable error of the gravimetrically computed deflection on the assumption of random variation of the mean anomalies of five-degree squares was computed to be ±0.38″; on the assumption of random variation of the mean anomalies of 30° squares, to be ±1.15″.—*Author's abstract*

158–4. Marussi, Antonio. Sul significato del secondo parametro differentiale della gravità in geofisica [The meaning of the second differential parameter of the gravity in geophysics]: Riv. Geofisica Appl., anno 14, no. 2, p. 65–72, 1953.

Correlations between the second differential parameter of gravity and purely geometric properties of the gravitational field, as expressed in level surfaces and in the shape of the plumb lines, are established. The force of gravity is considered as a scalar function of a point in space or on a surface of equal gravity. By the second differential parameter Marussi means the result of the mathematical operation of forming the divergence of the gradient of gravity or

gradient of its logarithm. This quantity (Beltrami's parameter) is related to the geometric characteristics of equipotential surfaces and plumb lines as well as to the changes in their direction. By applying the methods of vectorial analysis an expression is derived for the second differential parameter in terms of different curvatures, such as Gauss', Casorati's, and the average curvature of the equipotential surface. In 1909 Pizzetti showed that the second differential parameter can be approximately expressed as the average value of the studied function taken over a sphere or over geodetic circles around the point under consideration. In the similar method suggested by T. A. Elkins in 1951, the divergence of the surface gradient of the anomaly coincides to a first approximation with the second derivative along the vertical line.—*S. T. V.*

158–5. Lassovszky, Károly, and Szilárd, Oszlaczky. Graviméterregisztralasok globális analizise [The tidal variation of gravity. II.] (With summaries in English and Russian): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 3, szám 2, p. 27–30, 1954.

In an earlier paper (Geophys. Abs. 14392), results of observations made with two gravimeters at different times were presented. In this paper an extension of the same work is reported, in which the two instruments (Heiland H. 40 and H. 66) were used simultaneously. The mean values for the deformation coefficient thus obtained were 1.12 and 1.17 respectively.—*D. B. V.*

Matschinski, Matthias. Bibliographic essay on the mechanics of the earth's crust and especially on isostasy: See Geophys. Abs. 158–207.

INSTRUMENTS AND METHODS OF OBSERVATION

158–6. Muto, Katsuhiko. A GSI pendulum apparatus for gravity measurements: Acad. Japan Proc., v. 29, no. 8, p. 439–445, 1953.

The GSI instrument consists of three quartz pendulums and a recording device. Laboratory and field measurements indicate an accuracy of 0.2 milligal for the mean of several readings at a single station.—*M. C. R.*

158–7. Lozano Calvo, Luis. Fundamentos para gravimetros adecuados especialmente para la observacion sobre suelos inestables [The basic principles of gravimeters especially adopted for observations on unstable ground]: Rev. Geofísica año 12, no. 46, p. 101–117, 1953.

When a gravimeter is used on marshy, unstable ground, two difficulties often arise: it is almost impossible to eliminate the vibrations of the instrument, and it is difficult to level the instrument. Use of small platforms is feasible but expensive and makes the transportation difficult. Two new types of gravimeters—one called a torsion gravimeter, the other a differential gravimeter—are immune to these difficulties.

In the latter the bottom part of the instrument is spherical and the reference plane is made by the free surface of mercury filling this portion. This device makes the readings independent of the angle of inclination of the gravimeter. The instrument is calibrated on firm ground.

In the torsion gravimeter the deflection produced by the increase of the weight is compensated by torsional reaction of a wire strained by a micrometer screw, as in the Nørgaard gravimeter. The zero point of the instrument is obtained by bringing to coincidence the reflection of an illuminated point with the point

itself, using a combination of small prisms. Calibration of this instrument also must be made on firm ground.—*S. T. V.*

158–8. Sans Huelin, Guillermo. Los gravimetros telecomandados para la prospección gravimetrica en areas maritimas [Remote-control gravimeters for gravimetric exploration in marine areas] : Rev. Geofísica, año 12, no. 47, p. 234–237, 1953.

Improvements during the last five years in the gravity instruments for use in water-covered areas are primarily in the development of remote control. Two similar instruments consist of a strong bell-shaped box that can be lowered from the observers' boat to the ocean bottom, inside which is mounted the gravimeter with its heater and electronically controlled thermostat, and a motor for exact levelling of the box and adjusting of gravimeter; readings are made photographically. The depth to which such gravimeters can be lowered is about 400 m; the distance from the shore cannot at present be greater than 15 km because of difficulty in determining the exact position of the boat at greater distances.—*S. T. V.*

158–9. Dobrokhotov, Yu. S. Izucheniye periodicheskikh izmeneniy sily tyazhesti [Study of periodic changes of the force of gravity] : Akad. Nauk SSSR Vestnik, no. 4, p. 85–87, 1954.

To observe diurnal and other variations of gravity due to lunisolar effect and the resulting deformations of the earth, a special gravimeter of high sensitivity was constructed. With this instrument it is possible to measure and to record photographically the relative value of gravity and simultaneously to determine the deviations of the vertical at the station. The sensitivity of the instrument is such that the amplitude of the diurnal variation is 10 mm for visual observations and greater if photoelectric recording is used. The drift is linear with time and can be made very small. The main element of the gravimeter is a quartz fiber horizontally stretched and twisted by an eccentrically attached weight.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

158–10. Sand, Walter. Über die Bestimmung von Differenzen der Lotrichtung mit des Gradienten U_{zzz} [On the determination of deviations of the vertical by means of the gradient U_{zzz}] : Geofisica Pura e Appl., v. 27, p. 30–34, 1954.

A new torsion balance has been built at Freiburg im Breisgau (western Germany), with which it is possible to measure directly the gravity gradient U_{zzz} ($U_{zzz}=\pm\sqrt{U_{zzz}^2+U_{zzy}^2}$). In this paper Sand shows how the difference between the verticals of two points in the gravitational field of the earth can be calculated from U_{zzz} without the astronomic and geodetic measurements which made Eötvös' methods cumbersome.—*D. B. V.*

158–11. Tarrant, L. H. The least-squares method of determining regional contours: Great Britain Geol. Survey Bull., no. 6, p. 33–35, 1954.

In determining regional effects, the general problem is one of producing a set of smooth contours approaching as nearly as possible the original contours. Such a set can be represented by equations of the form $V=A+Bx+Cy+Dx^2+Ey^2+Fxy$, where V is the contour value at any point with coordinated x and y, and A to F are numerical coefficients. By determining A to F by least squares,

the condition of near approach to original contours is satisfied. If the points are chosen in a symmetrical array, many coefficients become zero, and if the scale is adjusted to make the points of the array unit distance apart, the remainder are easily calculated. A similar approach to the problem has been developed by Agocs. (See Geophys. Abs. 13094.)—*M. C. R.*

158–12. Tsuboi, Chuji. The first and second vertical derivatives of gravity: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 5, no. 2, 1952; reprinted from Jour. Physics of the Earth, v. 1, no. 2, p. 95–96, 1952.

A method is shown for calculating the distribution of $\delta g/\delta z$ from that of g. The first power quantities are less sensitive to local horizontal gravity variations and observational errors than the second derivative $\delta^2 g/\delta z^2$, and are preferable where the object is merely to get a quantity reasonably sensitive to small irregularities in gravity distribution.—*D. B. V.*

158–13. Tsuboi, Chuji. Anomalies of the vertical gradient of gravity associated with anomalies of gravity: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 5, no. 2, 1952; reprinted from Jour. Physics of the Earth, v. 1, no. 2, p. 97–100, 1952.

The relation between the anomalies of the vertical gradient and total gravity anomalies are investigated mathematically, and it is concluded that the former are sometimes too large to be neglected in the free-air reduction of gravity. A difference of 20 milligals is possible in the free-air reduction for an altitude of 3,000 m.—*D. B. V.*

158–14. Rosenbach, Otto. A comparison of the second derivative method of gravity interpretation with reflection seismics and geological findings in the Offenburg area: Geophys. Prosp., v. 2, no. 1, p. 1–23, 1954.

Second vertical derivatives of Bouguer anomalies in the Offenburg area in Germany were studied in relation to seismic reflection and borehole data. Second-derivative anomalies calculated from three different formulas resulted in nearly coincident null curves. The most sensitive formula used a point configuration involving a circle of radius less than the indicated grid spacing. One of the null curves followed closely the northeast-southwest disturbance clearly shown on the seismic map. A displacement in the central null curve was correlated with a heaved block. A geologic profile corroborates these and other results.—*R. G. H.*

158–15. Rosenbach, Otto. Quantitative studies concerning the vertical gradient and second derivative methods of gravity interpretation: Geophys. Prosp., v. 2, no. 2, p. 128–138, 1954.

A gravity map of an area in the Rhine valley, Germany, between Worms and Mainz was analyzed, using first- and second-derivative maps of the field, to localize the main fault and to determine minor structures within the graben. The fault was easily recognizable from the gravity data, but it was difficult to determine the inclination because of an overlapping of two large regional gravity anomalies. Derivative maps were constructed using several formulas and by comparing the distance between extreme values for both observed and theoretical derivative profiles, the angle of inclination of the fault could be determined.

Also by constructing derivative maps, two minor structures within the graben were better defined. Rosenbach points out that considerable caution in the interpretation of the data should be exercised. Factors that affect the interpretation are the number of measured stations per unit area, the use of proper computation formulas, and the choice of the proper grid size in making derivative calculations.—*I. Z.*

158–16. Coloma Perez, Antonio. Sobre la determinación de altitudes y correcciones gravimetricas [On the determination of altitudes and gravimetric corrections]: Rev. Geofísica, año 12, no. 47, p. 182–216, 1953.

This is a discussion of the determination of Fayé and Bouguer corrections and the reverse problem, or the determination of the altitude of a point above base level from the measured difference in gravity. Results are presented in a general table, in convenient form for use in computations.—*S. T. V.*

158–17. Andreyev, B. A. Prostoy metod rascheta geofizicheskikh anomaliy na vysote [A simple method of reduction of geophysical anomalies to a (given) altitude.]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 3, p. 6–9, 1950.

In two-dimensional problems, values of the potential function U (gravitational or magnetic) on the surface of the earth and on a plane at elevation h can be compared by using the formula

$$U(x'_1-h)=h/\pi\int U(x,0)dx/(h^2+(x-x')^2).$$

where x is the coordinate of a point on the earth's surface and x' the point at height h above it.

Andreyev simplifies the integration by introducing a new variable, and presents a chart for graphic determination of the integral. The accuracy of these procedures is said to sufficiently high.—*S. T. V.*

Andreyev, B. A. On the conditions of applicability of the formulas derived for two-dimensional problems in the interpretation of magnetic and gravitational anomalies. See Geophys. Abs. 158–74.

OBSERVATIONS OF GRAVITY AND GRAVITY SURVEYS

158–18. Romberg, Frederick [E.], and Barnes, Virgil E. A geological and geophysical study of Pilot Knob (South), Travis County, Texas: Geophysics, v. 19, no. 3, p. 438–454, 1954.

Pilot Knob is an exhumed volcano of Cretaceous age, composed of "serpentinized" pyroclastics and minor amounts of basalt in both intrusive and extrusive masses. The geology of Pilot Knob was reexamined, and gravity and magnetic observations made and interpreted, in order to present a complete picture of the feature itself, its history, its relation to the region and area surrounding it, and the resemblances between it and the serpentine plugs in the neighborhood, to which it is geologically related. Some of these plugs have been discovered by geophysical means, and some so discovered have produced oil; the application of gravity and magnetic data to such discoveries is analyzed.

The extrusive masses are here reported for the first time, and other evidence is given for the age and volcanic nature of Pilot Knob. The observations reveal 1) strong gravity and magnetic anomalies over the central basalt mass, 2) a pattern of weaker anomalies probably caused by flows and dikes and suggesting that Pilot Knob is situated near the intersection of two sets of fractures, and 3)

evidence that "serpentinized" pyroclastics show weak magnetic anomalies and (in the local setting) no visible gravity anomalies.—*Authors' abstract*

158–19. Bullerwell, W. A gravitational survey over a concealed portion of the Warburton Fault near Lymm, Cheshire: Great Britain Geol. Survey Bull., no. 6, p. 1–12, 1954.

The Warburton Fault trends north-northwest from Newton-in-Makerfield, Lancashire, through Warburton, towards Rostbern, Cheshire. Much of the area is covered with drift, and the fault is nowhere clearly visible at the surface although its existence is known from the repetition of a considerable thickness of Triassic rocks near Warburton. In September 1947, a torsion balance survey over the conjectured line of the fault northwest of Lymm indicated a strong northerly gradient with a slight swing toward the west and reduction in magnitude near the fault. The anomaly may be interpreted as the result of a fault of large throw and normal hade, with downthrow to the northwest. The density distribution indicated by the gravity data suggests that the Lower Keuper sandstone crops out at a shallow depth under the drift on the upthrown side of the fault.—*M. C. R.*

158–20. Bullerwell, W. A gravimeter survey over the Tilmanstone Fault, Kent Coalfield: Great Britain Geol. Survey Bull., no. 6, p. 13–20, 1954.

A detailed gravity survey, using a Frost gravimeter, was made of a residual gravity trough north of Tilmanstone discovered in 1947 in the survey made by the Anglo-Iranian Oil Co. The trough is apparently due to a broad depression in the surface of the Coal Measures which may be a shallow grabenlike structure. The heading in the Beresford Seam at Tilmanstone Colliery, which in 1940 first penetrated the broken ground from which the fault was inferred, is apparently near the position of maximum displacement. Gravimetric surveys for similar faults in coalfields where the Mesozoic rocks below the Chalk are not well developed are not believed likely to be successful.—*M. C. R.*

158–21. Bullerwell, W. A gravimeter survey of the Ston Easton-Harptree District, East Somerset: Great Britain Geol. Survey Bull., no. 6, p. 36–56, 1954.

In 1948 Welch indicated the probable existence of workable coals in the concealed Lower Coal Series in the Ston Easton-Harptree district and suggested a geophysical survey to test his general interpretation and to determine structural features where the geologic information was uncertain. The gravimeter survey here reported was undertaken for this purpose and also to demonstrate to what extent detailed surveys are likely to assist the geologist in other areas. The regional contours determined here indicate roughly the general structure. For reconnaissance of similar areas, a uniform network of 2 stations per square mile is recommended, with more or less in other areas depending on the complexity of the geology. For detailed mapping, the station density depends on the magnitude of the anomalies expected and the accuracy of the instrument. The spacing of 5.5 stations per square mile used in the Ston Easton survey is satisfactory for indicating major faults on the scale of an inch to the mile. The smallest fault located with confidence in the survey had a throw of 200 feet and was detectable under 300 feet of cover. The gravimetric method is believed of limited application in the detection of faulting in the Coal Measures.—*M. C. R.*

158–22. Gloden, A. Anomalies gravimétriques au Grand-Duché de Luxembourg [Gravimetric anomalies in the Grand Duchy of Luxembourg]: Ciel et Terre, 70e année, fasc. 5–6, p. 185–187, 1954.

By means of a survey of 96 stations made with a North American gravimeter in October 1948 by Cagniard, Gloden, and Lucius, the gravity network of Luxembourg was tied in with those of France, Belgium, and Germany. The Bouguer anomalies have now been calculated and show very satisfactory agreement with the gravimetric map of France. As altitudes were determined barometrically in the survey, some modification of isoanomaly lines may be expected if the heights of stations should be determined more precisely in the future.—*D. B. V.*

158–23. Běhounek, Rudolf. Tíhové isanomaly Malé dunajské nížiny a oblastí přilehlých [Gravity anomalies in the Little Danubian lowland and adjacent regions] (With summaries in English and Russian): Czechoslovakia, Ustřední Ústav Geol. Sborník, svazek 19, p. 273–284, 1952.

In the gravimetric surveys made by various geophysicists between 1939 and 1949 in the Little Danubian lowland and adjoining regions, an area of some 9,000 sq km was surveyed, 1,640 stations being occupied. Graf and Nørgaard gravimeters were used, and the density was about 200 stations in 1,000 sq km.

Results of these surveys are presented as a Bouguer map of the region with 5-milligal contour interval. Seven positive and four negative anomalies of as much as 25 milligals were found. The positive anomalies are interpreted as representing crystalline remnants of the Carpathians, both exposed and covered, and the negative anomalies as deep depressions filled with light sandy sediments.—*S. T. V.*

158–24. Bendefy, László. A Po-Síkság jelenkori süllyedése [Contemporary decline of the plain of Po] (With summaries in English and Russian): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 3, szám 6, p. 71–98, 1954.

The results of precise levelling and gravity measurements made in the Po plain are summarized. Nine maps and diagrams are included, showing not only superficial changes of level but suggesting probable movement of the whole block at depth. Certain fundamental problems are also discussed, including the idea of "nominal heights" in connection with determination of the period of changes in level; the choice of the fundamental point of reference; proposed application of a ten-year international time unit; distinction of absolute and relative movements.—*D. B. V.*

158–25. Boaga, G[iovanni]. Profilo gravimetrico tra il Tirreno e lo Jonio lungo il parallelo 40° [Gravimetric profile between the Tyrrhenian and the Ionian Seas along the 40th parallel]: Accad. Naz. Lincei Atti, Cl. sci. fis., mat. e nat., Rend., v. 14, fasc. 2, p. 175–178, 1953.

The results of a gravity survey made along the 40th parallel by the Università de Roma, in cooperation with the Servizio Geologico d'Italia are given in a profile and two tables of data (including Fayé and Bouguer anomalies) for 16 stations. Differences in the anomalies suggest the presence of a large structural feature.—*D. B. V.*

158–26. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity measurements along the lines of precise levels over whole Japan by

means of a Worden gravimeter. I. Shikoku Island: Acad. Japan Proc., v. 29, no. 6, p. 235–238, 1953.

In 1951 the Earthquake Research Institute of Tokyo University began a program of measuring gravity at every other bench mark along all lines of precise levels in Japan, or, in effect, at 4-km spacing. Measurements were made at 276 places in Shikoku, and the results given as a Bouguer anomaly map with 5-milligal contour interval. The anomaly increases toward the Pacific side of the island, to 100 milligals at Muroto Point. In general the contours trend west-southwest to east-northeast, in agreement with the structure. Negative anomalies near the city of Matsuyama suggest a depression in the crust; conspicuous positive anomalies north of Kagawa indicate presence of a dense mass underground.—*M. C. R.*

158–27. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity measurements along the lines of precise levels over whole Japan by means of a Worden gravimeter. II. Chugoku district: Acad. Japan Proc., v. 29, no. 7, p. 311–315, 1953.

Gravity measurements were made at 420 places in the Chugoku district in the westernmost part of the main island of Japan. Results are given as a Bouguer anomaly map contoured at a 5-milligal interval. The contours are in general parallel to the Japan Sea coast, except in the westernmost part of the district and near the city of Matsue. The anomaly increases towards the north. A conspicuous negative anomaly around Hiroshima indicates a 2-km depression of the crust. The positive anomaly north of Kagawa in Shikoku extends into this district forming an elliptic anomaly with major axis east-west. Horizontal strains of the crust after the Nankaidō earthquake of 1946 were notably smaller in this elliptic area than elsewhere, indicating the deep mass is relatively rigid.—*M. C. R.*

158–28. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity measurements along the lines of precise levels over whole Japan by means of a Worden gravimeter. III. Kinki district: Acad. Japan Proc., v. 29, no. 7, p. 316–320, 1953.

Gravity measurements were made at 480 places in the Kinki district, east of the Chugoku and Shikoku districts, and the results presented as a Bouguer anomaly map contoured at 5-milligal intervals. The anomaly increases both north and south to positive anomalies of 48 milligals on the Japan Sea coast and 153 milligals on the Pacific coast. A conspicuous negative anomaly about Lake Biwa suggests a depression in the crust deeper than indicated by present relief.—*M. C. R.*

158–29. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity measurements along the lines of precise levels over whole Japan by means of a Worden gravimeter. IV. Tōhoku district: Acad. Japan Proc., v. 29, no. 9, p. 503–508, 1953.

Gravity measurements were made at 667 places in the Tōhoku district in the northernmost part of the main island of Japan; the results are given as a Bouguer anomaly map contoured at 5-milligal intervals. The district as a whole is characterized by positive anomalies, but may be divided by a north-south line passing through Morioka and Shirakawa into an eastern zone—characterized

by parallel, nearly straight, closely spaced contours—and a western zone of irregularly curved contours. Bouguer anomalies are higher in the eastern zone, the average difference between the two areas being about 70 milligals. Correspondence of gravity minima to the distribution of Pleistocene and Recent formations is striking.—*M. C. R.*

158–30. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity measurements along the lines of precise levels over whole Japan by means of a Worden gravimeter. V. Chubu district: Acad. Japan Proc., v. 29, no. 10, p. 550–555, 1953.

Gravity measurements were made at 748 places in the Chubu district in the central part of the main island of Japan; the results are given as a Bouguer anomaly map contoured at 5-milligal intervals. The anomaly is negative in the central mountainous part of the district and increases toward the Pacific and Japan Sea coast, to a maximum of more than +50 milligals. A gravity low in the southwestern part of the district corresponds to the Nōbi plain where thick geologically young formations are found. The Fossa Magna is traceable but not clearly so in the gravity distribution. The steep gradient along the northern and middle sections of the line suggests a faultlike structure at not too great depth, but the gravity low along the northern section suggests a geosynclinal structure, either wide and shallow or narrow and deep.—*M. C. R.*

158–31. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity measurements along the lines of precise levels over whole Japan by means of a Worden gravimeter. VI. Kantō district: Acad. Japan Proc., v. 29, no. 10, p. 556–560, 1953.

Gravity measurements were made at 366 places in the Kantō district in the southeastern part of the main island of Japan, and the results given as a Bouguer anomaly map contoured at 5-milligal intervals. The anomalies are complex, and range from +171 milligals on the Pacific coast of the northern part of the prefecture of Ibaraki to —14 milligals about 25 km southwest of Tokyo. Steep gradients (as much as 120 milligals in 30 km) are found. A prolongation of the Morioka-Shirakawa line is found in the northeastern part of the district.—*M. C. R.*

158–32. Teixeira, Carlos. As anomalias da gravidade na parte portuguesa da ilha de Timor [Gravity anomalies in the Portuguese part of island of Timor]: Garcia de Orta, v. 1, no. 2, p. 211–217, 1953.

