Geophysical Abstracts 140 January-March 1950

(Numbers 11679–11907)

GEOLOGICAL SURVEY BULLETIN 976-A

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By MARY C. RABBITT, V. L. SKITSKY, *and* S. T. VESSELOWSKY

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

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GEOPHYSICAL ABSTRACTS 140, JANUARY–MARCH 1950

By MARY C. RABBITT, V. L. SKITSKY, and S. T. VESSELOWSKY

INTRODUCTION

Geophysical Abstracts are prepared by the Geophysics Branch of the Geological Survey, United States Department of the Interior, as an aid to those engaged in geophysical research and exploration. Periodicals, books, and patents are regularly searched for material dealing with geophysical exploration methods and with basic earth physics as represented by the fields of gravity, magnetism, electricity, seismology, radioactivity, and geothermal studies.

Because of the increasing diversity and amount of material covered, it has been found necessary to rearrange the order of the abstracts. Material in this issue has been grouped in three sections dealing with earth physics, exploration geophysics, and patents. The first section has been further divided into sections for gravity, magnetism, seismology, electricity, radioactivity, geothermal studies, tectonophysics, and regional studies. The section on exploration geophysics covers gravimetric methods, magnetic methods, seismic methods, electric methods, radioactive methods, well logging, and technical aids. Within each group the order of the abstracts is as follows: general papers, bibliographies, and reviews; theory; instruments; methods and techniques; observations.

As many readers may not have ready access to the source material, the abstracts are intended to be informative. All facts and opinions stated are those of the authors cited, except material needed for clarification which may be added in brackets. Where geologic and geographic names quoted differ from the official usage of the United States Geological Survey or the decisions of the United States Board on Geographical Names respectively, the latter are added in brackets.

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. Beginning with 128, Geophysical Abstracts are published as Bulletins of the Geological Survey.

As long as available, Geophysical Abstracts 124–127 issued as Information Circulars may be obtained free of charge from Publications Distribution Section, Bureau of Mines. All other numbers are now out of print. Geophysical Abstracts issued as Bulletins of the Geological Survey (with the exception of Nos. 87 and 88) may be purchased as single copies or by subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. For subscription, the Superintendent will accept a deposit of $5 in payment for subsequent issues. When this fund is near depletion, the subscriber will be notified. The deposit may also be used to purchase any other publication from the Superintendent of Documents.

Acknowledgments. Special thanks are due to Roland G. Henderson and Isidore Zietz who have prepared the abstracts signed R. G. H. and I. Z. Advice and assistance of other members of the Geological Survey in the preparation of the manuscript is gratefully acknowledged.

EARTH PHYSICS

GRAVITY [1]

11679. Lozano Calvo, Luis. Sobre la interpretación de las anomalías isostáticas [On the interpretation of isostatic anomalies]: Rev. Geofís., vol. 7, no. 26, pp. 156–165, 1948.

Theories of isostasy are reviewed.—*S. T. V.*

11680. Darling, F. W. Fundamental tables for the deflection of the vertical: U. S. Coast and Geodetic Survey Special Pub. 243, 38 pp., 1949.

Fundamental tables of the Cassinis type for the deflection of the vertical are valuable in calculations of incomplete isostatic compensation or overcompensation. They also provide means of testing the consequences of all sorts of variations in subsurface density and of testing the effect of varying definitions of isostasy. The tables give the deflection caused by masses of unit density which are sections of wedges cut by two conical surfaces with a common apex and a common axis passing through the deflection station and bounded above and below by surfaces of spheres concentric with the earth treated as a sphere. In the computation the radius of the earth is taken as 6371.2 kilometers, the gravitational constant as 6.670×10^{-8} c. g. s. units, and the mean gravity of the earth as 982.03 gals.—*S. T. V.*

11681. Gilbert, R. L. G. A dynamic gravimeter of novel design: Physical Soc Proc., vol. 62, no. 7, no. 355B, pp. 445–454, 1949.

The main element of the new dynamic gravimeter is a vertically stressed thin strip of beryllium copper supporting a mass capable of vibrating laterally. Variations of the weight of the mass, caused by changes in gravity force, produce variations in stress of the wire and therefore variations of the natural frequency of the system, this frequency being proportional to the square root of the stress. Changes of the frequency are determined by comparison with a fixed crystal frequency standard. In the instrument built by the author, with the string vibrating at 1,000 cycles per second a reading correct to 1 in 10^6 can be obtained in one hundred seconds. This accuracy can be improved to 1/50 cycle and thus accuracy of 1 in 10^8 can be obtained in about half an hour, making the instrument adaptable to measurements of earth tides. This particular instrument was designed for use at sea, and therefore the weight hanging on the string was damped electromagnetically for lateral and vertical movements and for rotations. An electronic thermostat kept the temperature inside of the casing constant to within $+0.0005°$ C. Details of construction of different parts of the instrument are given, as well as of the recording system employed for comparison of frequencies.

A gravimeter of the new design was used at sea during a cruise of a submarine in the English Channel, with a Vening-Meinesz three pendulum apparatus as a standard of reference. In spite of certain small imperfections the readings of the new gravimeter made at sea were affected with a probable error of only 1.5

[1] See also Geophys. Abstracts 11784, 11802, 11803.

mgal., the same as the pendulum determinations. The small dimensions of the instrument—3½×8 inches—make possible its use for measurements in drill holes.—*S. T. V.*

11682. Ising, Gustaf. Attempts to replace the elastic comparison force in gravimeters by capillary and electrostatic forces: K. svenska vetensk. arkiv. mat., astron. fys., Band. 36, Hefte 3, no. 7, 8 pp., 1949.

Following a suggestion in 1937 by the author that the elastic force in static gravimeters be replaced by capillary or electrostatic forces, experiments have demonstrated the possibility of obtaining a high degree of accuracy with such apparatus. In the capillary gravimeter, a capillary tube dips into the hermetically closed vessel containing the fluid and the position of the meniscus is observed through a microscope objective. The major problem in the design was to counteract the influence of variable temperature on capillary force and the sensitivity of the instrument to jerks during transportation. Hydrocarbons of the paraffin type, such as petroleum and benzine, were found to be the most suitable fluids for the purpose because of their extremely constant capillary properties. A description of the experimental capillary gravimeter and the theory of its operation are given. Gravity differences could be determined with a mean error of about 0.5 mgal. when the measurements were made on solid ground, and of 3 mgal. on board ship.

In designing the electrostatic gravimeters, the main difficulty was the necessity to attain an almost perfect insulation of the electroscope. The problem was solved by using a cascade-arrangement. Experiments with such gravimeters, though not yet concluded, appear to be very promising.—*S. T. V.*

11683. Jelstrup, G. Beskrivelse av Nørgaards gravimeter [Description of the Nørgaard gravimeter]: Norges Geog. Oppmålings virksomhet, Beretning, 1948, pp. 38–43, 1949.

The construction and theory of operation of the Nørgaard gravimeter of the newest type are described. Controlling relations are derived and analyzed to attain the greatest possible precision of measurement. Special attention is given to parts which eliminate the influence of the temperature variation by using materials of opposite temperature coefficients and by constructive arrangement. These changes in the original design of the gravimeter insure a temperature correction of only 1–2 milligals for a maximum temperature variation of 10° C. inside the housing. If a special thermostat is in operation the temperature inside the housing can be kept constant to within a fraction of a degree, making the temperature correction of an individual reading as low as 1/100 milligal. The description is illustrated by five drawings of the instrument.—*S. T. V.*

11684. Egyed, László. Az anomáliák magassági redukciójáról [The elevation correction of anomalies] [In Hungarian and English]: Földtani Közlöny, vol. 79, no. 1–4, pp. 94–111, 1949.

