Geophysical Abstracts 149 April-June 1952

(Numbers 13548–13802)

GEOLOGICAL SURVEY BULLETIN 991-B

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

GEOLOGICAL SURVEY BULLETIN 991-B

Abstracts of world literature contained in periodicals, books, and patents

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1952

UNITED STATES DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. - Price 25 cents (single copy). Subscription price: $1.00 a year; 35 cents additional for foreign mailing. The printing of this publication has been approved by the Bureau of the Budget, May 11, 1951.

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GEOPHYSICAL ABSTRACTS 149, APRIL–JUNE 1952

By Mary C. Rabbitt and S. T. Vesselowsky

INTRODUCTION

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

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

J. R. Balsley, D. F. Barnes, G. D. Bath, L. E. Birdsall, R. W. Bromery, W. J. Dempsey, R. G. Henderson, H. R. Joesting, R. W. Johnson, Elizabeth King, G. E. Manger, J. L. Meuschke, F. W. Stead, W. W. Schwendinger, and Izidore Zeitz have prepared the abstracts signed with their initials.

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

The system of transliteration used for Russian names and titles is that of the Board on Geographic Names. A table showing this system was included in Geophysical Abstracts 148.

Geophysical Abstracts 1–86 and 112–127 were issued as Information Circulars by the Bureau of Mines, and 87–111 were issued as Bulletins of the Geological Survey. Geophysical Abstracts 128 and following numbers have been published as Bulletins of the Geological Survey.

All Geophysical Abstracts published as Information Circulars are now out of print. Geophysical Abstracts issued as Bulletins of the Geological Survey (except no. 86, Bull. 886, and no. 88, Bull. 895–A which are out of print) may be purchased as single copies or by subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. Beginning with this issue, Geophysical Abstracts will be placed on an annual subscription basis. The price will be $1.00 a year and a subscription may be entered at any time to run for four consecutive issues. Single copies may be purchased for 25 cents. The foreign subscription will be $1.35.

EARTH PHYSICS

GRAVITY

13548. Shimazu, Yasuo. The density distribution within the earth after Bullen and the coefficient of sin $^2 2\phi$ in the gravity formula: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 2, no. 6, 8 pp., 1949.

The theoretical distribution of gravity on the surface of the spheroidal earth is given by $g=g_e(1+\beta \sin^2 \phi-\beta \sin^2 2\phi)$ where g_e is the equatorial sea-level value of gravity, ϕ the geographical latitude. The constants g_e and β can be obtained from gravity observations by means of least squares; but β being very small, must be obtained from knowledge of the density distribution within the earth. Darwin's value $\beta=7\times10^{-6}$ is based upon density assumptions of Roche and Wiechert. In this paper the differential equations solved analytically by Darwin are solved by numerical integration assuming Bullen's density distribution proposed in 1936. The resulting value of β is 8×10^{-6}. The difference between the author's and Darwin's value is too small to affect the least square values of g_e and β in Helmert's formula. The calculated value of β for a triaxial spheroid is the same as for a spheroid of revolution. In a note, attention is called to Bullard's calculation of β based on Bullen's density model proposed in 1942.—*R. G. H.*

13549. Egyed, László. Az izosztázia kérdéséhez. [Some remarks concerning isostasy]: Földtani Közlöny, v. 81, no. 10–12, pp. 374–383, 1951.

The problem of isostasy according to the Airy-Heiskanen hypothesis is discussed, under the assumption that the optimum value of the depth of the layer of compensation is determined by the condition that the sum of the squares of isostatic anomalies referred to the gravity force reduced to this depth is a minimum. The corresponding value of gravity force can be determined theoretically for the earth consisting of homogeneous shells. Certain refinements can be achieved by taking into account the rigidity of the crust.

Using the seismic data obtained from the explosions in Helgoland, Haslach and the Atlantic Ocean, on the thickness of different layers and assuming the following densities: ocean water 1.03; sedimentary layer 2.4; granitic layer 2.7; gabbroic layer 3.0; peridotitic magma 3.3, the author computed the pressure to be expected at a depth of 50 km and obtained for all these areas almost identical figures. The author concludes that isostasy exists over the whole surface of the earth with the exception of few areas which remain in an unstable condition, such as for example, the deep depressions in the bottom layer of the Atlantic Ocean.—*S. T. V.*

13550. Tsuboi, Chuji. The direct and indirect methods for determining the thickness of the isostatic earth's crust: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 2, no. 4, 6 pp., 1949.

A harmonic-series method of interpreting gravitational anomalies is recapitulated for the two-dimensional case. The observed and theoretical Bouguer

anomalies are each expanded in Fourier series. The mean thickness of the isostatic earth's crust can then be determined through term-by-term comparisons. The method is applied as an example to an east-west profile in the United States. The resulting value agreed with values obtained by other investigators.

It is shown that the Fourier-series method affords a simple graphical method of determining the most probable thickness of the isostatic earth's crust.—*R. G. H.*

13551. Lozano Calvo, Luis. Método para rectificar la red gravimétrica nacional y sus enlaces internacionales mediante observaciones con gravimetro [A method of correcting the national gravimetric network and its international ties by observations with a gravimeter]: Rev. Geofís., v. 10, no. 38, pp. 73–84, 1951.

Many measurements of gravity have been made in Spain since improvements in gravimeters made precise and rapid relative determinations possible. Theoretically with just one base station where pendulum measurements are made, it is possible to make a gravitational survey of the whole globe. The accuracy of each station is conditioned by the accuracy of the corresponding base station. In the Spanish gravity network of 208 stations, which has five pendulum base stations, the precision of the network may be improved by referring every measurement to a common ideal base station determined by the method of least squares. The procedure is explained using Spain as an example, but it may be used also for the improvement of gravitational ties between different national networks.—*S. T. V.*

13552. Morelli, Carlo. Taratura di due gravimetri Worden e collegamenti europei [Calibration of two Worden gravimeters and the tying of European gravimetric networks]: Annali Geofis., v. 4, no. 4, pp. 493–524, 1951.

A detailed report is presented on different tests made with two Worden gravimeters, on the determination of attainable precision of measurements, the range of indications and on possible changes in the drift of these instruments. Tests described consisted in relative determination of gravity at eighteen observatories of the West German network. At every one of these observatories the value of g had been recently determined with greatest precision using pendulum methods. The range of measurements was about 1,500 mgal. The average error of measurements was found to be less than 0.5 percent. The constants of instruments varied linearly.

In addition to the described tests the tying of following observatories was made by repeated measurements with gravimeters: Uccle, $g=981.1320\pm0.2$; Paris, $g=980.9438\pm0.3$; De Bilt, $g=980.2688\pm0.3$; Copenhagen, $g=981.5575\pm0.4$; Padova, $g=980.6586\pm0.4$; Monaco, $g=980.7330\pm0.4$; Brunswick [Braunschweig], $g=981.2655\pm0.1$; Rome, $g'=980.3616\pm0.4$; Teddington, $g=981.1963\pm0.2$. Provisional correction, obtained from these measurements, to the present Potsdam system of -13.9 ± 3.5 mgal was found.—*S. T. V.*

13553. Caloi, Pietro. Interpretazioni geofisiche di misure geodetiche [Geophysical interpretation of geodetic measurements]: Annali Geofis., v. 4, no. 3, pp. 323–354, 1951.

Evidence of the existence of vertical and horizontal movements of the crust, both slow, secular movements over extended areas, and more rapid displace-

ments in volcanic or seismically active regions, has been obtained from tide-gage and clinometric observations and geodetic surveys.

Geodetic observations by Japanese scientists before and after several earthquakes in different parts of Japan are analyzed and certain difficulties are indicated in interpreting related geodetic data because of uncertainty as to the extent of crustal deformations and therefore in the selection of points which are to be considered fixed. A method involving use of analytic geometry and the theory of elasticity is suggested to determine when there are displacements of detached land blocks as a result of an earthquake, and when it is more appropriate to speak of a continuous deformation of the earth's surface. In the former, discontinuities in the profiles covered by geodetic measurements should be discovered, and these profiles should then consist of a combination of straight segments, whereas in elastic deformations the profiles are continuous curves. The variation of the height of the bench marks during the very process of leveling also creates complications which may be solved by the use of least squares. The suggested procedure makes possible conclusions on the magnitude of dilatation, rotation and distortion of the area under consideration.—*S. T. V.*

13554. Okuda, Toyozo. On the change of local geoid in the southwestern part of Japan: Geog. Survey Inst. Japan Bull., v. 3, pt. 4, pp. 239–275, 1951.

The vertical deflections at 43 stations in the southwestern part of Japan have been redetermined since the Nankaidō earthquake of 1946 and the uncompensated local geoid for the area derived. Of the 43 stations, 19 old sites were reoccupied and marked changes in the vertical, during a period of 6 to 7 yr. including 1946, were detected in the vicinity of the epicenter. Sudden changes in the vertical and a possible secular variation in the prime vertical component of the vertical deflection have been suggested. The change in the surface form of local geoid is believed to bear a close relation to the mode of land deformation accompanying the earthquakes. A possible cause for the sudden change in the vertical may be a change in density of about 2.2 percent in the mean density of the earth's crust, which is 30 km thick in this area.—*L. E. B.*

13555. Bollo, Robert and Gougenheim, A. Variation périodique de la gravité en un lieu [Periodic variation of gravity at a point]: Annales Géophys., tome 5, fasc. 2, pp. 176–180, 1949.

In a series of measurements of gravity at Chambon-la-Forêt from July 5 to 9, 1948, with a North American gravimeter, three facts were verified: the ratio of variations for a rigid earth to those observed is 1.147; there is no phase difference between theory and observation; and the drift of the instrument is linear.—*M. C. R.*

13556. Crary, A. P., Cotell, R. D., and Oliver, Jack. Geophysical studies in the Beaufort Sea, 1951: Am. Geophys. Union Trans., v. 33, no. 2, pp. 211–216, 1952.

Seismic observations, ice-movement studies, and gravity measurements were made on the Beaufort Sea ice pack north of Barter Island, Alaska, during April 1951. Sonic soundings indicated ocean depths between 3,400 and 3,800 m. Measurements of the direction of ice movement were made by an acoustic method and correlated well with surface isobaric contours. Gravity-meter observations showed the maximum vertical ice movements to be about 0.05 cm in the period range of 5 to 40 sec. Seismic studies will be reported later.—*M. C. R.*

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13557. de Bruyn, J. W. Isogam maps of Caribbean Sea and surroundings and off southeast Asia: World Petroleum Cong., 3d session, The Hague, Proc., sec. 1, pp. 598–612, 1951.

Two gravity maps are presented on a scale 1:10,000,000 and contour interval 25 mgals. One map is of the Caribbean Sea and surrounding parts of North, Central, and South America; and the other is of southeast Asia, including the East Indian [Malay] Archipelago, the Philippines and New Guinea.

The maps are based on published pendulum observations and gravity surveys made by Royal Dutch Shell and affiliated companies. The Caribbean map is based on Hayford-Bowie isostatic anomalies (T=113.7 km) and the southeast Asia map on Vening-Meinesz regional isostatic anomalies (T=25 km, R=160 km).

Bathymetric charts of the two regions, also on a scale 1:10,000,000, are presented. Active volcanoes have been plotted on these charts.—*H. R. J.*

13558. Gerth, H. Antillen-Molukken, zwei Inselbögen, ein Vergleich des geologischen Baues und der Schwereanomalie [Antilles-Moluccas, two island arcs; a comparison of their geologic structure and gravity anomalies]: Geol. Rundschau, Band 39, Heft 1, pp. 273–284, 1951.

A comparison of the geologic history and present structure of these two island groups is presented and the correlation between their geology and the patterns of their gravitational fields is discussed. Both groups are the results of volcanic activity over a long period of time, from the Mesozoic to the present. In both groups, individual islands are the summits of submarine volcanoes. Both of these island arcs contain stable and unstable areas.

Analysis of the gravitational anomalies in relation to geologic structure is made on the basis of the Vening-Meinesz and Hess maps for the Malay Archipelago and the Antilles. Not all details of geology find their counterpart in the gravitational pattern, but the main features are in satisfactory agreement.—*S. T. V.*

13559. Jones, L. Les premiers resultats de la comparaison du Deuxieme Nivellement Général (1948) avec les nivellements anciens [First results of the comparison of the Second General Leveling Survey (1948) with previous surveys]: Soc. belge géologie Bull., tome 59 (1950), fasc. 1–2, pp. 156–162, 1951.

A general precise leveling of Belgium was made during 1947–1949. Results of this last survey are compared with those of previous surveys, chiefly with the data of the precise leveling of 1892. About 100 common bench marks were used in the two surveys. Assuming that the tendency towards isostatic equilibrium exists, it must be concluded that the zones of negative Bouguer anomalies determined by repeated gravimetric surveys are regions of gradual elevation, whereas those of positive anomalies are subsiding. A comparison of the 1892 and 1948 surveys shown on a gravimetric map indicates that the southern part of Belgium is rising about 1.0 to 1.5 mm per yr, and the northern part, especially the northwestern, is sinking.—*S. T. V.*

13560. Scheffer, Viktor, and Kántás, Karl. A Dunántúl régionális geofizikája [The regional geophysics of Transdanubia]: Földtani Közlöny, v. 79, no. 9–12, pp. 327–360, 1949; and Regionale Geophysik von Transdanubien: Acta Technica Acad. Sci. Hungaricae, tomus 1, fasc. 2, pp. 83–105, 1951.

Geophysical investigations of western Hungary are briefly summarized and a geologic interpretation of results is made. Data are compiled on maps, showing geology, Bouguer and isostatic anomalies, and vertical magnetic intensity. The Földtani Kozlöny article also includes data on earthquakes and thermal studies.—*M. C. R.*

13561. Olczak, Tadeusz. Mapa gravimetryczna Polski [Gravimetric map of Poland] : Poland Instyt. Geol. Biul., no. 64, 59 pp., 1951.

A gravity map of Poland is presented giving Bouguer anomalies, reduced to sea level, with 5-mgal contour intervals. Anomalies range from —40 to +40 mgal. The map was constructed from data obtained by different geophysicists of the Polish Geological Institute from 1933 to 1938. Warsaw (981.2412 gal) was used as base station.—*S. T. V.*

13562. Goguel, Jean. La structure des fossés africains et la gravimêtrie [The structure of the African rifts and gravimetry] : Annales Géophys., tome 5, fasc. 2, pp. 174–175, 1949.

Gravity anomalies have been computed for a rift bounded by two normal faults, assuming that density increases downward. In effect, the rift is represented as a triangular prism of negative density. For a crustal thickness of 25 km, rift width of 50 km, density increasing from 2.5 to 3.5, and vertical offset of 2,500 m, the density in the prism will be 0.1 less than the density at the same elevation in the margin. Anomalies computed on this basis differ only slightly from observed values.—*M. C. R.*

13563. Hales, A. L. and Gough, D. I. Measurements of gravity in Southern Africa, 58 pp., Pretoria, Government Printer, 1951.

Absolute gravity measurements were made in 1948 and 1949 by the Bernard Price Institute of Geophysical Research at 53 stations distributed through the Union of South Africa, South-West Africa, Southern Rhodesia and Bechuanaland. Invar pendulums standardized at Cambridge, England, were used with a quartz frequency standard and checked periodically at the base stations, to permit an estimated accuracy of 0.001 cm/sec^2 in the measured value of g. The departures of the free-air corrected values from the International formula agree with those given by Jeffreys but differ from the values given by Tanni. An analysis of the corrected data confirms the presence of isostatic compensation in southern Africa, but too few observations were made for an estimate of its depth. No significant relationship between the geologic structure beneath the station and the anomalies was found, although at two stations large positive anomalies were associated with underlying dense rock.—*E. K.*

13564. Cattala, Louis. Sur la répartition des anomalies gravimétriques de l'île de Madagascar [On the distribution of gravity anomalies on the island of Madagascar] : Acad. Sci. Paris Comptes rendus, tome 234, no. 5, pp. 547–548, 1952.

The anomaly associated with the central massif is only 60 to 80 mgal per 1,000 m of altitude, in contrast to the normal value of 100 mgal, thus lending support to Besaire's proposal that the Madagascar massif is placed on a gabbroïc substratum. Positive anomalies along the coast may be due to basaltic rocks at or below the surface, or to a decreased thickness of sediments. A gravity map is included.—*M. C. R.*

13565. Gulatee, B. L. Survey of India: Technical Report 1948–49, Pt. 3, Geodetic Work, 155 pp., 1950.

Chapter 3 of this report describes the progress made on the new 10-mile gravity network of India. One hundred and one stations, one-third in West Bengal and the rest in Madhya Pradesh, were established with a Frost gravimeter in an area of approximately 8,500 sq mi. Gravity and magnetic measurements made simultaneously in the Rāṇīganj area are interpreted in detail, and maps of the Hayford anomalies compiled from all data to March 1949, are given for India, Pakistan and adjacent parts of Burma.

Chapter 6 presents results of magnetic measurements made at different levels in the Kolar gold fields to gain information on the earth's field, but local anomalies masked any regional changes present.—*E. K.*

13566. Higasinaka, Hideo. A new gravity formula for the Far East: Acad. Japan Proc., v. 27, no. 9, pp. 577–581, 1951.

To determine the abnormal underground structures around Japan and the Philippines, the author suggests that the gravity anomalies should be based upon a gravity formula suitable for the neighboring continent. The new formula is derived from the Helmert gravity formula of 1901 by permitting the coefficients to take on small increments. The most probable value of the increments is obtained with the aid of least squares and gravity data for 287 stations in the Far East. The resulting formula differs slightly from the Helmert formula, but widely from the International formula. Since all the gravity anomalies in Japan have been based on the Helmert formula, they can be used for geologic interpretations.—*R. G. H.*

13567. Jackson, J. S. Density of Irish rocks: Dublin Inst. Advanced Studies, Geophys. Bull., no. 4, 10 pp., 1951.

Densities of 157 specimens of representative rocks of Ireland, in the collection in the Geophysics Laboratory of Trinity College, Dublin, have been determined to provide data for the evaluation and interpretation of gravity surveys of Ireland.—*L. E. B.*

MAGNETISM AND ELECTRICITY

13568. Gaibar Puertas, C. Reimantación del globo terrestre. [Remagnetization of the earth]: Rev. Geofís., v. 10, no. 39, pp. 155–179, 1951.

All investigations of the magnetic state of the earth since 1830, lead to the conclusion that during the last 100 yrs the intensity of magnetization has been diminishing at the average rate of 1 part in 1,500 each yr. Analysis of the records of 63 magnetic observatories distributed all over the world for two intervals, 1913–23 and 1933–43, suggests that about the year 1930 this process of demagnetization stopped and an important increase took place. This increase of magnetization has been produced by an expansion of the Eurasian positive isoporic focus; it does not represent a phenomenon of planetary extent, as, for instance, the area of South Pacific Ocean has not been affected by it. The greatest resistance to secular variations of geomagnetic field is said to be found in the simatic layer of the earth's crust.—*S. T. V.*

13569. Giacomo, P. Sur les oscillations rapides du champ magnétique terrestre [On the rapid oscillations of the geomagnetic field]: Annales Géophys., tome 5, fasc. 2, pp. 171–173, 1949.

Rapid and continuous recording of the magnetic field near Fribourg-en-Brisgau [Freiburg im Breisgau] from August 10 to October 20, 1948, indicated that periods of complex disturbance without sharp beginnings or endings lasting less than an hour and of amplitude of a few gammas per minute correspond to magnetic bays observed in ordinary recording. There are, in addition, more or less regular oscillations with periods of 0.1 to 1 min and amplitudes of a few gammas per minute which have a daily maximum at $8^h\ 30^m$ u. t.—*M. C. R.*

13570. Owen, David. An apparatus for studying the laws of the magnetic field due to an electric current in a long straight conductor: British Jour. Applied Physics, v. 2, no. 1, pp. 5–7, 1951.

To verify the equation $H=2I/10r$ for the magnetic field at r cm from a long wire carrying current I amps a vertical rectangular loop 70.7 cm high and 10 cm wide was oriented with its plane perpendicular to the magnetic median. The magnetic field at the center of the coil due to the vertical legs differs from the field due to two infinite parallel wires by 1 percent, the error being due to the effect of the horizontal legs. Values of H along the x-axis, which is through the center of the coil and in the plane of the coil, are determined by use of a compass needle to ascertain for given currents null points where the field due to the wires is equal and opposite to the horizontal component of the earth's field. The currents are plotted against x^2 where x is the distance of null points from the center of the coil. The nulls occur in pairs except for the I intercept value where they coincide at the center of the coil. The horizontal component of the earth's field can then readily be calculated as well as the field intensity along the x-axis. Similarly positions of null points along the Z-axis though the center of the coil at right angles to it can be found and the horizontal component of the earth's magnetic field be calculated.—*W. J. D.*

13571. Denisse, J. F., Steinberg, J. L., and Zisler, Siegfried. Contrôle de l'activité geomagnétique par les centres d'activité solaires distingués par leurs propriétes radioélectriques [Influence on geomagnetic activity of sunspots distinguished by their radioelectric properties]: Acad. Sci. Paris Comptes rendus, tome 232, no. 25, pp. 2290–2292, 1951.

Two types of solar activity have been noted, one accompanied by radioelectric transmission and the other not. Geomagnetic activity following the first type is nonrecurrent and sometimes associated with storms with sudden commencement. Recurrent storms with progressive beginning are not accompanied by radioelectric activity.—*M. C. R.*

13572. Afanas'yeva, V. I. and Kalinin, Yu. D. Ob odnoy osobennosti geograficheskogo raspredleniya polya magnitnoy buri [A peculiarity in the geographic distribution of magnetic storms]: Akad. Nauk SSSR Doklady, tom 82, no. 3, pp. 379–380, 1952.

Ninety geomagnetic storms recorded during the years 1938–48 at ten observatories, between magnetic latitudes Φ 32° to 72° were analyzed, and the storm-time variation D_{st} determined. It has been long known that the absolute value of D_{st} increases monotonically with decrease of Φ. At latitudes of 50° to 70° a

second maximum of about 40γ was found at the beginning of the storm. At latitudes 55° to 65° this is followed by a minimum of the *Dst* curve.

This rather complex relation between *Dst* and Φ is explained by the generation of electric currents I_F flowing in the ionospheric layer *F* in the direction of latitude circles and inducing currents I_E of opposite direction. The ratio of these currents is not constant, but varies with latitude, reaching a maximum near 60° latitude.—*S. T. V.*

13573. Ferraro, V. C. A., and Unthank, H. W. Sudden commencements and sudden impulses in geomagnetism: Their diurnal variation in amplitude: Geofis. Pura e Appl., v. 20, pp. 27–30, 1951.