Timor is within the narrow belt characterized by the greatest known gradients of gravity. (Within less than 100 km at certain places the negative anomaly of —200 milligals changes to a positive anomaly of +230 milligals. Gravity survey by the Companhia Ultramarina de Petróleos of the Portuguese part of the island shows that the northern shore of the eastern part of the island is characterized by strong positive anomalies of as much as +152 milligals, with negative anomalies found only in a narrow strip on the opposite shore. The distribution of anomalies may be interpreted as the effect of an inclined position of the sialic root of the island.—*S. T. V.*

158–33. Collette, B. J. On the gravity field of the Sunda region (West Indonesia): Geologie en Mijnbouw, jaarg. 16, no. 7, p. 271–300, 1954.

Gravity observations at sea by Vening Meinesz and on land by the Bataafsche Petroleum Mattschappij in west Indonesia have been corrected for the influence

of sedimentary basins, necessitating supplementary isostatic reductions; these effects were computed by the profile method. Resulting changes in the isostatic anomaly are small. An explanation for the gravity field is attempted on the basis of applied mechanics. The life time of the negative anomalies is determined by the rate of reaction of the substratum, for the crust is not thick enough to sustain the great stresses. Computations of their half life from data on post-glacial uplift of Fennoscandia range from 66 to 55,000 years, which is too short to account for the coexistence of negative zones in so many regions of the earth. The unavoidable conclusion is that horizontal forces acting in the crust sustain the anomalies of west Indonesia.—*D. B. V.*

158–34. Bemmelen, R. W., van. The geophysical contrast between orogenic and stable areas: Geologie en Mijnbouw, jaarg. 16, no. 8, p. 326–334, 1954.

According to general thermodynamic principles, the numerical values of factors such as viscosity of the substratum and thickness of the crust in orogenic areas will differ significantly from those in stable areas. As these values have been determined only for the latter, (for example, in Scandinavia) they should not be applied unaltered to calculations concerning orogenic belts. During orogenic paroxysms the consistency of the upper crust in orogenic belts may be lower than in stable areas, but in the longer geosynclinal periods preparatory to orogeny, much higher mean consistency is to be expected. The "Vening Meinesz zones" of negative anomalies are examples of such areas; their higher mean consistency might be the reason why the half life of their negative anomalies is actually about a hundred times longer than that shown by Collette's calculations, made on the basis of values in a stable area.

The isostatic anomalies in orogenic belts might result either from lateral compression or from chemical migrations causing changes in density in and also beneath the crust. Until the second possibility is investigated, Collette's conclusions are premature. Van Bemmelen here presents a possible physicochemical explanation of the negative anomalies of orogenic belts, and concludes with the suggestion that systematically collected data on heat flow at the surface, especially across orogenic belts, might deepen our understanding of the processes of mountain building.—*D. B. V.*

158–35. Collette, B. J. On the gravity field of the Sunda region (West Indonesia)—a postscript: Geologie en Mijnbouw, jaarg. 16, no. 8, p. 335–338, 1954.

Van Bemmelen's explanation for the gravity field of west Indonesia contains many uncertainties and seems to fail when applied to the Puerto Rico trench but cannot be refuted conclusively. However, the lateral compression hypothesis is preferable because it provides a more uniform adaptation to the geophysical data.—*D. B. V.*

MAGNETISM

MAGNETIC FIELD OF THE EARTH

158–36. Takeuchi, Hitoshi, and Shimazu, Yasuo. On a self-exciting process in magneto-hydrodynamics (II): Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 5, no. 2, 1952; reprinted from Jour., Physics of the Earth, v. 1, no. 2, p. 57–64, 1952.

This is the second part of a more complete paper published in the Journal of Geophysical Research (Geophys. Abs. 156–31. See also Abstract 157–25).—*D. B. V.*

158–37. Hardtwig, Erwin. Probleme des Erdmagnetismus [The problems of terrestrial magnetism]: Forschungen u. Fortschr., Jahrg. 27, Heft 4, p. 97–103, 1953.

This is a review of theories of geomagnetic phenomena. The geomagnetic field can be divided into a permanent portion, the dipole term, and the remaining portion, which is subject to variations. The dipole moment is constant when sufficiently long time intervals are considered. The axis of the dipole moment remains inclined in reference to the polar axis through the constant angle of 11.6°, but has a slow and not quite regular precession in the direction from east to west. The remaining or nondipole field manifests rapid and intense changes. The entire field shows a slow rotation of isogons in the direction contrary to the rotation of the earth. The nondipole field, during rotation, does not remain rigid, but undergoes important local distortions.

The causes of the permanent field or of the secular variations cannot be attributed to the gyromagnetic effect relating mechanical rotation of a body with its magnetization because the effect of rotation produces a moment 10^{10} times smaller than is necessary. Neither can the principle of separation of electric charges be accepted. The theory of Wilson (1923) and P. M. S. Blackett has been confirmed by observations of the geomagnetic field, and the magnetic field of celestial bodies.—*S. T. V.*

158–38. Macht, Hans G. On the increase of the earth's dipole moment: Jour. Geophys. Research, v. 59, no. 3, p. 369–376, 1954.

The problem of whether the earth's magnetic moment M is increasing or still decreasing cannot at present be definitely answered from a critical review of recent literature. From an investigation of Vestine's successive analyses of the geomagnetic secular variation since around 1910, the conclusion is reached that M, after having passed through a minimum a few years ago (probably between 1945 and 1952), is beginning to recover at present. A semiquantitative explanation of the secular change of M is afforded on the basis of a physical model of the main geomagnetic field (conception of two eccentric dipoles) as developed in an earlier publication. The hypothesis is advance of quasiperiodic cycles of about three centuries, with alternating demagnetization and induction (remagnetization) processes in the earth giving rise to corresponding cycles of decrease and increase of M.—*Author's abstract*

158–39. Gaibar-Puertas, C. Fluctuaciones experimentados par la intensidad de la fuerza geomagnetica durante el periodo 1885–1950 [Fluctuations in total geomagnetic intensity during the period 1885–1950]: Rev. Geofísica, año 12, no. 48, p. 255–305, 1953.

By using yearly averages of total magnetic force at observatories throughout the world, it has been possible to determine yearly gradients of the variation. The effect of the unequal distribution of observatories was eliminated by dividing the surface of the earth into eight sectors and then averaging the gradients in each sector, in each hemisphere, and finally of the two hemispheres. By this process it was determined that the magnetization was increasing from 1885 to 1895, decreasing from 1895 to 1915, again increasing from 1915 to 1941,

and decreasing from 1941 to 1950. A period of 48 years for the magnetization-demagnetization cycle is inferred.—*M. C. R.*

158–40. Rikitake, Tsuneji. Geomagnetic secular variation and motion of the earth's core: Geofisica Pura e Appl., v. 26, p. 30–40, 1953.

On the basis of the westward drift of the equatorial dipole in the two eccentric dipole models of H. G. Macht, the origin of geomagnetic secular variation cannot be in the deep interior of the earth's core because of the shielding effect of the high-conducting material of the core and its motions. But the westward drift of the core's top layer relative to the mantle seems to be quite reasonable, even taking into account the shielding effect of the mantle.—*M. C. R.*

158–41. Barta, György. A földmágneses tér évszázados változásának 44 éves periódusáról [On a 44-year period of the secular variation of the geomagnetic field] (With summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 3, szám 1, p. 3–24, 1954.

Barta has studied values from 36 observatories and finds that the 44-year cycle superimposed on the secular variation, as previously established by him, has appeared in all observations in the temperate zone since 1840, with an amplitude of 10–20 minutes in declination and 200 gammas in horizontal and vertical intensity. Equatorial observations show a 22-year period.

The phases of all magnetic elements except D and Y are the same throughout the globe, with maxima and minima at about 1906, 1928, and 1950. Equal phases of D and Y are observed along equal longitudes, with a lag from east to west, as though there were two waves drifting around the globe 180° apart.—*D. B. V.*

158–42. Chakrabarty, S. K., and Pratap, R. On the dynamo theory of geomagnetic field variations: Jour. Geophys. Research, v. 59, no. 1, p. 1–14, 1954.

The dynamo theory developed by Stewart, Schuster, and Chapman in order to explain the geomagnetic field variations no doubt gives qualitative explanations for the observed variations but differs appreciably in details. In the present paper, the analysis of Chapman has been modified and the dynamo equations have been solved without introducing approximations which are difficult to justify. The solution of the dynamo equation has been given in the most general form, which can be used for any given "ionospheric conductivity" and "atmospheric oscillations." The results obtained have been compared with those of Chapman, which show the effect introduced in the final result by the approximations used by Chapman. The results have been utilized also to calculate the diurnal variations in horizontal and vertical intensities, and these have been compared with the observed data. The results show that with a reasonable assumption for the conductivity and the atmospheric oscillations the dynamo theory can very well explain the observed facts.—*Authors' abstract*

158–43. Coulomb, J[ean] Comparaison entre pulsations magnétiques observées simultanément à 500 km. de distance [Comparison between magnetic pulsations recorded simultaneously 500 km apart]: Annales Géophysique, tome 10, no. 2, p. 159–161, 1954.

This is a comparison of magnetic pulsations recorded at Chambon-la-Forêt and at Saint-Michel 530 km away. Data are presented for the period December 6–11, 1953, and include comparisons of mean period, mean amplitude in gammas, number of oscillations, and time of beginning of the various disturbances. The comparison of diurnal pulsations, which could be correlated wave by wave at the two stations, reveals that the periods are practically the same. The ratio of the amplitudes at Chambon to those at Saint-Michel is 1.54. The longer period oscillations accompanying nocturnal bays show the same periods at the two places and the amplitude ratio is 1.21 in the same sense. Thus the ratio decreases as the period increases and rocks at greater depths, which are more nearly the same at the two stations, affect the disturbances.—*P. E. B.*

158–44. Imamiti, Syuiti. Magnetic pulsations observed by induction loops: Kakioka Magnetic Observatory Mem., v. 7, no. 1, p. 1–4, 1954.

Observations of the three components of magnetic pulsations of 20–60 sec period, observed by means of induction loops at the Kakioka Observatory are summarized in tables and graphs. The 20–60 sec pulsations appear most frequently in daylight hours, longer periods predominating at night. The equipment, and the general characteristics, amplitude, and phase differences of the three magnetic components are described.—*D. B. V.*

158–45. Kato, Yoshio; Ossaka, Justo; and Okuda, Mitsunao. Investigations on the magnetic disturbance by the induction-magnetograph, Part II: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 1, p. 10–21, 1953.

Kato's investigation of magnetic disturbances by means of induction-magnetometer records (Geophys. Abs. 12906) has been continued with an analysis of the dH/dt oscillation at the time of bay disturbance. This oscillation appears only at the initial part of bay disturbance, always in a north or south direction regardless of whether the bay is positive or negative. It is believed that the cause of the dH/dt oscillation is not fluctuation in the leakage current S_D, but fluctuation in the magnetic field due directly to motion of a corpuscular beam having different density or velocity.—*D. B. V.*

158–46. Kato, Yoshio; Ossaka, Justo; and Okuda, Mitsunao. Investigation on the magnetic disturbance by the induction magnetograph, Part III. On the magnetic storms: Tōhoku Univ. Sci. Repts. 5th ser., v. 5, no. 3, p. 85–122, 1953.

At the time of sudden commencement of the first phase, the oscillation dH/dt was noted to have a long period and amplitude. This is reduced to calm until the beginning of the main phase, when short period oscillation begins and continues into the initial part of the main phase. The dH/dt oscillation in the main phase may be caused directly by the magnetic field of a corpuscular beam approaching the earth, having different density or velocity.—*D. B. V.*

158–47. Fukushima, Naoshi. Constitution of polar magnetic storms (II): Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 5, no. 2, 1952; reprinted from Rept. Ionosphere Research in Japan, v. 6, no. 4, p. 185–193, 1952.

Geomagnetic variations on May 1 and 2, 1933, were examined on a number of magnetogram copies of world-wide data. It was noted that disturbances of rather simple form, the idealized form of which is equivalent to the current

system produced by an electric dipole along the auroral zone, are superposed upon the general geomagnetic variation at the severest stage and at the later stage of the magnetic storm, with duration from a few tens of minutes to about an hour. This corroborates the conclusion in the previous study (see Geophys. Abs. 157–31) that the disturbance field of polar magnetic storms consists of elementary disturbances, whose origin takes place intermittently or successively at some limited region along the auroal zone. This effect can be attributed to the occasional concentration of corpuscles from outside the earth impinging into some limited region along the auroral zone, if dynamo action in the upper atmosphere is assumed to be the main cause of the disturbance field.—*D. B. V.*

158–48. Yumura, Tetsuo. On the sudden commencement of geomagnetic storms (in Japanese with English summary): Kakioka Magnetic Observatory Mem., v. 7, no. 1, p. 27–48, 1954.

Statistical investigation of sudden commencements show that: latitude distribution of direction of the horizontal component, calculated from the magnetic meridian, is approximately symmetrical with respect to the magnetic equator; hourly distribution of direction angles depends upon local time at each observatory, with values concentrated around 0° between 12^h and 24^h, but fluctuating with large amplitudes between 6^h and 12^h; inverted *SC*'s appear more frequently during the 6^h–12^h interval in high magnetic latitudes; horizontal *SC* vectors do not point to magnetic north in high altitudes, as in middle and low latitudes; distribution of magnitudes of horizontal vectors of *SC* is found to be of the *W*-type with symmetry near the magnetic equator, the minimum of 0.4 occurring near magnetic latitude 30°.

The variation in sudden commencement thus seems to be affected by the sun's altitude, which does not seem compatible with an origin outside the earth's atmosphere. Correction for the influence of ultraviolet radiation from the sun gives no essential difference.

The ratio of the amplitude of the vertical component to that of the horizontal shows regular distribution with respect to the geomagnetic latitude, with maxima at about ±20–30° (positive regions) and minima at +15° and −35° (negative regions). It is difficult to interpret such distribution according to Chapman's theory of magnetic storms.—*D. B. V.*

158–49. Kato, Yoshio, and Ossaka, Justo. Time variation of the earth's magnetic field at the time of bay-disturbance: Tōhoku Univ. Sci. Repts., 5th ser., v. 3, no. 3, p. 111–113, 1951; Rept. of Ionosphere Research in Japan, v. 5, no. 4, 1951.

The changes of dH/dt are remarkable only at the initial part of bay disturbance, becoming calm at the time of maximum amplitude of the bay. The explanation suggested is that the source of the disturbance, corpuscular radiation from the sun, is suspended at this time, and the change of bay disturbance after its maximum is the variation in the interval until the ions which make up the current system lose their charge by recombination or attachment, and disappear.—*D. B. V.*

158–50. Rikitake, Tsuneji, and Yokoyama, Izumi. Anomalous relations between *H* and *Z* components of transient geomagnetic variations: Jour. Geomagnetism and Geoelectricity, v. 5, no. 3, p. 59–65, 1954.

Anomalously large amplitudes of the vertical component of geomagnetic variations have been observed at Hermanus in South Africa and at several Japanese observatories. The anomalous behavior in Japan can be explained by a magnetic field originating in the earth. The anomaly is approximated by an apparent magnetic dipole situated under central Japan.—*M. C. R.*

Kato, Yoshio, and Yokoto, Kenichi. Corrected paper on the phase difference of earth current induced by the changes of the earth's magnetic field. See Geophys. Abs. 158–84.

MAGNETIC PROPERTIES OF ROCKS AND MINERALS

158–51. Bruckshaw, J. M. Rock magnetism. Some recent developments: Science Progress, v. 42, no. 167, p. 406–418, 1954.

The results of the work of numerous investigators of the magnetization of igneous and sedimentary rocks throughout the world are reviewed and it is concluded that reverse magnetizations are most likely produced by cooling of igneous rocks or the formation of sedimentary rocks during a period of reversal of the earth's main magnetic field.—*J. R. B.*

158–52. Hospers, J. Rock magnetism and polar wandering: Nature v. 173, no. 4416, p. 1183–1184, 1954.

Lava flows, permanently magnetized in the direction of the local geomagnetic field on cooling through the Curie point, and sediments, polarized by the lining up of minute permanently magnetized particles of ferromagnetic minerals on deposition, were studied to gain information on paleomagnetic directions. The mean direction of magnetization was compared to the direction of the field due to a geocentric dipole. It is concluded that in recent geologic time the magnetic poles have centered on the geographic poles. The paths of polar wandering in the Tertiary and Quaternary suggested by Kreichgauer, Köppen and Wegener, and Milankovitch cannot be reconciled with data found in this study. Results from Eocene flows in Ireland, however, indicate a possible 5°–10° change in position of the geographic axis relative to that country.—*R. G. H.*

158–53. Graham, John W. Rock magnetism and the earth's magnetic field during Paleozoic time: Jour. Geophys. Research, v. 59, no. 2, p. 215–222, 1954.

A brief appraisal is given of the observations and arguments that are advanced in support of the opinion that during Paleozoic time the earth's magnetic field retained approximately its present orientation, and, except for possible brief excursions, its present sense.—*Author's abstract*

158–54. Veshev, A. V. Zavisimost' magnitnoy vospriimchivosti gornykh porod i rud ot soderzhaniya ferromagnitnykh komponentov [The dependence of magnetic susceptibility of rocks and ore bodies on their contents of ferromagnetic components]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 2, p. 68–81, 1950.

Veshev examines a two-component aggregate consisting of a substance having magnetic permeability of μ_1 and susceptibility of k_1, and containing magnetic inclusions with the properties μ_2 and k_2. If the inclusions are spherical with

radius r_0, the resulting permeability $\bar{\mu}$ and susceptibility $\bar{k}$ are represented by the formulas

$$\bar{\mu}=[\mu_2(1+2E)+2\mu_1(1-E)]/[\mu_2(1-E)+\mu_1(2+E)]$$

and

$$\bar{k}=(\bar{\mu}-1)/4\pi,$$

where E is the entire volume of the inclusion or $(4\pi/3)r_0^3\,v$, v being the number of spherical inclusions.

The case is considered of inclusions which are small ellipsoids of revolution, all similarly oriented. This makes the aggregate anisotropic; the resulting permeability μ_z in the direction of the axis of ellipsoids is:

$$\mu_z=\mu_1[\mu_2(1-Ek)-k\mu_1(1-E)]\diagdown[\mu_2(1-E)-\mu_1(k-E)];$$

in the plane perpendicular to this it is $\mu_x=\mu_y=\mu_1[\mu_2(1-El)-l\mu_1(1-E)]$. These formulas are not applicable when the ellipsoids are very flat; a set of corresponding expressions for μ_x, μ_y and μ_z are derived for this case.

The results of these analytical deductions were checked by laboratory measurements and a good agreement between measured and computed values was found.—*S. T. V.*

158–55. Manley, H[orace] Rock magnetism as a temperature indicator: Jour. Geomagnetism and Geoelectricity, v. 6, no. 1, p. 47–51, 1954.

The magnetic properties of a suite of pre-Cambrian dolerite dikes of the west coast of Scotland were determined and show good correlation with the degree of metamorphism. The field in which these rocks cooled was of the order of that existing today and not less than 0.12 gauss. The rate of demagnetization, assuming the field was 0.545 gauss, was 80 percent per 800 million years.—*M. C. R.*

158–56. Griffiths, D. H., and King, R. F. Natural magnetization of igneous and sedimentary rocks: Nature, v. 173, no. 4415, p. 1114–1117, 1954.

At a recent Geophysical Discussion of the Royal Astronomical Society recent developments in Great Britain in the study of natural magnetization of rocks were considered. Participants included G. D. Nicholls, S. K. Runcorn, J. McG. Bruckshaw, J. Hospers, E. Irving, R. Fisher, K. M. Creer, J. A. Clegg, and others. The permanent magnetism of rocks depends upon the properties of their iron oxide minerals which occur naturally as solid solutions of hematite, maghemite, magnetite, and ilmenite.

From various paleomagnetic studies of series of lava flows and sediments covering much of geologic time, the following conclusions may be drawn: there is no evidence of the polar wandering suggested by Wegener and others for recent geological times, but there is evidence of a 5° movement since Eocene time. Great Britain may have moved relative to the earth's geographic axis, explaining certain preferential directions of polarization found there. Some evidence was offered favoring the view that reversed magnetizations are due to reversal of the earth's magnetic field; however the question remains very much unresolved.

Particle size in relation to both domain size and limits set by the demagnetizing effect of thermal fluctuations is believed to affect magnetic stability. In model sedimentation experiments, discrepancies appear between inclination of the remanence and the applied field.—*R. G. H.*

158–57. Hatherton, T. The permanent magnetisation of horizontal volcanic sheets: Jour. Geophys. Research, v. 59, no. 2, p. 223–232, 1954.

The magnetisation of igneous rocks is often largely due to thermoremanent components. Several horizontal sheets of acid tuffs in New Zealand exhibit similar magnetisation patterns. Each sheet has a basic minimum Q value; superimposed on this is an amplitude of polarisation pattern which, for one sheet examined in detail, is found to vary with depth in a similar manner to the inverse ratios of the computed cooling times over the temperature range $T_o \longrightarrow 0.75\ T_o$, T_o being the instantaneous temperature of deposition of the lava.—*Author's abstract*

158–58. Kawai, Naoto, and Kume, Shoichi. The thermal fluctuation aftereffect found in the natural remanent magnetic polarization of rocks: Jour. Geomagnetism and Geoelectricity, v. 5, no. 3, p. 66–70, 1953.

The directions of magnetic polarization in pebbles of a conglomerate of known geologic age were measured with a sensitive astatic magnetometer. Agreement with Graham's results was found for many igneous pebbles, but sedimentary pebbles were exceptional. Laboratory measurements of the polarizations at intervals from 2 to 1,000 days and also at different temperatures suggest that the polarizations are due to thermal fluctuation aftereffect under the influence of the geomagnetic field during the interval since deposition.—*M. C. R.*

158–59. Grabovskiy, M. A., and Pushkov, A. N. K voprosy o vozniknovenii ostatochnoy namagnichennosti obratnoy polyarnosti v gornykh porodakh [On the origin of inverse remanent magnetization in rocks]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 320–329, 1954.

Experiments indicate that induced magnetization of a ferromagnetic rock cannot give rise to a magnetization of opposite polarity and of an intensity greater than that of the external field producing the induced magnetization; a ferromagnetic substance undergoing thermoremanent magnetization can produce a magnetic field of reversed polarity and of an intensity greater than that of a constant magnetic field in which the rock is cooling; in the thermoremanent magnetization of two rocks of different coercivity and different Curie points it is possible for one specimen to become magnetized with polarity opposite to that of the earth's field.—*S. T. V.*

158–60. Nagata, T[akesi]; Akihoto, S[yun-iti]; and Uyeda, S[eiya]. Self-reversal of thermo-remanent magnetism of igneous rocks (III): Jour. Geomagnetism and Geoelectricity, v. 5, no. 4, p. 168–184, 1953.