The necessity of making reductions for gravity anomalies as well as for the earth's theoretical gravity effects is stressed. Such reductions of g-anomalies can be obtained with the aid of a Taylor's series provided the vertical gradient, G_z, and the "vertical gradient of second order", $\partial G_z/\partial z$, have been determined. The latter may be readily computed from torsion-balance measurements.

A method is given for the determination of the vertical gradient of an anomaly by connecting the torsion-balance and gravity-meter observations in an area of different elevations. For two points of different elevations the following values

are supposed known, the Bouguer anomaly determined by the gravity meter, the gradient components determined by the torsion balance, and the third-order derivatives of the potential function determined by the aid of the torsion-balance measurements. A formula is obtained which gives the average value of the vertical gradient as the quotient of the deviation resulting from the comparison of the Δg differences observed by the gravity meter with the Δg differences calculated from the gradient values in accordance with Eötvös' method divided by the elevation differences of the two stations. When the two points of observation are at the same elevation, in an area where great variations of gradients are found it is shown that the calculation of isogams from the gradient values requires the use of third order derivatives. Thus in flat areas, isogams obtained from gravity-meter data are more reliable than those calculated from torsion-balance measurements.—*M. C. R.* and *R. G. H.*

11685. Hofmann, Walter. Über Anwendung einer Formel zur Berechnung des Vertical-gradienten der Schwere [A formula for computing the vertical gradient of gravity]: Geofis. Pura e Appl., vol. 14, no. 3–4, pp. 145–162, 1949.

As no instrument is available for direct measurement of the vertical gradient of gravity, and the sensitivity of existing gravimeters is not great enough to determine it by measuring gravity at two sufficiently near points, Evjen has proposed a method which gives the vertical gradient in terms of both the gravity anomaly at the point and the average values of the gravity anomaly about the point. Evjen's calculations assumed the earth's surface to be plane. This is modified to include the entire gravitational effect of the earth. The gravitational potential at a point on the earth's surface is represented as a series of spherical functions, each member containing the radius vector of the point, the angular velocity of the earth's rotation, and the geocentric latitude. From this can be derived the normal vertical gradient $\partial\gamma/\partial h = -(3085.6 + 2.2 \cos 2\phi) \times 10^{-9}$ c. g. s. A relation may also be established for the departure of the vertical gradient at a point of the geoid from this normal value, and this difference can be represented in finite form. Several practical examples and the application of the method to tectonic studies are discussed.—*S. T. V.*

11686. Osclaczky, Szilárd. Die mit einer Drehwaage messbare Massenwirkung eines "zweidimensionalen" Parallelepipeden in der vertikalen Ebene [Gravitational action of a two-dimensional parallelepiped, measurable by the torsion balance in the vertical plane]: Geofis. Pura e Appl., vol. 10, fasc. 5–6, pp. 174–180, 1947.

By a two-dimensional parallelepiped the author means one of infinite length and of varying cross section perpendicular to length. The gravitational potential u of such a body and the derivatives of u are determined only by the shape and the position of the cross section of the parallelepiped. Thus u is a function of only two variables. The torsion balance gives the values of the gradient $\partial^2 u/\partial xz$ and of the curvature $\partial^2 u/\partial x^2$, where x is the horizontal axis and z the vertical.

The author considers the plane XOZ as complex and determines the loci of equal gradients and curvatures. The loci are orthogonal circles, if the cross section of the parallelepiped is a rectangle stretching into infinity. These values can also be found when the cross section is deformed into a parallelogram with one side remaining constant.—*S. T. V.*

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11687. Tarczy-Hornoch, A. Über die Ausgleichung der Schwerkraftsgradienten [Adjustment of gravity gradients]: Geofis. Pura e Appl., vol. 14, fasc. 1–2, pp. 37–49, 1949.

A new method of adjustments of the measurements made with an Eötvös torsion balance is proposed and discussed in detail. If instead of adjusting the Δg values the gradients of gravity are adjusted, the results will be complete uniformity of isogams, free from discrepancies which result when the usual procedure is followed. The values Δg are not the observed quantities, but are functions of the distances and functions of different degrees of accuracy.

In deriving the corrections the differential equations of potential theory are replaced by difference equations and written $\Delta g = \text{gradient}_x \Delta x + \text{gradient}_y \Delta y + (\partial^2 u/\partial z^2)\Delta z$. The term $\partial^2 u/\partial z^2$ can be replaced by the normal variation of the gravitational force, equal to $2g/r$, where r is the radius of the earth. Introducing into this equation the observed values of the gradients and of x and y obtained at different stations during the survey, a system of equations is obtained which makes possible the evaluation of the most probable corrections to be applied. A complete example is included.—*S. T. V.*

11688. Morelli, Carlo. Sulla revisione dei capisaldi per le misure di gravita [On the revision of standards in gravity measurements]: Annali Geofis., vol. 2, no. 1, pp. 67–73, 1949.

Precise gravity measurements in recent years have indicated that the international reference system based on Potsdam determinations is in error by about +14 milligals.—*S. T. V.*

11689. Morelli, Carlo. Ulteriori elementi a sostegno di una correzione per i valori gravita [Latest data in favor of a correction to gravity values]: Annali Geofis., vol. 1, no. 1, pp. 83–86, 1948.

Determinations of gravity at Washington and Teddington and the author's work on the compensation of gravity values for different states of the international network indicate that a correction of -0.015 cm. sec.$^{-2}$ should be applied to the Potsdam value of gravity.—*S. T. V.*

11690. Cagniard, Louis, and Goudey, Raoul. Sue une comparaison indirecte des valeurs de référence admises pour l'intensité de la pesanteur à Paris et à Potsdam [On an indirect comparison of the reference values adopted for the intensity of gravity at Paris and Potsdam]: Acad. Sci. Paris Comptes Rendus, vol. 229, no. 18, pp. 896–897, 1949.

As topographic corrections at the Luxembourg stations Athenée and Couvent are uncertain because of inadequate maps, a North-American gravimeter was used to measure gravity values at Luxembourg-Artisans and Metz-Couvent relative to Paris, and observed values compared with German pendulum determinations at the same stations. The substantial agreement between gravity determined for these stations with reference to Paris (980.9773 and 980.9441 gals respectively) and to Potsdam (980.9772 and 980.9446 gals respectively) shows close similarity between the Paris and the Potsdam gravity systems.—*V. S.*

11691. Jones, L. Le levé gravimetrique de la Belgique 1947–1948 [Gravimetric survey of Belgium 1947–1948]: Soc. belge géologie Bull., vol. 59, no. 3, pp. 568–595, 1949.

A gravity survey of Belgium was made during 1947–48, using the Nørgaard gravimeter as the principal instrument. The total length of profiles covered was more than 16,000 km. and 380 stations were occupied. Final readings at each station were reduced to sea level and the free air anomaly computed. The normal value of gravity for the station was taken from the 1930 International Cassinis' formula. The Bouguer reduction was computed using density values ranging from 2.1 to 2.65 in accordance with the geologic structure. From the computed data maps of anomalies were drawn on a scale of 1=320,000 with 5-milligal contour intervals. A copy of the complete map, reduced size, is included.—*S. T. V.*

11692. Thirlaway, H. I. S., and Cook, A. H. Recent observations of gravity in Wales and the Borders [abstract]: Internat. Geol. Cong., Great Britain, 18th Sess., Titles and abstracts of papers, p. 30, 1948.