This is a further study of sudden commencements and sudden impulses at Cheltenham (Md.), Tucson, San Juan, Honolulu, Huancayo and Watheroo (*see also* Geophys. Abstract 13313). The diurnal variations of amplitude were studied during the period of 1926–46, and the greatest amplitudes were found to occur near 0^h local time, while the lowest values were about 7^h, except at Huancayo, which was found to be abnormal. The amplitudes of the sudden impulses may have a secondary minimum near 18^h, but this is not certain.—*L. E. B.*

13574. Nagata, Takesi. Sudden commencements preceded by the preliminary reverse impulse in a geomagnetic field: Nature, v. 169, no. 4298, pp. 446–447, 1952.

The magnitude of the preliminary reverse impuse and its ratio to that of the main impulse is believed to be significant in determining the diurnal frequency variation. The ratio of the magnitude of the preliminary reverse impulse to that of the main impulse, both in the horizontal component, depends on local time as well as on the geomagnetic latitude. From data covering 67 magnetic storms having sudden commencements with or without preliminary reverse impulses, collected from January 1946 through June 1949, and published by the U. S. Coast and Geodetic Survey, it seems that the preliminary reverse impulse appears principally in the afternoon with a maximum around 16^h local time.—*L. E. B.*

13575. Sivaramakrishnan, M. V. Geomagnetic field variations at Kodaikanal: Nature, v. 169, no. 4297, pp. 409–410, 1952.

The following anomalies in geomagnetic field variation have been observed at Kodiakānal during 1949–1951. A marked minimum sudden commencements occurs at about 8^h and 20^h local mean time. The type of sudden commencement characterized by increase in *H* preceded by small movement in the opposite direction is missing. Some sudden commencements have not been recorded at other observatories. During sudden commencements, a simultaneous increase in *H* and *V* is shown; in certain cases, an unusual decrease in *D* synchronous with increase in *H* and *V* was noted. In geomagnetic crochets during 1949–1951, ΔH, when present, was invariably positive and ΔV, when present, generally negative, but both were positive in the storm on June 13, 1951. Some examples of *H* and *V* in the same sense in normal daily magnetic variation have been observed.—*M. C. R.*

13576. Chapman, Sydney. The normality of geomagnetic disturbances at Huancayo: Geofis. Pura e Appl., v. 19, fasc. 3–4, pp. 151–158, 1951.

Although quiet-day solar and lunar daily variations in horizontal magnetic force are known, changes in H during major and minor magnetic activity are normal for this latitude. The normality of D_{st} (storm-time change) seems natural according to the Chapman-Ferraro theory of magnetic storms, but the normality of S_D (disturbance daily variation) is less easy to explain.—*M. C. R.*

13577. Rikitake, Tsuneji. On magnetization of volcanoes: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 1, pp. 72–82, 1952.

A method is developed for determining simultaneously the mean intensity of magnetization and effective scale of magnetic mass of a volcano from the observed distribution of anomalies in the earth's magnetic field. Applying the method to the results of the magnetic surveys of various volcanoes in Japan, the mean intensity of magnetization is determined, the values agreeing roughly with the experiments on the natural remanent magnetization of rocks composing the volcanoes and the results previously obtained by the analyses of magnetic survey. The effective scales of magnetic mass are also found to differ markedly for respective volcanoes, the difference being probably due to the structure of the volcanoes though no marked geologic evidence for such differences is found.—*J. R. B.*

13578. Yokoyama, Izumi. Magnetization of the gabbro from Mt. Tsukuba with special relation to the geomagnetic anomalies: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 1, pp. 83–91, 1952.

The anomalous decrease in dip angle with increase in altitude above 500 m on Mt. Tsukuba [Tsukuba-san] is attributed to the anomalous magnetization of the rocks. This is verified by a rough comparison of observed values and those computed from measurements of the magnetization of rock specimens.—*J. R. B.*

13579. Thellier, Émile and Thellier, Odette. Sur la direction du champ magnétique terrestre, dans la région de Trèves, vers 380 apres J–C [On the direction of the geomagnetic field in the region of Treves, about 380 A. D.]: Acad. Sci. Paris Comptes rendus, tome 234 no. 14, pp. 1464–1466, 1952.

Remanent magnetism of 14 samples from a Roman kiln at Herforst abandoned in the second half of the fourth century has been determined in the laboratory. Values vary within greater limits than those in samples from Carthage [*see* Geophys. Abstract 13321], but D=1° W. and I=61° 15′ N. are indicated.—*M. C. R.*

13580. Sandoval, R. O. Servicio Geomagnetico. Elementos magneticos en la Republica Mexicana. [Geomagnetic Services. Basic magnetic data in the Republic of Mexico]: Univ. Nacional México, Inst. Geofisica, 223 pp., 1950.

This is a compilation of magnetic data recorded in Mexico from 1769 to 1950.—*L. E. B.*

SEISMOLOGY

13581. Satō, Yasuo. Transformations of wave functions related to the transformations of coordinate systems, pt. 1: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 1–2, pp. 1–22, 1950.

The transformations of wave functions from one system to another is introduced to simplify the solutions of the boundary-value problems. The bounding surfaces discussed in this paper are planes, circular cylinder surfaces, and spherical surfaces.

The transformation of wave functions from polar to cartesian coordinates for both the two- and three-dimensional problems as well as the transformation in three dimensions from polar coordinates into cartesian, cylindrical, and polar coordinates systems are discussed. The last refers to the translation of the origin of polar coordinates.—*I. Z.*

13582. Satō, Yasuo. Transformation of wave functions related to the transformation of coordinate systems, pt. 2: Tokyo Univ. Earthquake Research Inst. Bull., v. 28, pts. 3–4, pp. 175–217, 1950.

The wave function is expressed in terms of rotated axes. The solution is obtained using the following development: Consider two cartesian systems with the Eulerian angles ϕ, χ, ψ, connecting the two. When ψ and χ vanish and only ϕ exists, the transformation is known as Φ. When ϕ vanishes and $\chi=\psi=\pi/2$ the operation is called W. When ψ vanishes and $\psi=\chi=-\pi/2$ the operation is W'. It can be shown that any transformation with the Eulerian angle (ϕ, χ, ψ) can be analyzed into the aforementioned operations. The operation Φ represents the rotation of the coordinate system around the z-axis by the angle ϕ. The operations W and W', however, are not as simple. For the operation W there exists the relation $P_n^m(\cos\theta^*)\exp(im\phi^*)=\sum_{k=-n}^{n} w_k(n,m)P_n^k(\cos\theta)\exp(ik\phi)$ where θ, ϕ, are the new coordinates and θ^*, ϕ^* are the old. A similar formula exists for W' involving coefficients w_k'. The general transformation $T[\phi, \chi, \psi]$ is analyzed into the elementary operations Φ, W, and W' and the coefficients w_k and w_k' are evaluated.— *I. Z.*

13583. Shimazu, Yasuo and Takeuchi, Hitoshi. Propagation of elastic waves in a medium under finite initial tensions: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 3, no. 16, 7 pp., 1950.

The propagation of elastic waves in a medium which is initially isotropic and subsequently subjected to finite tensions is studied. The velocities of the waves are expressed in terms of the given tensions and of the elastic constants of the initially isotropic medium. Several numerical calculations are included.—*I. Z.*

13584. Satō, Yasuo. Mathematical study of the propagation of waves upon stratified medium (1): Tokyo Univ. Earthquake Research Inst. Bull., v. 26, pts. 1–4, pp. 1–4, 1948.

The results obtained from studies of the propagation of waves on the surface of an elastic body are too intricate to apply to the propagation of waves in stratified media. A method is presented for effecting approximate calculations in practical cases. An asymptotic expansion is obtained for the integral $\int_a^b F(\xi)\begin{matrix}\cos\\ \sin\end{matrix}\xi x d\xi$ often appearing in problems of elastic waves. It is noted that the expansion is determined by the two limits of integration and the points where $dF(\xi)/d\xi$ becomes infinite. The validity of the expression can be tested by applying it to integrals whose asymptotic expansion is known.—*R. G. H.*

13585. Satō, Yasuo. Mathematical study of the propagation of waves upon stratified medium (2): Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 1, pp. 21–38, 1951.

The method of obtaining asymptotic expansion of integrals of the form $\int_a^b F(\xi) \begin{matrix}\cos \\ \sin\end{matrix} \xi x d\xi$ developed in the previous paper is verified by its application to two integrals whose asymptotic expansion is known.

The fundamental equations for propagation of waves in stratified media are set up in terms of displacement potentials. The problem of component displacements due to a point source of compressional waves in a superficial layer leads to integrals of the type investigated. The formal solution involves *P*, *S*, and Rayleigh waves. Numerical calculations of the derived expressions are to be given in a subsequent paper.—*R. G. H.*

13586. Ricker, Norman H. The form and laws of propagation of seismic wavelets: World Petroleum Cong., 3d session, The Hague, Proc., sec. 1, pp. 514–536, 1951.

The wavelet theory of seismogram structure was developed about twelve years ago from mathematical investigations of the form of a seismic disturbance resulting from the explosion of a charge of dynamite and of the laws of propagation of the disturbance.

From the theory the following important laws have been deduced: The center of the wavelet travels with a velocity given by the square root of elasticity divided by the density; the breadth of the wavelet is proportional to the square root of the propagation time of its center; the amplitude of the displacement function is proportional to the minus 4/2 power of the travel time of its center; the amplitude of the velocity function is proportional to the minus 5/2 power of the travel time of its center; the amplitude of the acceleration function is proportional to the 6/2 power of the travel time of its center; the amplitudes of the displacement, earth particle velocity and acceleration are proportional to the 5/6 power of the mass of the charge, the charges being spherical, and the explosion pressure being independent of the size of the charge.

An extensive series of experimental studies were carried out over a comparatively simple, homogeneous and isotropic earth. Two areas were chosen, one 3 miles north of Limon, Colorado, the other 37 miles north of Limon at the crossroads village of Last Chance. Both are located in the thick section of Pierre shale in the Denver basin in the eastern part of Colorado. Numerous graphs are presented of the data indicating that in the shale there is good agreement between experiment and wavelet theory.—*I. Z.*

13587. Satō, Yasuo. Velocity of Love waves *in* Study on surface waves, pt. 1: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 1, pp. 1–11, 1951.

A two-dimensional analysis is used to develop fundamental aspects of Love waves. The characteristic equation obtained from the boundary conditions necessary for *SH* waves is interpreted and it is demonstrated that Love waves are a sort of interference phenomenon. The minimum group velocity and corresponding phase velocity and period for Love waves are calculated and presented in tables and figures. Various forms of the characteristic equation are given.—*R. G. H.*

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13588. Satō, Yasuo. Velocity of surface waves propagated in elastic plates *in* study on surface waves, pt. 2: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 2, pp. 223–261, 1951.

The characteristic equation for *SH* waves in an infinite elastic plate indicates that standing waves are formed with wave fronts perpendicular to the free surfaces. The existence condition requires that the time for waves to travel up and down the plate perpendicularly is not smaller than the number of nodes in the plate multiplied by the period.

In examining *P* and *SV* waves in elastic plates solutions designated π_n^- and π_n^+ (n=0, 1, 2, . .) are obtained which represent all branches of dispersion curves in elastic plates including anomalous dispersion, ordinary Rayleigh waves and the M_2 waves studied by Sezawa and Kanai. The results of numerical calculations of phase and group velocities for three relationships of the elastic constants, λ and μ, are given including calculated amplitude distributions for certain values of the period where $\lambda=\mu$.

The study of an elastic plate lying upon a liquid is simplified by power series expansions when the wave length is much greater than the thickness of the plate. Power series conveniently establish the manner in which phase and group velocity are related to wave number and period. Expressions are given from which the amplitude of displacement and particle orbit are determined.—*R. G. H.*

13589. Satō, Yasuo. Love waves with double superficial layer *in* Study on surface waves, pt. 3: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 3, pp 435–444, 1951.

In discussing Love waves in a double superficial layer seven cases arise depending upon the distribution of *S*-wave velocities in the three media. The existence of solutions in three of the seven cases is either apparent or has been treated by others. The existence of the remaining four is established in this paper by examples. Where the velocity of *S* waves is least in the uppermost medium and greatest in the intermediate medium the dispersion curve exhibits a cut-off period. Similarly, when the velocity is greatest in the uppermost medium and least in the intermediate medium there are also cut-off phenomena.

It is shown that the group velocity of Love waves in a double superficial layer is finite at the point where the phase velocity of Love waves equals that of *S* waves in the intermediate layer, a result which is at variance with that of H. Menzel (Geophys. Abstract 5352).—*R. G. H.*

13590. Satō, Yasuo. Equivalent single layer to double superficial layer *in* Study on surface waves, pt. 4: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 4, pp. 519–528, 1951.

Several numerical examples are given which demonstrate that the dispersion curve of Love waves in a double superficial layer can be fitted well by a dispersion curve of simple Love waves in a single layer. The equivalent single layer, however, does not always give an appropriate value for the thickness of the crustal layers and the estimated density and rigidity often differ markedly from those of two layers. It is concluded that knowledge of the dispersion curve of Love waves is of little use in prospecting underground structure.—*R. G. H.*

13591. Satō, Yasuo. Love waves propagated upon heterogeneous medium *in* Study on surface waves, pt. 5: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 1, pp. 1–11, 1952.

Expressions are obtained for the displacements of Love-type waves in a semi-infinite solid in which the rigidity increases linearly with depth. The general solution for such waves in overlying homogeneous and isotropic crustal layers is well known. The boundary conditions for the composite problem lead to a determinant that vanishes, depending upon the phase velocity and the period. The relation of phase and group velocities to period, and the vertical distribution of amplitude are shown by the results of numerical calculations. —*R. G. H.*

13592. Biot, M. A. The interaction of Rayleigh and Stoneley waves in the ocean bottom: Seismol. Soc. America Bull., v. 42, no. 1, pp. 81–93, 1952.

A theory is developed for the propagation of two-dimensional unattenuated waves in a system consisting of a liquid layer overlying an infinitely thick solid. The solution is obtained by considering the waves in the liquid and in the solid independently of one another and coupling them together by the boundary condition that at the interface the ratio of normal stress to vertical displacement is the same for both media. Phase and group velocity are plotted for a few values of the physical constants. The solutions demonstrate the existence of Stoneley waves at small wave lengths with a phase velocity lower than that of sound in water. The phase velocity increases continuously with the wave length corresponding to Rayleigh waves for large wave lengths.

It is shown that Stoneley waves may exist at the interface of a massless solid and an incompressible fluid, showing they are independent of the existence of body waves.

Since dispersion curves of the phase velocity of Stoneley waves resemble the dispersion which can be expected in the sofar channel, the possibility exists of strong coupling between sofar waves and Stoneley waves permitting an alternating transfer of energy from one type of wave to the other.—*I. Z.*

13593. Caloi, Pietro. Effeti dell' attrito interno sulla velocità delle onde sismiche superficiali a brevissimo periodo [The effect of the inner friction on the velocity of very short period surface waves]: Annali Geofis., v. 4, no. 4, pp. 469–473, 1951.

This is an abbreviated version of the paper presented at the 9th General Assembly of the International Union of Geodesy and Geophysics, Brussels, 1951. Inner friction of the medium over which Rayleigh waves are propagated influences their velocity. Analysis shows that the theoretical value of this velocity, for very short waves, tends to infinity, but with increasing period rapidly approaches the values for a purely elastic medium. This effect is especially noticeable for large values of the ratio of the Lamé constant to the coefficient of friction of the medium.

On the other hand the damping exercised by the medium on the propagating wave also becomes infinitely strong when the period of the wave approaches zero. As soon as the period is 0.01 sec or less the wave is rapidly absorbed. Both these factors make the effect of friction noticeable only over a very short distance and can be studied only over a very narrow spectrum. These conclusions have been confirmed by the observations of Ikegami and Kishinouye.—*S. T. V.*

13594. Haskell, N. A. A note on air-coupled surface waves: Seismol. Soc. America Bull., v. 41, no. 4, pp. 295–300, 1951.

Frequency-dependent coupling between the atmosphere and an underlying denser medium is not restricted to ice sheets on water but takes place whenever the properties of the underlying medium permit propagation of vertical surface displacements with a phase velocity close to that of sound in air. The phase-velocity curve is divided into two branches by air coupling, corresponding to phase velocities greater than and less than the velocity of sound in air. The air-ice sheet-water coupling is an example of this phenomenon when the phase velocity of surface waves in the underlying medium increases with increasing frequency; part of the ground roll in seismic-exploration records represents this phenomenon when the phase velocity decreases with increasing frequency. The latter may also be of significance in the origin of microseisms.—*M. C. R.*

13595. Gassmann, Fritz. Elastische Wellen in einer Kugelpackung. [Elastic waves in a spherical packing]: Schweizer naturf. Gessell. Verh., v. 130, pp. 136–141, 1950; Inst. Geophys. Zürich Mitt., no. 16, 6 pp., 1951.

See abstract 13147.—*M. C. R.*

13596. Gassmann, Fritz, and Weber, Max. Schwingungsmesser mit elektronisch regulierbaren Konstanten [Vibrometer with electronically adjustable constants]: Schweizer naturf. Gessell. Verh., v. 130, pp. 141–144, 1950; Inst. Geophys. Zürich Mitt., no. 16, 4 pp., 1951.

Modifications to be introduced in the differential equation for the movement of a mechanical seismograph because of the addition of a piezoelectric crystal, an electrical amplifier, and optical registration, are discussed. Each detail introduces an equation of the form $L_i = L_{i+1}$, relating mechanical and electrical properties of the simpler instrument with those of the new one obtained by the addition of the said detail.

Applying this process to the seismograph with negligible damping and assuming all transformations to take place with perfect efficiency the equation of electrical seismograph is obtained in the form analogous to that of the mechanical seismograph. The great advantage of the new equation lies in the possibility of adapting the properties of the new instrument, such as its damping constant or period of vibration, to any specific conditions desired.—*S. T. V.*

13597. Gassmann, Fritz. Über mechanische Empfänger von Seismographen und Schwingungsmessern [On mechanical receivers of seismographs and vibrometers]: Archiv Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 3, Heft 5, pp. 408–422, 1951; Inst. Geophys. Zürich Mitt. no. 19, 14 pp., 1951.

The functioning of seismographs oscillating with one degree of freedom is investigated. A pendulum provided with a mechanical system of magnification is assumed as a typical instrument. The pendulum is called the mechanical receiver of the seismograph. Its movement is studied, employing a vector describing its translations and a tensor describing rotations. By the methods of tensor analysis, the general equation of the movement of the receiver is derived, in terms of instrumental constants, called response factors. By analyzing the ratios of these factors, all possible types of mechanical receivers oscillating with one degree of freedom can be classified and their operation determined

in advance. At the end of the article different models of such instruments are described.—*S. T. V.*

13598. Tandon, A. N. A simplified model of Wood-Anderson seismograph : Indian Jour. Meteorology and Geophysics, v. 2, no. 3, pp. 203–212, 1951.

Construction and adjustment of an instrument developed for use in seismically active regions near the Himalayas are described. The instrument is similar to the torsion seismometer described by Wood and Anderson in 1925, easy to construct, and can be made in laboratories with ordinary workshop facilities. The instrument can be adjusted to critical damping within the period range of 1 to 6 sec. It has been found to give best results for earthquakes at distances of less than 5,000 to 6,000 miles, but has also been successfully used as a vibrograph to measure short-period industrial vibrations.—*M. C. R.*

13599. Obert, Leonard and Duvall, W. I. Generation and propagation of strain waves in rock: U. S. Bureau Mines Rept. Inv. 4683, 19 pp., 1950.

In an investigation of the generation and propagation of strain waves produced in rock by the detonation of high-velocity explosives, 51 shots ranging in size from 1 to 64 sticks were fired and recorded at distances of 2 to 54 ft. The principal rock in the area was greenstone with stringers of epidote. Data on size of charge, distance, maximum compressive strain, maximum tensile strain, rise time (time required for wave to reach first compression peak), half period, major frequency, maximum rate of strain, and velocity of propagation are tabulated and certain relations are shown graphically. The maximum compressive strain, E, is given by the relation $E=K(\sqrt[3]{W}/D)^n$ where K and n are constants, W the charge size in sticks, and D the travel distance in feet. The duration of the compressive half of the pulse increases with increasing size and distance, indicating that the absorption of high-frequency components is greater than that of low-frequency components.—*M. C. R.*

13600. Kaufman, Sidney and Roever, W. C. Laboratory studies of transient elastic waves: World Petroleum Cong., 3d Session, The Hague, Proc., Sec. 1, pp. 537–546, 1951.

Experimental procedures for model studies of the propagation of transient elastic waves are described. A spark discharge is used as a source of energy producing a pulse with a time constant of approximately 10 microseconds. The recording system consists essentially of a transducer, amplifiers, and an oscilloscope. The transducer consists of an iron armature, bar magnet, pole piece, and an elastic model material situated between the pole pieces and the armature. The armature is securely imbedded at the surface of the model material. The transducer responds to the velocity component perpendicular to the armature. After amplification, the output is permanently recorded by photographing the record on an oscilloscope. The elastic material selected was a residue wax with a melting point of 54° C. It was made by casting the wax into a rectangular block. In cooling, the outside surfaces hardened before the interior so that the denser material settled in a plane region approximately midway between the top and bottom surfaces of the block.

Many observations were made, among which were a series of experiments with the spark source 3 cms above the surface of the wax block, the detector position being fixed. The source-detector distance was varied in 2 cm steps from 6 cms to 90 cms. The resulting records clearly indicate the following:

The first arrival, which is attributed to a compressional wave; the time of arrival of the maximum upward velocity, the zero velocity, and the maximum downward velocity features (these features spread apart in time up to a distance of 20 cms after which the spacing becomes more constant); the arrival time of the event, which appears to be a refraction from the acoustic discontinuity within the wax block; the arrival time of the event attributed to a Rayleigh wave; arrival time of an event at longer source-detector distances which is attributed to reflections at the bottom of the block.