Besides the dacitic pumice of Mt. Haruna, an igneous rock having the tendency of self-reversal of thermoremanent magnetization has been found in a pitchstone of Mt. Asio. Although the self-reversal property of the Asio ferromagnetic minerals is weaker than that of the Haruna ferromagnetic minerals, the magnetic and crystallographic properties of the former are fundamentally same as those of the latter.

By thermomagnetic separation, an ensemble of ferromagnetic grains in both the Haruna and the Asio rocks were divided into A, B and AB groups. The results of thermomagnetic measurement, chemical analysis, and X-ray analysis of these three groups showed tthat the A constituent is a titanomagnetite of the crystal structure of inverse spinel type having the Curie point of 430°–510° C, and the B constituent is an ilmenite-hematite solid solution of the rhombohedral crystal structure having the Curie point at about 230° C, while the AB grains are composed of both A and B constituents.

The measurement of thermoremanent magnetization of a large number of single grain gave the result that only the *AB* grains can have the reverse thermoremanent magnetization, the *A* and the *B* grains getting the ordinary normal thermoremanent magnetization.—*Authors' abstract*

158–61. Akimoto, Syun-iti. Thermo-magnetic study of ferromagnetic minerals contained in igneous rocks: Jour. Geomagnetism and Geoelectricity, v. 6, no. 1, p. 1–14, 1954.

The change in intensity of magnetization of ferromagnetic mineral grains separated from igneous rocks with change in temperature was measured in a strong magnetic field by means of a magnetic balance.

The Curie point and intensity of saturation magnetization, especially for titanomagnetites, could be interpreted as the magnetic properties of the solid solution of $TiFe_2O_4$ and Fe_3O_4. As a first approximation a linear relation was found between any two of the chemical composition, lattice parameter, the Curie point, and the intensity of saturation magnetization. In the ilmenite-hematite series, some minerals were found which have a peculiar thermomagnetic curve, with a higher intensity of saturation magnetization and higher Curie point.—*M. C. R.*

158–62. Chevallier, Raymond, Mathieu, Suzanne, and Vincent, E. A. Iron-titanium oxide minerals in layered gabbros of the Skaergaard intrusion, East Greenland. Pt. II. Magnetic properties: Geochim. et Cosmochim. Acta, v. 6, no. 1, p. 27–34, 1954.

Measurements of the magnetic constants of chemically analyzed titaniferous magnetites from the Skaergaard intrusion indicate that $FeTiO_3$ is completely exsolved as ilmenite lamellae. Up to about 6 percent Fe_2TiO_4, however, may remain in solid solution, the amount appearing to be more closely related to the temperature of consolidation of the rock than to the total Fe_2TiO_4 content of the mineral. The magnetic measurements provide a completely independent estimate of the Fe_2O_4 contents of the samples, which show good agreement with values calculated from chemical analyses. The coexisting ilmenites show little variation in magnetic properties; in particular there is no close relationship between magnetic properties and content of Fe_2O_3.—*Author's abstract*

158–63. Mašín, Jan. Magnetismus gabbrových vyvřelin středoceského plutonu [The magnetism of the gabbro intrusives of the pluton of central Bohemia] (With summaries in English and Russian): Czechoslovakia, Ustředni Ústav Geol. Sborník, Svazek 19, p. 185–212, 1952.

A magnetic survey of the gabbros at the northwestern margin of the central Bohemia batholith, in the area between Velké Popovice and Pysely, showed a major anomaly near the village of Zajecice, which was surveyed in detail. After a theoretical discussion of the possible causes of such an anomaly, Mašín concludes that it is caused by plate-shaped bodies containing considerable percentage of magnetite, whose upper margin lies at a depth of 10–30 m. Their position suggests that they are not veins but magnetic differentiates. Maps of vertical intensity and many tables and graphs are included in the paper.—*D. B. V.*

158–64. Manley, Horace. An estimate of the time taken for a dike to cool through its Curie point: Geofisica Pura e Appl., v. 27, p. 105–109, 1954.

The problem of the cooling of a dike is similar to that in the setting of concrete in walls and foundations, although the magnitude of the temperature changes is considerably different. On this basis, if the temperature at injection is 1,000° C, the country rock more than a dike's width away is never heated above 200° C. The controlling factor in the cooling of a dike below 600° C is the thermal diffusivity of the dike and the country rock. If the diffusivity is taken as 12×10^{-3} cgs units, dikes such as those in the Cleveland dike system would cool from 550° to 450° in one year, and hence a 60-foot dike would acquire its remanent magnetization in about one year. The effect of variables is to make the time of cooling of the order of 1 to 10 years.—*M. C. R.*

Ovchinnikov, I. K. On the theory of effective electric conductivity $\bar{\gamma}$, magnetic permeability $\bar{\mu}$, dielectric constant $\bar{\epsilon}$ of a medium containing foreign inclusions. See Geophys. Abs. 158–87.

INSTRUMENTS AND METHODS OF OBSERVATION

158–65. Bruckshaw, J. McG. Magnetic variometers: 115 p., London, Hilger and Watts Ltd., 1954.

This is primarily a handbook on the operation and maintenance of Schmidt-type variometers, especially the models manufactured by Hilger and Watts. The theory of the magnetometer and magnetic prospecting are reviewed briefly.—*M. C. R.*

158–66. Hirone, Tokutaro, and Maeda, Seijiro. An automatically recording magnetic balance: Tōhoku Univ. Research Inst. Sci. Repts., Ser. A, v. 6, no. 1, p. 67–76, 1954.

A chemical balance has been modified to provide continuous records of the variations of saturation magnetization with temperature. The specimen to be measured is suspended from one arm of the balance in an inhomogeneous magnetic field. The pointer of the balance carries one plate of a condenser whose other plate is fixed to the frame of the balance. This condenser, by means of a phase-sensitive capacity analyzer, controls the flow of current through a coil surrounding a small magnet suspended from the other arm of the balance. By this means the force exerted on the specimen by the interaction of its susceptibility with the inhomogeneous magnetic field is balanced by the same force exerted on the suspended magnet by its surrounding coil. The current flowing through the coil is recorded and after suitable calibration gives the saturation magnetization of the specimen.

The entire apparatus can be enclosed in a bell jar which can be evacuated. The specimen is suspended in a tubular extension around which a heating furnace or cooling vessel can be placed.—*J. R. B.*

158–67. Dürschner, Horst. Ein Magnetometer zur Bestimmung der magnetischen Eigenschaften von Gesteinen [A magnetometer for the determination of the magnetic properties of rocks]: Annales Géophysique, tome 10, no. 2, p. 152–156, 1954.

An apparatus for measuring remanent or induced magnetization of rock samples consists of a Helmholtz coil suspended by a gold fiber or gold band. If the sample is introduced into the homogeneous part of the field of the coils, a mechanical moment turns the Helmholtz coil an amount depending upon the magnetic moment of the sample. The other mechanical moment from the ter-

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restrial field is compensated by a second current coil, the magnetic moment of which is equal and opposite to the moment of the Helmholtz coil. Zero can be obtained by varying the current in the second system. The sensitivity of the apparatus is 10^{-6} gauss per mm scale value. Maximum dimensions of samples are 3 x 3 x 3 cm^3. The advantage of the system is its great sensitivity. An example of results obtained with the apparatus is included.—*P. E. B.*

158–68. Burkhart, K[urt]. Die Fernregistrieranlage für Deklination und Horizontalintensität am erdmagnetischen Observatorium in Fürstenfeldbruck [The remote-registration installation for declination and horizontal intensity at the geomagnetic observatory in Fürstenfeldbruck]: Geofisica Pura e Appl., v. 27, p. 116–120, 1954.

The photoelectric recording apparatus which has been used since October 1953 at the Fürstenfeldbruck Observatory in Bavaria is described. The *H*-variometer (Töpfer) is compensated for temperature, and a *D*-variometer, constructed at the Observatory, has a plexiglass case. The projectors, furnished with a special diaphragm, light up the variometers, which throw equally clear rectangles of light on the cells. The scale values are: for *D*, 0.70±0.3′; for *H*, 4.2±0.05 gamma per part. The arrangement is very useful for prediction of ionospheric disturbances.—*D. B. V.*

158–69. Manley, Horace. A new inductive method for the determination of the temperature variation of susceptibility of rocks: Geofisica Pura e Appl., v. 27, p. 98–104, 1954.

A method for determining the variation with temperature of magnetic susceptibility is based on the fact that, when placed in a magnetic field of intensity *H*, rock cubes produce a secondary field proportional to the inverse cube of the distance, *r*. As the intensity of magnetization is small, this secondary field can be expressed by kVH/r^3, where *V* is the volume of the cube and *k* is its volume susceptibility.

Two pick-up coils, inside a Helmholtz coil system, are accurately balanced so that in the absence of the cube, they have the same mutual inductance with the Helmholtz coil system. The distortion of the field due to introduction of the specimen is a direct measure of its susceptibility. A 2-cm cube with beveled edges is placed on the axis 7 cm from the nearest pick-up coil, completely enclosed by the fire-clay jacket of an electric furnace, which is in turn enclosed in a water jacket. Copper-constantan thermocouples measure the temperature at each end of the specimen.

Details of the apparatus are described, with photographs and schematic diagrams. A new rock-cutting machine, designed to cut more perfect cubes, is also described.—*D. B. V.*

158–70. Morton, L., Simpson, J. Arol, and Lachenbruch, S. H. Electron-optical shadow method of magnetic-field mapping: U. S. Natl. Bur. Standards Jour. Research, v. 52, no. 2, p. 97–104, 1954.

A technique was devised for the quantitative mapping of electric and magnetic fields by means of an electron-optical system. The field to be studied is placed in the path of an electron beam in the object space of an electron-optical lens system whose image space contains an opaque object, such as a wire grid, and the distortion of the shadow of this object due to the presence of the unknown field is measured as a function of position. When the field does not have axial

symmetry, additional experimental data of value may be obtained by repeating the experiment with different orientations of the field and (or) varying beam energies. From this shadow distortion and from known geometrical patterns of the electron-optical system, the angular deflections of different rays by the given field are calculated. The field distribution is then calculated from this deflection function and from any known or assumed qualitative properties of the unknown field.—*I. Z.*

158–71. Runcorn, S. K. Airborne magnetic surveys: Nature, v. 173, no. 4398, p. 281–283, 1954.

In discussions of the Royal Astronomical Society on airborne magnetic surveys, J. Squires gave details of the design, operation, and sensitivities of flux-gate magnetometers used in aerial surveying. A high permeability wire-measuring element whose alternating-current resistance depends upon the ambient magnetic field may also have applications in airborne surveys. A. B. Malone critically reviewed the interpretation method developed by Vacquier and others, and suggested an alternative "sharpness criterion" method for areas where the former would not be applicable. H. F. Finch, reporting on an absolute airborne magnetometer found that it gave results (good) within 0.5° in declination and within 200 gammas in horizontal and vertical components. The execution of aeromagnetic surveys and the reduction of data were described by P. A. Rankin. S. K. Runcorn referred to successes of airborne surveys and suggested their use in scientific problems such as the depth of the Curie-point isotherm under oceans and continents.—*R. G. H.*

158–72. Lundbak, Asger. About possibilities and limitations in aeromagnetic surveying: Geofisica Pura e Appl., v. 27, p. 110–115, 1954.

One of the problems of aeromagnetic surveying is that the quantity measured by the common type of flux-gate magnetometer is the total field; for different purposes other components may be desired. They can be obtained either by direct measurements or by computing procedures, but in both cases difficulties arise. The most serious difficulty is accelerations of the aircraft; long-period accelerations can be compensated by reference to the position of some body outside the aircraft, for instance the sun, but such values are mean values for definite short intervals of time. Pitch and roll of the aircraft also introduce inaccuracies.

Computations of horizontal or vertical components from total anomaly, according to various investigators, are reviewed. The prerequisite for such computations is that the anomalies be small in comparison with the earth's field.—*D. B. V.*

METHODS OF ANALYSIS AND INTERPRETATION

158–73. Tafeyev, Yu. P. Paletki dlya opredeleniya elementov zaleganiya vertikal'nogo plasta po magnitnoy anomaliy [A chart for determination of the position of a vertical slab from the magnetic anomaly]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 2, p. 64–67, 1950.

Charts for determining the vertical and horizontal components of the magnetic field produced by a vertical slab of infinite length magnetized vertically are given, based on the formulas:

$$Z=2I[\arctan(x+d)/h-\arctan(x-d)/h]$$

and

$$H=I\ln[(x-d)^2+h^2/(x+d)^2+h^2]$$

(where I is the intensity of the magnetization; $2d$ is the thickness of the slab; and h is the depth of its upper edge.) Both charts are constructed in double-logarithmic scale, with varying values of the parameter d/h.—*S. T. V.*

158–74. Andreyev, B. A. Ob usloviyakh primenimosti formul dvukhmernoy zadachi pri interpretatsii magnitnykh i gravitatsionnykh anomaliy [On the conditions of applicability of the formulas derived for two-dimensional problems in the interpretation of magnetic and gravitational anomalies] Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 3, p. 3–5, 1950.

In interpretation of magnetic and gravitational anomalies, it is often assumed that the disturbing body is infinitely extended in one direction, which reduces the problem to just two coordinates and simplifies the analysis. Andreyev discusses cases where such an assumption is admissible and computes the error committed by such simplification. The assumption is valid, for instance, in the case where the disturbing body is an ellipsoid of revolution with the ratio of long axis to transverse greater than 5. The resulting error in such a case is less than 2 percent.—*S. T. V.*

158–75. Contini, Camillo. Calcolo degli elementi del campo magnetico delle masse di forma qualunque [Computations of the elements of the magnetic field of masses of any shape]: Geofisica Pura e Appl., v. 26, p. 41–66, 1953.

For the approximate computation of the magnetic field of a heterogeneously magnetized mass of any geometric shape, the given mass may be divided into several (20–30) small bodies and the effect of individual parts on surrounding space computed. The summation of all elements is then the total field. A graphical procedure is also presented, as well as charts for convenient use of the derived formulas. Topographic corrections to be applied in magnetic surveys can be computed using the same charts and the procedure suggested by L. L. Nettleton for gravimetric surveys.

The same formulas and the same procedure can be used for the determination of the second derivatives of the gravitational field.—*S. T. V.*

158–76. Andreyev, B. A. Dva sposoba opredeleniya elementov zaleganiya krutopadayuschikh plastov po magnitnym anomaliyam [Two methods for the determination of the position of steeply dipping slab from magnetic anomalies]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 2, p. 59–63, 1950.

If a vertical slab of width $2b$ is buried with its top edge at depth h, the vertical component Z_a of the magnetic field can be expressed by the formula

$$Z_a = 2I \ (\arctan (x+d)/h - \arctan \ (x-d)/h,$$

where x is the coordinate of the point of observation in the (profile) plane transverse to the strike.

Andreyev suggests the use of the variation of

$$Z_a(\delta Z_a(x,l) = \tfrac{1}{2}[Z_a(x) - Z_a(x+l) + Z_a(x-l)]$$

where l is a short linear segment taken along the axis of x to the right or the left of point x.

For points of the y axis, the formula

$Z_a(0,l) = 2 \arctan d/h - [\arctan \ (l+d)/h + \arctan \ (l-d)/h]$ gives the values of

$Z_a(0,l)$ for any value of the ratio l/h. The values d/h ranging from 0.25 to 2.5 are computed and presented in graphs in a double logarithmic scale.

In another procedure use is made of the variations of $Z_a(x,h)$ so that the vertical coördinate z is changing. Then

$$\Delta\ (x,h)=Z_a(x,h)-Z_a(x,0)=2I\quad(\arctan x-\arctan y)$$

where

$$x=h(x+d)/[z(z+h)+(x+d)^2]\quad\text{and}\quad y=h(x-d)/[z(z+h)+(x-d^2)].$$

Field measurements give the values $Z_a\ (x,0)$, from which it is possible to construct the curve $\Delta\ (x,h)$ and thus to find the depth, using the angular coefficient of the best fitting curve.—*S. T. V.*

158–77. Bauman, V. I. Geologicheskaya interpretatsiya resul'tatov magnitometricheskoy s'yemki [Geologic interpretation of magnetic survey results]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 2, p. 3–58, 1950.

Bauman calculates the magnetic effect produced by a single pole; by an infinitely small dipole; by a thin infinite horizontal line of magnets having a magnetic intensity of $+\sigma$ per unit length; by two similar lines infinitely close and parallel, with magnetic intensities of $+\sigma$ and $-\sigma$ respectively; by two infinite parallel lines separated by a distance of $2\ l$; by an infinite horizontal slab having a thickness of $2\ b$ and intensity of $+\sigma$; by two infinite horizontal slabs, infinitely close, having a thickness of $2\ b$ and intensities of $+\sigma$ and $-\sigma$ respectively; and finally, by two parallel inclined slabs. Illustrations include the anomalies produced in each case as seen in the horizontal and vertical planes. Similar problems have been treated by Törnquist (see Geophys. Abs. 14434).—*S. T. V.*

158–78. Schleusener, Alfred. Wann muss die magnetische Vertikalintensitat in einem europaischen Messgebiet registriert Wereden? [When should the vertical magnetic intensity be recorded in a European measuring area?] Geol. Jahrb., Band 67, p. 361–365, 1953.

The most suitable interval between field measurements of vertical intensity, which are to be corrected for diurnal variations against observatory records in European areas, depends on the accuracy desired. For very precise work (limit of error, ± 2 to $\pm 5\gamma$), readings should be made every 2 to 4 hours in the field and at the base station, and within 100 km of an observatory. For surveys (± 5 to $\pm 10\gamma$ accuracy), field registration is not absolutely necessary but desirable, for by referring to observatory records, measurements made during rather strong disturbances (over 40γ) can be repeated. Base station readings should be made at the beginning and end of the work day and possibly once or twice during the day; maximum distance from an observatory should be 500 km. For coarse measurements ($\pm 15\gamma$ or more), such as over magnetite deposits, reference to observatory records is not necessary except to avoid large disturbances. Base station readings are necessary only in morning and evening.—*D. B. V.*

Andreyev, B. A. A simple method of reduction of geophysical anomalies to a (given) altitude. See Geophys. Abs. 158–17.

Tarrant, L. H. The least-squares method of determining regional contours. See Geophys. Abs. 158–11.

MAGNETIC OBSERVATIONS AND SURVEYS

158–79. Keller, Fred, Jr., Meuschke, J. L., and Alldredge, L. R. Aeromagnetic surveys in the Aleutian, Marshall, and Bermuda Islands: Am. Geophys. Union Trans., v. 35, no. 4, p. 558–572, 1954.

Total-intensity aeromagnetic surveys of the Aleutian, Marshall, and Bermuda Islands were completed in 1948. The anomalies associated with the Aleutian volcanoes are attributed mainly to topographic relief and are not an indication of the degree of volcanic activity. Eniwetok presents a magnetic pattern that would be produced by an irregular-shaped rimmed depression in the basement, modified by the two adjoining seamounts, and differs from Bikini, whose magnetic features would be produced by a broad seamount with irregular surface relief. The Bermuda survey demonstrated magnetic features typical of volcanic rocks. Comparison of an observed and a theoretical profile computed by Press and Ewing indicates that their assumptions are reasonably correct. The Aleutian Trench survey shows anomalies that are attributed to susceptibility contrasts but none that can be correlated with the trench. A traverse from Adak, Aleutian Islands to Kwajalein, Marshall Islands, exhibited several large anomalies that are presumed to be caused by susceptibility contrasts but may be indications of uncharted seamounts. Two traverses, one from Cape May, N. J., to Bermuda and the other from Bermuda to Long Island, N. Y., reveal a change in the magnetic field approximately 300 miles from the Atlantic Coast that indicates a possible thinning of the sial and an exposure of sima.—*Authors' abstract*

158–80. Hawkes, H. E., Wedow, Helmuth, and Balsley, J. R. Geologic investigation of the Boyertown magnetite deposits in Pennsylvania: U. S. Geol. Survey Bull. 995–D, p. 135–149, 1953.

The magnetite deposits at and near Boyertown, Pa., consist of replacements of calcareous sedimentary rocks, both Paleozoic and Triassic, near the contacts of intrusive bodies of Triassic diabase. A zone along the northwest margin of the Triassic basin near Boyertown was considered a particularly promising location for the occurrence of the favorable calcareous host rocks and hence for the existence of undiscovered deposits of magnetite.

An exploration program based on this premise was conducted in 1943 and 1944. Two deep diamond-drill holes demonstrated the down-dip continuity of the principal magnetite deposit at Boyertown. A geologic and magnetic survey of a belt 6 miles west and 3½ miles northeast of Boyertown uncovered two relatively large magnetic anomalies in addition to the anomaly over the known deposit at Boyertown. In addition, five experimental airborne-magnetometer traverses near Boyertown and an experimental ground-magnetometer survey within the city of Boyertown were run.—*Authors' abstract*

Romberg, Frederick and Barnes, Virgil E. A geological and geophysical study of Pilot Knob (South), Travis County, Texas. See Geophys. Abs. 158–18.

158–81. Bullerwell, W. A vertical force magnetic survey of the Coalisland District, Co. Tyrone, Northern Ireland: Great Britain Geol. Survey Bull., no. 6, p. 21–32, 1954.

A magnetic survey in the Coalisland District, made in March 1949 with a Watts variometer, indicated several large magnetic anomalies related to the Antrim basalts. The most striking feature was the marked change of field across the

northern part of the area from high magnetic values above the stratigraphically lower formations to low magnetic values over the Lough Neagh clays and the Antrim basalts. As the clays are nonmagnetic, the general reduction over their outcrop must be due to strong negative magnetization of the underlying basalts. The magnetization is of the order of 0.0028 cgs. units but is not constant throughout the area. Nevertheless the margin of the basalts could be traced in areas of average cover, and the presence of several faults in which the basalt is involved could be determined.—*M. C. R.*

Dizioglu, M. Y. Underground water investigations by means of geophysical methods (particularly electrical) in the Central Anatolia. See Geophys. Abs. 158–104.

ELECTRICITY

GENERAL AND THEORETICAL STUDIES

158–82. Bekefi, G. The impedance of an antenna above a circular ground plate laid upon a plane earth: Canadian Jour. Physics, v. 32, no. 3, p. 205–222, 1954.