A gravity survey of the Welsh borders, was conducted during 1947–48 using a Graf gravimeter at 600 stations. A general positive Bouguer anomaly of 5 to 10 mgal. in the plateau of central Wales is 15 to 20 mgal. greater than would result if the area were isostatically compensated. The excess mass seems to be supported by the strength of the crust, and the positive anomaly seems to coincide with the region of post-Cretaceous rejuvenation. In the Worcester basin the line of the Malverns divides the zone of positive anomaly from a deep anomaly trough with a minimum of −30 mgal. near Worcester. The gravity field may be explained by a series of faults striking north with a total downthrow of 8,000–10,000 feet. The trough is also well defined to the north and northeast and apparently it is mainly filled with Triassic rocks. In general, the pattern of the gravity field in the Welsh borders has a Caledonian trend.—*V. S.*

11693. Woollard, G. P. Regional gravity study of the Appalachian Mountain system [abstract]: Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, p. 1932, 1949.

A regional gravity network of several thousand observations has been established over the Appalachian Mountain system in an area between the Gulf of Mexico, the Allegheny Mountain front, and the Atlantic Coast. Bouguer anomalies indicate two dominant major gravity structures, a pronounced gravity minimum strip and an associated maximum strip, which parallel each other and the visible geologic structure. The anomalies are attributed to a thickening and thinning of the upper crust. In the mid-Appalachian area the gravity minimum is about −80 mgal. and the gravity maximum about +40 mgal. With a density contrast of 0.3 between upper granitic and lower more basic crustal material, a relief of about 9.5 km. is indicated on the base of the granitic layer. To the north the gravity pattern merges in southern Quebec with a similar pattern following the St. Lawrence River valley, and in the far south dies out just beyond the Coastal Plain overlap. Structural trends of the Appalachian and Ouachita provinces indicated by gravity appear to intersect at right angles. Structural syntaxis, if any, is similar to that at the junction of the arcs of the Kuril Islands [Chishima-rettō] and Aleutian Islands.—*M. C. R.*

MAGNETISM[2]

11694. Akademiîâ Nauk SSSR Vestnik. The new magnetic observatory [in Russian]: no. 7, pp. 116–117, 1949.

A new geomagnetic observatory has been recently established near Moscow for study of very small variations of the terrestrial magnetic field related to solar processes and to processes in the earth's crust. The main instrument of the observatory is a special induction coil of 100 meters diameter, composed of 38 turns, connected to a fluxmeter provided with a phototube and a recording apparatus. The sensitivity of this installation is about 1 mm. for 8 milligamma or for 8×10^8 oersted.—*S. T. V.*

11695. Konakhovich, ÎÛ. ÎA., Latyshev, G. D., and Tsimbalin, V. V. The measurement of the magnetic field by the induction method [in Russian]: Akad. Nauk SSSR Izv., ser. fiz., vol. 13, no. 4, pp. 456–464, 1949.

The ballistic method most commonly used in measurements of the intensity of magnetic fields is not adapted for continuous observation of the field. Each measurement being a discrete datum, necessitates the application of many corrections to the readings, and the limit of the error in a measurement is not less than 1/1000. Magnetic field intensity may be determined by measuring the e. m. f. generated in the coil of a special rotor placed in the magnetic field to be investigated. Generation of the stable frequency of rotation required by the method was achieved by using a quartz strip with a natural frequency of 50 kilohertz as the controlling frequency source.

This frequency was decreased 800 times in a six-cascade electronic scheme with 50 khz. as the initial frequency; 25 khz. frequency in the second step; 5 khz. in the third; 1250 hertz in the fourth; 250 hz. in the fifth and 62.5 hz. in the last cascade.

The current of this frequency, remaining stable in the measure of the initial source, feeds a selsyn motor driving the test rotor with a constant speed. The electromotive force generated in it is proportional to the intensity of the investigated magnetic field. Best results are obtained with a capacity of about 60μ F inserted in series before the driving motor, which creates in its stator a rotating magnetic field instead of the pulsating one. The electromotive force generated is measured by the compensation method, using a Raps' potentiometer.

Advantages of the method are the very high accuracy of the measurement, (in the experimental instrument it was 1×10^{-5} which can be increased by placing the first step of the controlling frequency in a thermostat), and the possibility of continuous observation of the magnetic field.

The absolute error of the measurement with a magnetic field intensity of 500 oersted is 4×10^{-5}; the relative value of the error decreases with increasing intensity and is limited only by the stability of the frequency.

A detailed description of the instrument is given as well as the wiring diagram of the set-up. Further improvements of the proposed method can be achieved by introducing photo-elements into the measuring scheme.—*S. T. V.*

11696. Petrova, G. N. Interior demagnetizing factor [in Russian]: Akad. Nauk SSSR Izv., Ser. geog. i geofiz., vol. 13, no. 4, pp. 363–368, 1949.

If a specimen is brought into a magnetic field it becomes magnetized and creates its own field opposite in direction and proportional to the intensity of magnetization. The factor of proportionality determining this secondary field, the exterior demagnetization factor, is determined by the properties of the sub-

[2] See also Geophys. Abstracts 11812 to 11819.

stance and the surrounding medium. If a sample of polycrystalline substance is placed in a closed magnetic field, the exterior demagnetization factor is zero but inside the substance the component parts having differently oriented fields decrease the total field intensity by a factor, termed the interior demagnetization factor, determined by the physical structure of the crystalline substance. This factor can be determined experimentally from the angle formed by the inclination of the hysteresis loop with the abscissa axis. Thus in studying magnetic properties of minerals it is necessary to distinguish between the average intensity of magnetization, the true intensity, and the intensity of the produced field.

In polycrystalline substances, the intensity of magnetization can be quite different in individual grains. Relations determining the intensity of magnetization in different component parts of the specimen are derived and the values of the interior demagnetizing factor are computed for varying percentages of individual grains in the substance. A formula is given for determining the average susceptibility of the specimen from its ferromagnetic components.—*S. T. V.*

11697. Hales, A. L., Wijk, A. M. van, and Gough, D. I. The magnetic field of the earth: South African Science, vol. 2, no. 10, pp. 214–215, 1949.

P. M. S. Blackett's formula for the relation observed between magnetic moment and angular momentum in massive rotating bodies is shown to lead to incorrect results. The equation obtained when it was used to calculate the decrease of horizontal magnetic intensity at a certain depth below the surface of a plateau of a given height above mean sea level indicated that, if the same argument were applied to the earth rotating around the sun, there would be a diurnal variation of field approximately 300 times the earth's field, which cannot be correct.

Other direct tests of theories of the origin of geomagnetism, by the measurements of the variation with depth of both the horizontal and the vertical geomagnetic component at Blyvooruitzicht, are reported. Such measurements should be made in a mountainous region which is known to contain no magnetic bodies.—*V. S.*

11698. Singer, S. F., Maple, E., and Bowen, W. R., Jr. Measurement of the earth's magnetic field at high altitudes at White Sands, New Mexico: Phys. Rev., 2d ser., vol. 77, no. 3, pp. 398–399, 1950.