The amplitude of the feature attributed to the Rayleigh wave relative to the amplitude of the compressional wave increases with distance, an unlikely development for a shear wave. These results check with theoretical predictions assuming idealized conditions of a homogeneous elastic earth subjected to a short impulse applied at a point of the surface. However contrary to theory, observations by Leet at the atomic bomb test of July 16, 1945, show a multicycle and almost sinusoidal character for the Rayleigh wave although the aforementioned idealized assumptions have presumably been met. The author suggests that the oscillatory character of Rayleigh waves observed in prospecting and in earthquakes is a result of either a distributed source or of a layered nonhomogenous medium.—*I. Z.*

13601. Wood, F. W. A new type of surface wave from earthquakes: Nature, v. 169, no. 4296, pp. 368–369, 1952.

Studies of the surface waves of 42 selected earthquakes which occurred "end-on" to the horizontal seismometers at Harvard indicate the existence of groups of surface waves with no horizontal component. These are named *Z* waves. Dispersion curves are similar to those of Rayleigh waves, and periods are similar to those of Rayleigh waves from the same earthquake except for a tendency for the *Z* waves not to be identifiable when the period is greater than 20 sec. The group velocity of *Z* waves is less than the group-velocity of Rayleigh waves travelling the same path; the ratio of velocities is about 0.93 to 0.96. Z waves have also been identified on the records of other observatories.—*M. C. R.*

13602. Anderson, Johannes, and Nerenst, Poul. Wave velocity in concrete: Am. Concrete Inst. Jour., v. 23, p. 613–36, April, 1952.

The quality of concrete can be tested by measuring the longitudinal wave velocity in the material with a condenser chronograph that is accurate to 1μ sec. An empirical formula for the increase in velocity (0.2 to 4.5 kmps) during setting is given.—*D. F. B.*

13603. Gayskiy, V. N. Opredelenye moshchnosti zemnoy kory v rayone nablyudayushchey stansii po seysmogrammam dalekikh zemletryaseniy [Determination of the thickness of the earth's crust in the vicinity of the observatory from seismograms of distant earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 12 (139), pp. 57–65, 1950.

Seismograms of the Irkutsk station in central Siberia were searched for phase *SP'*, which arrives at the surface being reflected from the base of the crust. This phase was found to arrive 8 to 15 sec after *S*. Using several seismograms, the increase of time was determined by the method of least squares and found to be a linear function of the angular distance. Assuming the average velocity of this *SP'* wave to be 6 kmps, it is possible to compute the thickness of

the crust from standard formulas. The thickness of the crust was computed as 44 km for many points, increasing in the vicinity of Lake Baikal to 70–75 km and over a small area even 88 km.—*S. T. V.*

13604. Rozova, Ye. A. Raspolozheniye epitsentrov i gipotsentrov zemletryasenii Srednei Azii [Positions of epicenters and hypocenters of earthquakes in Central Asia]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 10 (137), 131 pp., 1950.

Seismograms of eleven Central Asian and of sixteen other Russian observatories, representing the records of 2,830 earthquakes in different parts of Central Asia during the years 1941–48, were studied. Epicenters of all and hypocenters of 1,775 were determined. Depth of focus was computed by the method suggested by Rozova [see Geophys. Abstracts 10059, 10597 and 10850] and the results checked by the method of Wadati. Of the 1,775 earthquakes, 30 percent were shallow, 32 percent normal, and 38 percent intermediate. The foci of the last group are clustered around a depth of 100 ± 20 km, which coincides with the hypocentral zone of 106 km suggested by Galitzin. It is noted that seismic shocks closely following a principal earthquake cannot be interpreted as aftershocks because of the substantial changes in the position of the hypocenters.

Comparison of epicentral zones with established tectonic lines of faults in many instances fails to establish a causal correlation. This may be explained either by the inaccuracy of seismologic methods or by insufficient knowledge of the intricate geology of Central Asia.

The article includes many tables giving the dates of earthquakes, coordinates of the epicenters and hypocenters, and the maps indicating the known tectonic lines.—*S. T. V.*

13605. Tandon, A. N. Earthquakes [In Hindu with English abstract]: Indian Jour. Meteorology and Geophys., v. 3, no. 1, pp. 71–76, 1952.

This is a review of earthquakes and their effects.—*M. C. R.*

13606. Richter, C. F. and Nordquist, J. M. Instrumental study of the Manix earthquakes: Seismol. Soc. America Bull., v. 41, no. 4, pp. 347–388, 1951.

Epicenters and depth of foci of the 34 better-recorded shocks in the Manix series have been determined and from the records of these shocks crustal structure and wave velocities have been determined. The principal shock had an epicenter at 34°59.5′ N. lat, 116°33.5′ W. long. Alinement of the epicenters suggests an active structure striking about N. 30° W., at a large angle to the Manix fault. For a large proportion of the shocks the most clearly identified waves had velocities of 5.55, 6.21, 7.01, 8.20 kmps (*P* waves) and 4.00 and 4.55 kmps (*S* waves). Distribution of initial first motion is consistent with either a right-hand strike slip on a hypothetical fault with the same trend as the line of epicenters or with left-hand strike slip on the Manix fault. The latter displacement was observed, but it is possible that both occurred.—*M. C. R.*

13607. Di Filippo, Domenico and Marcelli, L. Tempi di tragitto delle onde *P** e spessore dello strato del granito nell' Italia Centrale [Travel times of *P** waves and the thickness of granitic layer in central Italy]: Annali Geofis., v. 4, no. 4, pp. 579–589, 1951.

Continuing their study of the Gran Sasso d' Italia earthquake of September 1950 (Geophys. Abstract 12938), the authors present now certain general con-

clusions concerning geologic structure of central Italy. The focal depth was determined by the method of P. Caloi, which is based on the angle of emergence of P_g. The most probable value of the velocity of P^* was found to be 6.38 kmps. The depth of the granitic layer in central Italy was found to be 26.1 km.—*S. T. V.*

13608. Hayakawa, Masami. Investigation of the time variation of seismic wave velocity [In Japanese with English summary]: Geol. Survey Japan Rept. no. 142, 51 pp., 1951.

The change of stress distributions in the earth's crust with the occurrence of earthquakes may be studied by the investigation of variation with time of seismic wave velocity. For this purpose, the seismic data of the Central Meteorological Observatory have been statistically studied.

Two methods were used: one a comparison of two earthquakes which occurred successively at the same location, and the second a comparison of two earthquakes with different epicenters.

The results of the investigation may be summarized as follows: variations with time of seismic wave velocity are found, amounting to differences in arrival times of 2 or 3 sec at most; these time variations appear 3 or 4 months before the occurrence of earthquakes; and the probability that these time variations appeared at random before earthquakes is so small that they must be considered as having some physical meaning. One explanation of these phenomena is a change of the elastic properties of substances composing the earth's crust.—*M. C. R.*

13609. Hattori, Yasumasa. Continuous variation of velocity with depth and distance [In Japanese with English summary]: Geophys. Exploration, v. 4, no. 2, pp. 59–61, 1951.

In a case when the velocity varies with depth and distance, the time-distance curve and its interpretation are discussed.—*Author's summary*

13610. Macdonald, G. A. The Kilauea earthquake of April 22, 1951, and its aftershocks: Volcano Letter, no. 512, pp. 1–3, 1951.

This earthquake had an intensity 5 on the modified Mercalli scale over an area 30 miles to the north and south of the epicenter, indicating a comparable depth of origin. The location of the epicenter is just east of Kilauea caldera but could not be determined exactly because all the seismometers in the area were dismantled by the shock. No surface faulting was observed but the numerous aftershocks seem to have originated along the Kilauea rift zones and the Kaoiki fault zone, with a few beneath the caldera and along the Hilina fault zone. Subsidence is thought to be the cause of the earthquake.—*E. K.*

13611. Macdonald, G. A. and Wentworth, C. K. The Kona earthquake of August 21, 1951: Volcano Letter, no. 513, pp. 1–4, 1951.

The main shock was probably the most severe since 1868 and had an intensity of 7 on the modified Mercalli scale. The epicenter is just off the coast of Hawaii west of Mauna Loa, and the level of the sea fluctuated a maximum of 4 ft both below and above normal. The main shock and hundreds of aftershocks were probably caused by movement along the Kealakekua fault which turns and extends out to sea at that point.—*E. K.*

13612. Berg, Helmut. Das rheinische Erdbeben bei Euskirchen am 8 März 1950 [The earthquake near Euskirchen in the Rhineland on March 8, 1950]: Geofis. Pura e Appl., v. 18, pp. 198–208, 1950.

The earthquake of March 8, 1950, in the Rhineland was of unusual intensity for this region, 7 on Mercalli-Sieberg scale near the epicenter.

From instrumental data at Göttingen, Strasbourg, Utrecht, and Karlsruhe, coordinates of the epicenter were determined as 50°47′ N. lat and 6°50′ E. long. with an error not exceeding ±3 km. The depth of focus was computed using Gassmann's formula; the average of 12 determinations was 6 km. Using Inglada's approximate formula for depth of focus, a value of 5 km was found. The following velocities of propagation were determined: P_n, 8.30 kmps; P_b, 6.95 kmps; P_g, 5.64 kmps; S_n, 4.86 kmps; S_g, 3.34 kmps.

On the basis of some 250 noninstrumental observations, isoseismal lines were constructed and the coordinates of epicenter determined. Other features of this earthquake are also discussed, such as the occurrence of foreshocks and aftershocks, and production of noise.—*S. T. V.*

13613. Sakuma, Shūzō, and Minakami, Takeshi. Minor activity of volcano Yake-yama in 1949: Tokyo Univ. Earthquake Research Inst. Bull., v. 27, pt. 1–4, pp. 117–121, 1949.

Two seismometers were installed at Akakura and Yunōkoti [Yunokawachi], following the initial explosion of Yake-yama in February 1949. Perceptible and nonperceptible earthquakes were recorded and the focus of the shock on February 7, determined as "not less than a few kilometers, not extremely shallow." It is concluded that the activity of minor scale took place along a line of weakness through the summit in a direction of N. 20° W.—*L. E. B.*

13614. Minakami, Takeshi. Earthquakes at the state of paroxysmal eruption *in* Recent activities of volcano Usu (3): Tokyo Univ. Earthquake Research Inst. Bull., v. 27, pt. 1–4, pp. 123–128, 1949.

For the precise investigation of earthquakes, five seismograph stations were installed at points around the base of volcano Usu-dake, and observations were made continuously from June to September 1949. Earthquakes of two types were noticed: some taking place on the southern side of Usu-dake at a depth of 2 to 5 km; and others originating at Hukuba at the eastern foot, at depths between the surface to 1 km. From the prevalence of the latter type, it is concluded that there may be a discontinuous boundary in the formations of Usu-dake at a depth between 1.3 and 0.5 km.—*L. E. B.*

13615. Minakami, Takeshi. Earthquakes followed by the birth and development of the lava dome *in* Recent activities of Volcano Usu (4): Tokyo Univ. Research Inst. Bull., v. 27, pt. 1–4, pp. 129–134, 149.

During formation of the lava dome, earthquakes were recorded at the Tōya Hot Spring [Tōyako-onsemmachi] station that differed from types previously discussed (*See* Geophys. Abstract 13614), being intermediate in mean period of earthquake motions. These seismograms resembled each other as though they were all copies of the same earthquake. Type *C* earthquakes probably occurred below the newly forming lava dome at depths from 0.5 to 1.0 km. It is believed that there is a close relation between these earthquakes and the forces acting at the base of the dome.—*L. E. B.*

13616. Tercedor, Mariano. La tectónica de la Depresión granadina, en relación con su elevada sismicidad [The tectonics of the Granada basin in relation to its high seismicity] [with English Summary]: Inst. geol. Lucas Mallada (Madrid), Estudios geol., no. 13, pp. 29–67, 1951.

The geology of the Granada basin and its geologic evolution are reviewed, and a detailed analysis of earthquakes which have occurred there since before the Christian era is presented. It is found that: most of the well-determined epicenters are within the Granada basin; in most seismograms there is a marked predominance of the north-south motion over east-west; the depth of focus of most earthquakes is less than 10 km, sometimes much less; and a noticeable difference in intensity is often observed in adjacent localities. The Granada basin is a typical graben.

The principal seismotectonic line passes almost through the center of the basin from Loja to Granada along the valley of Río Genil.—*S. T. V.*

13617. Mihailovič, Jelenko. Seizmička aktivnost Pomoravlja Moravska trusna oblast [Seismic activity of the Morava river valley]: Geološki Vesnik, tome 9, pp. 311–321, 1951.

Records of the earthquakes in the Morava valley during the years 1879–1940, indicate there were 1,530 seismic shocks, 1,500 of them being autochtonous. Thirty-seven earthquakes recorded were destructive, and 270 more are classified as violent. The Morava valley is a wide and long graben in the Carpatho-Balkan massive, stretching southward from the Danube for about 250 km. The area can be separated into four seismically independent zones, Braničevo, Resava, Juhor, and Kučaj. Each of these zones could be further subdivided into several seismogenetic blocks. Seismotectonic characteristics of these zones will be discussed in subsequent papers.—*S. T. V.*

13618. Korn, H. and Martin, Hans. The seismicity of South-West Africa: Geol. Soc. South Africa Trans. and Proc., v. 54, pp. 85–88, 1951.

This is an English version of the article abstracted in Geophys. Abstract 12396.—*M. C. R.*

13619. Watanabe, Akira. Geomorphology of the coastal districts of the southern part of Sikoku Island and its bearing on the crustal deformation accompanying great Naki Earthquakes. [In Japanese with English summary]: Geog. Survey Bur. Japan Bull., v. 1, pt. 1, pp. 37–72, 1948.

Crustal deformation of the Nankaidō region during earthquakes, unlike those in other parts of Japan, are characterized by a type of tilting motion taking the form of uplift and depression of the land with reference to sea level without any accompanying surface evidence of faulting.

The movements seem to be a continuation of the geomorphologic development of the island, and of the "Outer Zone" of southwestern Japan. This is especially true of the earthquake of December 21, 1946, which was a rebound of the crust, with the previously subsiding area being elevated at that time. A close relationship between crustal movements is inferred from coastal features and deformations by the earthquakes, as the areas uplifted by this earthquake closely coincide with the areas of coastal terraces. Mountain growth on the island seems to have resulted from upwarping in places accompanied by faulting or steep marginal flexure. A hinge line is also postulated to explain the marine ter-

races on the coast and the inland depressions. The position of the hinge line in the earthquake of 1707 was near the mouth of the Monobe river [Monobe-gawa] and that of the 1946 quake near Gotenno-hana; the greatest upheaval was near Asizuri-saki [Ashizuri-zaki] and decreased to the north and northwest, until it merged into the depressed area of the north. Terrace surfaces must have been formed by intermittent uplifts of minute amount and short intervals. The differences in height range from less than a meter to several meters.—*L. E. B.*

13620. Nakano, T. Relation between damages by earthquakes and topography [In Japanese with English summary]: Geog. Survey Bur. Japan Bull., v. 1, pt. 1, pp. 27–36, 1948.

The index of damage for wooden houses by earthquakes is closely related to topography, and may sometimes be predicted on that basis. It is very high on marshlands, moderate on sand dunes, and very low on alluvial fans and alluvial valley floors.

Damage by seismic sea waves is closely related to the height of beach ridges. Where there is a low beach ridge, damage by seismic sea waves is great, but if the height of the beach ridge is greater than the height of the seismic sea wave, there is usually no damage.—*M. C. R.*

13621. Tsuboi, Chuji. Passive seismicity index number for destructive earthquakes in Japan: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 2, no. 2, 5 pp., 1949.

The distribution of the passive seismicity index number for destructive earthquakes in historic time in and near Japan has been determined and is shown on a map. The index number, which expresses the "rate at which a place is attacked by earthquakes", is generally high along the Pacific coast.—*M. C. R.*

13622. Kawasumi, Hirosi. Measures of earthquake danger and expectancy of maximum intensity throughout Japan as inferred from the seismic activity in historical times: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 3, pp. 469–482, 1951.

Two charts of frequency and maximum acceleration to be expected in future earthquakes have been developed on the basis of a catalog of large earthquakes in historic times. The epicenters have been redetermined and magnitudes have been computed with reference to the Japanese seismic intensity scale, which can be related to the Richter magnitude by formulas which are given.—*L. E. B.*

13623. Lopez de Azcona, J. M. El problema de los microsismos [The problem of miscroseisms]: Inst. geol. min. España, notas y comunicaciones, no. 25, pp. 73–84, 1952.

This is a report of the discussions and resolutions adopted at the international conferences held at Rome in November 1951, under the direction of the Pontifical Academy of Sciences, on the nature and causes of microseismic disturbances.—*L. E. B.*

13624. Giorgi, Maurizio and Rosini, E. Sulla origine dei microsismi del Mediterraneo [On the origin of microseisms in the Mediterranean]: Annali Geofis., v. 4, no. 4, pp. 479–492, 1951.

For more than 3 yr the Instituto Nazionale di Geofisica and Servizio Meteorologico dell' Aeronautica Italiana have been studying the correlation between

microseismic disturbances and meteorological factors, especially in the Mediterranean Sea area. These studies have led to the conclusion that microseismic disturbances originating in the Mediterranean Sea basin have no direct relation to atmospheric cold fronts, but are generated over open spaces of the sea in zones containing centers of positive barometric gradients following the cold fronts. Analyses of thermodynamic soundings indicate that the greatest microseismic effect is produced when the turbulent mass of cold air has a width of from 1–3 km.

The article contains detailed data on several microseismic storms. The transmission of atmospheric energy through the mass of water to the solid bottom of the ocean is also discussed.—*S. T. V.*

13625. Caloi, Pietro. Sull'origine dei microsismi con particolare riguardo all' alto Adriatico [On the origin of microseisms, with particular reference to the upper Adriatic] : Annali Geofis., v. 4, no. 4, pp. 525–577, 1951.

In 1936 Caloi suggested that the passage of cyclones over the upper Adriatic Sea produced microseismic disturbances, the intensity being greatest when the frequency of microbaric variations coincides with that of the natural waves. Special importance is to be attributed to centers of the cyclones characterized by positive barometric gradients.

This phenomenon represents a clear example of the transfer of energy from the turbulent atmosphere to the water and to the bottom of the sea in accordance with the theory suggested in 1929 by Proudman concerning the effect of changes in atmospheric pressure on the sea. This transfer of energy is especially noticeable in the upper part of Adriatic Sea because of its shallowness, but identical phenomena may be observed when cyclones are generated over other seas or over the ocean, because, as Stoneley puts it, standing waves will be set up near the centre of an atmospheric depression, especially if the depression is advancing with a velocity comparable with that of the progressive waves. Microseismic disturbances will be produced also by a wind blowing in a constant direction and with a proper velocity.

Thus necessary conditions for the generation of microseismic disturbances are established. To these must be added certain geologic properties of the sea bottom, which is to receive impulses of energy coming down across the water. In this respect it is interesting to point to different effects of identical atmospheric phenomena taking place simultaneously in the upper Adriatic and in the Strait of Messina.—*S. T. V.*

13626. Dessauer, F. Mikroschwankungen des Atmosphaüendruckes [Microvariations of barometric pressure] : Helvetica Physica Acta, v. 24, fasc. 6, pp. 587–590, 1951.

A brief report is presented of observations in Frankfort am Main, Germany, and in Fribourg, Switzerland, on quasi-periodic variations of atmospheric pressure. The most important result obtained was the establishment of barometric variation of 10^{-3} to 10^{-4} mm mercury column with periods ranging from 4–15 sec, related to microseismic disturbances. These variations of barometric pressure were also discovered by Gutenberg and Benioff in 1941.—*S. T. V.*

13627. Schaffhauser, J. Piezoelektrische Methode zur Messung von Luftdruckschwankungen [Piezoelectric method of measuring the variations of atmospheric pressure] : Helvetica Physica Acta, v. 24, fasc. 6, pp. 591–595, 1951.

For observation of the variations of barometric pressure a tripartite stations when studying microseismic disturbances a new design of microbarograph is suggested. It consists of a pressure pot covered with a membrane of 0.02 mm aluminium sheet, exercising pressure on a crystal microphone. A disadvantage of the new design is the necessity of having very high electrical insulation of the piezoelectric element. Details of the instrument are illustrated by several figures.—*S. T. V.*

13628. Vander Elst, N. Les installations météorologiques et géophysiques de Binza [Meteorological and geophysical installations at Binza]: Inst. royal colonial belge Bull., tome 22, fasc. 2, pp. 1–22, 1951.

The observatory at Binza near Leopoldville is described. Geophysical equipment includes Sprengnether seismographs, Askania magnetometers and gravimeter.—*M. C. R.*

RADIOACTIVITY

13629. Picciotto, E. E. Les phénomènes radioactifs en géologie [Radioactive phenomena in geology]: Soc. belge géologie Bull., tome 59 (1950), fasc. 1–2, pp. 102–135, 1951.

This is a brief review of radioactivity and its principal applications to geologic problems, such as the thermal history of the earth and age measurements, and to geochemistry and petrography.—*M. C. R.*

13630. Bruckshaw, J. M. The age of the earth: Royal Coll. Science Sci. Jour., v. 21, pp. 77–86, 1951.

This is the text of a lecture delivered before the Mathematical and Physical Society of the college. Determination of the age of the earth by the rate of formation of sediments, salt content of oceans, cooling of the earth, and radioactive methods is described.—*M. C. R.*

13631. Danilevich, S. I. Rol' kaliya v radioaktivnosti zemli po sovremennym dannym [The part of potassium in radioactivity of the earth according to recent data]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 1, pp. 3–11, 1952.

A review is given of experimental determinations of the radioactivity constants of potassium. These include the content of K^{40} in the total mass of the element, its half-life and the two constants of disintegration. The author assumes the most probable values of the combined constant of β and γ disintegration to be 5.54×10^{-10} per yr, and of the half-life 12.5×10^{8} yr. Thus the amount of heat produced in 1 yr by 1 g of potassium is 22.9×10^{-6} cals.

The amount of heat produced in one hour in the crust of the earth by the uranium, thorium, and potassium contained in it is computed as 21.6×10^{16}, 20.217×10^{16}, and 2.34×10^{16} cal at the present time. The same amounts 4×10^{9} yr ago produced 39.03×10^{16}, 25.13×10^{16}, and 21.00×10^{16} cal respectively. This shows that in previous geologic history the importance of potassium as a radioactive element was much greater than at present.—*S. T. V.*

13632. Hurley, P. M. Alpha ionization damage as a cause of low helium ratios: Am. Geophys. Union Trans., v. 33, no. 2, pp. 174–183, 1952.