Recent theoretical work by Storer concerning the impedance of a vertical antenna in contact with a circular metal disk is extended to include the case when the system is laid upon an imperfectly conducting plane earth. An integral equation is developed for the radial electric field that exists over the surface of the earth. By a method similar to Storer's the expression for the impedance is put into a variational form and by a suitable trial function for the radial electric field, the desired result is obtained. The dependence of the trial function and of the impedance upon the dielectric constant of the earth is discussed. A comparison of calculations thus obtained with those based on the theory of Monteath shows satisfactory agreement.

Although the variational formulation developed by Storer fulfills its purpose when the ground plate is large as compared to the wavelength, it is not well suited for small disks of the order of several wavelengths in diameter. Bekefi describes, therefore, an alternate variational formula.

Numerical calculations are made for the case of a hard, dry earth and high signal frequency. A graph of the signal frequency against the real index of refraction shows the interesting result of a rapid fall off of frequency caused by a small departure of the latter from unity.—*I. Z.*

158–83. Grigor'yeva, N. P. Lineynyy neekvipotentsial'nyy provodnik [Linear nonequipotential conductor]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 2, p. 82–93, 1950.

In the theory of charged body it is usually assumed that the entire disturbing mass has the same potential. This assumption is not always admissible. Grigor'yeva analyzes the case of a horizontal linear conductor in a homogeneous isotropic medium under such conditions that the potential drop in the conductor is proportional to the potential gradient in the surrounding medium. The surface potential due to the action of the buried conductor is expressed by the equation: $u=i\sqrt{R_1 R_t}\{[\cosh \lambda (l-n_1/2\ l)]/\sinh \lambda\}$ where i=intensity of the current entering the conductor; R_1 is resistivity of the conductor per unit of length, R_t is "resistance of the transition" per unit of length; n_1 is the coordinate of the element on the conductor; $\lambda=2\ l\sqrt{R_1/R_t}$; and $2\ l$ is the length of the conductor.

From this expression the gradients can be readily computed; numerical values of the potential and of the gradient on the surface are presented in tables and graphs for different conditions of the problem.—*S. T. V.*

158–84. Kato, Yoshio, and Yokoto, Kenichi. Corrected paper on the phase difference of earth current induced by the changes of the earth's magnetic field: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 1, p. 41–43, 1953.

This paper corrects a mistake pointed out by Scholte in previous calculations (Kato and Kikuchi, Geophys. Abs. 12921) of the phase difference between the geomagnetic field and induced earth current, when the electrical conductivity of the earth varies as $\sigma(z)=\sigma_0(1-z/a)^{-\beta}$, where σ_0 is the conductivity at the surface, and a and β are constants.—*D. B. V.*

158–85. Yoshimatsu, Takasaburo. The local characteristics of earth-currents: Kakioka Magnetic Observatory Mem., v. 7, no. 1, p. 15–26, 1954.

By analyzing data from 15 observatories in various parts of the world, Yoshimatsu deduces the principal direction of potential gradients from the diurnal variations. At stations near the coast, the principal direction is usually perpendicular to the coast; at stations on narrow peninsulas, the direction is perpendicular to the length; at inland stations the direction is influenced by surrounding topography, probably because of electrical conditions of the ground, and in mountainous regions is parallel to the general trend of the system.—*D. B. V.*

158–86. Yanagihara, Kazuo. Disturbance daily variation of the earth-currents at Kakioka (in Japanese with English summary): Kakioka Magnetic Observatory Mem., v. 7, no. 1, p. 49–54, 1954.

This is an analysis of some characteristics of the S_D variation of earth currents, from records of the Kakioka observatory for the period 1934–1944. The mean values of S_D and $S_A=S-S_q$ show a secondary minimum at 10^h; the two are coincident in phase but the amplitude of the latter is about 40 percent of the former. The amplitude variation of S_A (or S_D) with seasons and years is clear in the diurnal, but not in the demidiurnal, component. The secondary minimum at 10^h is uncertain at equinox and sunspot maxima because of the predominant diurnal component in the same period.

These results indicate that S_D in earth currents does not seem to be a single diurnal wave as in geomagnetism. Comparison with records from Tucson and Watheroo shows that the appearance of the secondary minimum is not a local phenomenon at Kakioka but worldwide, which might be related to short-period disturbances.—*D. B. V.*

ELECTRICAL PROPERTIES OF ROCKS AND MINERALS

158–87. Ovchinnikov, I. K. K teorii effecktivnoy elektroprovodnosti $\bar{\gamma}$ magnitnoy pronitsayemosti $\bar{\mu}$, dielektricheskoy postoyannoy $\bar{\epsilon}$ sredy, imeyushchey inorodnye vklyucheniya [On the theory of effective electric conductivity $\bar{\gamma}$, magnetic permeability $\bar{\mu}$, dielectric constant $\bar{\epsilon}$ of a medium containing foreign inclusions]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 3, p. 33–38, 1950.

The effect of inclusions on electric conductivity, magnetic permeability, and dielectric constant of a mineral is analyzed, and the case of electrical conductivity is treated in detail.

When the inclusions are small ellipsoids of similar shape and orientation the aggregate becomes electrically anisotropic. The potentials in the directions of the coordinate axes are computed, using elliptic integrals of the first and second kinds. The expressions obtained are then extended to the case of a mixture of ellipsoids in random orientation.

The formulas derived in three analyzed examples are applied to the case of spherical inclusions, of tubular inclusions, and of inclusions consisting of elliptic laminae. Tables and graphs are presented to facilitate the computations.—*S. T. V.*

158–88. Noritomi, Kazuo, and Takagi, Akio. A note on the electrical polarization in quartz and perthite: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 3, p. 183–190, 1953.

When a potential difference is applied to a specimen of quartz the current varies with time according to the formula $i=At^{-n}$, where A is a constant dependent upon applied voltage, and n is a function of temperature, independent of voltage. The value of n decreased with rising temperature. In perthite, the current increases with time in the lower temperature range, but above 500° C the change is similar to that in quartz. In both, the polarization emf is negligible at higher temperatures; hence at temperatures above 600° C the conductivity of rocks, which increases sharply with rising temperature, can be measured by using direct current.—*D. B. V.*

158–89. Noritomi, Kazuo. Some consideration on the diffusion coefficient and the mobility of movable ions in rocks: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 1, p. 34–40, 1953.

Measurements of electrical conductivity at high temperatures give thermal variation curves from the gradient of which the activation energy is obtained. If the theory of electrical conductivity of ionic crystals can be applied to rocks, the diffusion coefficient of movable ions can be obtained. The ion mobility is also estimated under suitable assumptions. Values of the diffusion coefficient for rocks are sometimes 10^5 times smaller than for ionic single crystals, but this is reasonable if the rock is considered to be a mixed crystal. Mobility is estimated to be of the order of 0.01~100 cm/sec per volt/cm.—*D. B. V.*

158–90. McConnell, E. B., Jr. Self-potentials of reservoir sands: Pennsylvania State Univ. Min. Industries Expt. Sta. Bull. 62, p. 31–39, 1954; and Producers Monthly, v. 18, no. 8, p. 19–27, 1954.

The self-potentials of oil reservoir rocks were measured in the laboratory to determine some of the factors and considerations necessary for the interpretation of well logs, particularly in the Bradford, Pennsylvania, area. Self-potentials were obtained by placing sand cores between salt solutions of differing concentrations and observing the potentials developed across the cores.

The research has confirmed that the self-potential generated by a sand core in the laboratory may often be represented by the equation $SP=K \log R_m/R_w$, where R_m and R_w refer to the resistivities of the bore hole and connate water respectively, and K is a factor depending on the clay content of the core. For Bradford, Pa., oil sands, the equation $SP=45 \log R_m/R_w$ was found to give good approximations of the relation between the laboratory self-potential and the ratio of resistivities up to a concentration difference of 100 : 1.

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For the accurate interpretation of the self-potential well log in terms of the connate water resistivity it is concluded that it may often be necessary to resort to laboratory determinations of the self-potential constant *K*.—*Author's abstract*

158–91. McCardell, W. M., and Winsauer, W. O. Origin of the electric potential observed in wells: Am. Inst. Min. Metall. Engineers Trans., v. 198, p. 41–50, 1953.

The mechanism by which an electrical potential difference is developed between two salt solutions separated by shale is shown to be a consequence of the electrical double layer of the shale surfaces. A mathematical derivation is presented to show the dependence of the potential on the shale characteristics and on the concentration of the salt solutions. The equations developed describe adequately the potential-concentration behavior of a long shale core. The equations also describe the variation of potential of sand-shale mixtures with variation of clay content. Ion adsorption is an important factor in the development of the surface charge on the shale, and electrical resistivity and ion transference number data are employed to estimate the increase of surface charge with concentration. Since the potential is shown to be dependent on the characteristics of the particular system, water salinities estimated from the potential log by previously proposed methods may be low in some cases.—*Authors' abstract*

158–92. Perkins, F. M., Jr., Brannon, H. R., Jr., and Winsauer, W. O. Interrelation of resistivity and potential of shaly reservoir rock: Jour. Petroleum Technology, v. 6, no. 8, p. 29–34, 1954.

Both the abnormal resistivity exhibited by shaly reservoir materials and their potential are due to adsorption of ions. Interrelations between the two have been derived and verified by laboratory results. These relations which have resulted from this work may be used in a qualitative manner to estimate whether or not a particular shaly reservoir contains hydrocarbons, and also to estimate the porosity of shaly sands.—*Authors' abstract*

INSTRUMENTS AND METHODS OF OBSERVATION

158–93. Orsinger, Albert, and Van Nostrand, Robert [G.]. A field evaluation of the electromagnetic reflection method: Geophysics, v. 19, no. 3, p. 478–489, 1954.

In the electromagnetic-reflection method described a low-frequency square wave is transmitted by a large loop lying on the ground and a second loop, also lying on the ground, is used as a receiver for the transmitted energy, which consists of an electromagnetic surface wave and reflections. This received signal is compared with the signal from a scaled model consisting of a pair of small loops and a stack of plates having various resistivities. The layering in the model is manipulated by mixing the two signals in opposition and detecting the difference between the two on an oscilloscope until the received signal in the model is the same as that in the earth. In field trials of the system at five locations, estimates of the depth to a contact between 50 and 400 feet were obtained within an average accuracy of 5 percent.—*G. V. K.*

158–94. Ovchinnikov, I. K. Ob ispol'zovanii elipticheskoy polyarizatsii magnitnogo polya dlya razvedki [On the use of elliptic polarization of the magnetic field in exploration]: Vses. nauchno-issled. inst. razved. geofiz. Trudy, vypusk 3, p. 39–49, 1950.

The magnetic field produced in the ground by electromagnetic induction is ellipsoidal in shape. In the case of acoustic frequency the phase angle of this vector is strongly influenced by the electrical conductivity of the ground, making the phase angle a sensitive indicator usable in prospecting. Ovchinnikov presents tables of computed components of the magnetic vector from which the phase angle can be readily determined. The tables give the normal fields of loop conductor and cable conductor and of the same fields disturbed by a conducting sphere and cylinder, respectively.—*S. T. V.*

158–95. Doll, H. G. The MicroLaterolog: Am. Inst. Min. Metall. Engineers Trans., v. 198, p. 17–32, 1953.

The MicroLaterolog method makes use of circular concentric electrodes applied to the wall of the borehole under an insulated pad and current focused by an automatic control system so that a thin beam penetrates the formations almost horizontally and then opens widely at a short distance from the wall. Formations more than about three inches from the wall have a negligible effect on the measurements and the presence of mud cakes less than one-fourth inch thick do not affect the measurements. For thicker mud cakes, simultaneous recording of a curve analogous to the MicroLog provides a correction. The MicroLaterolog gives the value of the resistivity of the flushed zone directly, a quantity used for determination of formation factor and porosity. Field examples are given.—*M. C. R.*

158–96. Belluigi, Arnaldo. Su un Matranslog di massimo rendimento [On the most productive Matranslog]: Geofisica Pura e Appl., v. 26, p. 67–74, 1953.

The shape of the functions representing the transient portion of the Matranslog process are analyzed, and the conditions that would produce optimum operation are determined analytically. For this purpose the two integrals, representing the transient phase of the process, are computed and the curves of the final results traced. This makes it possible to determine the conditions of optimum operation, which give the greatest possibilities for the interpretation of the data obtained.—*S. T. V.*

158–97. De Witte, Leendert. Resistivity logging in thin beds: Jour. Petroleum Technology, v. 6, no. 7, p. 29–35, 1954.

Conventional resistivity logs do not give data that allow a complete quantitative interpretation in beds thinner than 20 feet. If the beds are 12 feet or more thick, the short and long normal curves may be interpreted qualitatively using simplified departure curves. The limestone, laterolog, and microlaterolog curves permit quantitative interpretation for beds that are at least 10 feet thick. For beds thinner than 10 feet, combinations of the microlaterolog with short-spaced laterologs and pseudolaterologs appear to be promising, using simplified departure curves.—*L. C. P.*

158–98. Birks, J. An evaporation method for measuring the resistivity-water saturation characteristics of cores: Producers Monthly, v. 18, no. 8, p. 28–30, 1954.

The resistivity and water saturation characteristics of cores may be measured by an evaporation method using a saturated solution of calcium sulfate of constant specific resistance. The method can be applied to cores covering the complete range of permeability and porosity.—*L. C. P.*

158–99. McGehee, F. M., Jr. Propagation of radio frequency energy through the earth: Geophysics, v. 19, no. 3, p. 459–477, 1954.

Measurements were made of the rate of attenuation of radio waves through the earth over the Carlsbad Caverns, N. Mex., and Mammoth Caverns, Ky. The signals were transmitted by horizontal rod antennae lying on the surface of the ground, while the signals were detected with loop antennae at various locations in the caves. The field-intensity patterns and wave polarizations indicated that transmission was through the ground for distances as great as 1,200 feet. The observed values of attenuation agreed with theoretical values for an assumed set of resistivities and dielectric constants.—*G. V. K.*

METHODS OF ANALYSIS AND INTERPRETATION

158–100. Sebestyén, Károly. Összehasonlító vizsgálatok a vertikális elektromos szondázási görbék kiértékeléséről [Interpretation of resistivity depth curves] (With summaries in English and Russian): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 3, szám 3, p. 31–39, 1954.

A discussion of the practical use of the differential, the cumulative curve methods, and the master curves.—*D. B. V.*

158–101. Poupon, A., Loy, M. E., and Tixier, M. P. A contribution to electrical log interpretation in shaly sands: Jour. Petroleum Technology, v. 6, no. 6, p. 27–34, 1954.

Improved logging methods may make feasible the quantitative interpretation of shaly sands, using the information provided by the electric logs.—*L. C. P.*

ELECTRICAL SURVEYS AND WELL LOGGING

158–102. Polak, Edward Jan. The application of resistivity methods in establishing the base of the water-bearing rocks in the Cannock Chase Coalfield: Geophys. Prosp., v. 1, no. 3, p. 197–207, 1953.

The Cannock Chase coal field in England was investigated by means of boreholes and resistivity surveys in order to insure maximum safety as well as maximum use of reserves in this area of heavily waterlogged overburden. Different resistivity methods were used in different parts of the area: an asymmetrical arrangement, with current electrodes over 5,000 feet apart with the line of potential electrodes at an angle of as much as 60° to them, proved quickest and gave best results in interpretation, but the Wenner configuration, Jakosky's method, and others were used where especially applicable. Results were checked against borehole evidence. It is concluded that the resistivity method provides a valuable adjunct to geological evidence, but that neither alone could guarantee complete safety for mining under conditions such as found here. Qualitative information for placing boreholes is provided where no quantitative interpretation of resistivity data is possible.—*D. B. V.*

158–103. Stefanović, Dragoljub, and Mladenović, Milan. Geofizivko ispitivanje akumulatsionog bazena Liverovići [Geophysical investigation of the storage reservoir near Liverovići]: Glasnik Prirod. Mus. Srpske Zemlje, Ser. A, kniga 5, p. 225–235, 1952.

Electrical-resistivity surveys were made of the site of the dam for the hydroelectric plant on the Gracanica river east of Nikšić. Depth to bedrock and the contact between the Verfen and middle Trias were determined. Good agreement was found between geologic profiles determined on the basis of these measurements and theoretical resistivity curves computed from known resistivities for limestone and other sediments in the valley.—*S. T. V.*

158–104. Dizioğlu, M. Y. Underground water investigations by means of geophysical methods (particularly electrical) in the Central Anatolia: Maden Tetkik ve Arama Enstitüsü Mecmuasi, no. 44–45, p. 63–70, Turkish summary, p. 71–76, 1953.

Geophysical investigations were made in the area between Polath and Konya in central Anatolia in order to determine the applicability of resistivity, electromagnetic, and magnetic methods in ground-water exploration. Three layers can be distinguished by resistivity methods, soil and limestone at the surface, the whole Neocene in the middle, and older crystallines as the basement. Because the magnetic susceptibility of the basement rocks is much higher, magnetic measurements can be used to determine the basement configuration. Electromagnetic methods were found to be particularly suitable for exploration of irregular water horizons in fractured limestones, which are most common in this region.—*D. B. V.*

158–105. Vecchia, Orlando. Recherches geophysiques pour un barrage au lac de Molvano (Venezia Tridentina) [Geophysical investigations for a dam on the lake of Molveno (Venezia Tridentina)]: Riv. Geofisica Appl., anno 14, no. 2, p. 73–85, 1953.

Because of a proposed increase in the height of the dam forming the Molveno lake a geophysical survey was made of the area around the dam and the valley in which the lake is formed. A seismic-refraction survey showed that the depth to bedrock immediately beneath the dam is about 100 m, and increases to about 200 m down the valley. To estimate the loss of water through underground leaks, the lake was emptied and an electric-resistivity survey made of the lake bottom. The resistivity measurements were repeated 10 times during the refilling of the lake as the level of the water increased. These measurements confirmed the seismic results and also indicated that the dam is watertight when the water level in the lake is some 50 m below the normal, but that the leakage rapidly increases as the water level in the lake goes above this line.—*S. T. V.*

158–106. Yüngül, Sulhi. Spontaneous potential survery of a copper deposit at Sariyer, Turkey: Geophysics, v. 19, no. 3, p. 455–458, 1954.

Several electrical methods were applied in exploration for quartz-vein chalcopyrite and auriferous-pyrite deposits in the Sariyer area about 12 miles north of Istanbul. The spontaneous polarization method was found most successful. Anomalous areas found by this means were drilled, and sulfide masses under a cover of unmineralized schists or alluvium were penetrated. The area of the Nalbant Çeşmesi anomaly was afterwards partly developed and the geologic section thus determined found to be in accord with that predicated on the basis of the spontaneous polarization data.—*M. C. R.*

SEISMOLOGY

GENERAL

158–107. Jung, Karl. Kleine Erdbebenkunde [An introduction to seismology]: 158 p., Berlin-Göttingen-Heidelberg, Springer-Verlag, 1953.

The topics considered are phenomena related to earthquakes and the fundamental ideas of seismology, the methods of recording earthquakes and the interpretation of seismograms, seismologic evidence regarding the structure of the earth, and seismic exploration.—*S. T. V.*

ELASTIC WAVES

158–108. Das Gupta, Sushil Chandra. Waves and stresses produced in an elastic medium due to impulsive radial forces and twist on the surface of a spherical cavity: Geofisica Pura e Appl., v. 27, p. 1–6, 1954.

Displacements and stresses produced by impulsive radial pressures and by impulsive twists have been determined. In the former case total flow of energy across a spherical boundary has been obtained.—*Author's summary*

158–109. Menzel, H. On the propagation of seismic waves in a solid body with elastic afterworking: Geophys. Prosp., v. 2, no. 2, p. 139–151, 1954.

The propagation of seismic waves in the earth cannot be satisfactorily explained if the rocks are considered to be perfectly elastic. By considering the medium as viscoelastic, Ricker and others have been able to deduce theoretical results that are in good agreement with observations in exploration seismology. However, the laboratory experiments of Sokoloff and Skriabin on samples of rocks indicated that the assumption of a viscoelastic medium was a poor one. They adopted the theory of elastic afterworking which in essence assumes that the earth behaves as a perfectly elastic body against fast changing disturbances and as a viscous fluid against slowly changing disturbances. This is the exact opposite of the assumptions made in viscoelastic theory.

Menzel uses the equations of Sokoloff and Skriabin but in addition assumes that every rock is to behave as perfectly elastic against hydrostatic pressure. The necessary equations are deduced and several important graphs are plotted. The following conclusions are reached: for stationary disturbances, waves of very short periods propagate with constant velocities; for longer periods, the velocity decreases as the period increases; and waves of long period attenuate considerably less than those of short periods. By plotting the velocity of propagation as a function of t_m, the time at which the disturbance reaches a maximum value, it can be shown that the velocity of propagation has a negligible minimum value for a certain range of t_m. In this region the waves cannot penetrate the medium. For very small and very large values of t_m, the situation is similar to that of stationary disturbances.

For short period waves, the agreement between the theory of elastic afterworking and observations is poor; in this case the theory of viscoelasticity is far better. However, laboratory experiments are explained by the theory of elastic afterworking and contradict the theory of viscoelasticity. Menzel suggests that more exact and systematical observations be made on the attenuation of amplitudes of seismic waves.—*I. Z.*

158–110. Mattice, H. C., and Lieber, Paul. On attenuation of waves produced in visco-elastic materials: Am. Geophys. Union Trans., v. 35, no. 4, p. 613–624, 1954.

A solution to the problem of wave motion produced when a pressure pulse is applied to the interior surface of a spherical cavity in a visco-elastic medium is obtained. Comparison with the elastic case indicates that viscosity significantly reduces the amplitude of the displacement in the vicinity of the wave front and decreases the velocity of propagation of the wave.

In the addendum, a pressure-time pulse defined by a function of the form $P(t)=P\zeta t \exp(-\zeta t)$ is applied to the cavity wall and a solution of the differential equations of motion is obtained using the theory developed in the main body of the paper. Since all values of the parameter ζ are admissible, pressure-time pulses of arbitrary form may be represented by superposing individual pulses of the above form corresponding to different values of ζ.—*Authors' abstract*

158–111. Nomura, Yūkichi, and Takaku, Kōshun. On the propagation of elastic waves in an inhomogeneous sphere: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 1, p. 22–33, 1953.