An Aerobee rocket containing a total field magnetometer fired at White Sands on April 18, 1948 reached a height of 372,000 ft. Telemetered data gave values of the magnetic field during flight with an estimated over-all accuracy of 1.0 milligauss or better. The principal results were: confirmation that the field strength decreases with altitude in accordance with calculations based on potential theory, the experimental data agreeing within 2 milligauss with the inverse cube relation; lack of evidence for or against the existence of circulating current sheets in the upper layers of the atmosphere because of the small effect at the latitude of the experiment.—*M. C. R.*

11699. Tschu, K. K. On the practical determination of lunar and luni-solar daily variations in certain geophysical data: Australian Jour. Sci. Research, ser. A, vol. 2, no. 1, pp. 1–24, 1949.

The application of the method proposed by Chapman and Miller to the determination of lunar and luni-solar daily variations in geophysical elements where these variations are overlaid by larger solar daily and irregular variations is described. Included among such luni-solar changes are the ionospheric electric currents induced by the lunar tide in the ionosphere owing to the tidal motion of

the air across the earth's magnetic field. These currents are revealed by variations of the geomagnetic field and also in the earth potential and earth currents induced thereby. Examples of the calculations are given.—*S. T. V.*

11700. Slaucitajs, Leonīds. Über die erdmagnetischen anomalien in den Gebieten um die Ostsee [Geomagnetic anomalies in the regions surrounding the Baltic Sea]: Geofis. Pura e Appl., vol. 15, no. 1–2, pp. 60–62, 1949.

The area around the Baltic Sea is known to be intensely magnetically disturbed. A map of the area shows the most important vertical component anomalies as great as +2,000 and +5,000 gammas found here by different investigators. For the geological interpretation of these anomalies a reference is made to numerous studies of this question.—*S. T. V.*

11701. Bossolasco, Mario. Suscettivita magnetica di alcuni minerali di magnetite [Magnetic susceptibility of some minerals of the magnetite group]: Geofis. Pura e Appl., vol. 12, pp. 53–60, 1948.

The magnetic susceptibility of rock samples from various ore deposits of Italy was measured using the method of G. Grenet. The results are presented in a short table.

The author finds, as did Sture Werner from his investigation of minerals in Sweden, that magnetic susceptibility varies within wide limits even with the same percent of magnetite content of rocks. Only in samples taken from the same deposit is it possible to establish a correlation between magnetite content and the magnetic susceptibility of a sample.

These results suggest caution in evaluating magnetic properties of a sample from its magnetite content or in estimating the probable iron content of a deposit from the susceptibility of the corresponding samples.—*S. T. V.*

11702. Roche, Alexandre. Sur les caractères magnetiques du système éruptif de Gergovie [The magnetic characters of the Gergovie eruptive rocks]: Acad. Sci. Paris Comtes Rendus, tome 230, no. 1, pp. 113–115, 1950.

From measurements of the vertical anomalies and determination of the permanent magnetization and susceptibility of samples from different parts of the area it is concluded that the eruptive system can be divided, magnetically, into three zones: dikes, necks, and sills on the eastern slope with strong negative anomalies and permanent magnetization opposite to the present earth's field; an upper layer forming the summit of the plateau characterized by a positive anomaly and permanent magnetization in the direction of the present earth's field; a lower part of the plateau with anomalies of different signs and magnitude and strong dispersion of the magnetization. This suggests the summit rocks are independent of the eastern eruptive group and that the dikes, necks, and sills were all emplaced at the same time. It is believed improbable that magnetization as constant as observed in the latter group could result from mineral alteration, and hence it must have been imposed at the time of emplacement.—*M. C. R.*

11703. Torreson, O. W., Murphy, Thomas, and Graham, J. W. Magnetic polarization of sedimentary rocks and the earth's magnetic history: Jour. Geophys. Research, vol. 54, no. 2, pp. 111–129, 1949.

Magnetic polarization of 99 samples of flat-lying, undisturbed sedimentary rocks, mostly Eocene to Pliocene in age with a few of Jurassic age, from eight sites in western United States have been measured. The direction of polarization in

the plane of bedding (declination) in two-thirds of the samples fell within a narrow range centering on geographic rather than geomagnetic north, 13° to 22° east of geographic north at the sites sampled. The dip or inclination of polarization in two-thirds of the samples fell within a small range centering on 63°, in relatively good agreement with the present average 69° inclination at the sites sampled. These results are consistent with the idea that for 50 million years or so the polarity of the earth's magnetic field has been the same as now and the average orientation of the magnetic axis has coincided with the earth's geographic axis.—*M. C. R.*

SEISMOLOGY

11704. Leet, L. D. Earth waves, 122 pp., Cambridge and New York, Harvard University Press and John Wiley and Sons, 1950.

The transmission of earth waves and methods of measuring and observing them are summarized with particular reference to applications of such knowledge in geophysical prospecting, measuring vibrations from dynamite blasts, and studying hurricanes.—*M. C. R.*

11705. Milne, W. G. Bibliography of seismology: Dominion Observatory Ottawa Pubs., vol. 14, no. 5, pp. 97–133, 1950.

Items 7004 to 7131, January to June 1949 and a complete bibliography of Japanese seismological works since 1939 compiled by Kawasumi are listed.—*M. C. R.*

11706. McKim, V. C. The history of the seismological station at Fresno, California: Seismol. Soc. America Bull., vol. 39, no. 4, pp. 239–242, 1949.

Seismological observations at Fresno from 1892 to 1935 by the Weather Bureau and from 1935 to the present at the seismograph station at Fresno State College are summarized.—*M. C. R.*

11707. Ramirez, J. E. New seismic station at Galerazamba, Colombia: Nature, vol. 164, no. 4163, pp. 288–289, 1949.

A seismological station was established at Galerazamba, Colombia in late January 1949. Coordinates of the station are: 10°47′08″ N. lat., 75°15′44″ W. long., height 21 m. above sea level. The station is equipped with two horizontal-component long-period, and one vertical short-period Sprengnether seismometers and a triple recording drum. The geology of the area, construction of the buildings, and proposed studies are outlined.—*M. C. R.*

11708. Tillotson, Ernest. Seismology in Britain: Nature, vol. 163, no. 4143, pp. 500–501, 1949.

A brief account is given of seismological activities during the past decade or so in Britain. Among these are E. R. Lapwood's investigation of the diffraction effects at the surface of a semi-infinite homogeneous elastic medium from a pulse emitted by a buried line source, G. E. R. Deacon's observations of microseisms, P. L. Willmore's moving-coil seismograph with nearly constant response to ground velocities of frequency 2–25 cycles per second and maximum sensitivity of 5,000 cm./cm./sec., and M. N. Hill's long-period inductance-bridge seismograph. Studies of the records of the Helgoland explosion in 1947 and the Soltau explosion of 1946 are also reported.—*V. S.*

11709. Lapwood, E. R. The disturbance due to a line source in a semi-infinite elastic medium: Royal Soc. London Philos. Trans., vol. 242, no. 841, pp. 63–100, 1949.