Measurements on samples of granitic rocks have yielded widely scattered helium ratios, always lower than the geologic age of the rock, and with a distri-

bution of which the mean is about a quarter of the age of the rock. This paper describes an investigation of the possibility that helium atoms escape only when crystal structure of minerals become damaged by intense localizations of alpha-particle ionization. Escape of helium from zicron and sphene was found to be almost zero for low alpha bombardment and to increase progressively until almost all helium is lost where samples have undergone bombardment of 10^{16} alphas per mg. As the activity of the zircons is within the range where damage is important, it is concluded that one cause of the high loss of helium from granitic rocks is the concentration of radioactive elements and helium into centers in which the damage will be great enough for the helium to escape.—*M. C. R.*

13633. McCrady, Edward. The use of lead isotope ratios in estimating the age of the earth: Am. Geophys. Union Trans., v. 33, no. 2, pp. 156–170, 1952.

Gerling's, Houtermans', Holmes', and Bullard and Stanley's calculations of the age of the earth using Nier's determinations of lead isotope ratios in lead ores are reviewed. It is pointed out that more data are required to establish statistical validity for these methods. Further, the age of the ore may not be the age of the enclosing rocks. The difference in isotope ratios in a granite as a whole and in the orthoclase alone should represent the radiogenic additions between the time of solidification of the granite and the present, thus making it possible to calculate the age of the granite in years measured backward from now. The same data may provide basis for determining the age of the original crust. A least-squares analysis of data from isotope ratios in lead ores indicates a maximum age of 5.07×10^9 years.—*M. C. R.*

13634. Cooper, R. I. B. The distribution of radioactivity: Nature, v. 169, no. 4296, pp. 350–352, 1952.

Recent advances in knowledge of the distribution of radioactivity in rocks and meteorites were described by C. F. Davidson and F. A. Paneth at a "geophysical discussion." The influence of these new facts on ideas of the earth's interior was discussed by E. C. Bullard and others. Davidson's paper has been published in the Mining Magazine, December 1951.—*M. C. R.*

13635. Picciotto, E. E. Distribution de la radioactivité dans les roches éruptives [Distribution of radioactivity in eruptive rocks]: Soc. belge géologie Bull., tome 59, (1950), fasc. 1–2, pp. 170–189, 1951.

Distribution of uranium and thorium in two granites, an anorthosite, and a norite was studied with nuclear emulsions. In the granites, the radioelements are distributed in heterogeneous fashion. In the Vosges granite, more than 72 percent of the radioactivity was concentrated in the accessory minerals and crack fillings. A granite from Elba showed similar but even greater concentration of radioactivity. In the anorthosite and norite, radioactivity is more feeble and is homogeneously distributed, the different minerals having activities of the same order of magnitude.—*M. C. R.*

13636. Norin, Rolf. Radioactivity and rhythm of sedimentation: Geol. fören Stockholm förh. Band 73, Häfte 3, no. 466, pp. 406–408, 1951.

Close agreement is found between the maxima of electrolyte concentration and of radioactivity in drill cores from the Rhoetic-Liassic of northwestern Scania [Skåne]. Coincident with these maxima are coal seams, indicating a rhythmic coordination of geological processes.—*F. W. S.*

13637. Breger, I. A. and Whitehead, W. L. Radioactivity and the origin of petroleum: World Petroleum Cong., 3d session, The Hague, Proc., sec. 1, pp. 421–427, 1951.

Since 1942 the American Petroleum Institute has sponsored, at the Massachusetts Institute of Technology, a project to investigate the effect of radioactivity on the transformation of marine organic materials into petroleum hydrocarbons. To date it has been possible by bombardment of alpha particles to convert fatty acids into aliphatic hydrocarbons, to convert a naphthenic acid into a cyclic hydrocarbon by means of alpha-particle bombardment, and to produce gaseous hydrocarbons found in association with crude oils. A linear relationship is suggested between the organic matter and radioactive elements in marine organic shales.—*F. W. S.*

13638. Garrigue, Hubert. Recherches sur la radioactivité de l'air libre [Research on the radioactivity of free air]: Acad. Sci. Paris Comptes rendus, tome 233, no. 16, pp. 860–862, 1951.

Observations of the radioactivity of air at Puy-de-Dôme and in a "flying laboratory" indicate the presence of a radioactive substance with half-life of a few hours. It is suggested that the abundant precipitation, influenced by condensation nuclei from recent atomic explosions, has effectively washed the lower atmosphere.—*M. C. R.*

13639. Kulp, J. L., Tryon, L. E., and Feely, H. W. Techniques of natural carbon-14 determination: Am. Geophys. Union Trans., v. 33, no. 2, pp. 183–192, 1952.

Techniques used at the Lamont Geological Observatory for preparation and counting of the C^{14} in natural carbon-bearing samples are described in detail.—*M. C. R.*

13640. Kulp, J. L. Age measurements in marine cores by Carbon 14: Columbia Univ. Lamont Geol. Observatory Tech. Rept. 5, 11 pp., 1952.

Measurements of the concentration of natural radiocarbon in the carbonate phase of deep-sea sediments may be used to determine age and also in detecting such phenomena as reworking of sediments and turbidity current deposition. The carbon in the deposited carbonate does not seem to exchange appreciably with modern carbonate. The sedimentation rate of deep-sea foraminiferal clay in 10 to 20 cm per 1,000 yr, and that of globigerina ooze only 1 to 2 cm per 1,000 yr. The rate of sedimentation in atolls may be greater than 35 cm per year.—*M. C. R.*

13641. Roberts, F. H. H., Jr. Carbon-14 dates and archeology: Am. Geophys. Union Trans., v. 33, no. 2, pp. 170–174, 1952.

Carbon-14 dating of materials from various archeological sites indicate approximately 10,000 yr human occupation of the New World. Grouping of dates in 8,000–8,500, 7,000, and 4,000–5,000 yr categories may indicate a break in the occupation with recurring waves of migration. It is certain that beginning about 1,500 B. C. there was a marked increase in population and that it continued to expand until the arrival of white man.—*M. C. R.*

13642. Bliss, W. L. Radiocarbon contamination: Am. Antiquity, v. 17, no. 3, pp. 250–251, 1952.

Before rushing into a revision of archeological chronologies based upon the dates recently published in Memoir 8 of the Society of American Archaeology, the possibilities for the contamination of carbon should be considered. Two factors to be considered in contamination are time of and the amount of contamination. The six kinds of contaminations are: chemical, water, plant, bacteria and mold, animal, and mechanical. Controls are needed to provide data for accurate datings, and tests should be established for determining amounts of contamination.—*L. E. B.*

13643. Godwin, Harry. Comments on radiocarbon dating for samples from the British Isles: Am. Jour. Sci., v. 249, no. 4, pp. 301–307, 1951.

Results of radiocarbon assay of 12 samples from the British Isles are in general agreement of the expected age. One sample from Ireland and two from England from pollen zone 2 (the Allerod horizon) range from 9,861 to 11,310 yr, and confirm previous estimates of the age of this important time marker. Six postglacial samples have also been dated; one accords closely with expectation, while the dates for the others suggest discrepancies of about 1,000 yr.—*L. E. B.*

HEAT

13644. Valle, P. E. Sull' aumento di temperatura nel mantello della terra per compressione adiabatica [On the increase of the temperature in the mantle of the earth due to adiabatic compression]: Annali Geofis., v. 4, no. 4, pp. 475–478, 1951.

The increase of temperature in the interior of the earth caused by adiabatic compression is of great importance in many problems of geophysics. An evaluation of this temperature is made on the basis of the theory of elasticity of ideal solids by deriving an equation relating density, temperature, and the velocities of seismic waves, both longitudinal and transverse, in an earth mantle assumed to be perfectly elastic. Using the methods of statistical mechanics, a simple relation $T^3/\rho\ v_l\ v_t^2$=constant is derived. T is the absolute temperature, ρ the density at a point of earth's interior, v_l and v_t are the velocities of the longitudinal and transverse waves at the point considered. From a consideration of the depths 1,000, 2,600, and 2,898 km and the corresponding values of velocities and density taken from the seismological studies, the temperature at the top of the core is found to be 1.24 times that at the depth of 1,000 km if the compression of the mass is going on adiabaticaly.—*S. T. V.*

13645. Bankovskiy, V. A. Geotermicheskiye usloviya Nesvetayevo-Shakhtinskoy kotloviny [Geothermal conditions in the Nesvetayevo-Shakhta syncline]: Ugol', no. 1, pp. 26–27, 1952.

On the basis of an extrapolation of temperature measurements in 23 drill holes of depths ranging from 400 to 700 m, a map has been constructed of geoisothermal lines for a level of 100 m below sea level. V. N. Dakhnov's suggestion that the increase of geothermal gradient in anticlinal structures is caused by the greater conductivity of stratified formations along the plane of the strata is repeated. The effect of the greater penetration of water through the cracks in the domes of anticlines must also be taken into account.—*S. T. V.*

13646. Claude, Georges. Les anomalies thermiques de Pechelbronn [The thermal anomalies of Pechelbronn]: Acad. Sci. Paris Comptes rendus, tome 234, no. 4, pp. 458–460, 1952; and also Le Génie Civil, tome 129, no. 5, pp. 93–94, 1952.

The abnormal gradients observed in the Pechelbronn region (only 9 m per degree near Soultz-sous-Fôrets) cannot reasonably be attributed to the high is suggested that the high gradients may be due to a layer charged with superheated water which has flowed from the Vosges, Rhine, or Black Forest to depths where its critical temperature is 375° and then risen again under thermo-artesian pressure. Theoretically such a layer should cause a negative gravity anomaly, and it is noted that such an anomaly is indicated on the 1942 gravity map of Alsace.—*M. C. R.*

VOLCANOLOGY

13647. Thorarinson, Sigurður. The approach and beginning of the Hekla eruption. Eye-witness accounts *in* the eruption of Hekla, 1947–1948, Vísindafélag Íslendinga, v. 2, pt. 1, 23 pp., 1951.

The article includes a list of eye- and ear-witness accounts of the beginning of the eruption of Hekla. From these it is concluded that the visible eruption of Hekla was preceded by tremors and started at 6:41 A. M. (Icelandic time; 7:41 Gmt) on the northeast side of the old summit, with a rapid rise of a volcanic cloud, followed by an earthquake at 6:50. Centers of eruption soon appeared along the 3.5 km ridge of the mountain until the ridge seemed to be an unbroken line. Shortly after 7 o'clock the volume of volcanic clouds began to diminish, and the detonations to decrease in intensity.—*L. E. B.*

13648. Einarsson, Trausti. A study of the earliest photographs of the eruption *in* The eruption of Hekla, 1947–1948, Vísindafélag Íslendinga, v. 2, pt. 2, 15 pp., 1951.

This is a collection of photographs taken by eyewitnesses at different distances from a few to 124 km from the volcano Hekla. The first photographs were made within 10 min after the first eruption, and the remaining ones within the next few hours. A discussion of the phenomena, such as the heights of vapor clouds and the extent of the lava flows, as interpreted from the photographs is included.—*L. E. B.*

13649. Kjartansson, Guðmundur. Water and mud flows *in* The eruption of Hekla, 1947–1948, Vísindafélag Isendinga, v. 2, pt. 4, 51 pp., 1951.

In the first stages of the eruption of Hekla great water masses poured from all sides of the volcano. This hlaup (an Icelandic word denoting a sudden, often catastrophic, rush of a flood or avalanche) seems to have started on all sides of the mountain simultaneously, about a quarter of an hour after the first earthquake was felt. The volume of the hlaup has been estimated to be about 3 million cu m at the start and about 2 million cu m at Hella, 61 km from the base of Hekla. The gradual decrease was due to seepage into pervious lava, or the formation of stagnant pools.

Violent blasts of superheated steam, bombs, and ashes are thought to be the effective factors for melting the snow, but erupted water of an unestimable quantity was added to this melt water to constitute the hlaup. Volcanic bombs

with a specific gravity slightly exceeding that of water were the most conspicuous features among deposits. Their total mass has been estimated to be about 0.5 million tons. These hlaup bombs gave off their heat to the waters of the advancing floods, and maintained high temperatures even across glaciers, and at great distances from the volcano. Hlaups seem to be a common phenomenon accompanying Hekla eruptions.—*L. E. B.*

13650. Einarsson, Trausti. The rate of production of material during the eruption *in* The eruption of Hekla, 1947–1948, Vísindafélag Íslendinga, v. 4, pt. 2, 18 pp., 1951.

The volume of material produced in the first hour was about 180×10^6 cu m and appeared in the form of bombs and pumice; during the first 24 hr the rate of production was estimated to be 1,000 cu m per sec. On the second day there was a marked decrease to about 100 cu m per sec. One week later the production was about 1 cu m per sec, with lava issuing from the "lava crater". The total amount of material produced is estimated to correspond to 400×10^6 cu m compact lava.—*L. E. B.*

13651. Einarsson, Trausti. The flowing lava. Studies of its main physical and chemical properties *in* The eruption of Hekla, 1947–1948, Vísindafélag Íslendinga, v. 4, pt. 3, 70 pp., 1951.

This paper deals with observations and measurements of flowing and consolidated lavas from Hekla. The lava flow averaged 2 m to 5 m in thickness during the first days of the eruption. It was vesicular, entirely plastic, and advanced downhill at the rate of 1 m per min. The lava crossed and buried a snow sheet without melting any of the snow, as a carpet of cooled blocks from the top of the flow, fell beneath the advancing flow and acted as insulators. Lava flowed from the "lava crater", a hooflike incision in the steep slope of the mountain, and was confined to a narrow "river" open all the way down to the lowlands. Temperatures in the "lava crater" were about 1,000 C, and gases caused local reactions which raised the temperatures to 1,250 C or more.—*L. E. B.*

13652. Einarsson, Trausti. The basic mechanism of volcanic eruptions and the ultimate causes of volcanism *in* The eruption of Hekla, 1947–1948, Vísindafélag Íslendinga, v. 4, pt. 5, 30 pp., 1951.

In this brief review of volcanology in general, and of Iceland and Hekla in particular, the author discusses the possibility of a relation of volcanology and seismology. In Iceland, volcanism is attributed to the yield of the crust, in certain narrow belts, to regional shearing stresses, and the regional stresses are part of a universal crustal stress field, thought to result from subcrustal plastic movement. It is concluded that the source of the universal magma of plateau basalt type, must be a fluidlike universal layer lying at a depth of about 100 km. The viscosity in this layer must be far below 10^{20} poises and is probably below 10^{10} poises.—*L. E. B.*

13653. Einarsson, Trausti. Studies of the mechanism of explosive activity in the Hekla eruption *in* The eruption of Hekla, 1947–1948; Vísindafélag Íslendinga, v. 5, pt. 2, 54 pp., 1951.

In this paper observations of the four types of explosive activity during the eruption of Hekla are presented, and the mechanism underlying the explosive activity discussed. The initial phase was the vapor phase, consisting of the

violent outrush of water vapor. This was followed by the bomb phase, during which bread-crust bombs were hurled out, and the pumice phase. These first three phases lasted about one hour. The final or ash phase was a succession of separated explosions and lasted for about three months.

The cause of explosions is believed to be the escape into the air of the imprisoned water vapor in the magma. The observed fact that the vapor partly condensed immediately upon release into the atmosphere leads to the conclusion that the temperature of the vapor release from the magma must have been less than 300 C, and an estimate of the quantity of vapor relative to the magma production leads to the conclusion that the vapor was of meteoric origin, that it entered the magma at a shallow depth, possibly through the main fissure, and escaped into the air before attaining thermal equilibrium with the magma.—*L. E. B.*

13654. Bullard, F. M. Parícutin, Mexico's newest volcano: Tulsa Geol. Soc. Digest, v. 19, pp. 94–98, 1951.

This is a brief review of the activity of the Parícutin, from its birth in February 1943, thru June 1950.—*L. E. B.*

13655. Termer, Franz. Die Tätigkeit des Vulkans Parícutin (Mexico) im November 1949 [Activity of Parícutin Volcano in November 1949]: Geol. Rundschau, Band 39, Heft 1, pp. 95–98, 1951.

A brief report is presented about a trip made in November 1949 to the crater of Parícutin. The volcano was still quite active, throwing out masses of glowing magma every 2 to 8 min, ejecting clouds of steam and stones up to a height of 600 m and with lava continuously flowing in a stream about 80 m wide. The activity was substantially less than during the years 1943–48.—*S. T. V.*

13656. Cucuzza-Silvestri, Salvatore. L'eruzione dell' Etna del 1947, pt. 1 [The eruption of Mount Etna of 1947, Pt. 1]: Bull. volcanologique, ser. 2, tome 9, pp. 81–111, 1949.

A detailed logbook of observations of different phenomena accompanying the eruption of Mount Etna in February 1947, is presented. Observations at the volcanologic observatory near the summit of Mount Etna, those at the geophysical observatory of Catania, as well as many noninstrumental observations from various surrounding localities are included. This eruption is considered typical in all respects of eruptions of Mount Etna. No seismic shocks were noticed before or during the eruption. Included are 45 photographs illustrating various phases of the eruption.—*S. T. V.*

13657. Ponte, Gaetano. Riassunto delle principali osservazioni e ricerche fatte sull' Etna [Summary of the principal observations and research on Mount Etna]: Bull. volcanologique, ser. 2, tome 9, pp. 65–80, 1949.

This is a summary of the principal recent and current observations and investigations at the station on the summit of Mount Etna. These studies include all phases of volcanology as well as different methods of protection against danger and damage from volcanic eruptions. Seismic and tilt observations are being made, and gravitational, magnetic, and electrical surveys of the area are planned.

The following forms of eruptions can be distinguished on Mount Etna: "terminal" eruptions from the main crater, "lateral" ones from small craters rising on the sides of the volcano, and "subterminal" eruptions. The last subterminal eruption occurred in 1911 with the formation of a new large crater on the terminal cone of Mount Etna.

Other topics discussed are the various forms of effusions from the volcano, the behavior of the lava streams during cooling, formation of cavities and oblong galleries by the intense contraction of the lava on solidification, filling of these galleries with the new lava. Forms of explosions observed and their causes are also described.—*S. T. V.*

13658. Ichimura, Takeshi, Morimoto, Ryōhei, and Tsuya, Hiromichi. A brief note on the recent explosive activity of Volcano Yakeyama: Tokyo Univ. Earthquake Research Inst. Bull., v. 27, pt. 1–4, pp. 107–114, 1949.

The eruption of Yake-yama in February 1949, was a sudden explosion of volcanic ash and steam. The article describes the eruption, mud flow, and fumaroles, and presents a geologic and petrographic report on the volcano and its ejecta.—*L. E. B.*

13659. Minakami, Takeshi. On the temperature and viscosity of the fresh lava extruded in the 1951 Oo-sima eruption: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 3, pp. 487–498, 1951.

In the eruption of Oo-sima [Ō-shima] on March 19, 1951, measurements were made of fresh lava temperatures, both external and internal, and viscosity determined from measurements of thickness, width, and inclination of slope, and maximum rate of flow. The internal temperature was found to be 1,000–1,030 C at a distance of 500 m from the source, while at the source it was 1,125 C; the viscosity was 5.6×10^3 poises. Laboratory experiments using remelted lava from various volcanoes, including Ō-shima, showed that at temperature of 1,150 C, the remelt had a viscosity of 5×10^4 poises; lavas in the natural state at the same temperature had a viscosity of only 4×10^3 poises. The difference is attributed to the richer gas content of the natural lava.—*L. E. B.*

13660. Richter, N. Mondkraterformationen auf der Erde [Formation of moon craters on the earth]: Geofis. Pura e Appl., v. 20, pp. 15–23, 1951.

In discussions on the origin of craters on the surface of the moon, the statement is often made that no craters of similar form are found on the earth. However, there are several volcanic craters found on the surface of the earth having a form similar to those on the moon. Most of these craters are found in equatorial Africa. A table is given listing main features of these craters and comparing them with the craters found on the moon.—*S. T. V.*

13661. Martel Sangil, Manuel. Genesis del Archipiélago Canario [The genesis of the Canary Islands]: Inst. geol. Lucas Mallada (Madrid) Estudios geol., tomo 7, no. 13, pp. 69–80, 1951.

A review is presented of different hypotheses concerning the origin of Canary Islands. These islands are considered by some to be a remnant of previously existing continents, and their formation is attributed by others to a series of volcanic eruptions, first submarine, later taking place above sea level. On the basis of traces of extensive volcanic activity found everywhere on these islands a theory is advanced that the islands were created by subcrustal currents of sima producing first a folding of the sialic layer and finally its fracture.—*S. T. V.*

13662. Cabrera Kabana, Manuel. Sobre el origen del Archipiélago canario [On the origin of Canary Islands]: Inst. geol. y min. España, notas y comunicaciones, no. 25. pp. 153–160, 1952.

Three theories have been advanced concerning the origin of Canary Islands. The first hypothesis, that these islands are the remaining fragments of the mythical Atlantis, is now considered a poetic legend. Two new hypotheses concerning the origin of this archipelago are advanced. According to more recent hypotheses, the Canary Islands are the result of a splitting off of the northwestern extremity of the mountains along the northern coast of Africa, or the result of local submarine volcanic activity. The latter is considered more probable.—*S. T. V.*

TECHTONOPHYSICS

13663. Van Bemmelen, R. W. The endogenic energy of the earth: Am. Jour. Sci., v. 250, no. 2, pp. 104–117, 1952.

Deformations and transformations which have occurred throughout the entire span of the earth's existence, as well as those in evidence today, testify to the presence of endogenic energy within the earth. Terrestrial energy is an inheritance from the protoplanetary state of evolution; it may be stored and liberated within the earth by: thermal vibration of atoms—the internal heat; nuclear fission of natural radioactive elements; and interatomic physicochemical forces. Besides these terrestrial energy reserves, there is the potential energy of the gravitational field, together with the kinetic energy of the earth's rotation. In the thermal conception, convection currents play the leading role, the premise in these being a state of chemical homogeneity in the substratum. Since cosmological, geochemical and seismologic evidence is at variance with this premise, hypotheses which deal with thermal energy sources alone cannot explain all geologic evolution.

The possibility is considered that the energy source is rather of a chemical nature. Deviations in the force of gravity, and the resulting mass displacements and tectonic deformations can originate by gravity field changes due to cosmic forces, the distribution of matter remaining constant, or by changes in the distribution of matter resulting in deviations from gravitational equilibrium. Changes in earth constants (such as rotation, pole locations, tidal movements) may have been important in early stages of earth development, but not in the geologic era. In addition, the present geotectonic relief does not represent gravitational equilibrium. The systematic relationship between tectonic and igneous processes show that the physical and chemical properties of crustal matter vary in the course of geologic evolution. The earth's history seems to be a complicated story of physicochemical chain reactions resulting in the manifold deformations and transformations. It is suggested that the cosmic cooling of the earth, possibly a sudden cooling due to the expulsion of the moon in the earlier stages of earth evolution, has thrown the earth's silicate mantle out of its chemical equilibrium. Restoration of the physicochemical balance in the silicate mantle, especially in the outer part, effected by chain reactions, and largely retarded by undercooling, is supposed to be the fundamental source of endogenic terrestrial energy.—*R. W. J.*

13664. Quiring, Heinrich L. Ejektion und 3. Keplersches Gesetz. Kinematik und Energetik der Mondausschleuderung [Ejection and the 3rd law of Kepler. Kinematics and energetics of the ejection of the moon]: Gerlands Beitr. Geophysik, Band 62, Heft 2, pp. 81–99, 1952.