The mathematical study of elastic wave propagation (see Geophys. Abs. 157–70) has been extended to the case of an elastic sphere of large radius having a concentric spherical fluid core whose radius is also large. The media of both shell and core are inhomogeneous, and their respective velocities are proportional to r^{-m} and r^{-s}, where m and s are arbitrary real numbers larger than -1. Using values of elastic constants taken from seismological observations, reflection and refraction at the inner fluid boundary are calculated for the value $m=0.3$, which takes into account waves far from the source.—*D. B. V.*

158–112. Sato, Ryosuke. On the propagation of tremors along the interface between solid and water produced by a point source in a solid. I. (In Japanese with English summary): Zisin, v. 7, no. 1, p. 8–20, 1954.

The problem of the propagation of tremors over the plane surface of a semi-infinite homogeneous isotropic elastic solid, generated by a three-dimensional point source, was studied by Sakai in 1934. The mathematical treatment in stratified media is complicated, partly because of the difficulty of obtaining poles on the complex plane. In this paper, water is taken as one medium, and a solid in which there is the same point source as assumed by Sakai as the other. It is assumed that both media are homogeneous, isotropic, and perfectly elastic; that the effect of gravity is negligible; that rigidity in the water is zero; that Poisson's ratio in the solid is ¼; and that the depth of the water is infinite. In this first paper, the branch points and poles of $D(\gamma)$ or $E(\gamma)$ (function defined by Sakai) are studied.—*M. C. R.*

158–113. Honda, Hirokichi, and Nakamura, Kohei. Notes on the reflection and refraction of *SH* pulse emitted from a point source: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 3, p. 163–166, 1953.

The reflection and refraction of the *SH* pulse at the boundary between two elastic media is investigated mathematically using the methods of Sakai. The displacements are calculated for the direct wave and the reflected and refracted *SH* pulses. The displacements are calculated with reasonable assumed

velocities, rigidities, and other constants and give results essentially the same as those of Pekeris (Geophys. Abs. 7044).—*D. B. V.*

158–114. Honda, Hirokichi, and Nakamura, Kohei. On the reflection and refraction of the explosive sounds at the ocean bottom: Tōhoku Univ. Sci. Repts., 5th ser., v. 4, no. 3, p. 125–133, 1953.

Reflection and refraction at a solid sea bottom of explosive sounds originating in a point source in the water have been treated mathematically. When the velocities of the longitudinal and transverse waves of the floor are greater than the velocity of the sound waves in water, both kinds of waves are refracted back into the water from the bottom, after travelling some distance along the bottom surface at horizontal distances from the source larger than some definite critical values. Expressions of reflected and refracted waves are obtained for periodic as well as aperiodic cases. Some numerical examples are given.—*D. B. V.*

158–115. Van Melle, F. A. Note on "The primary seismic disturbance in shale" by N. Ricker and W. A. Sorge: Seismol. Soc. America Bull., v. 44, no. 2A, p. 123–125, 1954.

Ricker and Sorge (Geophys. Abs. 13223) described experiments which seem to be in agreement with a law of decay of amplitude of the earth-particle velocity from small explosions with the $-5/2$ power of the travel time. Computations of the energy in the compressional wave from a 1-pound shot of 60 percent dynamite at a distance of 722 feet (distance between shot and geophone in a hole in Pierre shale at Limon, Colo., listed by Ricker and Sorge) indicate that this energy is of the order of 0.05 percent of the chemical energy available. This agrees with experimental work done by a crew of Shell Development Co., although the Shell values of the same order were found over a greater range than is compatible with a $-5/2$ power decrease of the velocity amplitude.

Reflections have been observed with travel times of 7 to 8 sec (Geophys. Abs. 12946). Extension of the $-5/2$ power law to such travel times indicates that the velocity amplitude of the reflection, where speed contrasts are as high as 2:1, will be so low that it falls below the particle velocity of the wind disturbance. If a higher output of energy per pound of explosive is assumed for the locality of Junger's experiments than for Pierre shale, then the difficulties for short travel times become serious. The indications are that the $-5/2$ power law has a rather narrow range of validity.—*P. E. B.*

INSTRUMENTS AND METHODS OF OBSERVATION

158–116. Gamburtsev, G. A. Opticheskiye seysmonaklonomery [Optical seismoinclinometers]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 305–311, 1954.

Seismoinclinometers are inclinometers capable of measuring very slow periodic undulations of the crust; two such instruments designed by Gamburtsev are described. The first consists of a vertical pendulum whose bob oscillates in a viscous liquid; a horizontal crosspiece is fixed at the midpoint of the rod and carries at one end a small mass, thus forming a horizontal pendulum capable of swinging in a horizontal plane due to the torsional resistance of the rod of the first (vertical) pendulum. Another seismoinclinometer is obtained by the addition of a relatively heavy box capable of oscillating in the same plane as the first (vertical) pendulum around a horizontal axis situated beneath it.

Either system contains a great number of elements capable of being so adjusted that the natural periods of oscillation of the instruments range from 60 sec to 4,800 sec, and the sensitivity can be varied within wide limits.—*S. T. V.*

158–117. Gutiérrez Burzaco, José Manuel. Cronometro a péndulo de gravedad para sismografo [Chronometer with gravity pendulum for seismographs] : Meteros, año 3, no. 4, p. 433–438, 1953.

An improved chronometer has been developed in the laboratories of the Servicio Meteorologico Nacional for use in seismological observations, in which the point of suspension of the pendulum is placed over the anchor-shaped escapement by means of a double elastic lamina. The instrument has proved effective and reliable during tests.—*S. T. V.*

158–118. McKay, A. E. Review of pattern shooting: Geophysics, v. 19, no. 3, p. 421–437, 1954.

Patterns of shot holes and patterns of seismometers are now standard technique in many areas currently being surveyed by the seismograph. This paper reviews some of these pattern arrangements and shows comparison records in a number of areas such as New Mexico, west Texas, western Oklahoma, Mississippi, and Florida. Although pattern shooting is definitely proven as a useful technique, it is not to be construed as a cure-all for difficult shooting areas.—*Author's abstract*

158–119. Volponi, Fernando. Nuevo metodo sismografico para el estudio de fundaciones de diques de embalse [A new seismic method for the investigation of dam foundations] : Acta Cuyana de Ingenieria, v. 1, no. 1, p. 1–34, 1953.

In a seismic refraction technique specially adapted for exploration of river beds across which dams are to be constructed, shot points are located along a longitudinal section of the river and waves are recorded by geophones along an arc reaching from one shore to the other or placed in the cross section containing the shot point. Depth to bedrock and thickness of alluvium are determined from differences in travel times. Use of the method in two places in Argentine is described.—*S. T. V.*

158–120. Ez, V. V. O rezul'tatakh issledovaniy geofizicheskikh usloviy vozniknoveniya vnezapnykh vybrosov uglya i gaza v ugol'nykh shakhtakh [Results of the investigations of the occurrences of outbursts of gas and coal in coal mines] : Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 302–303, 1954.

In a conference in 1953 sponsored by the Russian Academy of Sciences, the causes of and precautions against outbursts of gas and coal in coal mines were discussed. Conditions producing bursts of solid material were studied theoretically and experimentally in the laboratory and in the field. The studies included continuous observation of the strength of the side walls in mines, using the seismoacoustic method to determine the stress under which the wall is standing and the presence or absence of cracks in it. Measurements of the seismic velocity in the wall of the mine are said to give reliable information on the state of the wall or supporting columns.—*S. T. V.*

158–121. Roberts, F. A., and Dennison, A. T. A device for overcoming the effects of static on seismic shot signals: Geophys. Prosp., v. 1, no. 3, p. 192–196, 1953.

A simple device for sending an accurate series of signals at fixed intervals designed to minimize interference with radio transmission of refraction-time signals by electrical storms is described and illustrated schematically. With this system, which basically comprises a normal thyratron time base switched on by the breaking of the detonator link, the explosion of the charge gives a shot signal of the usual form which is then followed at regular intervals by a series of exactly similar ones. As the signals occur at constant intervals, the position of any one of them can be computed from the position of any two others. If the first is obscured by interference, it is most unlikely that it would be impossible to measure at least 2 of the 30 or so signals that would appear on a normal record.—*D. B. V.*

METHODS OF ANALYSIS OF SEISMIC SURVEY DATA

158–122. Hagedoorn, J. G. A process of seismic reflection interpretation: Geophys. Prosp., v. 2, no. 2, p. 85–127, 1954.

Seismic-reflection depth points are commonly plotted vertically below the shot point, or below a midpoint between the shot point and a detector. These vertically plotted positions are true positions only where there is no dip. However, a vertically plotted surface can be thought of as a transformation of the actual surface with a continuous point-to-point relationship; and therefore, the actual surface can be derived from it.

A vertically plotted point must lie on a surface of equal reflection time, which is also a surface of maximum concavity. It must also lie at the axis of a surface of maximum convexity. When vertically plotted points describe a surface of maximum convexity, they are all reflected from a single reflecting point which must represent a sharp bend downward (such as a fault).

By using charts depicting surfaces of maximum concavity and convexity for the appropriate velocity distribution, it is possible to "migrate" vertically plotted points to their true positions. The same charts can be used either for two-dimensional migration (on a cross section) or three-dimensional migration (on a depth contour map).—*L. C. P.*

158–123. Press, Frank, Oliver, Jack, and Ewing, Maurice. Seismic model study of refractions from a layer of finite thickness: Geophysics, v. 19, no. 3, p. 388–401, 1954.

Two-dimensional model studies of seismic-refraction arrivals indicate that determinations of velocity and depth may be unreliable if the ratio of wavelength to thickness of the layer is large. Experiments were made on a single layer, on 2 layers, and on 3 layers. Sheets of plexiglass, brass, and aluminum one-sixteenth of an inch thick (horizontally) were used as the lower, intermediate, and higher velocity layers. The vertical thicknesses of the model layer ranged from ¼ inch to 8 inches, and spreads as long as 60 inches with detector spacings of 2 inches were used. Misleading velocities, particularly for greater distances and second arrivals, were observed on the two- and three-layer models. Masked layers, selective absorption in the overburden, and "echeloning" of travel-time curves were noted. Many of these phenomena are similar to those observed in seismic-refraction field surveys. They may explain in part the discrepancies between well-shooting velocities and refraction velocities.—*L. C. P.*

158–124. Posgay, Károly. Szeizmikus reflexiós mérések középhibája [Mean error of seismic reflection measurements] (With summaries in English and Russian): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 3, szám 4, p. 41–54, 1954.

A method of finding the mean error in seismic-reflection arrival times rapidly is presented in which the correction equations are deduced from equations for propagation times measured with symmetrically located seismometers. Practical examples of its application are included.—*D. B. V.*

158–125. Tárczy-Hornoch, A[ntal]. Zur Bestimmung der reflektierenden Ebene bei den seismichen Reflexionsmessungen [On the determination of the reflecting plane by seismic reflection measurements]: Geofisica Pura e Appl., v. 27, p. 87–97, 1954.

Adjustment of seismic-reflection data by conversion to equal geophone altitudes is a cumbersome method. A simpler way to increase the accuracy of determination of reflection planes is to use indirect observations to obtain the most probable values of the velocity and the coordinates of the image of the shot point. Mean-square errors of the unknown quantities may be calculated from the adjustment. The approximate value needed for the adjustment can best be calculated from the linear equations.—*D. B. V.*

158–126. Bading, Rolf. Zur reflexionsseismischen Erfassung einer Bruchtektonik [On the seismic reflection interpretation of a fault structure]: Geol. Jahrb., Band 67, p. 73–82, 1953.

Under favorable conditions it is possible to determine structure from seismic reflection data even in complexly faulted regions. Many examples of seismograms are given, showing the effect of vertical layers and the angles of faults.—*D. B. V.*

158–127. Tárczy-Hornoch, Antal. A terjedési sebesség metatározásáról a reflexiós szeizmikus módszernel [Determination of propagation with the seismic reflection method] (With summaries in Russian and English): Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Köslemények, kötet 3, szám 5, p. 55–69, 1954.

Tárczy-Hornoch derives a formula for more precise determination of velocity for three seismometers, equally spaced along a line. For velocities greater than 1,500 m per sec and depth greater than 1,000 m, wider spacing is necessary.—*D. B. V.*

158–128. Reich, Hermann. Über reflektierte Refraktionsimpulse [On reflected refraction impulses]: Geol. Jahrb., Band 67, p. 135–142, 1953.

Certain impulses appearing in refraction seismograms and travel-time curves are obviously caused by reflections of the refracted waves, which may occur in the case of well-defined boundary planes that act as effective reflecting planes as well as "conductors" for the refracted impulse. Such contacts can be recognized in the Donau region, namely the upper surface of the crystalline basement, and the contact of the Malm limestone with the underlying Mesozoic rocks.—*D. B. V.*

158–129. Helms, Hans von. Anwendungsmoglichkeiten kombinierter Reflexions- und Refraktionsmessungen insbesondere zur Bestimmung von Durchschnittgeschwindigkeiten [Possibilities of application of com-

bined reflection and refraction measurements especially to the determination of average velocities]: Geol. Jahrb., Band 67, p. 115–126, 1953.

By means of calculations for the cases of two horizontal layers and two inclined layers and by practical examples, the usefulness of combined reflection and refraction measurements is demonstrated. Where true average velocity is known, the layer velocity of individual reflecting horizons, which also appear in the refraction travel-time curve, can be determined and from this, often, their stratigraphic position. Where the true average velocities are not known, but where it is reasonable to assume that horizons appear simultaneously in reflection and refraction (as in the Oberkante of the Upper Cretaceous of northwestern Germany, for example), a satisfactory approximation of the average velocity can be determined by direct measurement. Depth determinations in reflection as well as refraction measurements can be made precise in this way.—*D. B. V.*

158–130. Linsser, Helmut. Geometrische Probleme bei der Auswertung von Untertage-Seismogrammen [Geometric problems in the evaluation of underground seismograms]: Geol. Jahrb., Band 67, p. 127–134, 1953.

There are geometrical problems in the interpretation of seismic records made underground. The usual method of construction of the image point is not applicable. Reflections must be calculated at each seismograph individually. From these a group of ellipsoids of rotation is obtained to which the reflection plane is tangential. When the ellipses are projected upon a level, the reflecting plane appears in a zone of aggregation. This method is valid only if the reflecting plane is perpendicular; otherwise a correction must be introduced in the construction of the ellipses. The case of very gentle dip and the evaluation of surveys on several levels are also discussed.—*D. B. V.*

158–131. Mota, Lindonor. Perfil de refracao *R*–1 [The *R*–1 refraction profile]: Brasil Univ. Escola de minas Rev., año 18, no. 1, p. 27–30, 1953.

This is a practical example of the use of Mota's previously described method of determining the dip and depth of layers (Geophys. Abs. 12821). The profile considered is one in Riachão in the Estado do Maranhão.—*M. C. R.*

OBSERVATIONS OF SEISMIC WAVES

158–132. Perri, Emilio. Sopra un'onda lenta superficiale provocata da esplosione vicina: I [On a slow surface wave produced by nearby explosions: I]: Geofisica Pura e Appl., v. 27, p. 7–29, 1954.

Records of experimental explosions at Fegino (Genoa) show a surface wave having higher velocity than that of Rayleigh waves but appreciably less than that of shear waves, and anomalous dispersion. Analyzed mathematically, this wave is found to be a compound wave formed by superposition of a condensational and a distortional wave, both damped, having the same frequency and same initial phase. Absorption of energy in the x and z directions is considered. It is assumed that the wave is propagated along the x axis, with the distortional wave having a lower absorption coefficient in the x and z directions.

Equations are derived for the phase velocity V_* as functions of the respective specific velocities of the two component waves, $v_1=(V_*/\Omega_1)$; $v_2=(V_*/\Omega_2)$ where Ω_1 and Ω_2 are, respectively, the velocities of undamped longitudinal and trans-

verse waves in the same medium. The formulas are valid for any homogeneous isotropic medium.

The phase velocity calculated according to Perri's formulas, 788 m per sec, is in good agreement with the experimental results.—*D. B. V.*

158–133. Caloi, Pietro. Onde longitudinali e trasversali guidate dall' astenosfera [Longitudinal and transverse waves guided by the asthenosphere]: Accad. Naz. Lincei Atti, Cl. sci. fis., mat. e nat. Rend., v. 15, fasc. 6, p. 352–357, 1954.

Earthquake energy entering the asthenosphere may become channeled within it, particularly if the focus is in it or near its boundaries—that is, at depths of 50 to 200 km. Seismograms of earthquakes with foci at 60 to 100 km, several of which are reproduced, show such waves clearly.—*D. B. V.*

158–134. Honda, Hirokichi. Amplitudes of *P* and *S*, magnitude and energy of deep earthquakes: Tōhoku Univ. Sci. Repts., 5th ser., v. 3, no. 3, p. 138–143, 1951.

Analysis of published constants A_P and A_S, characteristic of the *P* and *S* amplitudes respectively, of deep earthquakes, shows that log A_P and log A_S are proportional to the magnitude *M* given by Gutenberg and Richter; the energy ratio of *S* to *P* is very large (15 or more) for deep earthquakes of small magnitude, and small (less than 1) for those of large magnitude; and the energies of deep earthquakes estimated by Gutenberg and Richter are proportional to those expected from the values of A_P and A_S.—*D. B. V.*

158–135. Hodgson, J. H., and Allen, J. F. Tables of extended distances for *PP* and *pP:* Dominion Observatory Ottawa Pubs., v. 16, no. 11, p. 351–362, 1954.

This paper is the third in a series extending Byerly's method of determining the direction of faulting in an earthquake to deep focus earthquakes and permitting the use of secondary *P* phases. Here tables of extended distances are presented for the reflected wave rays *PP* and *pP*, for earthquakes of all focal depths down to 0.12 *R*. The tables are consistent with earlier ones for *P*, *PKP*, and *PcP* [see Geophys. Abs. 14287], so that the several phases can be used in a single solution.—*Authors' abstract*

158–136. Honda, Hirokichi, and Ito, Hiroshi. On the reflected waves from deep focus earthquakes: Tōhoku Univ. Sci. Repts., 5th ser., v. 3, no. 3, p. 144–145, 1951.

Methods of calculation of the initial motion of *P*, *S*, *pP*, and *ScS* from deep-focus earthquakes, that do not assume that energy leaves the focus equally in all directions are described. Studies of the initial motions of *P*, *S*, and *ScS* recorded near the epicenter of the deep earthquake of April 21, 1939, in the northern Japan Sea lead to the conclusion that the earth's core is liquid. Initial motions of *P*, *pP*, *S*, and *ScS* from the earthquake of February 20, 1931, in Siberia were calculated theoretically for Stuttgart, Kew, and Buffalo observatories from the *P* and *S* motions near the epicenter and found to be consistent with those observed.—*D. B. V.*

158–137. Ewing, Maurice, and Press, Frank. An investigation of mantle Rayleigh waves: Seismol. Soc. America Bull., v. 44, no. 2A, p. 127–147, 1954.

Dispersion of Rayleigh waves for a new range of periods ranging from 1 to 7 minutes is described. Pertinent data are listed for R_2, R_3, R_4, R_5, and R_7 Rayleigh waves for three earthquakes recorded at Pasadena, with Pasadena magnitudes of 8 to 8.6. The data show that a single dispersion curve represents all the orders of Rayleigh waves and that there is no indication whatever of a systematic shift of this curve with increasing length of path. The group velocity curve shows a long-period and a short-period branch merging at a minimum value of 3.54 kmps with a corresponding period of about 225 sec. Refraction and attenuation effects for these waves are negligible at the continental margins. Possibly the known variation of velocity with depth in the mantle can account for the observed dispersion.

Estimates of the absorption suggest that it can be ascribed largely to the effects of internal friction, which may be specified by a dimensionless parameter Q. For periods of 140 and 215 sec, the absorption in the upper mantle is found to be given by $1/Q=670\times10^{-5}$. This is of the same order as that reported from vibration measurements at audio frequencies on laboratory samples of crystalline rock at normal pressure and temperature.—*P. E. B.*

158–138. Brilliant, Renée M., and Ewing, Maurice. Dispersion of Rayleigh waves across the U. S.: Seismol. Soc. America Bull., v. 44, no. 2A, p. 149–158, 1954.

A dispersion curve for Rayleigh waves traveling across the United States was computed from records for 6 stations lying approximately on a great circle path including the epicenters of two earthquakes in the Tonga area. The great circle path was nearly normal to the coast. A curve of the velocity of Rayleigh waves of each period for the oceanic part of the path was obtained by extrapolating to zero continental path the arrival times at all the seismographic stations and converting these arrival times into the corresponding velocities. Comparison with theoretical curves of Ewing and Press, after taking into account the depth of water, indicates thicknesses of unconsolidated sediment of 0.7 and 0.8 km between the southern California coast and the Tonga and Solomon Islands respectively.—*P. E. B.*

158–139. Evernden, Jack Foord. Direction of approach of Rayleigh waves and related problems (Part II): Seismol. Soc. America Bull., v. 44, no. 2A, p. 159–184, 1954.

Data presented in Part I of this paper (Geophys. Abs. 156–100) concerning determinations of azimuthal variations by tripartite methods are discussed in detail.

Extensive wandering of the plane of polarization of seismic surface waves is due to variations in the azimuth of arrival of surface waves. This variation is in turn a function of the inhomogeneities in the crustal layers. The departures of surface-wave arrivals from station-to-epicenter great-circle paths, when interpreted on the basis of the theory of ray paths on a spherical shell, are shown to be consistent with the known differences between Pacific and continental structure. Surface waves arriving at Berkeley from a given earthquake do not have the nature of a continuous train of waves, but are characterized by the arrival of groups or packets composed of only a few periods. Thus the coda is not entirely a dispersion phenomenon, but also has a scattered or refracted component. On this basis the two horizontal components of motion as recorded by paired seismographs do not necessarily show perfect in-phase relationships.

The explanation lies in simultaneous arrivals from different azimuths, not in departures of particle motion from Rayleigh's theory. It is concluded that transverse motion does not exist in observed Rayleigh waves. Data on phase velocity versus period in conjunction with this conclusion and earlier investigations of orbital motion indicate that current theory affords an adequate explanation of the characteristics of the observed Rayleigh waves.

Experimental phase and group velocity curves for Rayleigh waves, derived from the observed data, are included.—*P. E. B.*

158–140. Byerly, Perry, and Herrick, Charles. *T* phases from Hawaiian earthquakes: Seismol. Soc. America Bull., v. 44, no. 2A, p. 113–121, 1954.