A solution is given, in terms of double integrals, for the disturbance at any point near the surface resulting when a cylindrical pulse is emitted from a line source buried in a semi-infinite homogeneous elastic medium. Approximate evaluation of these integrals for depths of source and point of reception which are small in comparison with their distance apart allows a description of the sequence of pulses arriving at the point of reception. When this is at the surface and distant from the epicenter, the disturbance is made up of the following pulses, in order of arrival: for initial P at the source, P, surface S, and Rayleigh; for initial S, surface P, S, and Rayleigh. If the initial pulse has the form of a jerk in displacement, both P and S arrive as similar jerks, but the Rayleigh pulse is blunted. Surface P takes a minimum-time path and arrives with a jerk in velocity, but surface S is confined to the neighborhood of the surface and arrives as a blunted pulse. It is shown also that when the sharp S-pulse of ray theory is converted to a blunted pulse by the presence of surface S and the spreading of S, the duration of this composite pulse is approximately that of the observed scatter of readings of S_g and similar waves from near earthquakes.—*M. C. R.*

11710. Riznichenko, Ю. V. Seismic quasi-anisotropy [in Russian]: Akad. Nauk SSSR Izv., ser. geog. i. geofiz., vol. 13, no. 6, pp. 518–544, 1949.

The propagation of elastic waves through media consisting of parallel and isotropic layers is analyzed. Such a medium has certain features of anisotropy, the velocity of wave propagation being different in different directions, but the entire medium cannot be treated as one anisotropic layer. This necessitates the use of a special term—"quasi-anisotropic medium." The elastic properties in different directions of such a stratified medium are characterized by different coefficients of anisotropy, defined as the ratios of: the effective velocity, as determined by the travel time curve, to the average velocity; the velocity in a certain stratum to the boundary velocity of the same stratum; and the velocity in the direction perpendicular to the strata to that parallel to them. Only longitudinal elastic waves are considered.

In the last case the coefficient of quasi-anisotropy varies with the length of the propagating waves. With long waves the distinction between a simple anisotropic medium and a stratified, quasi-anisotropic one is especially noticeable.

Sufficiently accurate results for the first two conditions can be obtained by the methods of geometrical optics, whereas the problem of determining the ratio of the velocities perpendicular and parallel to the strata requires a special analysis. As the first step the elastic properties of the medium are determined in two perpendicular directions. The corresponding moduli are found from the system of equations of strain, obtained for each layer and from the corresponding boundary conditions, along each boundary plane stresses being equal in the points of adjoining layers. The method used is similar to that for determination of dielectric constants of a stratified medium.

From the moduli of elasticity corresponding to the principal directions, it is possible to compute the corresponding velocities of propagation. Only approximate values of these velocities are given, but their accuracy is satisfactory for the problems of applied seismology. In the case of waves which are long compared to the thickness of the strata the error is negligible.

Precise expressions and approximate formulas for different moduli of elasticity which are sufficiently accurate for many practical applications are given. Changes

in the derived formulas for various wave lengths are computed. For certain wave lengths, the coefficients of quasi-anisotropy become important and cannot be neglected in seismic exploration.—*S. T. V.*

11711. Price, W. J., and Huntington, H. B. Acoustical properties of anisotropic materials: Acoustical Soc. America Jour., vol. 22, no. 1, pp. 32–37, 1950.

Theoretical and experimental investigations on the propagation of elastic waves through anisotropic media are briefly reported. The pulsed ultrasonic method was used in the experiments and measurements were made on small crystals cut from different substances.

It was found that for any given direction of the normal to a wave front there are, in general, three possible modes of propagation. The corresponding possible displacements of a particle are mutually perpendicular, but these displacements are not necessarily parallel or perpendicular to the wave normal. Transfer of energy between the modes of propagation can occur for certain cases of normal reflection. A phenomenon analogous to optical birefringence sometimes occurs, when the energy does not travel in a direction parallel to the wave normal.—*S. T. V.*

11712. Maecker, H. Quantitativer Nachweis von Grenzschicht wellen in der Optik [An analytical proof of the existence of boundary waves in optics]: Annalen der Physik, 6 Folge, Band 4, Heft 8, pp. 409–431, 1949.

Mintrop's waves are generated and can be observed when an elastic wave is totally reflected at the boundary between two layers, the lower of which has the higher velocity of propagation. The refracted wave spreads along the boundary line with a higher velocity and arrives at the surface, beyond a certain distance, together with the direct and the simply reflected waves.

Experimental arrangements are described which make possible the observation of such waves, and numerous photographs illustrate the details. A theoretical analysis is presented which establishes the conditions of appearance of boundary waves. Optical phenomena are discussed primarily, but several analogies are quoted from seismology.—*S. T. V.*

11713. Takahashi, Ryutaro, and Hirano, Kintaro. A new horizontal-component seismograph for comparison observations [in Japanese with English summary]: Tokyo Imp. Univ. Earthquake Research Inst. Bull., vol. 19, no. 3, pp. 527–533, 1941.

A horizontal component seismograph of the inverted pendulum type was designed for the greatest possible accuracy and ease of manipulation. All jewels were made to press lightly on pivots by means of flat springs which eliminated backlash between the pivot and the jewels. The helical spring and the needle system were replaced by a connecting rod with pivots and flat springs at both ends. The air damper consists of a pendulum bob, which acts as a piston, covered with two cylinders which are provided with wide clearance to facilitate the adjusting of the instrument and eliminate the rubbing of the piston on the cylinder walls. The geometrical magnification of the seismograph is 47.5 and the natural period is 8.0 seconds. The velocity of the recording paper is 12 centimeters per minute. Four such seismographs, when installed parallel to each other, gave identical records. Two drawings of the new seismograph and 21 sample records are included.—*S. T. V.*

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11714. Rouaud, André. Sur la détermination des constantes des séismographes électromagnetiques [Determination of the constants of electromagnetic seismographs]: Annales Géophys., vol. 4, no. 2, pp. 124–160, 1948.

The determination of the constants of electromagnetic seismographs when the periods of the pendulum and the galvanometer are different is investigated. The particular case chosen for analysis is that in which the roots of the characteristic equation of the coupled pendulum-galvanometer system are close to the quadruple root, so that a development in limited series is possible within a close range of the root. The relations found are generalizations of Rybner's for equal or nearly equal periods. Examinations of the case of nearly equal periods results in the same formulas as Rybner's. Approximate formulas are given for the rapid determination of constants in this last case.—*M. C. R.*

11715. McComb, H. E., Neumann, Frank, and Ruge, A. C. The determination of true ground motion from seismograph records: U. S. Coast and Geodetic Survey Special Pub. 250, 52 pp., 1949.

A reprint of "The determination of true ground motion by integration of strong-motion records: A symposium" in Seismol. Soc. America Bull., vol. 33, no. 1, 1943.—*M. C. R.*

11716. Byerly, Perry, Mei, A. I., and Romney, Carl. Dependence on azimuth of the amplitudes of *P* and *PP:* Seismol. Soc. America Bull., vol. 39, no. 4, pp. 269–284, 1949.

The *PP*/*P* amplitude ratio has been used to infer second order discontinuities in the earth and also to distinguish Pacific and continental structures. The displacement of a point at the surface of the earth produced by body waves from a distant source depends on several factors. The effect of the factor which depends on the energy radiating from the source is investigated here. By an extension of Nakano's work on the correlation of first motion in *P* with direction of forces at the focus it is shown that the ratio of *PP*/*P* is a function of the azimuth from a fault source for certain kinds of movement. It is concluded that the ratio *PP*/*P* depends on too many factors to be useful in determining any one of them.—*M. C. R.*

11717. Agamennone, Giovanni. La profondita del foco dedotta dall' angolo d'emergenza delle onde sismiche [Depth of focus derived from the angle of emergency of seismic waves]: Geofis. Pura e Appl., vol. 12, pp. 108–112, 1948.