Kinetic relations at the moment of separation of the moon from the earth are analyzed by the principles of theoretical mechanics under the assumption that no external celestial body acted in the process and that the explosive forces producing ejection were of the same kind as in any volcanic eruption but of a much greater intensity. The physical reality of such forces is postulated because of the great depth of the portion of the ejected mass, as can be concluded from geologic evidence. Brought to the surface of the earth, these deep-lying masses expanded explosively up to 100,000 times their initial volume thus producing great propulsive effects. Among the consequences of the ejection of the moon are the shortening of the day and a substantial change in the inclination of the earth's axis to the plane of ecliptic, producing an abrupt change in the climate of different parts of the earth.—*S. T. V.*

13665. Nadai, A. L. Stress and strain in the outer solid shell of the earth: Am. Geophys. Union Trans., v. 33, no. 2, pp. 247–276, 1952.

With comparatively simple means, expressions are developed for the distribution of stresses and for both components of the displacements in radial and in tangential direction over extended portions in the thin solid shell of the earth. The problem is solved for the distribution of stress and elastic strain in this thin, solid, spherical shell under the action of the tide-generating forces of the moon and sun by making use of the theory of thin, curved elastic shells. The stresses and the cyclically changing components of the elastic displacements in tangential direction permit drawing some conclusions concerning the permanent distortions to be expected in such a shell by considering the mechanical properties of the rocks under the high temperatures prevailing at the lower levels in the thin, solid shell of the earth.—*Author's abstract.*

13666. Kulikov, K. A. Dvizheniye polyusov zemli i ismenyayemost' shirot [The displacement of the poles and the variation of latitudes]: Uspekhi astron. Nauk, tom 5, pp. 111–135, 1950.

Toward the end of the 19th century Euler found theoretically that the axis of rotation of the earth cannot remain constant, but describes a conical surface with very small angle at the vortex. Since the beginning of this century a number of astronomical observatories, situated on the same latitude circle, make regular determinations of their latitude. The most reliable data, obtained at Greenwich and at the Naval Observatory in Washington, indicated an angular variation of the axis of about 0.025 sec. From these data Chandler found two superimposed periodic variations of the earth's axis, one of 14-, and another of 12-months period. The generally accepted explanation attributes this movement to seasonal transfer of the air and vapor masses from one hemisphere to another.

Certain differences in the variation of latitude determined by different observatories may be explained by local displacements of subcrustal masses affecting the direction of the vertical. In contrast Japanese geophysicists take these local changes in latitude to be proof of local horizontal displacements of the crust.—*S. T. V.*

13667. Takeuchi, Hitoshi. On the earth tide in the compressible earth of varying density and elasticity: Tokyo Univ. Fac. Sci. Jour., Sec. 2, v. 7, pt. 2, pp. 1–153, 1951.

To infer the internal constitution of the earth by means of theoretical studies of earth tides, values of the density and elastic constants are used which are compatible with those obtained through the investigations of modern seismology.

In developing the equations for the earth tides, the following assumptions were made: The earth is in a state of initial stress which may be regarded as a hydrostatic pressure balancing the self-gravitation of the earth; earth stresses consist of both initial stress and an additional applied stress; the additional strain which results from additional stress is measured from the initial state and is connected with the additional stress through Hooke's Law; the density, hydrostatic pressure, the potential due to the initial stress and the elastic constants are functions only of the distance, r, from the center of the earth.

At any point there exists the potential, $V=V_0+K$ where V_0 is the potential of the gravitational forces at the initial state and K is a small perturbing potential due to the tide-generating forces and the deformation of the earth resulting therefrom. Assuming K may be expressed as $K=K_nW_n$ where K_n is a function of r only and the displacements u, v, w may be expressed in terms of $F_n(r)$ and $G_n(r)$ which are also functions of r only, then three linear differential equations are obtained which may be solved for F_n, G_n, and K_n.

The following boundary conditions must also be satisfied: At discontinuous surfaces the displacement, stress, and potential measured from the initial state is continuous; at discontinuities of surface density the difference of the potential gradients $\delta K/\delta r$ without and within the surface equals $-4\pi f$ times the surface density where f is Newton's gravitation constant; the normal and shear stresses at the surface of the earth are zero.

To solve the fundamental differential equations with the prescribed boundary conditions, a numerical integration was performed for the case of equilibrium tidal deformation of the earth and also for the case of a normal load on the earth's surface. The following numerical data were used in the evaluation: Determinations of velocities P and S waves within the earth obtained by Gutenburg and Wadati; density distribution by Bullen; density at the earth's surface of both 3.0 and 2.7; discontinuities at 500 kms and 2,900 kms; in the liquid core below 2,900 kms, the rigidity $\mu=0$.

The results of the calculations were compared with the results of observations of the following: reduction of oceanic tides by the earth tide; horizontal pendulums; water-pipe tiltmeters; Chandler's motion of the rotation axis of the earth; gravimeters; tidal variation of the latitude; annual variation of the latitude; tilting of the earth's surface by oceanic tides.

It is found that the observational results agree quite well with the computations. Thus the internal constitution of the earth inferred from the results of investigations of modern seismology is compatible with that inferred from the earth tide.—*I. Z.*

13668. Takeuchi, Hitoshi. Equations of motion of self-gravitating elastic sphere of variable density and elasticity: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 2, no. 15, 16 pp. 1949.

The assuptions involved, the boundary conditions, the method of solution, and the differential equations of motion are all discussed in abstract no. 13667.—*I. Z.*

13669. Tsuboi, Chuji. Apparent change in inclination of the base line rhombus at Mitaka: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 2, no. 1, 7 pp., 1949.

A rhombus of five short geodetic base lines, each about 100 m in length, at the Tokyo astronomical observatory in Mitaka [Mitakamachi], had been precisely measured 29 times from 1919 to 1943, and the measurements show there is a measurable variation in length. On 19 of the 29 measurements, the relative heights of the terminal points of the base lines were also determined by means of precise leveling. The present study shows a discrepancy in the figuring of the northward tilt. The curves of dilatation and of the eastward tilt were compared, and were found to be opposite before the 1923 earthquake, and parallel after that date. This is the only feature that can be stated with some certainty to have a connection with the occurrence of strong earthquakes.—*L. E. B.*

13670. Hagiwara, Takahiro, Rikitake, Tsuneji; and Yamada, Juhei. Observations of the deformation of the Earth's surface at Aburatsubo, Miura Peninsula. Pt. 1: Tokyo Univ. Earthquake Research Inst. Bull. v. 26 pts. 1–4, pp. 23–26, 1948.

This is the first of four articles in a study of the secular deformation of a peninsula at Aburatsubo [Aburatubo-wan], near the southern extremity of the Miura Peninsula [Miura-hantō], Japan. Part 1 describes the instruments used: a pair of Ishimoto-type all-silica tiltmeters; a pair of water-tube tiltmeters with a remote control device; and silica-tube extensometers of various types, all of which were installed in a horizontal gallery drilled in Tertiary sandstone.

The authors found that the extension and contraction of the earth's surface due to the ocean tide were very large, of the order of 10^{-7} to 10^{-6} per unit length.—*L. E. B.*

13671. Hagiwara, Takahiro; Rikitake, Tsuneji; Kasahara, Keichi; and Yamada, Juhei. Observations of the deformation of the Earth's surface at Aburatsubo, Miura Peninsula. Pt. 2: Tokyo Univ. Earthquake Research Inst. Bull., v 27, pts. 1–4, pp. 36–38, 1949.

The observed deformation was considered to be due to the variation of the load of sea water because the records showed a remarkable parallelism between the mode of variation of the ocean tide and the extension and the tilting of the earth's surfaec.—*L. E. B.*

13672. Hagiwara, Takahiro; Rikitake, Tsuneji; Kasahara, Keichi; and Yamada, Juhei. Observations of the deformation of the Earth's surface at Aburatsubo, Miura Peninsula. Pt. 3: Tokyo Univ. Earthquake Research Inst. Bull., v. 27, pts. 1–4, pp. 39–44, 1949.

From formulas and experimental studies using agar-agar models, it is concluded that the actual topography around the observing point approximately satisfies the conditions of a plain surface, and that the influence of topography is small. Deformations due to tidal load were found to be so complicated that an explanation by the simple theory of a semi-infinite elastic earth is not possible.—*L. E. B.*

13673. Hagiwara, Takahiro; Kasahara, Keichi; Yamada, Juhei; and Saito, Sadao. Observation of the deformation of the Earth's surface at Aburatsubo, Miura Peninsula. Pt. 4: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 3, pp. 455–468, 1951.

This paper discusses secular variation of the inclination of the earth's crust. Precise leveling proved to be more effective in measuring the deformation. The inclination, as measured by precise leveling, was toward the south, and the value of linear strain as measured by the instruments varied about 10^{-6} in a year, a figure which agrees with the changes in the base lines of the rhombus in the compound of the Tokyo astronomical observatory at Mitaka.—*L. E. B.*

13674. Brouwer, H. A. The movement of island arcs: Geol. Soc. London Quarterly Jour., v. 106, pt. 2, no. 422, pp. 231–239, 1951.

Ideas on the origin and movement of island arcs are summarized in this, the sixth William Smith lecture.—*M. C. R.*

13675. Vening Meinesz, F. A. A third arc in many island arc areas: K. Nederland, Akad. Wetensch. Proc., Ser. B., v. 54, no. 5, pp. 432–442, 1951.

Three island-arc areas, the Antillean, Mariana, and Banda show, in addition to the volcanic island arcs and their accompanying outside tectonic arc, a third arc on the inside of the volcanic island arc. This third arc is seldom elevated above sea level and is not characterized by strong volcanicity, folding, or seismicity.

Local convection currents of a few million years duration in the substratum caused by a downwarping of the sial and an accompanying temperature gradient, due to the higher content of radioactive material in the sialic material, are postulated as the mechanism of formation of the island arcs and the accompanying inner and outer arcs. Such currents in addition to providing for subsidence by the sinking of low-temperature material and elevation by the rising of high-temperature material also result in shear to horizontal drag exerted by the current. Compressional stresses of 10,000 kg per cm^2, far in excess of what the crust can withstand, may be produced by these combined effects.

If the currents have depth dimension comparable to the thickness of the earth's mantle and last several tens of millions of years, they can also bring about great geosynclinal development.—*W. J. D.*

13676. Shimozuru, Daisuke. Dynamical measurement of the elastic constants of rocks subjected to initial stresses. Measurement of Young's Modulus under uniaxial compression: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 1, pp. 63–69, 1952.

A rectangular rock specimen is suitably supported and compressed in a testing machine and then forced into vibration. The resonant frequency is determined and from this Young's modulus is calculated. Basalt and granite show rapid increase of Young's modulus with increased compression, apparently because of compaction of the rock by closing of minute cracks and cavities. Pitchstone and andesite with glassy groundmass show little increase of Young's modulus with increasing compression. Rock with high initial Young's modulus shows little change of Young's modulus with stress.—*J. R. B.*

13677. Shimazu, Yasuo and Takeuchi, Hitoshi. Effect of tension upon the elastic parameters of isotropic solids: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 2, no. 23, 6 pp., 1949.

A solution is given of the problem of small deformations given to a solid which is originally under tensions of arbitrary magnitude along three mutually perpendicular directions. The complete expressions for the coefficients of

the additional strains are given in terms of the elastic constants, the given tensions and the coefficients for the strain invariants of the third order.—*I. Z.*

13678. Eardley, A. J. Tectonic divisions of North America: Tulsa Geol. Soc. Digest, v. 19, pp. 60–67, 1951.

This lecture was presented as one of the Distinguished Lectures of the American Association of Petroleum Geologists in 1951. It reviews the tectonic divisions of North America.—*L. E. B.*

INTERNAL CONSTITUTION

13679. Jeffreys, Harold. Origin of the earth: Nature, v. 169, no. 4294, pp. 260–261, 1952.

This is a review of Urey's paper in Geochimica et Cosmochimica Acta. Certain difficulties are pointed out, and it is indicated that the theory needs considerable modification although "it is certainly stimulating."—*M. C. R.*

13680. Borchert, H., and Trögen, E. Zur Gliederung der Erdkruste nach geophysikalischen und petrologischen Gesichtspunkten [On the layering of the Earth's crust from geophysical and petrologic points of view]: Gerlands Beitr. Geophysik, Band 62, Heft 2, pp. 100–126, 1952.

The crust of the earth may be divided into several shells with sharply pronounced petrologic properties. Beneath the lower boundary of crystalline schists and granite is a layer of gabbro, 20 to 40 km thick, succeeded to a depth of 60 km by pyroxenite and peridotite. Still deeper is a layer resembling eclogite and beyond it a transitional zone to a very viscous, basaltic magma. It is concluded that the sialic shell was initially formed of an unique basaltic molten substance, the remnants of which are found now in the South African diamond pipes. Petrologic development of other shells are also discussed.—*S. T. V.*

13681. Umbgrove, J. H. F. A model of the earth's crust: K. Nederland. Akad. Wetensch. Proc., ser. B, v. 54, no. 5, pp. 443–448, 1951.

A diagram of horizontal layering from the surface of the earth to the asthenosphere where the material can resist only small stress differences is presented and discussed. The upper layer has a thickness of 10 km, a density of 2.7, and velocity of longitudinal waves 6.10–6.13 kmps. In mountain roots the lower surfaces of this layer are 20 km deep. The layer thins toward the continental margin and is absent in the oceanic sector.

The intermediate layer is 25 km thick in the continental sector, has a density of 3.0, and a longitudinal-velocity range of 6.3–7.3 kmps. This layer rises to a depth of only 5 km and a thickness of less than 10 km in the oceanic sector. The base of this intermediate layer is the Mohorovičić discontinuity.

The lower layer, which has a density range of 3.27–3.30 kmps and longitudinal wave velocity of 8.1–8.2 kmps, is most evident in the oceanic and continental margin area and is less easily distinguished in the continental and mountain root sections where the Mohorovičić discontinuity and the asthenosphere are closer together and may coincide.

The lower boundary of the earth's crust is taken to be 45 km deep but depths of 40 to 35 km can also be calculated assuming the density of molten basaltic material to be 2.6 and 2.5 respectively.—*W. J. D.*

13682. Birch, Francis. Elasticity and constitution of the earth's interior: New York Acad. Sci. Trans., ser. 2, v. 14, pp. 72–76, 1951.

Experiment and the theory of elasticity in condensed matter will give a clearer understanding of the physical principles of seismology. Two facts are outstanding: at a depth of 2,900 km there exist two modes of propagation for elastic waves, compressional and rotational; and a discontinuity exists in the velocity, and the rotational waves disappear at this depth. This disappearance leads to the supposition that the core of the earth is liquid, a supposition supported by the studies of earth tides and variation of latitude.

The Adams-Williamson method is examined and improvements are introduced which allow for departures from adiabatic compression due to variation in temperature. The "typical values" from the Adams-Williamson equation are used to calculate the expected rate of variation with depth of the quantity, $\phi = V_p^2 - 4/3\ V_s^2$ where V_p and V_s are the velocities of compressional and rotational wave, and the results are compared with variation in seismic velocities for the given depth. The comparison of the two between a depth of several hundred to 900 km gives deviations much too great to be explained by compression of a uniform material, and hence this region cannot be homogeneous. Below the 900 km level and down to the 2,900 km discontinuity the seismic values compare favorably with the expected values for ϕ and this is the locus of the homogeneous material, if such exists in the mantle.

If a homogeneous condition is accepted, it becomes possible to find a value for ϕ at zero pressure, and the ratio obtained is $51\,(\mathrm{km/sec})^2$. The room-temperature value for the material between 900 and 2,900 km is probably about $60\,(\mathrm{km/sec})^2$. A table shown gives values of ϕ for some materials, and the silicates are all too low, with olivine being far too low. No known material with a plausible composition has the required elasticity; thus a new phase or phases must exist in this layer. This supports the conclusion that it is a transition layer in which the composition or phase or both must change. The solution is approached in the consideration of eclogite as the principal component of the mantle. The great thickness of this transition layer makes unlikely the persistence of a single phase change spread across such a range of pressure, and it is hypothesized that a multicomponent system is involved, with gradual changes in phase as well as in chemical composition. The transition layer may hold the key to such geophysical phenomena as earthquakes, orogeny, and thermal convections. The composition of the inner core is suggested to be alloys of iron and the abundant lighter elements.—*R. W. J.*

13683. Berlage, H. P. Some remarks on the internal constitution of the bodies of the solar system: K. Nederland. Akad. Wetensch. Proc., v. 54, no. 4, Ser. B., pp. 344–349, 1951.

If the mean densities of the bodies of the solar system are plotted as a function of their masses, these bodies lie within a narrow belt with a pronounced maximum for the Earth and a bifurcation into two distinct limbs for the smaller bodies. With increasing mass this belt may be extended to an asymptotic termination in the Sun's mean density or it may be produced upward toward the hypothetical white dwarf star which would result from the Sun's degeneration. The decreasing branch with bodies larger than the Earth is the result of increasing gravitational attraction of the lighter elements. The increasing branch with bodies smaller than the Earth may be the result of increasing compression with probable transition of elements to atomic phases in the core. The large

variation among the smaller bodies suggests a marked difference in composition between them. While iron may be a major constituent of the inner, smaller planets, it may be scarce in the larger planets. Pending a more accurate determination of the mean density of Pluto the relation between the origin and composition of the planets cannot be determined.—*E. K.*

EXPLORATION GEOPHYSICS

GENERAL

13684. Favre, B. Les méthodes géophysiques de recherche du pétrole [Geophysical methods of exploration for petroleum]: Assoc. Ing. Fac. Polytech. Mons Pub., fasc. 4, pp. 37–52, 1951.

Magnetic, gravimetric, electric, and seismic methods of exploration are reviewed.—*M. C. R.*

13685. Garcia Gutiérrez, Luis. La exploraciôn geologica minera [Geologic exploration in the mining industry]: Rev. minera petrolera, v. 17, no. 218–219, pp. 9–12, 1952.

The different possibilities of exploring a given area are briefly reviewed. Among geologic methods, as contrasted to exploratory drilling, are mentioned the magnetic, electrical, seismic, gravimetric and radioactive methods of exploration. The importance of simultaneous application of several geophysical methods to the same problem is emphasized.—*S. T. V.*

13686. Houghton, H. M. Five years of geophysics in western Canada: Oil in Canada, v. 4, no. 29, pp. 19–24, 1952.

This paper was presented at the meetings of the Canadian Society of Exploration Geophysicists in Calgary in May 1952, and the American Association of Petroleum Geologists in Los Angeles in March 1952. It is chiefly a statistical study of operational problems peculiar to the bush country in northwestern Alberta.—*M. C. R.*

13687. Ferrer, Arturo, Serra, Nicolas, Holmer, Ralph, and Taylor, E. F. History and status of petroleum exploration in Uruguay: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 4, pp. 677–687, 1952.

Petroleum exploration in Uruguay is being conducted by agencies of the Uruguayan Government in cooperation with North American specialists. Exploration began with geologic studies, and at present geophysical surveys, using gravity, magnetic and electrical-resistivity methods, are being made of the basalt-covered basin in the northwestern section. Methods now in use may provide satisfactory information on structural trends below the basalt. It is planned to drill test wells after suitable locations have been determined.—*L. E. B.*

13688. Brasil Conselho nacional do petrólio. Relatório de 1950. [Annual report of 1950]: Rio de Janeiro, 245 pp., 1951.

This annual report of the Conselho Nacional do Petróleo includes a short description of the geologic and geophysical exploration done in 1950 in the important river basins and in the states of Brazil. Geologic, gravity and structural maps are included in all sections, and a map of the crystalline basement of the Amazon basin, determined from seismic data.—*L. E. B.*

13689. Gees, R. H. El desarrolo de los métodos de investigación geofísicos en Alemania a partir de 1945 [The development of geophysical methods of exploration in Germany since 1945]: Rev. Geofís., v. 10, no. 39, pp. 180–207, 1951.

This is a review of geophysical exploration in northwestern Germany. Gravitational, electrical, magnetic and seismic methods were employed, mostly in search for oil. Some prospecting was also done for sweet water on the islands of North Sea. Differences in the specific resistivity of strata containing salt water and those containing sweet water made it possible to use electrical methods for localization of usable water deposits. The importance of the use of different geophysical methods of exploration is emphasized, and several examples of their effective combination are quoted.—*S. T. V.*

13690. Marin y Bertran de Lis, Agustin. Visita a los campos petroliferos de Alemania Occidental [A visit to oil fields of western Germany]: Minería y Metalurgia, no. 127, pp. 9–21, 1951.

A brief description is given of geologic features of the most important oil fields of northwestern Germany which now have a monthly production of more than 100,000 tons. The scientific level of exploratory work of German geophysicists is emphasized. The principal methods employed are seismic, both refraction and reflection, but gravimetric, magnetic, and electrical methods also contribute to success of prospecting, which in some instances is outstanding. In Georgsdorf oil field eight of twelve drill holes indicated geophysically were found to be productive.—*S. T. V.*

13691. Vajk, Raoul. Geophysical exploration of southwest Hungary: Geophysics, v. 17, no. 2, pp. 278–310, 1952.

Geophysical exploration of an 8,000,000-acre oil concession in southwest Hungary during 1933–43 included about 20,000 torsion balance, 12,000 gravitymeter, and 15,000 magnetometer stations and reflection seismograms at 2,500 shot points. Results are presented as gravity, magnetic, seismic, and tectonic maps and discussed in some detail. The gravity data were especially useful in structural interpretations.—*M. C. R.*

13692. Sorge, B. W. Safety and geophysical exploration: Geophysics, v. 16, no. 2, pp. 236–243, 1952.

The safety and accident-prevention record of geophysical operations has substantially improved during the last decade. But safety records can still be improved through the cooperation of geophysical operators with each other, with established safety agencies, and with the special committee on safety of the Society of Exploration Geophysicists. A list of the basic requirements for a safety program is presented and discussed.—*L. E. B.*

13693. Cram, I. H. Exploratory bottlenecks: Tulsa Geol. Soc. Digest, v. 19, pp. 89–93, 1951.

The author lists potential bottlenecks in the exploration for oil, as the lack of knowledge of the origin and migration of petroleum; failure to develop new trap-finding tools; mental inertia founded upon insufficient knowledge, imagination, and courage; lack of team work among the organizations; the political-economic climate; and the geologist himself, who through lack of exploratory leadership may slow up progress.— *L. E. B.*

GRAVITY METHODS

13694. Grant, F. S. Three dimensional interpretation of gravitational anomalies: Geophysics, v. 17, no. 2, pp. 344–365, 1952.