T phases, arising from earthquakes in Hawaii, have been studied on the records at the Berkeley stations. Tabulated data are given on 17 earthquakes from 1929 to 1952. The records indicate that the larger part of the motion over the land path in California is not a longitudinal wave in all probability. Periods of *T* recorded range from 0.25 to 0.7 sec. On both Wood-Anderson horizontal and Benioff vertical instruments the period occurring most frequently is 0.5 sec. Waves of this period are found throughout the *T* phase. The waves of 0.25 sec period usually appear in the small motion at the beginning and at the end of *T* recorded by the Benioff instruments. Those with periods between 0.35 sec and 0.45 sec occur most often as groups or pulses, with the largest amplitudes in the maximum motion. Waves with periods greater than 0.5 sec always appear in the groups of maximum motion. Those with periods as great as 0.7 sec were found only on the Wood-Anderson records.

The speed of *T* on the Hawaiian land path was determined from times of the beginning of the *T* group at the Berkeley station. A line representing a speed of 6 kmps, a value currently very popular in seismology, could be drawn through the scatter of points. Similarly, a value of 6 kmps could be used for the land path in California, although 7 kmps would fit the data better. Correction of the travel times with the value 6 kmps for land paths yields a mean *T* speed in water of 1.47 kmps, the value given by Ewing, Press, and Worzel for the speed of the maximum of *T* from shocks in the West Indies.—*P. E. B.*

158–141. Båth, Markus. A study of *T* phases recorded at the Kiruna seismograph station: Tellus, v. 6, no. 1, p. 63–71, 1954.

Five cases of clear *T* phases from earthquakes in the Norwegian Sea recorded at Kiruna since 1951 are studied. To the author's knowledge these observations are the first of this kind in Europe and also the first so far to the north—on the borders of the Arctic Ocean. It is verified that *T* propagates as a sound wave through the water. Different phases, constituting *T*, have been identified, travelling along the land path as *Pg*, *Sg*, and a third wave with a land velocity of 2.7 kmps, probably an *S* wave in more superficial layers than granite. The conditions for sound-channel transmission in the ocean are studied. The efficient use which can be made of the *T* phase in epicentre locations is illustrated with a particular case. The period of *T* is remarkably constant and equal to 0.5 sec. By amplitude calculations it is shown among other things that different submarine earthquakes are not equally efficient in producing a *T* phase; reasons for this behaviour are discussed. A theoretical explanation is given for the fact that at the same time as the amplitude of *T* may be larger than that of *P* at Kiruna, there is no *T*, but a clear *P* recorded at Uppsala.—*Author's abstract*

158–142. Wadati, K[iyoo], and Inouye, W[in]. On the *T*-phase of seismic waves observed in Japan: Geophys. Mag., v. 25, no. 3–4, p. 159–165, 1954.

Clear-cut *T*-phases have been observed on the records of 29 earthquakes originating near Japan. The velocity observed in the intermediate earthquake of June 6, 1951, was 1.47 kmps, on the basis of 5 observations. A similar velocity was found for the deep earthquake of March 6, 1951, on the basis of 4 observations. These and other observations confirm that the velocity of the *T*-phase coincides with the velocity of sound waves propagating through the sound channel around Japan. The amplitude of the phase is increased if the epicentral distance of the continental slope is about the same as the depth of focus. This suggests that the *T*-phase may originate as a *SV*-wave incident on the continental slope and refracted into the water as well as a boundary wave through the channel where the energy is concentrated.—*M. C. R.*

Tuve, Merle A., Tatel, Howard E., and Hart, Pembroke J. Crustal structure from seismic exploration. See Geophys. Abs. 158–215.

EARTHQUAKE OCCURRENCES AND EFFECTS

158–143. Suzuki, Ziro. A statistical study on the occurrence of small earthquakes, I: Tōhoku Univ. Sci. Repts., 5th ser., v. 5, no. 3, p. 177–182, 1953.

If the empirical relation $n(a)\delta a = ka^{-m}\delta a$ between the maximum trace amplitudes a and the number of earthquakes $n(a)$ found by Ishimoto and Iida holds good at an observation station, then a similar formula $f(A)\delta A = KA^{-m}\delta A$ should be valid for the distribution of the maximum amplitude at the hypocenter A. The result is independent of the mode of amplitude attenuation by the propagation of seismic waves and the distribution of the earthquakes in the seismic region.—*M. C. R.*

158–144. Wadati, K[iyoo], and Iwai, Y. The minute investigation of seismicity in Japan (1): Geophys. Mag., v. 25, no. 3–4, p. 167–173, 1954.

Studies of the distribution of earthquakes of magnitudes greater than 5 between 1926 and 1952 in the Kwantō and Kyūshū districts of Japan show there is a marked tendency toward increasing focal depths progressively landward and inland from the trench offshore to the volcanic zone. Earthquakes of intermediate depth occur frequently in the region of active volcanoes, but are practically unknown in other areas. There may be no direct relationship between the occurrence of intermediate earthquakes and current volcanic activity, but in Japan the coincidence seems to be "too remarkable to be regarded accidental."—*M. C. R.*

158–145. Murauchi, Sadanori. A study of the variation in the seismic activity before and after great earthquakes. First Rept.: Tokyo Nat. Sci. Mus. Bull., no. 30, p. 6–20, 1951.

In a preliminary study of the variation of seismic activity before and after the great Nankaidō earthquake of 1946, shocks in selected areas were tabulated for 30-day, 24-hour, and 30-minute intervals over a 2 year period. When there is a noticeable difference in activity after the earthquake, it is reasonable to conclude that the condition of the crust has changed in that region.—*D. B. V.*

158–146. Belousov, V. V. K voprosu o metodakh seymicheskogo rayonirovaniya [On the methods of seismic zoning]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 209–222, 1954.

The seismotectonic method of zoning, as proposed by Gubin, is based on the assumed correlation between earthquakes and tectonic dislocations on the surface of the earth. When at any point of such a tectonic line a new differential movement is observed, the entire length of this rupture is considered to be seismically endangered.

Belousov points out that the epicenters of many recent earthquakes in the Caucasus are along lines perpendicular to geologically established lines of rupture, indicating movements at great depth not apparent at the surface of the earth. It is necessary to investigate the crust by geophysical methods to a depth determined by the depth of the foci of these earthquakes, and to make more precise observations of even feeble seismic shocks and to record them continuously. Only after sufficient observations of seismic movements to great depth in a region are available will it be possible to establish correlations between these movements and the earthquakes at the surface. The seismotectonic method provides no information about the movement of such earthquakes. The intensity of seismic shocks at a given point can only be said to be inversely proportional to the distance from the point to the conjectured rupture. In summary Belousov says that the suggested seismotectonic method of zoning is no method at all unless it can give the answer to the questions about the time of a future earthquake, its intensity, and the area affected.—*S. T. V.*

158–147. Gubin, I. Ye. O seysmicheskom rayonirovanii yugo-zapadnoy Turkmenii [On the seismic zoning of southwestern Turkmen S. S. R.]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 223–243, 1954.

A seismotectonic map of southwestern Turkmen S. S. R. was constructed on which seismic conditions of this region are shown. Certain possible foci at great depth on Kopet Dag and on the Malyy Balkhan, not associated with known geologic structures, are not taken into account. The intensity of seismic shocks at these foci has never exceeded 3–4; if the deep shocks should reach even intensity 6 or 7, it will be necessary to modify the zoning map because no more violent earthquakes in these regions can be expected. The constructed map is more detailed than the existing seismostatistical maps of 1949 and 1951, but is not considered final.—*S. T. V.*

158–148. Krestinkov, V. N. Istoriya razvitiya struktury i seysmichnost' severnogo Tyan'-Shanya [The structural history and seismicity of northern Tien Shan]: Akad. Nauk. SSSR Izv. Ser. geol., no. 3, p. 92–108, 1954.

Earthquakes in the northern Tien Shan from 1770 to 1952 are listed. Instrumental data have been available since 1885. The distribution of epicenters indicates that there are two seismic zones, southern and northern, with an aseismic zone between. However, the apparent lack of seismicity in the latter may be due to the sparseness of population in that area; many shocks recorded instrumentally could have centered in this so-called quiet zone without having been reported. The southern seismic zone follows the boundary between two large scale structural complexes, the southern Tien Shan uplift and the Tarimsky massif. The structure of the northern zone is considerably more complicated.—*D. B. V.*

158–149. Tanabashi, Ryō, and Ishizaki, Hatsuo. Earthquake damages and elastic properties of the ground: Kyōto Univ. Disaster Prevention Research Inst. Bull., no. 4, 70 p., 1953.

The results of several years' study of the relation between the nature of the ground and earthquake damage to wooden buildings, by statistical examination of destroyed buildings and experiments with elastic waves, are summarized in this paper. The damage is found to be roughly proportional to h_i/v_i, where v_i=velocity of surface waves and h_i'=thickness of the surface layer (corrected).—*D. B. V.*

158–150. Steinbrugge, Karl V., and Moran, Donald F. An engineering study of the Southern California earthquake of July 21, 1952, and its aftershocks: Seismol. Soc. America Bull., v. 44, no. 2B, p. 201–462, 1954.

This is a very detailed study of the damage to various structures by the earthquake of July 21, 1952, and its aftershocks, including that of August 22, 1952. The damage to buildings, refineries and pumping plants, oil wells, storage tanks, roads and bridges, and various other items is discussed in detail with a view to evaluating the effectiveness of current earthquake-resistive design, and aiding earthquake-insurance underwriters. Many photographs and maps are included, as are diagrams showing structural failures.—*P. E. B.*

158–151. Ericksen, George E., Concha, Jaime Fernández, and Silgado F., Enrique. The Cusco, Peru, earthquake of May 21, 1950: Seismol. Soc. America Bull., v. 44, no. 2A, p. 97–112, 1954.

The epicentral area of the Cusco earthquake, within which buildings were extensively damaged, covered only about 12 km^2 within the Cusco (Cuzco) Basin, and the earthquake may be considered local in effect. The depth of focus probably was between 8 and 9 km. The maximum intensity in the epicentral area was estimated to be 7 on the modified Mercalli scale, and the acceleration was less than 300 gals. The extensive damage in the epicentral area is attributed largely to poor construction and the age of buildings. The buildings that were most seriously damaged were colonial churches 250 to 300 years old, old adobe houses, and new houses of combined adobe and rock or brick construction. Many of the buildings that were destroyed in this earthquake had previously been damaged during an earthquake in 1941.

From a summary of the geology of the Cusco Basin it is concluded that the most extensive damage was to buildings resting on thick, water-saturated, alluvial gravels.—*P. E. B.*

158–152. Tandon, A. N. Study of the great Assam earthquake of August 1950 and its aftershocks: Indian Jour. Meteorology and Geophysics, v. 5, no. 2, p. 95–137, 1954.

The epicenters and origin time of the major earthquake of August 15, 1950, and of 54 aftershocks that occurred by the end of April 1951 were determined by a least-squares solution based on the Jeffreys-Bullen (1940) tables. The main shock occurred at $14^h\ 09^m\ 28.5^s$ G. m. t. at lat. 28.46° N, long. 96.66° E. Aftershocks were scattered within the area bounded by lat. 24.39° and 31.20° N and long. 90.35° and 97.26° E. Magnitudes were determined from the data of Indian stations, that of the main shock as 8.5 and of aftershocks from 5.3 to 7.0. Depths of foci were all shallow. Velocities of P, P^*, $\overline{P}$, S, S^*, and $\overline{S}$ were determined to be 7.91, 6.55, 5.58, 4.46, 3.85, and 3.43 kmps, respectively. The

depth of the granitic layer is 24.8 km and of the intermediate layer 2.15 km (means from *P* and *S* observations). Extensive tables are included.—*M. C. R.*

158–153. Suzuki, Ziro; Noritomi, Kazuo; Ossaka, Justo; and Takagi, Akio. On the tunami in Sanriku District accompanying the Tokachi earthquake, March 4, 1952: Tōhoku Univ. Sci. Repts., 5th ser., v. 4, no. 3, p. 134–138, 1953.

Wave heights and fronts of the tsunami of March 4, 1952, in the Sanriku district have been compared with those of the Sanriku tsunami of March 2, 1933. The direction of wave fronts is different in the northern part of the area, but is similar in the southern. The maximum height in the area in the 1952 tsunami was 2.1 m at Otomoura.—*D. B. V.*

158–154. Kato, Yoshio; Noritomi, Kazuo; Ossaka, Justo; and Takagi, Akio. Report of tunami in Shizugawa Harbour accompanying Tokachi earthquake on March 4, 1952: Tōhoku Univ. Sci. Repts., 5th ser., v. 4, no. 3, p. 143–145, 1953.

Wave heights at various points of observation in Shizugawa Harbour, Tōhoku, from the tsunami of March 4, 1952 (maximum, 1.2 in), have been compared with the results of model experiments carried out in a tank by Ogiwara and Okita; good agreement was found.—*D. B. V.*

158–155. Suzuki, Ziro, and Nakamura, Kōhei. On the heights of the tunami on March 4, 1952, in the district near Erimomisaki: Tōhoku Univ. Sci. Repts., 5th ser., v. 4, no. 3, p. 139–142, 1953.

Observations of heights of the tsunami of March 4, 1952, on the eastern and western shores of Erimo-misaki, Hokkaido, show that there is no evidence that the western part of the cape was in the shadow zone, which it would have been if the tsunami had been generated at the epicenter and had a short wave length. The maximum height was nearly 4 m at Kirittapu.—*D. B. V.*

SEISMIC SURVEYS

158–156. Officer, C. B., [Jr.], and Ewing, Maurice. Geophysical investigations in the emerged and submerged Atlantic Coastal Plain, Part VII: Continental shelf, continental slope, and continental rise south of Nova Scotia: Geol. Soc. America Bull., v. 65, no. 7, p. 653–670, 1954.

The results of a series of refraction profiles made over the continental shelf south of Nova Scotia and extending down to the adjacent deep basin are reported. The resulting geologic and crustal sections show the manner in which the gradation from continent to ocean takes place. The Coastal plain sediments reach a maximum thickness of around 20,000 feet on the gently sloping area at the bottom of the continental slope and thin further seaward. The crystalline basement of metamorphic rocks and granites over Nova Scotia gradually thins under the continental margins and pinches out toward the ocean basins. It drops abruptly under the continental slope from 5,000 feet to 20,000 feet. The Mohorovičić discontinuity is measured on a single profile at a depth of 52,000 feet under the continental rise.—*Authors' abstract*

158–157. Beatty, W. B. Shallow exploration for iron ore with the reflection seismograph: Explosives Engineer, v. 31, no. 6, p. 172–174, 187, 1953.

A description of Stanford Research Institute's shallow reflection experiments in Minnesota. See also Geophys. Abstract 14119.—*L. C. P.*

158–158. Mühlen, W[alter] von zur, and Tuchel, G. A study of well velocity data in northwest Germany: Geophys. Prosp., v. 1, no. 3, p. 159–170, 1953.

The article is based on data from 74 seismic well velocity surveys in northwest Germany.

The effect of overburden is illustrated by means of diagrams representing interval velocities against depth. To eliminate observational errors and lithological variations from well to well, interval velocities from about the same depth are averaged. Thus, relatively uniform curves are obtained for lower Tertiary, Upper Cretaceous, and Lower Cretaceous (Albian), making the effect of overburden better evident than from individual observations. The vertical gradient of velocity for these geological sections are given. Furthermore, they are compared with curves for Lower Tertiary and Cretaceous obtained in North America. Due to its high lime content, the Upper Cretaceous of northwest Germany has a much higher velocity than that observed in the Cretaceous of North America. The curves for shales of the Lower Tertiary and Lower Cretaceous (Albian), however, are similar in both countries. In older formations, on the other hand, for example Jurassic and Triassic, lithologic character has the dominant influence and the effect of overburden is rather small and often scarcely noticable.

The data considered cover a depth range down to 2,700 meters. The interval velocities are generally based on the use of various equal intervals.—*Authors' abstract*

Rosenbach, Otto. A comparison of the second derivative method of gravity interpretation with reflection seismics and geological findings in the Offenburg area. See Geophys. Abs. 158–14.

158–159. Cassinis, R., and Carabelli, E. Misure sismiche di spessore del ghiaccio al ghiacciaio dei Forni (Lombardia) [Seismic measurements of the thickness of ice in the Forni glacier (Lombardia)]: Riv. Geofisica Appl., anno 14, no. 2, p. 87–99, 1953.

An experimental seismic survey was made to determine the most reliable and convenient way of obtaining the thickness of the ice of a glacier. A standard 12-channel seismograph system with all 12 channels responding well to low-frequency waves of 6 to 10 cycles per second was used. It is recommended that in similar surveys reflected waves of much higher frequency as high as 100 cycles per second be used. Shot holes should be very shallow (about 1 m deep), and geophones should be distributed with spacing of only 10 m along two profiles crossing one another. Explosive charges must be small, not more than 180 gr. The distance from the shot point to geophones must be selected so that reflected impulses arrive at geophones before the direct transverse waves. The interpretation of the data was made according to the procedure of S. M. Rock (See Geophys. Abs. 4338). The results were checked by shooting one refraction profile, about 1 km long, along the axis of the valley. Good agreement was found between these results, as well as with the geology of the area.—*S. T. V.*

Vecchia, Orlando. Geophysical investigations for a dam on the lake of Molveno (Venezie Tridentina). See Geophys. Abs. 158–105.

MICROSEISMS

158–160. Imbert, Bertrand. Microséismes et houle dans l'Océan Indien sud [Microseisms and swell in the southern Indian Ocean]: Annales Géophysique, tome 10, no. 2, p. 175–184, 1954.

The presence of some 70 miles of pack ice around the coast of Adélie Land, combined with the fact that Australia and New Zealand are approximately 3,000 km away, indicates that the microseisms recorded in Adélie Land must have been generated in water 2 to 4 km deep. A further more general check is given for data from a number of coastal observatories. It indicates a linear relationship between periods and depths in agreement with a theoretical relationship, of Press and Ewing, for deep water. A discussion is given of the different oceanographical factors which, inside a barometric low, can modify the amplitudes of microseisms. Empirical curves are presented for several relationships, including those of amplitudes of microseisms and swell versus the translational speeds of barometric lows. The effect of rotation of the winds is important and the coalescing of two "fetches" with different mean directions will produce a swell that generates microseisms of amplitude involving a certain amplitude factor. The application of a formula to data on microseism storms at Macquaric Island leads to an amplitude factor of the same order of magnitude as that derived for this case from the theory of Longuet-Higgins. The results are thus in accord with the theory of Longuet-Higgins according to which microseisms are generated by standing waves at sea.—*P. E. B.*

158–161. Inouye, W[in], Hirono, T., and Murai, G. Microseisms and surf: Geophys. Mag., v. 25, no. 3–4, p. 175–183, 1954.

Comparisons of microseisms observed at Tokyo and sea waves recorded at Jogashima, 60 km south of Tokyo, from March 16 to October 31, 1952, confirm Longuet-Higgins theory on the period of microseisms. The relation observed between the amplitudes of the microseisms and the corresponding sea waves and the positions of the cyclones and cold fronts, suggests that microseisms are generated in two places, the sea bottom near a coast and the ocean basin about the cyclone center, as suggested by Longuet-Higgins.—*M. C. R.*

158–162. Darbyshire, J. Structure of microseismic waves: estimation of direction of approach by comparison of vertical and horizontal components: Royal Soc. London Proc., Ser. A, v. 223, no. 1152, p. 96–111, 1954.

Analysis of microseisms recorded at Kew Observatory on 8 to 10 October 1951 affords further confirmation of the wave-interference theory of microseism generation, and allows those of 8 to 10 October to be attributed to a fast moving depression between the Azores and Iceland.

Although the bearing of the microseism generating area changes by more than 90° during the period investigated, there is no appreciable difference in the ratio of the mean amplitudes of the north-south and east-west horizontal components as would be expected if the microseisms consisted entirely of Rayleigh waves. An investigation of the phase differences between the three components, using Lee's method, suggests that the microseisms consist of Rayleigh and Love waves in comparable proportions. Making use of this assumption, the vertical component, which is not affected by Love waves, is correlated with the two horizontal components with an electronic correlating device, and the bearing of the micro-

seism area can be deduced from the correlation coefficients. The calculated bearings agree reasonably well with those obtained from the meteorological charts.

The bearing of a storm on 12 to 15 November 1945, studied in a previous paper, was also calculated satisfactorily.—*Author's abstract*

ISOTOPE STUDIES AND AGE DETERMINATIONS

158–163. Vinogradov, A. P. Geokhimiya isotopov [The geochemistry of isotopes]: Akad. Nauk SSSR Izv. Ser. geol., no. 3, p. 3–19, 1954.

This is a review of contemporary knowledge of the isotopes of the elements in the lithosphere, hydrosphere, and atmosphere and their bearing on fundamental geologic problems such as the age of the earth as a whole and of individual portions of the crust; origin of the atmosphere; distribution of oxygen, sulfur, carbon, and hydrogen in the crust; and the relation between hypogene and hypergene processes.—*D. B. V.*

158–164. Damon, Paul E. An abundance model for lead isotopes based upon the continuous creation of the earth's sialic crust: Am. Geophys. Union Trans., v. 35, no. 4, p. 631–635, 1954.

A mathematical model for common lead isotope ratios has been derived on the basis of Wilson's hypothesis that the continents have been growing throughout geologic time by segregation from an originally uniform simatic crust. The age of the sialic crust in Holmes' model is nearly the same as the age of the ancient nuclei of the continents in this model. In the model based on continuous creation of sialic material it may be assumed that lead can be derived from either sima or sial or both, and the known variations in common lead isotope ratios may thus be explained. An attempt should be made to correlate lead isotope ratios on a regional basis. The ratios are not considered quantitative criteria for age of deposition.—*M. C. R.*

158–165. Bagge, E. Isotopen-Bestimmungen als Hilfsmittel paläontologischer Forschung [Isotope determinations as an aid to paleontological research]: Umschau, Jahrg. 54, Heft 12, p. 364–366, 1954.

The new field of research which can be called "isotope paleontology" applies the isotope ratios of C^{12} and C^{13} and O^{16}, O^{17}, and O^{18} to paleontological problems. Carbon of plant origin can be distinguished from that of limestone or volcanic origin by means of the isotope ratios ($C^{12}:C^{13}$=91–93:1, 87–89:1, and 89–90:1, respectively). The O^{18} abundance in shells is an indication of the temperature of the seas in which they were secreted.—*D. B. V.*

158–166. Kohman, Truman P. Geochronological significance of extinct natural radioactivity: Science, v. 119, no. 3102, p. 851–852, 1954.