The suggestion of several seismologists that the depth of focus of an earthquake be determined by measuring the angle of emergence of the first seismic wave is critically analyzed. This method requires knowledge of the exact amplitudes of the first phase, P_g or P, from which must be calculated the amplitude and the direction of the displacement of the ground, the apparent angle of emergence and then the true angle. It is also necessary to know the travel times for the arrival of the same wave from the focus to several other seismic stations, located as near as possible to the epicenter, in itself a very serious limitation of the method. Finally it must be assumed that the incident seismic wave everywhere in its path from the focus to the point of observation is propagated through homogeneous formations, an assumption very seldom justified.

Determinations of the focal depth of different earthquakes by this method and by other means are compared and the inaccuracy of the method noted. Its use is recommended only in the absence of other necessary data.—*S. T. V.*

11718. Bath, Markus. Travel times of the principal earthquake waves for Uppsala: Uppsala Univ., Geol. Inst. Bull., vol. 32, pp. 105–130, 1948.

Travel times of *P, S, PP, SS, L,* and *M* waves have been determined from 315 records of normal or shallow earthquakes with a mean focal depth of 17 km. obtained during 1913–43 on a Wiechert 1,000-kilogram horizontal seismograph at the Meteorological Institute of Uppsala, Sweden. Epicenter data were taken from the related studies and tables of Gutenberg and Richter, Jeffreys and Bullen, as well as from some other data. The study contains extended tables, indicating differences of travel time obtained for various phases; it gives also an evaluation of the accuracy of the method of the analysis. A comparison of the travel times of the seismic waves arriving at Uppsala from different quadrants showed no appreciable difference for the body waves, but a striking difference for *L–O,* indicating the greatest velocity in the northwest and southwest quadrants and the smallest in the northeast and southeast quadrants. The former velocity was 4.21 km./sec, the latter 3.91 km./sec.—*S. T. V.*

11719. DiFilippo, Domenico. Il terremoto delle Azzorre del 25 November 1941. [The Azores earthquake of November 25, 1941]: Annali Geofis., vol. 2, no. 3, pp. 400–405, 1949.

The coordinates of the epicenter of the earthquake have been determined as 37°25′41″ N. lat., 19°00′65″ W. long., and the time of origin as $18^h03^m54.7^s$ G.c.t. The method of Caloi and Peronaci was used, in which approximate values of the unknowns are introduced into the equation defining the azimuth of the epicenter in the spherical triangle formed by the North Pole, the point of the observation and the epicenter of the earthquake, and the corresponding corrections are computed as partial derivatives. Seismograms from 36 observatories were used and the final values were determined by the method of least squares.—*S. T. V.*

11720. Inglada Ors, Vicente. Nota sobre la profundidad hipocentral del sismo del Apenino Toscano-Romañol de 11 Febrero de 1939 [A note on the depth of focus of the earthquake in the Tuscany-Romagna region of the Apennines, February 11, 1939]: Geofis. Pura e Appl., vol. 12, pp. 181–189, 1948.

A depth of focus of 7 km. for this earthquake was determined, using Koveslighety's method, which is based on the measurement of the areas enclosed by successive isoseismal lines and the determination of the equivalent circular areas and their radii. This compares favorably with the depth of 7–10 km. obtained by Caloi from a study of Italian seismograms.—*S. T. V.*

11721. Hayes, R. C. Earthquakes in New Zealand during the year 1947: New Zealand Jour. Sci. Technology, sec. B, vol. 30, no. 2, pp. 102–105, 1948 (1949).

Epicenters, times of origin, and maximum felt intensity of all earthquakes located in the New Zealand area are tabulated and shown on a map.—*M. C. R.*

11722. Lemcke, Kurt. Zur Tectonik des Erdbebengebietes der Hohenzollernalb [On the tectonics of the seismic region of the Hohenzollernalb]: Neues Jahrb. für Mineral., Geologie und Paläontology, Abt. B, Heft 1–3, pp. 20–25, 1949.

Observations during 1946 on the seismicity of the Hohenzollernalb partly complete, partly modify knowledge of the tectonics of this region. The existence of the Hohenzollern graben is confirmed. Other dislocations, genetically independent

of the graben, were discovered. The most important of these is the fault running along the Schmicha brook with a vertical displacement of 30–35 meters. Several other faults show a throw up to 45 meters. The source of earthquakes often observed in this region is now attributed not to faulting of the Hohenzollern graben, but to the newly discovered faults, an explanation which is in better agreement with seismic observations.—*S. T. V.*

11723. Valle, P. E. Sull' interpretazione dei sismogrammi tra 80° e 120° [Interpretation of seismograms between 80° and 120°]: Soc. Sismol. Italiana Boll., vol. 40, no. 1–2, 1942. Reprinted as Ist. naz. geofis. Rome pub. 103.

From experimental data curves are drawn for *SKS–P*, *S–P*, and *S–SKS* between 80° and 120°. Tables at 0.5° intervals show the differences between these curves and Macelwane's.—*M. C. R.*

11724. Montandon, Frédéric. Sur les ondes séismiques du tremblement de terre valaisan de 1946 [On the seismic waves of the Valais earthquake of 1946]: Soc. phys. et histoire nat. Genève Archives Sci., vol. 2, fasc. 1, pp. 192–196, 1949.

Superposition of E. Wanner's isoseismal lines for the four principal shocks of 1946 in the Valais, Switzerland, on N. Oulianoff's sketch of local geology, inferred from seismographic data of Swiss stations for the earthquake of January 25, 1946, shows that the four isoseismal contours form loops extended northwardly over the supposed three adjacent structures, the Mont Blanc-Vosges anticline, the Sierre-Berne-Delémont-Mulhouse syncline, and the Aar-Black Forest anticline. Three project in tongue-like fashion along the syncline, as if squeezed between the two anticlines, indicating greater intensity in the syncline, where sediments would be thick, than in the anticlines, where they would be thinner. Surface evidence supports Oulianoff's thesis that the Mont Blanc massif, the Vosges, the Aar, and the Black Forest massifs are connected by granitic anticlines at depth (*see* Geophys. Abstracts 137, no. 11083).—*V. S.*

11725. Nagata, Takeshi. Summary of the geophysical investigations on the great earthquake in southwestern Japan on December 21, 1946: Am. Geophys. Union Trans., vol. 31, no. 1, pp. 1–6, 1950.

Geophysical studies of the earthquake are summarized briefly. According to Kawasumi, the magnitude of the earthquake determined from the distribution of seismic intensity was 6.5, corresponding to a total seismic energy of 10^{26} ergs. Precise leveling surveys show that deformation of Muroto Peninsula [Muroto-hantō] from 1895 to 1935 had been an inclination in the direction S. 10° E. with almost constant velocity, the total tilt amounting to 1.4 seconds. The change accompanying the present earthquake was exactly opposite in sense. Generally speaking, however, the peninsula is again tilting southward. Crustal movement of the sea bottom which caused the tsunamis apparently also involved a wide area.—*M. C. R.*

11726. Oulianoff, Nicolas. Seismologie et structure du soubassement des Alpes [Seismology and the structure of the sub-basement of the Alps], abstract: Internat. Geol. Cong., Great Britain, 18th Sess., Titles and abstracts of papers, p. 28, 1948.