By considering the series expansion of the gravitational potential, any closed distribution of mass may be replaced by a point mass, a triple of dipoles, a quintuple of quadrupoles, and a septuple of octupoles all superposed at some given point in the body without affecting the external field in any way. This is tantamount to using multipoles up to and including order 3, the higher order terms being neglected since they represent a contribution beyond the sensitivity of the instrument. For large distances between observer and mass, the first order term predominates. As the distance becomes smaller, the higher order terms become more important. Formulas are derived for calculating the moments in terms of derivatives of the known surface field. If the density contrast of the mass is known, the shape and dimensions may be approximately determined.

Calculation of the moments are simplified by introducing the concept of symmetry groups analogous to those used in crystallography. Any mass distribution is then classified as belonging to one of these groups. Further simplifications are made by considering the origin of coordinates at the center of gravity of the body and allowing one of the body axes to lie along the line of greatest symmetry. Moments are evaluated for several of the symmetry groups. A method is given for locating on the ground the position of the center of gravity of any anomalous material. The relation method is described which adjusts the initial solution to give better agreement over the whole field.—*I. Z.*

13695. Gassmann, Fritz. Graphical evaluation of the anomalies of gravity and of the magnetic field, caused by three-dimensional bodies: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 1, pp. 613–621, 1951.

A graphical method is presented for evaluating the gravitational or magnetic field of bodies of any given shape. The formula for the gravity anomaly at a point A of space due to a body of constant density is written in spherical coordinates with origin at A. The triple integration is accomplished in two steps. With the aid of a contour map of the body on the horizontal plane and a simple circle graph a "concentrate" of the body is obtained in a vertical plane. A reticule consisting of circles and radial lines is used in carrying out the double integration in the vertical plane. The method can be used to evaluate integrals whose integrands are products of more general functions of the separate spherical coordinates.—*R. G. H.*

13696. Nepomnyashchikh, A. A. Logarifmicheskiye gravitatsionnyye paletki [Logarithmic master charts for gravitational surveys]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 1, pp. 40–46, 1952.

Putting the known expressions of the second derivatives V''_{xz} and V''_{yz} of the potential function V into logarithmic form, equations are obtained of the kind $\log V''/K = \log \sigma + \log F\ x/h$, where K is the gravitational constant, σ the density of the body, x the corresponding horizontal coordinate, and h the depth of the disturbing body. Graphs constructed for this equation with different values of σ have identical shapes, being displaced up or down on the ordinate axis. If this construction is performed taking an abscissae, $\log x/h$, instead of x/h, new graphs are obtained whose shape is also independent of h. The equation of the latter will be $\log V''/K = log\ \sigma + \log F\ (\log x - \log h)$.

Sixty-six master charts of the last equation were constructed for bodies of different geometric shapes, buried parallel to the surface of the earth or inclined to it. These charts were found very useful in interpreting the results of gravitational surveys.—*S. T. V.*

13697. Rogers, G. R. Subsurface gravity measurements: Geophysics, v. 17, no. 2, pp. 365–377, 1952.

Vertical gravity measurements in a vertical mine shaft were made at approximately 100-ft intervals and an anomalous gravity field, due to a sulfide ore body penetrated by the shaft, was disclosed. Three Worden and one Frost gravity meters were used and simultaneous readings were made to —1,242 ft, with two meters mounted on a dinky cage. Measurements at greater depths, to the lowest level at —2,916 ft, were made from firm "set-ups" in mine workings within 20 ft of the shaft center line.

Topographic corrections were applied and the Bouguer anomaly calculated and plotted to an arbitrary datum of zero at the shaft collar. It is shown from these data that changes in density contrast between each pair of stations can be calculated. These are tabulated.

Comparison of the results with a theoretical curve of gravity above, through, and below a sphere of density contrast 1.0 shows good correlation for the upper positive portion of the anomaly but poor for the lower negative portion. This may be due to sulfides known to extend below the limits of the theoretical sphere.—*W. J. D.*

13698. Solaini, Luigi. Principal characteristics and results of the gravimetric surveys made in Italy for oil and gas exploration: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 1, pp. 240–254, 1951.

Gravimetric surveys to aid in oil and gas prospecting in northern Italy have been made during recent years by the Institute of Applied Geophysics of the Politecnico, Milan. A total of 3,500 stations was occupied in an area of 7,000 sq km. Additional earlier surveys in the Po valley and other areas covering some 74,000 sq km were made in less detail by other organizations.

The earlier surveys indicated the major structural features, which are considered related to uplift of Cretaceous and Miocene formations, and in some places to the presence of igneous rocks. The main present problem in the northern Italian plains is to detect small gravity anomalies associated with individual sedimentary structures, above a background of large and complex regional anomalies. This can be resolved within limits by choosing station densities commensurate with the complexity and gradient of regional anomalies, so that local residuals as small as 0.2 mgal can be identified.

A graphic method was used to remove regional anomalies. Good qualitative agreement was generally found between the resulting residuals and sedimentary structures. A number of these anomalies are discussed with reference to structural and stratigraphic features as outlined by reflection seismic surveys and drilling.

The author concludes that gravity surveys are suitable for indicating structures lying at shallow to intermediate depth in the Po valley.—*H. R. J.*

13699. Weiss, Oscar. Contribution of geophysical surveys to the discovery of Stilfontein Gold Mine in South Africa: Mining Engineering, v. 3, no. 10, pp. 886–890, 1951; Am. Inst. Min. Met. Eng. Trans., v. 190, pp. 886–890, 1951; also summarized in Mining Mag., v. 85, no. 5, pp. 315–316, 1951.

Stilfontein and surrounding areas in the Klerksdorf district of the Transvaal are covered by dolomites and lavas that overlie the much-faulted Witwatersrand system, but efforts to locate gold-bearing reefs by drilling have been unsuccessful. In 1947 a gravity traverse by B. D. Maree along the main road revealed a low, and a subsequent gravity survey by Weiss Geophysical Corp. outlined a low of 3 or 4 mgal in the southeast part of Stilfontein. Drilling in this low verified the presence of a block of lower Witwatersrand quartzite, including the rich Vaal reef, upfaulted into the denser dolomite and lava. The company also made ground-magnetic profiles and aeromagnetic profiles 500 ft above ground. The magnetic data indicate the presence of Lower Witwatersrand magnetic shales at relatively shallow depths in the north, but the probable absence of major upthrows of these shales in the south.—*E. K.*

MAGNETIC METHODS

13700. Longacre, W. A. The Hotchkiss Superdip as a vertical intensity magnetometer: Mining Engineering, v. 3, no. 10, pp. 891–896, 1951; Am. Inst. Min. Met. Eng. Trans., v. 190, pp. 891–896, 1951.

In the Marquette Range of northern Michigan a vertical magnetometer has been used in exploration for relatively nonmagnetic soft red hematite ore, and a Hotchkiss superdip oriented to measure vertical intensity was used in exploration of specular hematite and magnetite where anomalies are very large. For mapping and interpretation purposes it then became necessary to calibrate both instruments in the conventional unit of gammas of vertical intensity. Superdip readings taken at seven base stations of a known range of about 16,000 gammas, previously determined by Ruska and Askania magnetometers, when substituted in fundamental superdip equations, gave the instrument constant and the absolute magnetic intensity at one base station. Gammas of vertical intensity were then computed from the constant and a trigonometric ratio of the reading and sensitivity angles. The theoretical effect of temperature change on the instrument was found to be proportional to change in the instrument constant and to change in the trigonometric ratio.—*G. D. B.*

13701. Kohanowski, N. N. Geomagnetic survey of Rolette and Towner Counties, North Dakota: North Dakota Geol. Survey. Rept. of Inv. No. 6, 4 pp., 1951.

This is a brief report of a vertical intensity magnetic survey of Rolette and Towner Counties and adjacent parts of Pierce, Ramsey and Cavalier Counties. The survey indicates a thickening of strata towards the southwestern part of the area. Two anomalies are interpreted as indications of an asymmetric anticline and an escarpment. A contour map and magnetic profiles are included.—*J. L. M.*

13702. Jankovič, Slobodan. Magnetitsko ležište na Suvom Rudištu, Kopaonik [The magnetite deposit at Suvo Rudishte, Kopaonik] [with English summary]: Geološki Vesnik, tome 9, pp. 255–267, 1951.

A geologic description of the Suvo Rudište region is given. A survey of the mineralized area about 12,000 sq m was made by magnetic method, measuring the variation of the vertical component. Anomalies ranging from −6,000 to +12,000 gammas were discovered. The results of the investigation are presented as two magnetic profiles and a map.—*S. T. V.*

13703. Satō, Mitsunosuke and Suyama, Junji. Geophysical prospecting in Takanokura Mine, Soma County, Fukushima Prefecture [In Japanese with English summary]: Geol. Survey Japan Bull., v. 1, no. 3, pp. 49–52, 1950.

Magnetic and electrical surveys at the Takanokura mine are described. Two new anomalous areas were found.—*Author's summary*

13704. Jensen, Homer. Aeromagnetic survey helps find new Pennsylvania iron ore body: Eng. Min. Jour., v. 152, no. 8, pp. 56–59, 1951.

The airborne magnetometer was used in the discovery of a new large ore body in eastern Pennsylvania. The 900,000 acre survey was made at a cost of less than 7¢ per acre. Subsequent diamond-drill work has established the body at a depth of 1,500 to 3,000 ft but with virtually no surface expression. For the instrumentation and compilation procedure see Geophys. Abstract 12994.—*R. W. B.*

13705. Canada Geological Survey. Aeromagnetic maps of Northwest Territories: Dept. of Mines and Tech. Surveys, Geophysics Papers 49, 53, 54, 63, 76, 79, 80, 81, and 84; 1952.

This is a continuation of the series listed in Geophys. Abstracts 13001, 13212, and 13452. The following quadrangles in the District of Mackenzie have been published as blue line aeromagnetic maps, which show by contour lines the total magnetic intensity at about 1,000 ft above ground level: G. P. 49, Preble Island; G. P. 53, McConnell Island; G. P. 54, Fort Resolution; G. P. 63, Deskenatlata Lake North; G. P. 76, Buffalo River; G. P. 79, Mackenzie Rocks; G. P. 80, Breynat Point; G. P. 81, Ile du Mort; and G. P. 84, Swamp Lake. The maps were prepared on a scale of 1 in.=1 mile, and the contour interval of 10 to 500 gammas, depending on the intensity of the anomaly.—*L. E. B.*

13706. Canada Geological Survey. Aeromagnetic maps of the Province of Quebec: Dept. of Mines and Tech. Surveys, Geophysics Papers 70, 85 and 86; 1952.

This is a continuation of the series listed in Geophys. Abstracts 13004, 13006, and 13454. The following quadrangles in Abitibi county have been published as blue line aeromagnetic maps, which show by contour lines the total magnetic intensity at about 1,000 ft above ground level: G. P. 70, Obalski River; G. P. 85, Lac Guéguen, and G. P. 86, Senneterre. The maps were prepared on a scale of 1 in.=1 mile, and the contour interval of 10 to 500 gammas, depending on the intensity of the anomaly.—*L. E. B.*

13707. Fleming, C. A. and Reed, J. J. Mernoo Bank, East of Canterbury, New Zealand: New Zealand Jour. Sci. Technology, v. 32, Ser. B, no. 6, pp. 1–4, 1951.

Reference is made to an aeromagnetic survey for the New Zealand Geological Survey on January 16, 1951. The survey was flown across the Mernoo Bank at an altitude of 1,000 feet. The anomalies, which are of the order of 100 gammas, are smaller than those recorded over andesite or basalt from Christchurch to Akaroa but larger than those observed over sedimentary rocks between Amberley and Kaikoura at comparable altitudes.—*E. K.*

SEISMIC METHODS

13708. Weatherby, B. B. Uses and abuses of the seismic method: Oil in Canada, v. 4, no. 33, pp. 30, 32, 34, 36, 48, 1952.

This is a reprint of the article abstracted in Geophys. Abstract 13456, with the addition of pictures.—*L. E. B.*

13709. Rosaire, E. E. Studies in nonstructural petroleum prospecting II. The comparative resolution of pertinent Gulf Coast refraction anomalies: Geophysics, v. 17, no. 2, pp. 244–277, 1952.

The objective of this study is a test of the nonstructural hypothesis (see Geophys. Abstract 12973) in refraction prospecting. The identification of near-surface significant stratigraphic anomalies is based on their postulated unique characteristics: observable magnitude on depths of survey too shallow to intercept the underlying structure, double-peaked maximum configuration, off-structural orientation of maximum leads, and change in type of configuration as the survey depth increases to structural interception. These characteristics are discussed in some detail with reference to Gulf Coast refraction surveys of 1924–31.—*M. C. R.*

13710. Gough, D. I. A new instrument for seismic exploration at very short ranges: Geophysics, v. 17, no. 2, pp. 311–333, 1952.

A sledge hammer is used as the energy source for a new shallow-refraction outfit, which uses only one seismometer, the range being varied by moving the hammer. The amplified output of the seismometer is viewed on a cathode-ray tube, which also shows a timing pulse that is triggered by an inertia contact on the hammer. Travel times accurate to 0.1 msec are obtained adjusting calibrated controls on the timing circuit so that the pulse coincides with a well defined phase of the seismic wave. The instrument has been successfully tested at dam sites in South Africa. In well compacted ground *P* waves were recorded at distances as great as 250 m, but in soft alluvium the *S* phase had to be used for depth determinations.—*D. F. B.*

13711. Woods, J. P. Up-hole times: Geophysics, v. 17, no. 2, pp. 229–235, 1952.

The up-hole travel time for the seismic impulse from a dynamite explosion depends on more than charge depth and formation velocity; in practice it is influenced by charge size, by filter setting, by instrument sensitivity and by previous history of the shot hole ("one cannot shoot twice in the same place—after the first shot, the same place is not there any more"). To avoid anomalous up-hole times caused by the firing line and by the drilling mud the seismometer should be offset at least 20 ft from the hole.—*D. F. B.*

13712. Krey, Theodore, Über die Bewertung von Mischungsschüssen in der angewandten seismik [Evaluation of interlocking recording in their application to seismic methods of prospecting]: Erdöl u. Kohle, Jahrg 4, Heft 7, pp. 385–387, 1951.

A comparison is made of two arrangements of recording often used in seismic reflection prospecting. The first is the method of multiple detection (in German "Bündeln"), when several seismometers, used in series or parallel, feed a single recording trace. In the other arrangement, called composite or inter-

locking recording with overlapping seismometer output (in German called "Mischen"), each seismometer feeds two or more recording traces. Quite often these two arrangements are considered completely equivalent, but this is not so. Using the theory of probability, the author proves that it is necessary to have about 50 percent more geophones in composite recording in order to obtain records of the same reliability. This conclusion is obtained by assuming coincidence of the moments of respective arrival of reflected waves to geophones. Similarly it can be shown that in composite recording of reflected waves with small phase differences interpretation can become very difficult. This is not the case when the phase differences at individual geophones are equal to $\pi/2$ or more. However, the author emphasizes the great usefulness of multiple recording in practical work.—*S. T. V.*

13713. Cantos [Figuerola], José. Une modalité d'application et d'interprétation de la méthode sismique [A procedure of application and interpretation of the seismic method]: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 1, pp. 590–597, 1951.

A procedure used in seismic refraction surveys by the Institute Geologico y Minero de España is described. The geophones are left in place and the shots displaced along a straight line in both directions. Formulas are worked out for the interpretation of the resulting travel-time curves.—*M. C. R.*

13714. Riznichenko, Yu. V. O sovmestnoy obrabotke ryada nablyudenii golovnykh seismicheskikh voln [A joint treatment of observations of seismic frontal waves]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 1, pp. 12–20, 1952.

This is the continuation of the study (Geophys. Abstract 13460) of the determination of the wave path near the receiving station from observations of travel time curves at different points of observation and of the gradients of these curves. The velocities of refracted waves and the position of the refracting boundary can be determined by a geometric construction. Knowledge of the structure between the shot point and receiving point is not necessary, and absolute values of the time interval between the shot and the arrival of the wave are not used in the solution of the problem. Near the point of observation the refracting boundary is assumed to have a plane element of sufficient extension. Other assumptions are that velocities in formations separated by the refracting boundary are constant and that the seismic ray observed at its arrival is parallel to the refracting boundary element. The last assumption leads to the equation determining the angle i of the emergence of the ray as $\sin i = V/V_r$, where V is the velocity in the upper formation and V_r the velocity along the refracting boundary.—*S. T. V.*

13715. Menzel, H. Über das Spektrum seismischer Wellen, die durch Sprengungen erzeugt werden [On the spectrum of seismic waves produced by explosions]: Annali Geofis, v. 4, no. 3, pp. 301–321; Italian translation, pp. 443–448, 1951.

It is known from observations that the spectrum of waves produced by an explosion undergoes substantial changes along the path of propagation. Near the shot point the predominant frequency of the waves may be 100 or more cycles per sec, but at great distances only a few cycles per second. The spectrum of waves arriving at a given point is determined not only by the thermodynamic

processes during the explosion, but also by the properties and structure of the medium through which the waves propagate.

A mathematical investigation of the variation of the frequency of seismic waves propagating through a perfectly elastic medium is presented. Two factors are considered as influencing the frequency: interference of two waves, one coming directly from the shot point, the other reflected at the surface of the ground; and the dissipation of energy by reflection, refraction and curving of the ray. The phase difference resulting from two interfering waves is found to be determined by the depth of the explosive charge, distance from the shot point, and the seismic velocity in the medium. The dissipation factor is of greatest importance within the weathered layer and consequently cannot be neglected in seismic prospecting. The effect of reflections taking place in the weathered layer is concluded to be of fundamental importance in causing the change of the spectrum.—*S. T. V.*

13716. Fitch, A. A. and Lloyd, E. H. The precision of travel-time curves in the seismic method of geophysical surveying: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 1, pp. 497–513, 1951.

The degree of certainty in the measurement of times, distances, and elevations at which seismic impulses are recorded and its effect on the structural interpretation of seismic data are considered. Straight-line paths are assumed and an expression derived for the variance (square of the standard deviation) of the estimate of the angle of dip. The expression consists of two terms, one the contribution of errors of observation, the other resulting from uncertainties and errors of velocity in the rocks above the refracting or reflecting horizon. In the examples quoted, the former is much larger than the latter. The chief method of improving accuracy is by increasing the number of detectors and decreasing the spacing.—*M. C. R.*

13717. Thralls, H. M. and Mossman, R. W. Relation of seismic corrections to surface geology: Geophysics, v. 17, no. 2, pp. 218–229, 1952.

The arbitrary application of any set type of near-surface corrections to seismic data can lead to erroneous results. Youthful, mature, and rejuvenated topographies indicate fundamentally different correction procedures, and careful consideration of both surface outcrops and velocity data is necessary. In youthful topography best results were obtained with a "floating" elevation reference plane at the mean of the horizontal and base-of-shot datums. Examples are given for four areas.—*D. F. B.*

13718. Krousky, L. Über den Einfluss von Messfehlern auf die Bestimmung von Neigung und Tiefe eines Reflexionselementes [The effect of errors in measurements on the determination of the dip and depth of a reflecting boundary]: Erdöl u. Kohle, Jahrg. 5, Heft 4, p. 210, 1952.

The influence of unavoidable errors in measurements of travel time, distances between geophones, and other parameters is analysed, especially when the position of a salt dome with steep flanks is to be determined. Using Taylor's formula, the author computes the total error from the errors made in evaluations of individual parameters entering into formulas.—*S. T. V.*

13719. Krey, Theodore and Helwich, B. Les réflections a l'intérieur des domes de sel et leur importance pour les recherches de pétrole [Reflections in the interior of salt domes and their importance in petroleum exploration]: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 1, pp. 583–589, 1951.

Examples are given of surveys of salt domes in Germany in which the paths of reflections must have passed through the salt. The reflecting horizon may be the interior of the lateral or overhanging face, or a contact between two Permian horizons, both containing salt layers, which constitute the dome. Interpretation of such reflections is discussed.—*M. C. R.*

13720. Rummerfield, B. F. Seismic exploration of the Denver-Julesburg basin: Geophysics, v. 17, no. 2, pp. 334–343, 1952.

Recent developments in northeastern Colorado and southwestern Nebraska have resulted in a marked increase in seismic activity in the Denver-Julesburg basin. Fair to good seismic interpretations can be obtained in much of the basin, but care must be exercised in evaluating anomalies to make certain that such features are the results of subsurface structural conditions and not merely a measurement of variations in weathered zones, topography, near-surface beds, or velocities.—*M. C. R.*

13721. Daly, John W., and Page, C. N. Seismograph interpretation as related to changes in sedimentary section in West Texas and New Mexico: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 4, pp. 658–676, 1952.

Seismic velocity in typical sediments in the Permian basin of west Texas and New Mexico range between 24,000 fps in massive reef limestone and dolomite and 12,000 fps in basin type shales and sands. Isochron maps on which the reflection times between datum planes are drawn as contours can indicate the distribution of the various sediments and are valuable in avoiding interpretation of lithologic changes as structural features.

Time maps on which either the two-way travel times or average velocities between datum planes are shown as contours represent both distance and velocity. Adequate velocity control and regional well control are necessary to determine which factor is predominately responsible for time changes. *W. J. D.*

13722. Ingalls, P. C. Sand bar located by seismograph: Oil and Gas Jour., v. 49, no. 25, pp. 141, 1950.

A new method of interpretation of reflection seismograph records for delineating small structures has been advanced and tested at South Ceres pool, Noble County, Oklahoma. Because seismic waves travel more slowly in fluid-saturated sandstone than in unsaturated rocks, records of shots across an oil-bearing sand lens indicate exaggerated depths for the portion of the reflecting horizon beneath the sand lens. Differential compaction of the surrounding shale causes a slight high above the lens. Consequently, fluid-saturated sand lenses may be located by the measuring of time differences between two essentially parallel reflecting horizons. "Time thicknesses" caused by the high above and false low below a sand body will indicate the presence of a comparatively slow-velocity mass.—*M. C. R.*

13723. Solaini, Luigi. Esempio di ricerca sismica del fondo roccioso [An example of seismic exploration of a rocky foundation]: Riv. Geofis. Appl., v. 12, no. 2, pp. 73–82, 1951.