An extinct natural radionuclide is defined as an unstable nuclide whose half life is sufficiently short to have resulted in complete decay since the presumed origin of the elements but sufficiently long to have produced identifiable effects. Such a half life would have to be between 3×10^{8} and 2 or 3×10^{8} year if the universe and the elements are 4 to 8×10^{9} years old and chemical fractionations of elements yielding products now accessible took place no earlier than 3×10^{8} year after the formation of the elements. Extinct natural radioactivity, if it exists and is detectable, should be useful in determining the times of ancient

geologic events associated with the formation of appropriate minerals, as there would exist a functional relationship between the age of the mineral that once contained an extinct natural radionuclide and the quantity of the radiogenic product. An experimental search for such extinct natural radionuclides is reported under way in the laboratories of the Carnegie Institute of Technology Department of Chemistry.—*M. C. R.*

158–167. Carr, Donald R., and Kulp, J. Laurence. Dating with natural radioactive carbon: New York Acad. Sci. Trans., ser. 2, v. 16, no. 4, p. 175–181, 1954.

A review of the methods, techniques, and applications of carbon-14 dating.—*M. C. R.*

158–168. Straaten, L. M. J. U. van. Radiocarbon datings and charges of sea level at Velzen (Netherlands): Geologie en Mijnbouw, jaarg. 16, no. 6, p. 247–252, 1954.

On the basis of radiocarbon age determinations combined with detailed geological investigations, van Straaten concludes that the average rise of sea level has been much slower during the last 4,000 years than in the preceding period. Because of the errors inherent in both the radiocarbon dating and geologic evidence, three different interpretations are given for the relative changes in sea level, one of which is regarded as most probable.—*D. B. V.*

158–169. Bruet, E. L'âge absolue de la dernière grande éruption peléene de la Soufrière de la Guadeloupe [The absolute age of the last great peléean eruption of the Soufrière of Guadeloupe]: Bull. volcanolog., sér, 2, tome 13, p. 105–107, 1953.

In a previous paper, Bruet and Aubrat fixed the date of the last great peléean eruption of the Soufrière as pre-Columbian, probably not earlier than the year 1000. Since then, two deposits have been discovered which contain much wood charred during that eruption. Carbon-14 determinations made at Columbia University on two samples give an age of 550±150 years, which is in good agreement with earlier conclusions. —*D. B. V.*

158–170. Rankama, Kalervo. The isotopic constitution of carbon in ancient rocks as an indicator of its biogenic or nonbiogenic origin: Geochim. et Cosmochim. Acta, v. 5, no. 3, p. 142–152, 1954.

A lower limit of 90.5 for the C^{12}/C^{13} ratio of biogenic carbon may be inferred from Wickman's measurements. In the absence of geologic evidence to the contrary, carbon in shales, slates, and schists may be considered biogenic if its isotopic composition is within the biogenic range.—*M. C. R.*

148–171. Suess, Hans E. Natural radiocarbon measurements by acetylene counting: Science, v. 120, no. 3105, p. 5–7, 1954.

A new standardized method for the determination of radiocarbon for age measurements, involving acetylene counting, has been developed and is in use in the U. S. Geological Survey. The acetylene gas is produced in a series of chemical reactions in which carbon dioxide from the sample is combined with ammonium hydroxide to produce ammonion carbonate and water, strontium chloride is added to precipitate strontium carbonate, the carbonate is reduced to a carbide by reaction with an excess of magnesium powder in an evacuated

stainless steel tube, the reaction product dumped into water inside an evacuated system, the gases thus formed dried by passing them through a trap cooled by an acetone mixture and a Drierite column, and the acetylene condensed in a liquid nitrogen trap. The principle of the counting technique is that developed by Libby, with the cosmic ray background eliminated by a ring of cosmic-ray counters in anticoincidence with the sample counter. Pulses are amplified in a linear amplifier of a NICC methane counter Model 117 and fed into an RCL anticoincidence circuit Mark 15 Model 40 and registered. The advantages of the method are that only a small sample (1 g) is required, less than 12 man-hours of work are required for preparation of the acetylene, and the stability of the counting system and reproducibility of absolute counting rates eliminate the need for more than one check run every 2–3 weeks.—*M. C. R.*

158–172. Suess, Hans E. U. S. Geological Survey radiocarbon dates I: Science, v. 120, no. 3117, p. 467–473, 1954.

Radiocarbon dates obtained by acetylene counting are reported for 63 samples. The ages of most of the samples were determined to date pre-Mankato substages of the last glaciation. The dates show that a major glacial advance took place in North America some 20,000 years ago, and reached its maximum extent between 18,000 and 19,000 years ago, penetrating, at least in Illinois, farther south than any other previous stage of Wisconsin glaciation. Other samples were measured as part of investigations of changes of water temperature with time along the California coast, late Pleistocene sea-level changes, and archeological and miscellaneous geologic problems.—*M. C. R.*

158–173. Potzger, J. E., and Courtemanche, Albert. A radiocarbon date of peat from James Bay in Quebec: Science, v. 119, no. 3104, p. 908, 1954.

Radiocarbon dating of samples from 19 bogs in Quebec indicate that forests migrated northward during the warm dry (xerothermic) period of post glacial times; some varieties had extended their range as far as James Bay but have since been depressed southward about 350 miles.—*M. C. R.*

158–174. Geiss, Johannes. Isotopenanalysen an "gewöhnlichem Blei" [Isotope analyses on "common lead"]: Zeitschr. Naturforschung, Band 9a, Heft 3, p. 218–227, 1954.

This paper presents the results of a mass spectrometer investigation of the isotope ratios of nonradiogenic leads in 30 samples of galena from various places. The results are tabulated under the headings $Pb^{204}/Pb^{206}.100$, $Pb^{207}/Pb^{206}.100$, and $Pb^{208}/Pb^{206}.100$. In a detailed analysis of these data, the question of original lead (that formed with the earth's crust) and lead subsequently formed by disintegration, and their bearing on age determinations, are explored.—*D. B. V.*

158–175. Epstein, S[amuel], and Mayeda, T. Variations of O^{18} content of waters from natural sources: Geochim. et Cosmochim. Acta, v. 4, no. 5, p. 213–224, 1953.

The oxygen isotopic analyses of marine and fresh waters, in conjunction with salinity data in the former case, provide information on evaporation and condensation processes in existing water bodies. A large fraction of the fresh water removed from the warm ocean current areas is isotopically similar to the ice and snow found in Greenland and in the mountains in the northwest of North America rather than to the waters in the Great Lakes or typical rain

water. The lowering of salinity in the cold Alaskan and California currents seems to be primarily due to meltwater from snow and ice. The existence of large bodies of ice and snow seems to play an important part in determining both isotopic composition and salinity of shallow ocean waters. The isotopic composition of fresh water varies over a large range and is dependent upon its history and its source.—*Authors' summary*

158–176. Gentner, W., Prag, R., and Smits, F. Alterbestimmungen nach der Kalium-Argonmethode unter Berücksichtigung der Diffusion des Argons [Age determinations by the potassium-argon method with regard to the diffusion of argon]: Zeitschr. Naturforschung, Band 8a, Heft 3, p. 216–217, 1953.

In a previous investigation of the Buggingen potash deposits, it was shown that the abundance of radiogenic argon in different layers varies, within narrow limits, in comparison to the corresponding abundance of potassium. Measurements with a specially constructed mass spectrometer now show that the A^{40} content depends on crystal size, suggesting that the difference in argon content can be attributed to diffusion.—*D. B. V.*

158–177. Grant, F. S. The geological significance of variations in the abundances of the isotopes of silicon in rocks: Geochim. et Cosmochim. Acta, v. 5, no. 5, p. 225–242, 1954.

Physical and chemical processes which may lead to variations in the isotopic content of rocks are discussed in this paper, with special emphasis given to the processes of chemical exchange which may occur during the early stages of formation. Quantitative calculations deriving from physical understanding of these mechanisms have been applied whenever possible to the case of silicon, and lead to certain conclusions relating the isotopic abundances of silicon to the geological history of the mineral. They are: limits may be calculated for the isotopic content of rocks which formed in equilibrium from a common magma; it is unlikely that diffusion processes play any part in the separation of silicon isotopes, either in the solid or liquid state; analysis of abundances in a given mineral can reveal whether or not sedimentation during its history is a necessary hypothesis. The paper is entirely theoretical, and except for a few minor extensions to existing methods, it contains no original developments.—*Author's abstract*

RADIOACTIVITY

RADIOACTIVITY CONSTANTS

158–178. Wetherill, G. W. Spontaneous fission yields from uranium and thorium: Phys. Rev., v. 92, no. 4, p. 907–912, 1953.

Relative spontaneous fission yields from uranium and thorium have been determined by extracting zenon and krypton from geologically old uranium and thorium minerals and measuring the isotopic abundances of these gases in a mass spectrometer. Arguments are presented for believing that the anomalous isotopic abundances observed are caused by spontaneous fission rather than by some other fission process. The spontaneous fission yield curve peaks were found to be much sharper than those associated with other fission processes. Evidence was found for fine structure in the fission yield curve at mass 132,

possibly connected with preferential formation of spontaneous fission fragments containing 50 protons and 82 neutrons. Evidence for neutron induced fission in pitchblende was found.—*Author's abstract*

158–179. Porschen, W., and Riezler, W. Natürliche Radioaktivität von Wolfram [Natural radioactivity of tungsten]: Zeitschr. Naturforschung, Band 8a, Heft 8, p. 502, 1953.

Using nuclear chromatin plates, Porschen and Riezler have detected weak alpha activity in tungsten. The average range of particles in the emulsion is $10.7 \pm 0.24\mu$, from which it is calculated that the alpha-particle energy is 3.2 MeV. The decay constant is 3.1×10^{-18} years; the half life is calculated on the basis of Gamow's formula to be 6×10^{8} years. The radioactivity must be due to a hitherto unknown light isotope, for example W^{178}.—*D. B. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

158–180. Bilicke, Walt. How to use a counter: Mines Mag., v. 44, no. 6, p. 40, 90–92, 1954.

This is an explanation of the use of Geiger and scintillation counters in uranium prospecting.—*L. C. P.*

158–181. Davenport, A. N., and Stevens, G. W. Use of X-ray film for comparing radioactivities: Nature, v. 174, no. 4421, p. 178–179, 1954.

The radioactivity, in terms of relative quantities of silver, of six different sources were compared by direct chemical analysis, by a Geiger-Müller counter, by means of a series of autoradiographs together with the relative activity of each source as derived from plots of density against log-exposure time, and by visual density matching to determine the exposure time needed by each source to give a standard density. The third method gave an accuracy comparable with that obtained by counting; even the last method yielded an accuracy adequate for semiquantitative work. The determination of radioactivity by autoradiography is said to simplify corrections for decay, facilitate assessment of isotopes of short half lives, and make practicable comparisons of very weak sources.—*R. C. H.*

158–182. Palumbo, D[onato]. Teoria per la determinazione del contenato radioattivo dei minerali. II [Theory of the determination of radioactive content of minerals. Pt 2]: Annali Geofisica, v. 6, no. 4, p. 467–481, 1953.

In a continuation of his previous work (see Geophys. Abs. 14959), Palumbo computes the number of the tracks of alpha particles emitted per square centimeter by the material lying on a nuclear emulsion, assuming that the ratio between the range of the alpha particle having a given energy content is independent of this initial amount; the assumption is also made that the range η of the particle in the material and that in the photographic emulsion ξ are related by the equation $\eta = l(\xi)$. The shape of the function $l(\xi)$ is computed on the basis of Bethe's theory by introducing empirical data. The theory is then applied to several radioactive substances such as U^{238}, U^{235}, and thorium.—*S. T. V.*

158–183. Imbò, G[iuseppe], and Castertano, L[uigi]. Analisi radioattiva delle rocce col metodo fotografico [Radioactive analysis of rocks by the photographic method]: Annali Geofisica, v. 6, no. 3, p. 315–320, 1953.

Using the formulas derived in previous studies (see Geophys. Abs. 13884 and 13885), it is possible to obtain a system of equations so that the number of atoms of thorium C^1, radium C^1, and actinon A disintegrating during the time of exposure per cubic centimeter of the substance can be calculated from the number of alpha particles recorded on the photographic plate and from the projections of the paths in the emulsion that are longer than a certain definite range. It is also possible to derive the number of atoms of An, thorium A, and actinium C disintegrating. Under less favorable conditions, it is possible to determine the number of disintegrating atoms of thorium C^1, thorium A and radium C^1 and verify the conditions of the single family of thorium or else only the number of disintegrating atoms of thorium C^1 and radium C^1.

Uranium and thorium can be determined without approximations in the first; in the second, approximations must be made for the uranium family, and in the last, for both radioactive families so that calculated values have a different significance in each case.—*S. T. V.*

158–184. Nelson, John M. Prospecting for uranium with car-mounted equipment: U. S. Geol. Survey Bull. 988–I, p. 211–221, 1953.

The U. S. Geological Survey has prospected for uranium with a car-mounted Geiger-Müller counter since 1945. The basic principles of the car-traverse technique are simple. Rocks and soils of abnormally high uranium or thorium content are surrounded by an equivalently high gamma radiation field. An abnormal gamma-radiation field that extends across a road or highway can be detected at relatively high speeds by a car or truck equipped with a suitable Geiger-Müller counter. Once detected by car traversing, the deposit can be examined with light portable instruments, and the better portions sampled. The prime advantage of the car-traverse technique is the rapidity of the scanning process, 100 to 200 miles per day, which permits exploration of large areas in a short time.—*Author's abstract*

158–185. van Bavel, C. H. M., Hood, E. E., and Underwood, N. Vertical resolution in the neutron method for measuring soil moisture: Am. Geophys. Union Trans., v. 35, no. 4, p. 595–600, 1954.

A source of fast neutrons and a slow-neutron detecting device in close proximity have been used to measure the moisture content of soil. The work was done with a 10-mc Ra-Be source and a BF_3-filled counter (2.5×30 cm). Rates varied between 16 and 2 counts per second. The vertical extent of the soil layer contributing 95 percent of the measured counting rate varied from 65 cm with very dry material (4.4 percent water by volume) to 45 cm with saturated material (38 percent water by volume). It has been shown possible, by partial shielding of the counting tube with cadmium foil to increase vertical resolution, at expense of counting rate. This procedure is not very effective, however.—*Authors' abstract*

RADIOACTIVITY OF ROCKS, WATERS, AND AIR

158–186. Holland, Heinrich D., and Kulp, J. Laurence. The transport and deposition of uranium, ionium and radium in rivers, oceans, and ocean sediments: Geochim. et Cosmochim. Acta, v. 5, no. 5, p. 197–213, 1954.

The important factors controlling the concentration of the radioelements in the oceans are the influx, the rate of radioactive decay, and the rate at which the

radioelements are removed by sedimentation. With such data as are available for the concentration of uranium and radium in ocean water, their rates of influx, and their rates of deposition, it is possible to estimate the concentration of ionium in sea water ($3.1 \pm 1 \times 10^{-15}$ gm/cc, and the amount of ionium annually transported into the oceans. It may be further concluded that in the geochemistry of uranium, influx and deposition in shallow water are of major importance while in the case of ionium, influx and deep water deposition seem most important and in the case of radium, the production by radioactive decay of ionium, the disintegration of radium itself, and deep water deposition are important factors. Ionium is not in equilibrium with uranium in ocean water.—*Authors' abstract*

157–187. Holland, Heinrich D., and Kulp, J. Laurence. The mechanism of removal of ionium and radium from the oceans: Geochim. et Cosmochim. Acta, v. 5, no. 5, p. 214–224, 1954.

By the use of radiothorium (Th^{228}) and thorium X (Ra^{224}) as tracers for ionium (Th^{230}) and radium (Ra^{226}) respectively, it has been found possible to study the adsorption and base exchange of these elements on deep-sea sediments. Extrapolation of the adsorption data obtained with these tracers to the region of the actual concentration of ionium and radium in sea water shows that the quantity of ionium and radium adsorbed is comparable to that observed on recent deep-sea sediments. This seems to demonstrate that base exchange is the mechanism by which ionium and radium are removed from ocean water. In turn this establishes the interpretation of the radium versus depth curves as reflecting ionium decay which is the basic for the ionium method of age determination. Finally, this information delimits the variables which must be controlled in applying this method to the dating of events on the ocean floor.—*Authors' abstract*

158–188. Gott, Garland B., and Hill, James W. Radioactivity in some oil fields of southeastern Kansas: U. S. Geol. Survey Bull. 988–E, p. 69–122, 1953.

Radium-bearing precipitates derived from oil-well fluids have been found in more than 60 oil and gas fields in southeastern Kansas. Most of the formations in the area have no higher concentration of radioactive constituents than is normally found in rocks of similar lithology, but in a few wells drill samples from beds just below the eroded top of the Arbuckle group and from some limestone in the Kansas City group have an abnormally high radium content. The radioactivity of the precipitates ranges from 0.000 to 10.85 percent equivalent uranium oxide, and the uranium oxide content ranges from 0.000 to 0.006 percent. Most of the radioactivity is caused by radium. The highest radioactivity caused by radium in the rocks from this area that have been radiometrically analyzed is equivalent to that of 0.26 percent uranium oxide. This analysis indicates as much radium as would be found in equilibrium with about 0.5 percent uranium. It is suggested that significant quantities of uranium may be present in the subsurface rocks.—*M. C. R.*

158–189. Coppens, R[ené]. Estudio de la radiactividad de la arena de la playa de Langosteira, en Finisterre (Galicia-España) [Study of the radioactivity of the sand of the Langosteira playa in Finisterre (Galicia, Spain)]: Inst. geol. min. España, notas y comunicaciones, no. 34, p. 5–12, 1954.

The major part of the radioactivity exhibited by the sand of the Langosteira playa in Finisterre is due to monazite grains 100-200 μ in diameter which emit an average of 3 alpha rays per cm^2 per sec and have a thorium-uranium ratio of about 5/100.—*D. B. V.*

158–190. Makranczi, B. Otnositel'noye raspredeleniye radioaktiviosti v nekotorykh kislykh izverzhennykh porodakh Vengrii [Relative distribution of radioactivity in the component parts of some acid eruptive rocks of Hungary] (In Russian with French résumé): Acta Geol. Acad. Sci. Hungaricae, tomus 2, fasc. 3–4, p. 251–256, 1954.

With apparatus constructed at the experimental physics institute at the University of Debrecen to measure the radioactivity of small samples, it was found that the radioactive matter in the acid rocks of the Velence and Mecsek mountains is contained not only in biotite but other components as well.—*M. C. R.*

158–191. Szalay, S. The enrichment of uranium in some brown coals in Hungary: Acta Geol. Acad. Sci. Hungaricae, tomus 2, fasc. 3–4, p. 299–311, 1954.

A geochemical enrichment of uranium in some brown-coal layers near the detritus zone of the granitic mountains of Hungary has been observed. The uranium content of the coal is about 0.01 percent, or about the same as the uranium content of bioliths. It seems highly probable that the same general geochemical law is responsible for all such enrichments in bioliths. Laboratory experiments indicated that decomposing plant debris, peat, lignite, and brown coal, have an adsorption power and capacity for uranium that is sufficiently high to explain the geochemical enrichment. Subsequent experiments verified that the humic-acid colloid particles are responsible for the adsorption, which is a cation exchange process. The adsorption equilibrium constant of humic-acid substance is much higher for uranium than for cations of lower valence and lower atomic weight.—*M. C. R.*

158–192. Sanchez Serrano, E. La radiactividad de algunas aguas naturales españolas [The radioactivity of several Spanish natural waters]: Bol. Radiactividad, v. 25, p. 24–27, 1952–53.

The results of radon measurements made on 30 natural waters in Spain, most of them hitherto unpublished, are listed. With the exception of three samples from Valdemorillo (Madrid) which contained 130.5, 166.5, and 174.4 millimicrocuries per liter, radon contents measured were less than one or at most a few millimicrocuries per liter.—*D. B. V.*

158–193. Sanchez Serrano, E. Bibliografia anotada (1904–1954) sobre radiactividad de aguas naturales españolas [Annotated bibliography (1904–1954) on radioactivity of Spanish natural waters]: Bol. Radiactividad, v. 25, p. 28–65, 1952–53.

An annotated bibliography covering the first 50 years of radioactivity studies on natural waters in Spain, most of which have been made by the Instituto de Radiactividad in Madrid. Entries are arranged chronologically.—*D. B. V.*

158–194. Oshima, Yoshio; Yamada, Naoharu; and Mifune, Masaaki. Radon content of hot springs in Tottori prefecture, Japan [In Japanese with English summary]: Okayama Univ. Balneological Lab. Repts., no. 14, p. 1–4, 1954.

The radon content of 166 water samples from hot springs in Iwai, Tottori, Yoshioka, Mamamura, Togo, Sekigane, Misasa, and Kaike was measured with an I. M. Fontactoscope. Sixty-six contained more than 30×10^{-10} curies per liter, the highest being $1{,}150\times10^{-10}$ curies per liter at Hisui-no-Yu in Misasa. The radon content was higher in springs which issue from granite than those in other districts. No definite relation between radon content and temperature of water was determined. Radon content was generally high in "simple" thermal waters or in weak sodium chloride springs, but low in sulfated springs or in saline springs that had a comparatively high sulfate content.—*M. C. R.*

Kohman, Truman P. Geochronological significance of extinct natural radioactivity. See Geophys. Abs. 158–166.

HEAT

158–195. Jacobs, J. A. Temperature distribution within the Earth's core: Nature v. 173, no. 4397, p. 258, 1954.

The case of an earth cooling from a molten state and forming a solid inner core, a liquid outer core, and a solid mantle, is satisfied by a melting-point depth curve discontinuous at the mantle-core boundary and finally rising in the core to values exceeding temperatures in the mantle. F. E. Simon's values of melting temperature at the inner core boundary and at the center of the earth were used with adiabatic temperature gradient curves to calculate a lower limit of 3,600° K and an upper limit of 4,000° K for the melting point of the mantle at the core boundary.—*R. G. H.*

158–196. Uffen, R. J., and Misener, A. D. Temperature distribution within the Earth's core: Nature, v. 173, no. 4397, p. 259–260, 1954.

At the core-mantle boundary Uffen's work indicates a melting-point temperature of 5,000° K in the mantle and Simon's work indicates a temperature of 3,000° K in the core. According to these data, solidification would begin at the core boundary and progress outward.

The mean adiabatic temperature gradient in the core as determined from work of Valle and work of Bullard exceeds the mean melting-point gradient for this region as determined from Simon's data and raises questions concerning the possibility of a liquid outer core and convection currents.—*R. G. H.*

Manley, Horace. An estimate of the time taken for a dyke to cool through its Curie point. See Geophys. Abs. 158–64.