The Swiss earthquake of January 25, 1946, was recorded by the Neuchâtel, Basel, Zürich, Chur stations—near the epicenter and disposed fan-wise relative

to it. Analysis of the records enabled the author to show that the granitic cores of the ancient Mont Blanc and Aar massifs have a north-south orientation, confirmed the hypothesis that there are direct connections between the Mont Blanc and the Vosges and between the Aar and the Black Forest, and that these two ancient ridges are separated by a depression formed before Alpine folding. It was also established for the first time seismologically that there are within the crust structures which are separated by vertical surfaces.—*V. S.*

11727. Gutenberg, Beno. Structure of the earth's crust in the continents: Science, vol. 111, no. 2872, pp. 29–30, 1950.

Discrepancies between results from studies of earthquake waves and those from artificial explosions are beyond the limits of error. The following interpretation is proposed: material below the sediments has a velocity of about 6 km./sec. for longitudinal waves which increases with depth and approaches 7 km./sec. at a depth of 10 km. At approximately 15 km. depth the velocity decreases, either abruptly or gradually, with a minimum of about 5½ km./sec. at 20–25 km. Below this, it again increases, possibly suddenly, and again increases suddenly to 8.1 or 8.2 km./sec. at the Mohorovičić discontinuity. In artificial explosions the waves refracted through the surface layers with relatively high velocities are recorded but waves reaching the lower velocity layer are refracted downward. The source of most shallow earthquakes would be in the low velocity layer. Rays starting not too far from horizontal could not leave the low-velocity layer in accordance with ray optics and thus could form a "sofar channel". Energy radiating from the channel would form the *P* phase. Unpublished work by Richter is in excellent agreement with the new hypothesis.—*M. C. R.*

11728. Gutenberg, Beno. Properties of the earth's crust beneath the oceans [abstract]: Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, p. 1892, 1949.

There are two major units of the earth's crust, one consisting of the continents and the bottom of the Indian and Atlantic Oceans, with andesitic crustal material, and the second the Pacific basin with possible outlying areas in the Caribbean, southern Antilles and Arctic regions, with younger eruptive basaltic rocks. Geophysical evidence for the discontinuity between these units consists of great ocean deeps, negative gravity anomalies, and shallow earthquakes, followed on the continental side by zones of intermediate earthquakes and active volcanoes, and deep earthquakes. Other evidence for the difference in structure includes the higher velocity in the Pacific basin for 20-second surface waves, the loss of energy in surface waves travelling along the Pacific boundary, the smaller amplitudes of longitudinal waves reflected under the Pacific, the occurrence of 80 percent of all earthquakes in the circum-Pacific belt, and the lack of shocks in the interior of the Pacific basin in contrast to the Atlantic and Indian Oceans.—*M. C. R.*

11729. Ewing, Maurice. Seismic studies in ocean basins [abstract]: Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, pp. 1885–1886, 1949.

Seismic refraction measurements in the North Atlantic in general show that basement rocks in which longitudinal waves have a velocity of 7.6 km./sec. underlie approximately 2 km. of unconsolidated sediments. Reflection measurements over large areas, including the approaches to continents, main basins, and central highland of the mid-Atlantic Ridge, cannot yet be interpreted as indicating reflecting surfaces which are continuous over distances of tens of miles. On the eastern and western flanks of the Ridge and throughout the Bermuda Rise, however, it is

possible to map a buried reflecting surface, probably the top of the basement, which is continuous over hundreds of miles at depths to 4,000 feet. Absence of intervening reflections indicates a remarkable homogeneity of the overlying sediments.

A proposed new theory of surface wave dispersion under oceans can be interpreted to indicate that seismic refraction results are valid for most if not all of the Atlantic and Pacific Ocean basins. If this conclusion is accepted, it is strong evidence that the ocean basins have never stood higher with respect to the continents than at present, and land bridges, if they existed, must have been very narrow.—*M. C. R.*

11730. Ewing, Maurice, Worzel, J. L., Hersey, J. B., Press, Frank, and Hamilton, G. R. Seismic refraction measurements in the Atlantic Ocean basin: Geol. Soc. America Bull., vol. 60, no. 8, p. 1303, 1949.

A reversed seismic refraction measurement at 34° N. lat., 66°30′ W. long. indicated the ocean floor there consisted of two layers. A velocity of 24,800 ft./sec. (7.58 km./sec.) was found for the second layer. The velocity in the upper layer was assumed as 5,600 ft./sec. (1.70 km./sec.), indicating a thickness of 4,500 ft. for the sedimentary layer. The granitic and intermediate layers are thus apparently lacking.—*M. C. R.*

11731. Hill, M. N., and Swallow, J. C. Seismic experiments in the Atlantic: Nature, vol. 165, no. 4188, pp. 193–194, 1950.

Experimental observations were made in August 1949 near 53°50′ N. lat., 18°40′ W. long. in water approximately 1,300 fathoms deep. Depth charges set to fire at 900 feet were detected by quartz hydrophones suspended 150 feet below sono-radio buoys which transmitted information from the recording instrument to ship. Preliminary calculation of results indicates two interfaces, at depths of 7,700 and 16,800 feet. Velocities of 6,900, 6,400, and 7,300 ft./sec. in the uppermost layer, 16,300, and 17,300 ft./sec. in the intermediate layer, and 21,700 and 20,600 ft./sec. in the lowest medium were observed at different locations. The first layer is believed to be sediments which are not highly consolidated. The second may be granite or may also be early Paleozoic sediments as the thickness is much less than the granitic layer of the continents.—*M. C. R.*

11732. Morelli, Carlo. Studio di alcune esplosioni subacquel nel Golfo di Trieste [Study of submarine explosions in the Gulf of Trieste]: Annali Geofis., vol. 2, no. 1, pp. 113–136, 1949.

Explosives detonated on the sea bottom at distances of 3–10 kilometers and in a marble quarry 16 kilometers from the Trieste seismograph station were recorded by the Wiechert and Alfani instruments as well as the Geiger accelerometer. The velocities of *P* and *S* waves were determined as 2,680 and 1,720 meters per second respectively. Strong amplitudes of the direct longitudinal waves were observed in the water at short distances from the shot points. Rayleigh-type surface waves were found at the boundary of the water-ground system as predicted by the theory of Press and Ewing.—*S. T. V.*

11733. Raitt, R. W. Studies of ocean-bottom structure off southern California with explosive waves [abstract]: Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, p. 1915, 1949.

Sediment thickness and basement velocity in the Pacific Ocean area between Point Eugenia and Santa Cruz Island and extending 800 nautical miles west of

San Diego have been studied by reflection and refraction methods. TNT bombs were used as sound sources, and recording was by pressure-actuated crystal hydrophones.

Beyond the continental slope, in water about 2,000 fathoms deep, the sediment thickness was a few hundred meters, and the basement velocity approximately 6.5 km./sec. One 60 km. reversed profile indicated that the velocity increases to 8 km./sec. at a depth of about 5 km. beneath the basement surface. A strong second arrival with a velocity of 3.6 km./sec. may be a basement shear wave.

Inside the continental slope the greatest sediment thickness observed was about 3 km. in Santa Cruz basin, where water depth is 1,050 fathoms. Basement velocities range from about 4.5 km./sec. near land, where metamorphic rocks outcrop, to 6.3 km./sec. beneath Santa Cruz basin.—*M. C. R.*

11734. Willmore, P. L. Seismic experiments on the North German explosions, 1946 to 1947: Royal Soc. London Philos. Trans., ser. A, vol. 242, no. 843, pp. 123–151, 1949.