This is a report of a seismic refraction survey to determine the bedrock profile under a moraine. The area surveyed, 1,300 x 750 m., is a narrow V-shaped valley. By making three seismic profiles with distances between geophones of about 50 m., an accurate bedrock profile was obtained.—*S. T. V.*

13724. Wesley, R. H. Geophysical exploration in Michigan: Econ. Geology, v. 47, no. 1, pp. 57–63, 1952.

A short review of seismic techniques is followed by a summary of their application to various engineering problems in Michigan, where the equipment was also used to study the damage caused by vibrations from a construction project.—*D. F. B.*

13725. Gees, R. H. Nuevas investigaciones con el método sismico de refracción, de masas salinas achatadas y escarpadas, en Alemancia del Noroeste [Recent investigations by the seismic refraction method of salt domes of flat and steep shapes in northwestern Germany]: Rev. Geofís., v. 10, no. 38, pp. 85–97, 1951.

Numerous investigations of salt domes of different shapes have been made in Germany during recent years, using the seismic refraction method. A great number of travel-time curves have been obtained along radial profiles with the dome as the center. Shooting was usually started several kilometers away from the dome and progressed at short intervals toward the dome; after this the position of shots and geophones was exchanged and the same profile followed in opposite direction. Such investigations were made on isolated domes, on domes covered with high velocity layers and on domes pierced by strata. The shapes of the domes were later determined and velocities in overlying geologic layers checked. This makes it possible to make accurate interpretations of the dome as well as the tectonic details from even a few travel-time curves obtained in new areas of exploration.—*S. T. V.*

13726. Yüngül, Sulhi. Çukurova'da petrol aramalarinda kullanilan gravimetrik ve sismik usullerin korrelasyonu ve bunlarin bazi jeolojjk entrepretasyonu [Correlation and some geological interpretation of the seismic and gravimetric surveys in Çukurova] [in Turkish and English]: Türkiye Jeoloje Kurumu Bülteni, v. 3, no. 2, pp. 27–45, 1952.

In the search for oil structures in Çukurova, Turkey, results of gravimetric and seismic surveys could not be correlated successfully. In two areas, a dome was indicated by seismic surveys, but not by gravity surveys; while in a third area, a gravity survey showed a dome which was not shown by the seismic survey. Recently, the area was resurveyed, and a satisfactory correlation between gravimetric and seismic data was found.—*L. E. B.*

13727. Germain-Jones, D. T. Seismic surveys over asymmetrical structures in southwest Persia: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 1, pp. 546–563, 1951.

Dome-shaped limestone anticlines, as much as 30 miles long and 8 miles wide, form the oil reservoirs in southeast Persia. They are usually asymmetrical, the dips in the steeper southwest flanks being between 30° and 90°, and on the

northeast, rarely exceeding 30°. Location by geologic methods alone is difficult or impossible because of the behavior during folding of the series above the reservoir rock. The basic technique used has been long range arc shooting combined with line observations. Discrepancies between reflection- and refraction-survey results may have been caused by the assumption of constant velocity in the overburden or by multiple reflections.—*M. C. R.*

ELECTRICAL METHODS

13728. Krayev, A. P. Osnovy geoelektriki [Principles of geoelectric methods of prospecting] : Pt. 1, 445 pp., Moscow, 1951.

This is the first volume of a handbook of electrical methods of prospecting for minerals written for university students majoring in geophysics. The book includes an introductory section on fundamentals of electricity and magnetism, and eight chapters on electrical properties of the earth's crust and methods of measuring them; the general electromagnetic state of the earth; electric phenomena in the atmosphere, and the magnetic field of the lithosphere; electrical fields of regional dimensions; telluric currents, and radio waves in the crust of the earth; natural electrical local fields around ore bodies and water streams; artificial electrical fields in the earth; standard electrical field over a homogeneous massive and the electromagnetic field of a loop and of an extended linear electrode; electrical fields around ore bodies of various geometric forms; anomalies of a field, and the electrical method of exploring a salt dome.—*S. T. V.*

13729. Nomura, Yūkichi. On the diffraction of electric waves by a perfectly reflecting wedge : Tōhoku Univ. Sci. Repts., ser. B, v. 1–2, no. 1, pp. 1–23, 1950.

Spherical electric waves from an oscillating-dipole source and diffracted by a perfectly reflecting wedge of arbitrary angle are treated in detail. The resultant field is obtained with the aid of Hertz vectors, image theory, and multivalued solutions of the wave equation.

The field in the geometric shadow is of practical importance in estimating the effect of a mountain range on the propagation of radio waves. Expressions are derived for the field for both a dipole perpendicular to the edge and a dipole parallel to the edge. Numerical calculations show that the nearer the receiver is to the edge of the shadow, the less the wedge angle affects the diffraction. When neither source nor receiver is near the side of the wedge, the diffraction is only slightly affected by the wedge angle.—*R. G. H.*

13730. Wait, J. R. The cylindrical ore body in the presence of a cable carrying an oscillating current: Geophysics, v. 17, no. 2, pp. 378–386, 1952.

The electromagnetic equations are solved for the case of an infinite cable carrying an oscillating current parallel to a conducting cylinder with the assumption of arbitrary homogeneous electrical properties of the media within and without the cylinder. The electrical field outside is computed for the special case where the outer medium has a poor conductivity. The magnetic field is computed for $a << \rho$ or $a << \rho_0$ where a is the radius of the cylinder and ρ, ρ_0 are the distances from the point and cable respectively to the center of the cylinder. The field is expressed in terms of a reflection coefficient, q which in

turn is a function of the frequency. Graphs for the in-phase and out-of-phase components of the reflection coefficient are presented for the cases where the ratio of the permeability of the medium within the cylinder divided by the ratio of the permeability of the medium without the cylinder is 1, 1.2 and 2 respectively.—*I. Z.*

13731. Alfano, Luigi. Studi sulla interpretazione dei sondaggi elettrici verticali [Studies on the interpretation of vertical electrical sounding]: Riv. Geofis. Appl., v. 12, no. 2, pp. 83–106, 1951.

Analysis of the results of vertical electrical sounding (see Geophys. Abstract 13233) is extended to the problem of three strata. Starting from the formula derived by Stefanescu for the value of electrical potential as determined by the usual four-electrode arrangement and applying previously suggested transformations, the author derives the formula for the apparent resistivity of the lowest layer, in which several coefficients are represented by infinite series. To make the formula amenable to numerical calculations approximations are introduced, leading finally to an expression similar to Hummel's formula. In certain cases the derived formula can be conveniently used in numerical computations; the necessary integral values can be determined graphically.

The possibility of treating the four-layer problem in a similar manner, using the Stefanescu equations with corresponding simplifications, is suggested.—*S. T. V.*

13732. Huber, A. Geoelektrische Tiefenmessungen in Tälern [Geoelectric deep sounding in valleys]: Archiv. für Meteorologie, Geophysik u. Bioklimalotogie, Ser. A, Band 3, Heft 5, pp. 464–469, 1951.

In deriving formulas for apparent resistivity of the ground, using Wenner's arrangement of electrodes, the assumption is made that the surface of the ground and the boundary surfaces separating the underground layers are horizontal parallel planes. This assumption is not admissible when the measurements are made in narrow valleys with complicated geologic structure. The latter case is treated here under the simplifying assumption that the ground consists of a horizontal semicylinder of a known electrical resistivity and is surrounded by a medium of different electrical properties. Using Bessel and Hankel functions, the apparent resistivity of the ground is determined, and from the derived formula graphs are computed and a master chart constructed. No experimental measurements testing these results were made.—*S. T. V.*

13733. Migaux, Léon. Dix ans d'application de la méthode tellurique [Ten years of use of the telluric method]: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 1, pp. 624–645, 1951.

Principles of the method are reviewed, and the advantage and limitations of the method are discussed. Examples are given of surveys in Europe and Africa and the results obtained.—*M. C. R.*

13734. Baranov, V. Interprétation quantitative des mesures en prospection par courants telluriques [Quantitative interpretation of the data of exploration by telluric currents]: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 1, pp. 646–653, 1951.

Quantitative interpretation in prospecting by the telluric method consists of searching the current lines in the soil while knowing the density of the

current measured at the surface. To avoid too long and involved computations, we limit ourselves to the cylindrical or two-dimensional case. This problem can then be resolved quite easily, thanks to a mathematical apparatus which seems no more complicated than that which is necessary in classical prospecting methods.

Thus, the telluric method, at first purely empirical, is provided with a more secure mathematical basis.—*Author's abstract.*

13735. Pritchett, W. C. Attenuation of radio-frequency waves through the earth: Geophysics, v. 17, no. 2, pp. 193–217, 1952.

Although several studies have suggested the possibility that radio waves penetrate sufficiently deep into the earth to be useful in petroleum prospecting, normal values of the earth constants when applied to the conventional electromagnetic theory of wave propagation give results which indicate that attenuation of radio-frequency waves through the earth would be too high, especially in the brine-saturated regions commonly found at depths greater than a few hundred feet. In an experiment, designed to measure the attenuation of a radio wave in the earth, a transmitter and receiver, both battery powered, were lowered into mud-filled holes for about 100 ft, to the middle of a 40-ft bed of shale. The resistivity of the mud filling of the holes was matched to that of the shale to prevent reflections from the walls of the hole. The transmitter was of normal design with an unmodulated output of 1,652 kc, and the heterodyne-type receiver, designed for low-noise level, was sharply tuned to this frequency. The maximum output voltage from the receiver was always obtained when the transmitter and the receiver were at the same depth, thus proving the transmission to be through the ground. Receiver-output voltages were taken at separations ranging from 5 to 155 ft and the signal decline was compared with calculated values. These results are analyzed mathematically. The experiment is believed to prove that for this 1,652-kc wave, the attenuation would be so great as to limit penetration to a few hundred feet, and that radio-frequency prospecting would be limited to very shallow depths, or to rare, exceedingly dry areas. The paper is followed by numerous discussions and replies to these by the author.—*R. W. J.*

13736. Rikitake, Tsuneji and Kishinouye, Fuyuhiko. Electrical properties of soil at radio frequencies [In Japanese with English summary]: Tokyo Univ. Earthquake Research Inst., Bull., v. 29, pt. 2, pp. 423–431, 1951.

The dielectric constant and electrical resistivity of soil at radio frequencies were measured by inserting soil specimens from the grounds of Tokyo University between two plates of a condenser which was connected with a resonance circuit composed of a coil, a variable condenser, and a thermojunction. The circuit was loosely coupled to a high-frequency oscillator. Changes in the electric current induced in the resonance circuit were measured by means of a galvanometer connected to the thermojunction, and from the measurements the electrical properties of the soil were determined. The electrical properties of soil were found to be determined by water content as well as mechanical properties. The dielectric constant changed from 4 to more than 30 and resistivity from 500 to 10 kiloohms as the water content changed from 0 to 50 percent. Changes in the electrical properties with frequency were also measured.—*M. C. R.*

13737. Belluigi, Arnaldo. Su una nuova prassi geoelettrica induttive per ricerche di conduttori nel sottosuolo in particolare in galleria di miniera [A new geoelectric inductive apparatus for exploration for subsurface conductors, especially in mine galleries]: Servizio geol. Italia Boll., v. 71, (1947–1949), pp. 193–200, 1951.

A description is given of a new inductive device, called an "electrical mineralization indicator," for exploration of electrically conductive lodes or veins. It is a combination of inductive coils, amplifiers, vacuum tubes, ammeters, and voltmeters, so arranged that the secondary currents, induced in surrounding conductive formations, can be separated and conveniently measured, even if the distance between the primary and the secondary fields is small, as it often is in mine galleries. Circuit diagrams and constructional data are given.—*S. T. V.*

13738. Borrego Gonzalez, Joaquin. Nuevo interruptor doble de precisión para compensaciones en el método eléctrico de corriente continua, con potenciómetro de oposición [A new precise two-way switch for compensation in the direct-current electrical method with an opposing potentiometer]: Inst. geol. min. España notas y comunicaciones, no. 24, pp. 73–78, 1951.

A double commutator especially designed for use in geophysical investigations in the field is described. It is of simple construction, but assures simultaneous reversing of currents in two circuits as is essential for precise measurements. Construction of the switch is illustrated by a figure.—*S. T. V.*

13739. Enslin, J. F. Geophysical methods of tracing and determining contacts of dolerite dykes in Karroo sediments in connection with the siting of boreholes for water: Geol. Soc. South Africa, Trans. and Proc., (1950), v. 53, pp. 193–204, 1951.

In the Orange Free State, Natal, and Transvaal the most reliable source of water is the indurated and fractured contact zone of dolerite dikes with the Karroo mudstones and shales. Most of the dikes are between 6 and 30 ft wide with a contact zone of a few inches to a foot which yields water up to 2 ft from the contact. These dikes are concealed by soil cover in the Transvaal and western Orange Free State. Magnetic and electrical resistivity and potential surveys were successfully used to locate and trace these dikes. Magnetic methods were found to be more rapid, economical, and accurate and should be used except where dikes are nonmagnetic. It was possible to locate the contacts by magnetic methods to within 3 ft in most cases but the dip of the dike could not be found since the anomalies are largely caused by remanent magnetization. Constant separation-resistivity or potential measurements were preferred to resistivity-depth profiles, but gave no information on width of the dike since there was little contrast in the resistivities of the weathered dolerite and the surrounding sediments.—*E. K.*

13740. Manfredini, Antonio. Ricerca idrica con mezzi geofisici nel comune di Guidonia [Hydrological research with geophysical methods in Guidonia]: Servizio geol. Italia Boll., v. 71, pp. 207–215, 1951.

A brief report is given on electrical exploration for water in the vicinity of Guidonia, Italy. Unusual problems were involved because part of the area was covered with refuse from rotary cement ovens and soaked with used storage-battery acids, and because the subsurface formations were dipping steeply. The

upper layer was clay, overlying a layer of tuff, below which were two layers of limestone that formed the base of probable water deposits. The resistivity of the upper limestone layer was 34 ohm-meters, and of the second ranged from 45 to 60 ohm-meters.

The Wenner-Lee modification of the configuration of electrodes was used. By burying deeply the measuring electrodes and using parallel displacements of profiles, it was possible to overcome these aforementioned difficulties. On the basis of the electrical measurements the depth of the limestone was predicted as about 70 m. Drilling confirmed its presence at a depth of 74 m and also a substantial amount of ground water at a depth of 78 m.—*S. T. V.*

RADIOACTIVE METHODS

13741. Merritt, J. W. Surface mapping by gamma ray: Tulsa Geol. Soc. Digest, v. 19, pp. 100–101, 1951.

A new semidirect method of detecting stratigraphic traps in the search for oil is based upon the measurement of gamma-ray intensities of the surface soil. Hydrocarbon analyses show a greater quantity of light hydrocarbons escaping around and directly above the margins of oil and gas production. A higher water evaporation has been observed in areas where there is greater gas movement, and as a result there is a build up of water soluble compounds, some of which are radioactive, in the marginal anomaly. The radioactive intensity pattern mapped by a highly sensitive gamma-ray detector tends to follow the hydrocarbon surface-intensity pattern.—*L. E. B.*

13742. Lundberg, Hans. Airborne radioactivity surveys: Oil and Gas Jour., v. 50, no. 49, pp. 165–166, 1952.

The author's past experience with ground and aerial measurements has shown that there are radioactive lows over oil fields and radioactive highs over their perimeters. He attributes this to the solution of radium minerals from near-surface formations by upward-rising sulfide waters which precipitate radium salts when they encounter downward-percolating oxygen-rich surface waters that oxidize the sudfides to sulfates. These waters are laterally deflected by an oil pool creating a lack of radioactivity above it and a concentration along its edges.—*R. W. B.*

WELL-LOGGING METHODS

13743. Cantos Figuerola, José. La testificación geofisica en los sondeos [Geophysical well testing]: Minería y Metalurgia, no. 123, pp. 7–17, 1951.

This is a review of the different geophysical methods used in drill-hole exploration. Resistivity and self-potential logging, and an inductive method are described. Procedures for the determination of the dip of formations, thermal properties, and side-wall sampling are also discussed.—*S. T. V.*

13744. Vellinger, E. Le carottage par les boues de forage [Surveying of the drill holes by mud logging]: Inst. Franç pétrole Rev., v. 4, no. 12, pp. 399–402, 1951.

Mud logging of a drill hole consists of the observation and recording of changes in the composition of the mud at different depths, usually known at every moment of operation. An important advantage of this method is that it is applied

during the process of drilling, not after the hole is finished, and the influx of gas or oil into the drill hole can thus be immediately discovered.

Parallel diagrams of electric-resistivity logs and mud-analysis logs are given in the article. This method reduces the number of necessary lithologic samples and facilitates the interpretation of electric logs—*S. T. V.*

13745. Walstron, J. E. Coring, electric logging, and other testing methods in exploratory wells: Oil and Gas Jour., v. 49, no. 28, pp. 298–327, 1949.

This is an analysis of various methods by which formations penetrated in exploration drilling may be evaluated through a coordinated use of several sampling, testing, and logging techniques. Included are three exploratory-drilling program charts, classified on the basis of the formation-evaluation methods that are used. With all three methods an electric log is always run and frequent side-wall samplings are advocated.—*L. E. B.*

13746. Pollard, T. A. and Reichertz, P. P. Core analyses practices—Basic methods and new developments: Am. Assoc. Petroleum Geologists, v. 36, no. 2, pp. 230–252, 1952.

The more common of the older or conventional core-analyses methods and the more significant of the new developments are briefly discussed and illustrated diagramatically in a nonmathematical treatment. Subjects discussed are various methods for the determination of porosity, permeability, interstitial-water content, total water, and residual-oil content, grain-size and pore-size distribution, mineral and chemical composition of core samples, electrical properties of cores, specific surface of reservoir rocks, and fluid-flow behavior by means of visual core-analysis methods. The methods of the new large-core analysis are briefly discussed. The most significant new developments to be added in recent years to the basic methods of core analyses are said to be: pore-size distribution or mercury capillary-pressure studies, which seem to have a significant bearing on important properties of both oil-producing reservoirs and of nonproducing sediments; the proposed centrifugal and drying-rate methods of estimating interstitial-water content of oil-bearing rocks; the application of physical instruments and other new methods in the mineralogical and chemical composition of sediments, including differential thermal analysis; improvements in studying the electrical properties of rock samples; the potential application of improved visual methods of study of core samples and their properties; and rapid adaptation of old methods and development of new methods for determining the properties of large cores and the limestone reservoirs from which the large cores are taken.

An extensive bibliography of more recent articles in core analysis is given.—*G. E. M.*

13747. Ford, R. D. MicroLogging: Tulsa Geol. Soc. Digest, v. 19, pp. 39–45, 1951.

This is a brief article discussing the principle, equipment and interpretation of the MicroLog. Several examples are given and compared with electric logs made in the same bore holes.—*L. E. B.*

13748. Topper, Wilfred and Greer, W. J. A new system of electric logging: World Oil, v. 131, no. 5, pp. 119–120, 122, 124, 1950.

A logging system employing electronic controls, vacuum-tube metering circuits, and carrier-frequency transmission signals is described. The system is known

as an FM logging system because it uses frequency modulation to transmit measurements from the logging tool in the borehole to recording equipment at the surface. Multiple records from one run of the logging tool are possible, and loss of accuracy because of cable leakage is eliminated. Such a system has been successfully used on the Gulf Coast.—*M. C. R.*

13749. Owen, J. E., and Greer, W. J. The guard electrode logging system: Jour. Petroleum Technology, v. 3, no. 12, pp. 347–356, 1951; *also* Am. Inst. Min. Met. Engr. Trans., Tech. paper 3222, v. 192, pp. 347–356, 1951.

The guard-electrode system measures the resistivity of formations by employing a thin disk of current which is caused to flow perpendicular to the bore hole. The control of this current disk is obtained in a brute force manner through the use of relatively long equipotential electrodes above and below the measuring electrode.

The log obtained from the system is free of "lag," "plateau," "shadow," "reflection" and other distortions evident on conventional logs. The proportionate contributions of the hole size and invaded-zone resistivity to the apparent-resistivity reading are reduced when the mud and filtrate resistivities are lower. Thus, the guard system favors the use of conductive muds.

The mathematical development of the theory is given in an appendix. Equations are derived to evaluate the effects of mud resistivity, hole size, invaded-zone resistivity and depth, and the true formation resistivity.

Sample logs from several provinces are reproduced and compared with conventional electric logs to illustrate the much greater detailed lithology that can be presented by the guard-electrode system.—*Author's abstract.*

13750. Doll, H. G. The Laterolog: A new resistivity logging method with electrodes using an automatic focusing system: Jour. Petroleum Technology, v. 3, no. 11, pp. 305–316, 1951; *also* Am. Inst. Min. Met. Eng. Trans., Tech. paper 3198, v. 192, 1951.

The laterologging system involves use of a controlled focusing system of electrodes by which current is forced into the formation perpendicularly to the wall of the hole. The effect of the mud column and of the adjacent formations on the value of the apparent resistivity measured opposite a given bed is practically eliminated wherever the thickness of the bed is equal to the thickness of the sheet of current, a few inches to a few feet depending on the distance between electrodes. Field examples of the use of this method are given.—*M. C. R.*

13751. Hamilton, R. G. Common fallacies in electric log interpretation: Tulsa Geol. Soc. Digest, v. 19, pp. 108–111, 1951.

This is a brief discussion listing common fallacies in interpretation of, and the factors influencing the magnitude and shape of self-potential curves and resistivity curves.—*L. E. B.*

13752. Walstrom, J. E. The quantitative aspects of electric log interpretation: Jour. Petroleum Technology, v. 4, no. 2, pp. 47–56, 1952; *also* Am. Inst. Min. Met. Eng. Trans., Tech. paper 3280, v. 195, pp. 47–56, 1951.

This is a review of the present state of electric-log interpretation, written primarily for petroleum engineers and geologists. Basic steps in the quantitative determinations of the amount of oil or gas in subsurface formations are outlined, and the reliability of these determinations under various conditions discussed.—*M. C. R.*

13753. Wyllie, M. R. J. Theoretical considerations involved in the determination of petroleum reservoir parameters from electric log data: World Petroleum Cong., 3d session, The Hague, Sec. 2, pp. 378–393, 1951.