VOLCANOLOGY

158–197. Finch, R. H., and Macdonald, Gordon A. Hawaiian volcanoes during 1950: U. S. Geol. Survey Bull. 996–B, p. 27–89, 1953.

An eruption of Mauna Loa, the largest since 1859 in terms of estimated volume of lava extruded, began June 1 and continued until June 23. Seven flows poured out, both southeastward and westward, and three of the western flows entered the ocean. The total volume of lava extruded is estimated to have been more than 600 million cubic yards. Temperatures ranged from 1,080° C at the source fountains and 1,110° in the glowing throat of a spatter cone, to 840° in the lava river 10 miles from the vents. A large number of

earthquakes accompanied and directly followed the outbreak. Harmonic tremor was continuous during the first part of the eruption but intermittent during later stages, the fluctuations apparently being related to variations in the amount of lava being extruded.

No surface eruptive activity occurred at Kilauea during the year. Directions of tilting at the edge of Kilauea caldera suggest an increase of volcanic pressure under Kilauea followed by a sudden decrease at the time of the Mauna Loa eruption, and renewal of pressure increase following the end of the eruption. In early December there was very rapid southward tilting accompanied by more than 650 earthquakes as the entire top of Kilauea subsided, the amount of subsidence being more than one foot in the vicinity of Halemaumau. The subsidence is interpreted as resulting from decrease of volcanic pressure and withdrawal of the Kilauea magma column.—*M. C. R.*

158–198. Ponte, Gaetano. Sull' eruzione etnea del 1950–51 [On the Etna eruption of 1950–1951]: Bull. volcanolog., sér. 2, tome 13, p. 121–128, 1953.

A lateral eruption on the southeast flank of Etna began in the evening of November 25, 1950, and continued until the night of December 1–2, 1951. The rising column of magma first forced its way to the surface with explosive manifestations at a subterminal crater used in the 1947 eruption; other earlier vents were blocked by solidified lava or landslips. Soon, however, the lava found a lower channel between strata, and flowed from several vents farther down the slope, while activity ceased at the higher crater. By the end of the first week, explosions had become rare, and the flow of lava decreased gradually from that time until the end of the eruption.—*D. B. V.*

158–199. Georgalas, G. C., and Papastmatiou, J. L'éruption du volcan de Santorin en 1939–1941—l'éruption du dôme Fouqué (Troisième communication provisoire) [The eruption of the volcano Santorin in 1939–1941—the eruption of the dome Fouqué (Third preliminary communication)]: Bull. volcanolog., sér. 2, tome 13, p. 3–38, 1953.

After an 11½-month period of quiescence, Santorin volcano in the Aegean Sea became active on August 8, 1939. During the first maximum of activity (August 20 to September 2), the dome Triton with one small lava coulee was formed. In a second maximum ending November 25, the dome Ktenas with one lava coulee was formed. During the latter activity, a new center became active on November 13, at a place where an "Explosion-strichter" had been formed during the first maximum. This third phase lasted 240 days (until July 9, 1940) and formed a third dome, Fouqué, with 3 lava flows. The eruption of Fouqué is described in detail.—*D. B. V.*

158–200. Georgalas, G. C. L'éruption du volcan Santorin en 1950 [The eruption of the volcano Santorin in 1950]: Bull. volcanolog., sér. 2, tome 13, p. 39–55, 1953.

After the 1939–41 eruption cycle, Santorin was in a quiescent state, with solfataric activity only, until January 10, 1950, when a new rather weak eruption took place at the upper part of the eastern slopes of the Geogios dome (formed during the eruption of 1866–1870). This eruption lasted 23 days and formed a new dome (Liatsikas).

The activity in the first 4 days averaged 4 explosions per hour, reached a maximum on January 15 with 8 per hour, and gradually diminished until the night of February 1–2, when it ceased completely. During the entire eruption only one paroxysmal explosion occurred. Solid ejecta were thrown horizontally and vertically to distances of 100-200 m, the explosion clouds reached a height of 50–300 m, and lava covered about 7,312 m^2.—*D. B. V.*

158–201. Gèze, Bernard. Les volcans du Cameroun occidental [The volcanoes of the western Cameroun] : Bull. volcanolog., sér. 2, tome 13, p. 63–92, 1953.

After a detailed description of the structure of each of the volcanic massifs Mont Cameroun, Manengouba, and Bambouto, and the minor volcanoes of Mont Roumpi, the Haut Moungo, and Mont Koupé, Gèze summarizes the volcanic history and discusses the relation to structure of the region. The great volcanic massifs lie along one of the two principal tectonic axes, the "Cameroun direction," which trends south-southwest–north-northeast. In part the zone of volcanism is bounded by two major faults and is comparable to portions of the Rift Valley of east Africa.—*D. B. V.*

158–202. Minakami, T[akeshi]. Activity of Mount Asama: Volcano Letter, no. 523, p. 8, 1954.

Mount Asama became active again on December 27, 1953. The Asama eruptions are ordinarily vulcanian in type and of explosive character, usually marked by an interval of several days between eruptions during any one active period. Present eruptions, however, are on a comparatively small scale and at frequent intervals. From December to the end of February, eruptions ranged from none to 10 per day.—*V. S. N.*

158–203. Johnson, C. G. Volcanic eruptions on O-shima and on Suwanose Island : Volcano Letter, no. 523, p. 8, 1954.

Mihara-yama on O-shima ceased to erupt about February 15 with the last strong activity on January 27. Volcanic eruptions on Suwanose Island in the northern Ryukyu group began at 12 : 30 p. m., February 22, 1954.—*V. S. N.*

158–204. Bemmelen, R. W., van. Rélations entre le volcanisme et la tectongénèse en Indonésie [Relations between volcanism and tectogenesis in Indonesia] : Bull. volcanolog., sér. 2, tome 13, p. 57–62, 1953.

Van Bemmelen analyzes the distribution of volcanism in space and time in Indonesia, and its relation to orogenetic evolution. The volcanism is the physicochemical manifestation of internal forces, tectogenesis, the mechanical manifestation. Volcanoes are classified as positive or negative geomorphologic forms, according to the ratio between the amount of magma emitted and the distance from the vent that is reached by the products.—*D. B. V.*

Bruet, E. The absolute age of the last great peléean eruption of the Soufrière of Guadeloupe. See Geophys. Abs. 158–169.

TECTONOPHYSICS

GENERAL

158–205. Gzovskiy, M. V. O zadachakh i soderzhanii tectonofiziki [The aims and the content of tectonophysics]: Akad. Nauk. SSSR Izv. Ser. geofiz., no. 3, p. 244–263, 1954.

Tectonophysics, to Gzovskiy, means the study of mechanical processes that have produced deformations and fractures in the crust. In these studies the methods of theoretical physics must be supplemented by model experiments in the laboratory and by observations in the field. As the first problem the mechanical properties of different rocks must be investigated and their elasticity, viscosity, and strength determined. Reliable methods of modeling of tectonic processes and more precise methods of observation and investigation in the field must be developed. It is necessary to study different tectonic forms, to analyze mechanical conditions leading to their differences, to work out the patterns of acting forces and of boundary conditions corresponding to different tectonic structures. This will make it possible to study the simplest forms first and later to analyze processes leading to more complicated structures, such as synclinoria and anticlinoria.—*S. T. V.*

158–206. Gurevich, G. I. O tak nazyvayemom "mekanicheskom analize" v geologicheskoy literature [The so called "mechanical analysis" as employed in geologic literature]: Akad. Nauk. SSSR Izv. Ser. geofiz., no. 3, p. 264–279, 1954.

Gurevich deplores the tendency to make use of the laws of mechanics in analyzing tectonic phenomena without even an elementary knowledge of these principles. Many examples from textbooks and papers are cited to show that this tendency to explain tectonic processes by the basic principles of the theory of elasticity and of the strength of materials leads to absurd results. Most of the quoted works are those of Russian and American geologists.—*S. T. V.*

FORCES IN THE EARTH AND OROGENESIS

158–207. Matschinski, Matthias. Essai de bibliographie de la mécanique de l'écorce terrestre et spécialement de l'isostasie [Bibliographic essay on the mechanics of the earth's crust and especially on isostasy]: Rev. géomorphologie dynamique, 4eannée, suplement to no. 6, 42 p., 1953.

A general bibliography of works pertaining to crustal mechanics, classified by subject, country, and author.—*D. B. V.*

158–208. Matschinski, M[atthias]. Sulla genesi delle montagne [On the origin of mountains]: Accad. Naz. Lincei Atti, Cl. sci. fis. mat. et nat., Rend., v. 16, fasc. 1, p. 54–62, 1954.

Matschinski again presents his theory of orogenesis, based on the assumption that the crust, shortly after its formation, was broken into segments (the continents) having a smaller radius of curvature than the interior. (See Geophys. Abs. 12223.)—*D. B. V.*

158–209. Vening Meinesz, F. A. Crustal warping in the Netherlands: Geologie en Mijnbouw, jaarg. 16, no. 6, p. 207, 1954.

Vening Meinesz has calculated the amount of subsidence in the Netherlands resulting from subcrustal flow towards Scandinavia in response to melting glaciers. The total amount of subsidence still to come will not exceed 3½ m; the downward movement will become slower gradually and cease about 6800 A. D., followed by slow return movement upwards. A gravity survey in the North Sea would give greater precision to these calculations.—*D. B. V.*

158–210. Castro, Honorato de. Variación en la latitude de los puntos de la superficie terrestre [Variation in the latitude of the points of the earth's surface]: Petroleos Mexicanos, 2ª época, tomo 1, no. 19, p. 1515–1520, 1954.

The latitude of a given point on the earth's surface is not an invariable element, but may vary with change in either the direction of vertical or the axis of rotation of the earth. The former can be caused by continental drift or isostatic compensation; shifting of the axis can be and has been measured. Graphs show the paths of the north pole from 1800–1900, 1900–1912, and 1912–1918.—*D. B. V.*

158–211. Dungen, F. H. van den, Cox, J. F., and Mieghem, J. van. L'effet sur la position de l'axe instantané de rotation de la Terre d'échanges de quantités mouvement entre l'atmosphére et le globe [Effect on the position of the axis of the instantaneous rotation of the earth of the exchange of amounts of movement between the atmosphere and the globe]: Acad. Royale Belgique Bull., Cl. sci., 5e ser., tome 39, no. 1, p. 24–28, 1953.

Meridional winds can exercise on the lithosphere a couple that rotates with the earth, the effect of which is to displace the axis of rotation with respect to the stars, affecting the calculated values of declination.—*Author's abstract M. C. R.*

158–212. Dungen, F. H. van den, Cox, J. F., and Mieghem, J. van. Sur des variations du niveau des mers et de la vitesse de rotation de la Terre [On the variations of sea level and the velocity of rotation of the earth]: Acad. Royale Belgique Bull., Cl. sci., 5e ser., tome 39, no. 1, p. 29–34, 1953.

Rise of sea level resulting from the melting of glaciers has an effect on the moment of inertia and the velocity of rotation of the earth. Calculations made with certain simplifying assumptions show that if the ice masses are at latitudes greater than 47° the moment of inertia increases, and conversely if the ice masses are at latitudes less than 47°. Ice in Greenland, Spitzbergen, and Antarctica would cause a decrease in the velocity of the order of 0.0008 second per day, whereas melting of the Asiatic glaciers would cause an increase of the order of 0.00001 second per day, which is negligible.—*M. C. R.*

158–213. Melchior, P. J. Sur le deplacement des poles d'inertie a la surface de la terre, de 1900 à 1950 [On the displacement of the poles of inertia at the surface of the earth from 1900 to 1950]: Acad. Royale Belgique Bull., Cl. sci., 5e ser. tome 39, no. 4, p. 442–446, 1953.

Melchior discusses the displacements of the poles that have been computed for the period 1900–50, taking into account the rise of sea level caused by the more intensive melting of ice in polar regions during this period and the deformation of the earth produced by this change in load distributed over the surface of the

earth. He concludes that the elasticity of the earth makes necessary the introduction of a correction factor of 0.7 in the results computed on the assumption of a rigid earth.—*S. T. V.*

Collette, B. J. On the gravity field of the Sunda region (West Indonesia). See Geophys. Abs. 158–33.

Bemmelen, R. W. van. The geophysical contrast between orogenic and stable areas. See Geophys. Abs. 158–34.

Collette, B. J. On the gravity field of the Sunda region (West Indonesia)—a postscript. See Geophys. Abs. 158–35.

ELASTIC CONSTANTS AND STRENGTH OF ROCKS

158–214. Hughes, D. S., and Kelly, J. L. Second-order elastic deformation of solids: Phys. Rev., v. 92, no. 5, p. 1145–1149, 1953.

Expressions for the velocities of elastic waves in stressed solids are derived using Murnaghan's theory of finite deformations and third-order terms in the energy. For isotropic materials, in addition to the Lamé constants λ and μ, three additional constants; l, m, and n, are required to describe the material.

By measuring the transmission time of elastic pulses through the material, the velocities of longitudinal and shear waves are determined as a function of the applied stress. By subjecting the material to hydrostatic pressure as well as simple compression, it is found that seven functions of the three constants, l, m, n, can be measured and thus numerical values calculated. Results are given for polystyrene, iron and Pyrex glass.—*Authors' abstract*

INTERNAL CONSTITUTION OF THE EARTH

158–215. Tuve, Merle A., Tatel, Howard E., and Hart, Pembroke J. Crustal structure from seismic exploration: Jour. Geophys. Research, v. 59, no. 3, p. 415–422, 1954.

The exploration of the earth's crust with seismic waves has an accuracy limited by conversion-scattering and the scattering of surface and interior irregularities. These scattering effects produce signals masking the smaller signals which might be present from minor structural features. Consequently, only the broader aspects of crustal structure may be observed with the seismic method. Our data in the form of travel-time plots may be fitted with a family of theoretical curves derived from a group of velocity vs depth relationships of a somewhat similar nature. These show that the wave velocity is greater at greater depths within the crust. The demarcation between crust and mantle (where the compressional velocity is 8 km/sec) may be abrupt—less than 250 meters—or, as an extreme, may be gradual—within several kilometers. More complex velocity vs depth functions may be made to fit the data, but these require more complex assumptions. For example, it is not necessary to assume the existence of discrete systematic intermediate layering to fit the data; smooth continuous functions suffice and, in addition, no systematic reflections have ever been observed from such intermediate layers.—*Authors' abstract*

158–216. Tamaki, Ituo. The crustal structure of Japan derived from observed travel time curves of shallow earthquakes [In Japanese with English summary]: Zisin, v. 7, no. 1, p. 1–7, 1954.

Deviations from mean travel-time curves may indicate lateral inhomogeneities in the crust. Thirty vertical sections were taken across Japan and the travel-time curves determined from data of earthquakes and observatories in a belt near the sections. The results are shown in figures. The indicated crustal structures are complex.—*M. C. R.*

Damon, Paul E. An abundance model for lead isotopes based upon the continuous creation of the earth's sialic crust. See Geophys. Abs. 158–164.

Jacobs, J. A. Temperature distribution within the Earth's core. See Geophys. Abs. 158–195.

Uffen, R. J., and Misener, A. D. Temperature distribution within the Earth's core. See Geophys. Abs. 158–196.

GENERAL GEOPHYSICAL EXPLORATION

158–217. Hammer, Sigmund. Geophysical activity in 1953: Geophysics, v. 19, no. 3, p. 517–528, 1954.

Geophysical activity in the search for oil in 1953 on a global scale maintained but probably did not exceed the record high established in 1952. Increased activity in Mexico, South America, Africa, and the Far East offset small but definite declines in geophysical activity in the United States and Canada. In the United States and Canada seismic and gravity crew months were 4.3 and 2.5 percent lower, respectively, than the previous year. Magnetic exploration is apparently increasing, largely owing to the advantages of the airborne magnetometer. Investment by the oil industry of the world in geophysical exploration during 1953 was probably 350–400 million dollars. Reported for mining geophysics was an expenditure of more than 5 million dollars. The magnetic method, especially the aeromagnetic method, was most used, followed in order (on the basis of applied man power but not expenditure) by resistivity and allied methods, geochemistry [sic!], self-potential, electromagnetic, gravity, radioactivity, and seismic methods.—*M. C. R.*

158–218. Matschinski, M[atthias]. Prospection géophysique et certitude d'interprétation de ses données [Geophyscial exploration and certainty of interpretation of its data]: Geofisica Pura e Appl., v. 27, p. 35–84, 1954.

The outlines of the problem of geophysical interpretation are given with a simple example of linear interpretation in seismic reflection. Matschinski differentiates between algebraic and statistical interpretation and mentions examples of the least-squares method. There are four fundamental problems in geophysical interpretation: first, choosing the hypothetical geologic structure and describing it in mathematical terms having various parameters; second, determining the numerical values of these parameters; third, determining the likelihood of all possible values, not merely the most probable; and fourth, determining the likelihood of the hypothesis itself. In geophysical calculations, it is necessary to accept some limit for the variations of the parameters. A detailed scheme for calculation of the probability of the assumed structure is given followed by a complex example of the application of the general theory to the determination of a fault from gravity observations.—*D. B. V.*

158–219. Swartz, C[harles] A., and Sokoloff, V. M. Filtering associated with sampling of geophysical data: Geophysics, v. 19, no. 3, p. 402–419, 1954.

Geophysical data are often subjected to a variety of selective sampling operations in order to make their interpretation easier. These sampling operations act as filters which tend to separate the signal from the noise and include electrical filtering in seismic amplifiers, multiple geophones, seismic mixing, averaging of seismic arrival times, and the preparation of residual gravity and magnetic maps. Sampling by simple averaging of equally spaced points along a curve (which may represent a gravity or seismic profile or a seismogram trace) tends to remove the higher frequencies and retain the lower frequencies as the number of points averaged is increased. Sampling by taking the successive differences of equally spaced points tends to attenuate the longer wave lengths and bring out random errors more distinctly. Geophone mixing most effectively suppresses ground roll when the geophone spacing is half the wave length of the ground-roll component. The familiar residual curves and electrical filtering are other examples of sampling. The statistical detection of seismic reflections as developed by the Massachusetts Institute of Technology group is also a sampling method with filtering effects. In the latter method, a compromise must be made in choosing the optimum operator between achieving maximum noise suppression and reproducing the desired signal.—*L. C. P.*

158–220. Matjasic, Wallace L. Case history of Wild Goose gas field, Butte County, California: Geophysics, v. 19, no. 3, p. 509–516, 1954.

The discovery well of the Wild Goose gas field was drilled and completed in 1951 on a structure located by a reflection seismograph survey conducted in 1950. An additional seismograph survey was made subsequent to discovery to define the structure better for further development. The illustrations include two seismic cross sections, a contour map based on the original seismic reflection data, an aeromagnetic map, a structure contour map, and an electric log of the discovery well. The producing sands are in an interval between the Forbes shale of Upper Cretaceous age and the overlying Capay shale of Eocene age.—*Author's abstract*

158–221. Dobyns, D. Ray, and Roper, W. B. Geophysical history of Mamou Field, Evangeline Parish, Louisiana: Geophysics, v. 19, no. 3, p. 490–508, 1954.

Successive stages in the geophysical exploration of the Mamou field included a seismic survey in 1926, torsion-balance survey in 1934, magnetometer and torsion-balance surveys in 1936, gravity-meter and seismic surveys in 1942–43, and detailed seismic surveys from November 1943 to June 1945. The discovery well was completed in December 1945. Discovery of the field is attributed to three factors: recognition of an anomalous gravity condition; recognition from a very small amount of seismic data in the follow-up surveys that an anomalous subsurface condition existed; and obtaining enough seismic control at the Wilcox depth to be reasonably certain of the faulting and associated dip into the fault.—*M. C. R.*

158–222. Pohly, Richard A., and Harris, Steven H. Exploration problems and procedures in the Williston Basin: World Oil, v. 139, no. 1, p. 119–124, 1954.

In unglaciated areas of the Williston Basin, reconnaissance gravity and magnetic surveys may indicate structures below unconformities that may not be evident at the surface. Detailed reflection seismograph surveys or slim-hole drilling are recommended where favorable structure is indicated. In glaciated areas, a similar exploration approach is recommended; much greater reliance must be placed on geophysics because of the paucity of good surface exposures.—*L. C. P.*

158–223. Richardson, Welch. Shooting for oil in the Gulf of Mexico: Explosives Engineer, v. 31, no. 5, p. 135–153, 1953.

This is a description of the current reflection-seismograph exploration for oil under the continental shelf off the shores of the Gulf States.—*L. C. P.*

158–224. Brewer, Quentin L. Public and private activities in the uranium industry on the Colorado Plateau: Mines Mag., v. 44, no. 8, p. 25–28, 1954.

Exploration and development of uranium by public and private agencies on the Colorado Plateau are reviewed. Geophysical studies include the use of airborne scintillation equipment, radiometric well-logging devices, and hand Geiger and scintillation counters, as well as conventional geophysical measurements.—*L. C. P.*

158–225. Wantland, Dart. Examples of geophysical exploration for uranium, Colorado Plateau area: Mines Mag., v. 44, no. 8, p. 18–24, 61, 1954.

Radioactivity logging in drill holes and airborne radiation surveys are being conducted in the Colorado Plateau region by the U. S. Atomic Energy Commission and the U. S. Geological Survey in the search for uranium. Private enterprise is also engaged in these activities. Electrical resistivity surveys on the Colorado Plateau were first conducted by Sherwin F. Kelley in 1941. The U. S. Geological Survey has made resistivity studies at a number of uranium deposits.

Resistivity investigations of the King Tut Mesa in the Oak Springs area, Apache County, Ariz., and San Juan County, N. Mex., were conducted in 1952 by the U. S. Bureau of Reclamation on behalf of the AEC. It was found that resistivity highs in horizontal resistivity profiling are associated with uranium mineralization.—*L. C. P.*

158–226. García Siñeriz, José. Memoria General 1953: Inst. geol. min. España, 136 p., 1954.

The geophysical work of the Instituto geologico y minera de España during the year 1953, reported on pages 100–103, included several investigations in search for water and carbonaceous deposits, using gravimetric, electric, and seismic methods. Brief summaries of the results are given.—*S. T. V.*

158–227. Morelli, Carlo. La geofisica e lo studio del sottosuolo [Geophysics and the study of the subsurface]: Industria Mineraria, anno 5, no. 4, p. 193–196, 1954.

This is a brief review of geophysical methods (gravimetric, magnetic, seismic, electric, and radioactive) and their applications in geology, in prospecting for minerals, and in engineering. Special mention is made of two problems that are important in Italy, exploration for natural gas and for natural sources of heat to be used in the production of electrical energy.—*S. T. V.*

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