The formation parameters that may be calculated from electrical-log data are interstitial-water salinity, connate-water saturation, porosity, and permeability. Calculation of interstitial-water salinity from the electrochemical component on the self-potential curve seems to be theoretically justifiable. Calculation of accurate formation factors is theoretically impossible because oil sands are never completely flushed by invading mud filtrate. However, it should be possible to correct the apparent formation factors and to use the average values in a formula relating resistivity index to a power function of connate-water saturation. If the appropriate power function is known, the average connate-water saturation computed from log data should agree closely with the average saturation found by conventional core analysis. Calculation of average formation porosity is contingent upon the availability of some core-analysis information. The value of the electric log in the estimation of permeability is uncertain, but on the basis of certain arbitrary assumptions it may be possible to estimate a lower limit to the average formation permeability.—*M. C. R.*

13754. Wyllie, M. R. J. and Spangler, M. B. Application of electrical resistivity measurements to problem of fluid flow in porous media: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 2, pp. 359–403, 1952.

The application of electrical-resistivity measurements to the study of flow processes in porous media, especially natural consolidated porous media of interest to the petroleum industry, is discussed. Use of the Kozeny equation for consolidated and nonisotropic porous media depends on the derivation of the Kozeny constant. It is postulated that this constant is obtainable if the tortuosity is measurable. Experimental evidence suggests tortuosity can be derived from resistivity measurements.—*M. C. R.*

13755. de Witte, Leendert. Relations between resistivities and fluid contents of porous rocks: Oil and Gas Jour., v. 49, no. 16, pp. 120–122, 124, 126, 128–132, 1950.

Results of theoretical and experimental studies of factors determining the resistivities of porous rocks are presented. Current conduction by the combination of randomly distributed conductive solids and interstitial water is taken as equivalent to current conduction by a mud slurry in an inert porous medium. The formation factor is then the ratio of the resistivity of the rock to the theoretically computed resistivity of the "slurry." On this basis, formulas are worked out which, for partially oil-saturated sands, represent a generalization of Archie's formula.—*M. C. R.*

13756. de Witte, Leendert. Simplified departure curves in resistivity logging: Oil and Gas Jour., v. 50, no. 40, pp. 117-118, 120–122, 1952.

The term "apparent resistivity," and the parameters involved in resistivity-well-log interpretation, are reviewed. For infinitely thick beds, by the equivalence principle, it can be shown that three or more measurements of apparent resistivity at different spacings will not suffice to resolve the unknown parameters. Simplified departure curves, in which apparent resistivities are plotted against

invaded zone and true resistivities for fixed ratios of spacing over hole diameter, are then applied in a graphical procedure to prove this. The method reveals that an infinite number of possible solutions of the unknown parameters occur for the normally used spacings. By the same procedure it is then shown that the long normal and long lateral configurations provide fair resolution of the parameters in thick beds. Laterolog and induction methods may also show resolution for limited bed thicknesses. There remains a great need for a method with sufficient resolution to provide a unique solution among the equivalent combinations of invaded-zone resistivity, invasion diameter and true resistivity.—*W. W. S.*

13757. Winsauer, W. O., Shearin, H. M., Jr., Massom, P. H., and Williams, M. Resistivity of brine-saturated sands in relation to pore geometry: Am. Assoc. Petroleum Geologist, v. 36, no. 2, pp. 253–277, 1952.

Experiments were performed in a tortuosity cell by means of which a comparison was obtained of ion travel time through straight capillary channels and through tortuous channels of rock specimens over the same straight-line distance. The ratio of the lengths is equal to the square root of the ratio of the respective travel times and is a measure of the tortuosity, τ, of the porous medium. Tortuosities of indurated sandstones were found to range from 1.5 to 3.3 and were lower than previously supposed.

The Mounce potential, lithologic description, grain-size analysis, carbonate and clay content, mineral composition, packing index, grain roundness, apparent fractional cross-sectional area of the porosity, formation resistivity factor and visual pore size and shape was obtained for each rock sample for which tortuosity was determined. The authors found that the relation between the formation resistivity factor F, the tortuosity τ, and the fractional porosity P may be expressed empirically as $F=\tau/P^{1.67}$. In terms of porosity alone, the empirical relation $F=(P-.06)^{-1.48}$ was derived. The results are compared with the Archie equation $F=P^{-m}$.—*G. E. M.*

13758. Wright, T. R. and Pirson, S. J. Porosity-profile determination from electric logs: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 2, pp. 299–311, 1952.

The LS 32-in. sonde is useful for the bore-hole determination of limestone porosity. With potential drop measured across the distant MN ($\cong 4$ in.), the device has a radius of investigation of about 10 in. and therefore responds almost wholly to the resistivity of the zone invaded by mud filtrate.

The ratio $\rho a/\rho m$ (where ρa is the apparent resistivity in the vicinity of the electrodes M and N and ρm is the resistivity of the mud) is calculated for the maximum apparent resistivity, ρa (max) corresponding to infinite resistivity in a dense nonporous limestone. Departure curves show that divergence of various values of $\rho a/\rho m$ from $\rho i/\rho m$ where ρi is the resistivity of the invaded zone.

Where the mud resistivity and resistivity scale are given, the departure curves can be used directly to give the porosity by the Archie relation $\phi=\sqrt{\rho m/\rho i}$. Where mud resistivity and scale are lacking, as in old logs, the bore-hole resistivity of a nonporous limestone is chosen as the base line of zero deflection, and maximum deflection as mud resistivity under bottom-hole conditions. The percentage deflection (at a given depth) is referred to an empirical calibration curve showing percent of maximum deflection versus porosity by core analysis as established for a reference well. Modifications are given for different bore hole sizes.

Theoretical justification of the method is investigated. The method is stated to be adequate only for intergranular porosity, and for uniformly distributed small vugs and fractures.—*G. E. M.*

13759. Doll, H. G. and Martin, Maurice. Electrical logging in limestone fields: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 2, pp. 395–417, 1951.

Because of the generally higher resistivities and variable porosity of limestones, conventional electrical logging has been less successful in limestone areas than in sandstone and shale. Recent improvements, such as limestone sonde, selective SP, micrologging, induction logging, and laterologging, all of which are described, have been useful in more accurate investigations of limestone formations. Selective SP and MicroLogs are used for the identification of and accurate determination of boundaries of permeable formations. Laterologs and induction logs provide data for measurement of true resistivities needed for analysis of saturation. Resistivity values recorded in MicroLog and limestone sonde logs may be used for evaluation of the formation factor from which the porosity can be derived.—*M. C. R.*

13760. Tixier, M. P. Porosity index in limestone from electrical logs: Oil and Gas Jour., v. 50, no. 28, pp. 140, 142, 169, 170, 173; and no. 29, pp. 63–66, 87, 1951.

A method for porosity determinations in limestones is outlined. From consideration of electrical-log data, it is found that porosity is given by $(Rm/Ri)^{\frac{1}{2}}$ multiplied by a correction factor which is a function of the residual connate water for a given mud resistivity. The expression $(Rm/Ri)^{\frac{1}{2}}$ is called the porosity index. This gives the porosity directly in water-bearing limestones drilled with salt mud or in oil-bearing limestone drilled with fresh mud with a self-potential of about —100 mv. The correction factor may have to be determined empirically, but standard calibrations, which are given, may be applied.—*M. C. R.*

13761. Archie, G. E. Classification of carbonate reservoir rocks and petrophysical considerations: Am. Assoc. Petroleum Geologists Bull., v. 36, no. 2, pp. 278–298, 1952.

Pore structure is a basic determinant in such petrophysical measurements as the flow of fluids (permeability), fluid distribution (capillary pressure), and the flow of electricity (resistivity). A skeleton classification of limestone pore structure is based on the texture of the matrix and the character of the visible pore structure. The texture of the matrix is typed as compact crystalline, chalky, and granular or saccharoidal. Visible pore size is divided into classes based principally on pore diameter. Photographs illustrate combinations of these types and classes, and a skeleton classification with symbols is presented in a table.

The minute pore structure of the matrix cannot be readily seen or investigated but contains connate water that affects electrical and neutron measurements. Porosity measurements can be made on cuttings showing visible pore distribution, except where the pore diameter approaches drill-cutting size; here the "weathered" or "solution channel" faces and secondary crystal growth indicate porosity. The relation between porosity and permeability, formation resistivity factor and porosity, and resistivity and connate water in porous limestones of several different kinds of the classification are treated graphically.

As few limestones are known where the porosity is uniform over a vertical interval of a few feet or more, the geometrical problem in well logging, (the combination of layer thickness, bore-hole diameter, electrode spacing and mud filtrate invasion) is acute.

Resistivity, self-potential, and radioactivity logs are presented for several of the carbonate reservoir types, and correlation with porosity, permeability, and connate water discussed.—*G. E. M.*

13762. Jones, P. J. Electric log resistivity, porosity and water saturation for clean and shaly sandstones: World Oil, v. 132, no. 2, pp. 140–142, 146, 148, 1951.

Porosity and water saturation of clean sandstones may be estimated by use of Archie's equations, but in shaly sandstone the cementation factor may not be known and an erroneous evaluation made from electric-log data. A procedure is outlined and an equation given which permits such determinations. This procedure may also serve as a standard for calibration of resistivity-logging devices in the field and laboratory.—*M. C. R.*

13763. Griffiths, J. C. Grain-size distribution and reservoir rock characteristics: Am. Assoc. Petroleum Geologists, v. 36, no. 2, pp. 205–229, 1952.

Advancing knowledge of sedimentary rocks emphasizes dependence of petroleum reservoir performance on the nature of the rocks as well as fluid behavior, and the interaction of both. The properties of a rock which determine reservoir-rock characteristics are not infinitely variable and completely independent. Thus mineral composition varies with grain size, orientation is a function of shape, and so on. Porosity, as an example of bulk property, is a result of a group of properties such as mineral composition and grain size, shape, and orientation. Until the interrelationships between such different properties are established, it will be impossible to relate porosity to reservoir-rock characteristics in a sufficiently accurate manner to be applied to reservoir-rock behavior. Permeability and distribution of fluid content are sensitive to minor changes in mineral composition and texture, as is exemplified by hydration and swelling of clay minerals.

Disregarding the carbonate rocks, petroleum reservoir rocks generally fall into Krynine's groups of quartzites, arkoses, low-rank graywackes, and the transitional quartzose graywackes, with the latter two by far more common. Diagrams of size analyses illustrate that oil-reservoir rocks are among best-sorted sediments. On the average, the reservoir rock will be better sorted than the surrounding barren sediments.—*G. E. M.*

13764. Decker, G. J. and Martin, Maurice. The Laterolog and salt-mud well logging in Kansas: Oil and Gas Jour., v. 50, no. 41, pp. 119–120, 123–124, 127, 129, 1952.

Use of Laterolog, MicroLog, and gamma-ray logs to supplement conventional electrical logs has been successful in Kansas where formations are mostly limestone with interbedded shale streaks. Examples of the use of this combined technique are discussed in some detail.—*M. C. R.*

13765. Persch, Fritz. Die Bestimmung des Grundwasserspiegels im Schlumberger Diagramm [The determination of the water table from the Schlumberger diagram]: Braunkohle, Wärme u. Energie, Band 4, Heft 7–8, pp. 132–135, 1952.

When prospecting for brown coal deposits in the Rhineland, German geophysicists have made extensive use of drill-hole logging by Schlumberger methods. The diagrams obtained were of great help in correlating strata and in general exploration of geologic structures. The procedure employed was identical with that used in prospecting for oil. In addition, determinations of the water table and the water-bearing strata penetrated by the hole were made, the depth and amount of water being of great economic importance in coal mining.

On the basis of actual records typical features of the curves indicative for the height of the water table and for the amount of water in the hole are discussed. The procedure is applicable to wells before casing is put in place.—*S. T. V.*

13766. McKellar, I. C. and Collins, B. W. Self-potential logs of two Canterbury water wells: New Zealand Jour. Sci. Technology, v. 32, sec. B, no. 6, pp. 1–4, 1951.

Self-potential logs were made in two of six wells drilled at Heathcote, near Christchurch, New Zealand, and compared with the driller's logs which showed reworked loess with interbedded sands and gravels. The difference in potential with maximum and minimum flow of water indicated the variations in porosity with maximum porosity in the sand layers and very little in the gravel.—*E. K.*

13767. Swift, Gilbert. Simultaneous gamma-ray and neutron logging: Geophysics, v. 17, no. 2, pp. 387–394, 1952.

Instrumentation for radioactivity well logging has been developed whereby two curves, the gamma-ray curve and the neutron curve, are made simultaneously, together with a record of the casing-collar positions, on one upward passage of the logging instrument. All elements of the system are described. The resulting log is continuously drawn at the surface on a multipen recorder, thus saving rig time and eliminating possibility of discrepancies in depth between curves which may occur where successive runs are required.—*F. W. S.*

13768. Fearon, R. E. and Mardock, E. S. The quantitative interpretation of radioactivity logs: World Petroleum Cong., 3d session, The Hague, Proc., Sec. 2, pp. 418–434, 1951.

The quantitative interpretation of porosity of reservoir rocks from radioactivity logs is based on the assumption that neutron curve deflections are directly related to porosity of the reservoir rocks and that a neutron-derived porosity calibration can be established for a given reservoir by core analysis. Error in measurements and in sampling, arising from inhomogeneity of formational porosity and from differences between the particular region sampled by the neutron curves and by the coring process, can be estimated by statistical analysis.—*F. W. S.*

13769. Simpson, D. J. Some results of radiometric logging in the boreholes of the Orange Free State gold fields and neighboring areas: Geol. Soc. South Africa Trans. Proc., v. 54, pp. 99–133, 1951.

Radiometric logging in boreholes of narrow diameter has been used in problems of correlation and the location of auriferous and uraniferous conglomerates of the Witwatersrand system. The results of this work have shown a very well defined cyclic distribution of the uranium in specific well-defined zones out

of which it is seldom found. The remarkable continuity of these radioactive markers has enabled correlation to be made between widely separated areas in the Orange Free State. Because the uranium deposition is not greatly affected by facies changes in the sediments, hitherto unsuspected extensions to the conglomerate horizons of the Leader-Basal zone have been found.

The data obtained from radiometric logging further suggest that there has been cyclic deposition of alternate uranium-bearing and nonuranium-bearing material in the upper sediments of the Witwatersrand system. These data also tend to support an alluvial origin for the uranium, as it is difficult to envisage any thermal or hydrothermal theory which can explain the widespread distribution.

The close affinity between the occurrence of gold and uranium in the Witwatersrand system allows the detection of uranium to act as a guide to the possible presence of gold.—*F. W. S.*

13770. Bush, R. E. Interpretation of radioactivity logs in reef limestone: Texas Jour. Sci., v. 4, no. 1, pp. 113–121, 1952.

This is a reprint of the paper abstracted in Geophys. Abstract 12844.—*F. W. S.*

13771. McGaha, S. W., and Terry, J. M. Lane-Wells correlation study; central Kansas area: Tomorrow's Tools-Today, v. 18, no. 1, pp. 18–21, 1952.

Standard gamma-ray and neutron-curve responses for the subsurface formations in the state of Kansas show that the gamma-ray curve clearly indicates stratigraphy for ease of correlation and that the neutron curve defines zones containing fluid; the combined radioactivity logs are a primary aid in initial or secondary recovery programs.—*F. W. S.*

13772. Morgan, J. V. Correlation of radioactive logs of the Lansing and Kansas City groups in central Kansas: Jour. Petroleum Technology, v. 4, no. 4, pp. 111–118, 1952; *also* Am. Inst. Min. Met. Eng. Petroleum Trans., Tech. Paper 3311, v. 195, 1952.

A study of gamma ray-neutron logs and core data in the Lansing-Kansas City groups indicates that definite zones exist which are related to production and which may be generally correlated over an appreciable portion of central Kansas. A suggested system of zoning and nomenclature is developed and illustrated, along with examples of its specific application in over-all evaluation and in development of zonal production characteristics.—*F. W. S.*

PATENTS

GRAVITY EXPLORATION

13773. Mounce, W. D. Method and apparatus for underwater gravity surveying, U. S. patent 2,595,092, granted Apr. 29, 1952. 3 claims. Assigned to Standard Oil Development Co.

MAGNETIC EXPLORATION

13774. Kogbetliantz, E. G. System for measuring magnetic fields, U. S. patent 2,590,979, granted Apr. 1, 1952. 10 claims.

A pair of permanently magnetized needles and means for mounting one for oscillation about a common axis perpendicular to the magnetic axes of both.

13775. Arvela, A. J. Magnetic variometer, U. S. patent 2,596,638, granted May 13, 1952. 3 claims.

13776. Jensen, Homer. Method and apparatus for magnetic explorations, U. S. patent 2,598,698, granted June 3, 1952. 7 claims.

Aeromagnetic surveying, including continuous photographic record of terrain and total intensity with superposed indications of sensitivity.

SEISMIC EXPLORATION

13777. Mayne, W. H. Seismic surveying, U. S. patent 2,591,177, granted Apr. 1, 1952. 2 claims. Assigned to Olive S. Petty, San Antonio, Texas.

Means of amplifying and recording signal energy or determining improper connection of seismometer at remote station.

13778. Parr, J. O., Jr. Seismic surveying, U. S. patent 2,591,192, granted Apr. 1, 1952. 4 claims. Assigned to Olive S. Petty.

A means of determining at remote stations faulty connections between seismometer and conductor.

13779. Eisler, J. D. Vibrator Detector, U. S. patent 2,591,795, granted Apr. 8, 1952. 6 claims. Assigned to Stanolind Oil and Gas Co.

13780. Woods, J. P. Seismic method and apparatus, U. S. patent 2,592,780, granted Apr. 15, 1952. 5 claims. Assigned to the Atlantic Refining Co.

Underwater seismometer.

13781. Piety, R. G. and Thomas, M. E. Seismometer, U. S. Patent 2,593,052, granted Apr. 15, 1952. 12 claims. Assigned to Phillips Petroleum Co.

Seismometer comprises a pair of paramagnetic cores with coil wound on each and armature between cores.

13782. Green, R. P. Method of seismic surveying, U. S. patent 2,594,767, granted Apr. 29, 1952. 8 claims. Assigned to Engineering Laboratories, Inc.

13783. Barthelmes, A. J. Method for determining subsurface geological structure by seismic surveying employing refraction shooting, U. S. patent 2,596,463, granted May 13, 1952. 1 claim. Assigned to Seismograph Service Corp.

13784. Minton, J. P. Seismic prospecting, U. S. patent 2,599,064, granted June 3, 1952. 9 claims. Assigned to Socony-Vacuum Oil Co., Inc.

A freqency-selective system.

13785. Finn, R. S. Method and apparatus for seismic prospecting, U. S. patent 2,599,245, granted June 3, 1952. 12 claims. Assigned to Seismograph Service Corp.

Underwater prospecting method.

13786. Peterson, Glen. Electrostatic seismometer, U. S. patent 2,599,775, granted June 10, 1952. 5 claims. Assigned to Phillips Petroleum Co.

A capacitive seismometer consisting of a set of fixed-spaced conductors in the form of flat rings and a set of spaced conductors in the form of discs.

13787. Fay, C. H., and Tvedt, T. J. Seismograph amplifier control, U. S. patent 2,600,051, granted June 10, 1952. 6 claims. Assigned to Shell Development Co.

13788. Heiland, C. A. and Murray, M. T. Method for geophysical exploration, U. S. patent 2,601,522, granted June 24, 1952. 4 claims.

Explosive energy is directed at an angle equal to that of the critical refraction ray of the underlying formation.

ELECTRICAL EXPLORATION

13790. Brant, A. A. Resistivity method for determining ore continuity, U. S. patent 2,599,688, granted June 10, 1952. 3 claims. Assigned to Newmont Mining Corp.

Method of establishing ore continuity between two zones separated by barren ground by resistivity measurements, one current electrode being placed in first ore occurrence, and one measuring electrode in second.

RADIOACTIVITY

13791. Borkowski, C. J. and Fairstein, Edward. Proportional counter, U. S. patent 2,590,925, granted Apr. 1, 1952. 6 claims. Assigned to United States of America, represented by the U. S. Atomic Energy Commission.

13792. Schneider, B. B. Radiation detector, U. S. patent 2,599,352, granted June 3, 1952. 2 claims. Assigned to Texaco Development Corp.

13793. Siegert, A. J. F. Process for detecting gamma rays, U. S. patent 2,601,334, granted June 24, 1952. 5 claims. Assigned to The Texas Co.

An improvement whereby the detection of gamma rays below the 0.5 megavolt level is emphasized.

13794. Rose, J. E. and Hinspater, E. W. Pocket ionization chamber, U. S. patent 2,601,637, granted June 24, 1952. 6 claims. Assigned to the United States of America, represented by the U. S. Atomic Energy Commission.

WELL LOGGING

13795. Krasnow, Shelley and Curtiss, L. F. Method and apparatus for measuring radioactivity, U. S. patent 2,590,873, granted Apr. 1, 1952. 36 claims. Assigned to Schlumberger Well Surveying Corp.

13796. Krasnow, Shelley and Curtiss, L. F. Multiple element radioactive ray recording. U. S. patent 2,590,874, granted Apr. 1, 1952. 5 claims. Assigned to Schlumberger Well Surveying Corp.

13797. Butterworth, G. J. Circuit control for well surveying instruments, U. S. patent 2,590,930, granted Apr. 1, 1952. 4 claims. Assigned to Sperry-Sun Well Surveying Co.

13798. Long, A. B. Well logging apparatus, U. S. patent 2,590,982, granted Apr. 1, 1952. 6 claims. Assigned to Sun Oil Co.

A device for concurrently measuring and recording temperature, pressure, and viscosity of well borehole fluids.

13799. Goble, R. W. Method and apparatus for measuring the cross sectional area of well bores by supersonic waves, U. S. patent 2,595,241, granted May 6, 1952. 12 claims. Assigned to Eastman Oil Well Survey Co.

13800. Krueger, W. F. Apparatus for determining the time of descent of instruments within boreholes, U. S. patent 2,599,112, granted June 3, 1952. 3 claims. Assigned to Sperry-Sun Well Surveying Co.

13801. Brant, A. A. Drill hole magnetometer apparatus, U. S. patent 2,599,687. granted June 10, 1952. 9 claims. Assigned to Geophysical Exploration Co.

TECHNICAL AIDS

13802. Fisher, J. L. Liquid damped galvanometer, U. S. patent 2,596,019, granted May 6, 1952. 10 claims. Assigned to Century Geophysical Corp.

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