Observations of seismic waves at distances up to 50 km. from the Soltau explosion, and between 50 to 1,000 km. from the Helgoland explosion indicate an average velocity for the first arrivals of 4.4 km./sec. between 4 and 24 km. from the shot point, 5.95 km./sec. between 24 and 120 km., and 8.18 km./sec. beyond 120 km. Significant local variations were found at the shorter distances. Alternative hypotheses of the distribution of velocity in the upper layers gave estimates of 27.4 and 29.6 km. for the depth of the ultrabasic layer. P^* was not significantly recorded, but several onsets 7 or 8 sec. after P_n may have represented a wave travelling for most of its path in the ultrabasic layer and reflected at the critical angle between that layer and the surface. It was not clear whether the onsets close to the expected time of P_g should be treated as one or more phases. Confused motion persisted during the period when transverse waves were expected, but, with the possible exception of S_n, there was no significant concentration of observations about lines representing recognized phases.

The thermal energy of the Helgoland explosion was 1.3×10^{20} ergs, and the energy in the seismic waves was of the order of 10^{17} ergs.—*M. C. R.*

11735. Benioff, Hugo. Seismic evidence for the fault origin of oceanic deeps: Geol. Soc. America Bull., vol. 60, no. 12, pp. 1837–1856, 1949.

Strain characteristics determined by study of elastic rebound strain increments of aftershock sequences derived from the instrumental magnitude scale are in close agreement with the creep-recovery characteristics of rocks as measured in the laboratory. The method has been extended to a study of sequences of earthquakes in active seismic regions. For a given sequence a graph of accumulated increments plotted against time represents the actual fault movement during the interval. The method may also be used to determine whether or not a chosen sequence represents movements of a single fault structure.

Studies of the Tonga-Kermadec Islands and South American earthquakes suggest that they originate on great faults, approximately 2,500 and 4,500 km. long respectively, dipping under the continental masses. The transverse dimensions are approximately 900 km. each and both extend to depths of approximately 650 km. It is suggested that oceanic deeps associated with these faults are the surface expression of downwarping of the oceanic blocks while upwarping of the continental blocks has produced the islands of the Tonga-Kermadec region and the Andes. Preliminary examination of other deep-focus sequences associated with oceanic deeps, such as the Aleutian sequence, that from southern Japan to

Kamchatka, several sequences in the East Indies, Central America, and West Indies, suggests that all may be generated on similar great faults.—*M. C. R.*

11736. Kuhn, Werner. Zur Diskussion über die Homogenität des Erdinnern [On the homogeneity of the earth's interior]: Die Naturwissenschaften, vol. 33, no. 10, pp. 311–312, 1946.

The discontinuity at the depth of 2,900 kilometers is believed to be the result of a gradual decrease in viscosity which prevents the transmission of transverse waves and greatly damps longitudinal waves. The core is stated to consist of ten percent iron in which is dissolved 90 percent hydrogen under pressure of 2×10^6 atmospheres at a temperature of 5,000° C.—*S. T. V.*

11737. Bath, Markus. Some long period variations of microseismic activity: Geofis. Pura e Appl., vol. 12, pp. 121–126, 1948.

Seismograms of the Uppsala Observatory for 1907–47 were investigated for periodicity of microseism disturbances. An eleven-year period, negatively correlated to the sunspot frequency, was established. This is probably connected with the displacement of the dominant cyclonic tracks as in years of maximum solar activity the cyclones move on more southerly lines than in years of minimum solar activity. Slight indications were also found for a 28 month period.

No correlation exists between sunspots and microseisms for individual months, as the meridional displacement of dominant cyclonic tracks is slow and does not react to short-time variations of solar activity.—*S. T. V.*

11738. Leet, L. D. Discussion of tripartite microseismic measurements: Seismol. Soc. America Bull., vol. 39, no. 4, pp. 249–255, 1949.

The accuracy of the determinations of the bearing of microseismic waves by tripartite station measurements will be seriously affected if waves approach from more than one direction. In many, if not all, storms the evidence suggests such occurrences. Specific cases are discussed of waves of the same and of different periods crossing a tripartite network and it is shown that routine averaging of intervals from time marks to the nearest crest or trough may lead to serious errors if the pattern and character are not considered. Velocity determinations also may be in error when they are based solely on horizontal component records which do not permit distinguishing between Rayleigh and *Q* waves.—*M. C. R.*

11739. Leet, L. D. Microseisms: Sci. Am., vol. 180, no. 2, pp. 42–45, 1949.

Research on the origin of microseisms and their uses in the prediction of storms is traced through the works of E. Wiechert, B. Gutenberg, F. Kishinouye, H. Krug, J. Ramirez, M. Gilmore, and Leet. Microseisms produce a unique pattern of wave motion at each station, indicating that they come from a multiplicity of sources and represent groups of waves crisscrossing the earth's crust from several directions. Although the tripartite method has suggested deep barometric lows over the oceans as the origin of microseisms, the method is not infallible if the direction of propagation of a wave is calculated regardless of whether it is a pure wave of a known type or the product of some complicated combination of waves. The use of a pure Rayleigh wave isolated in microseisms as a guide to direction, as done by Leet in studying the cyclonic storm of November 14, 1945, does not in itself possess the desired accuracy but in combination with the tripartite method it may make possible a determination of the direction of travel of an isolated pure microseismic wave.—*V. S.*

11740. Morelli, Carlo, and d'Henry, G. Sulle cause dei microsismi [Causes of microseisms]: Annali Geofis. vol. 2, no. 2, pp. 281–289, 1949.

From a study of microseisms registered at the Geophysical Observatory of Trieste as related to 43 meterological conditions from the records of the Swiss Meteorological Zentralanstalt for 1946–48, it is concluded that any atmospheric disturbance of a periodic character and sufficient intensity can cause microseisms. This effect remains local except in an atmospheric disturbance over the ocean, when microseisms are always produced, even if the cold front or the lines of occlusion are over the continent. When the center of the cyclone is over the continent and the front over the ocean no microseismic disturbance spreading over any considerable area was discovered. Increases in the area covered by the cyclone increases the intensity of the microseisms. If the cyclone moves so that its center is displaced from the continent toward the ocean the microseisms increase in amplitude. Certain differences are recognized between the microseisms resulting from an atmospheric disturbance over the Atlantic Ocean and one over the Mediterranean Sea.—*S. T. V.*

11741. Zanon, F. S. Microsismi meteorici [Microseisms produced by meteorological factors]: Geofis. Pura e Appl., vol. 12, pp. 200–209, 1948.

The correlation of microseisms observed during 1933–34 on the Vicentini microseismograph at the Venice Seismological Observatory with cyclones observed over the north Atlantic Ocean, near Greenland and the shores of the Scandinavian peninsula was investigated. A regularity is noted in the variation of the period of microseismic waves from six seconds to nine seconds with a simultaneous increase in amplitude, parallel to the decrease of the distance of the cyclone from Venice. Conversely when the cyclone diminishes in intensity or begins to move away, the amplitude of the waves decreases and the period gradually changes from nine seconds to six.

Impulses caused by periodic variation of the barometric pressure in the cyclone over the ocean produce impulses in the granitic layer of the crust which travel great distances. For regions where the natural oscillations of the upper layer have a period of about 6–9 seconds, these impulses are manifested as forced vibrations of great intensity. Thus microseisms caused by cyclones over the northern Atlantic Ocean are recorded in Venice in spite of the separation by the Swiss Alps.—*S. T. V.*

11742. Wanner, E. Erdbebengeräushe [Seismic noise]: Geofis. Pura e Appl., vol. 12, pp. 127–129, 1948.

Several aftershocks of the earthquake of January 27, 1946 in Valais, Switzerland, accompanied by pronounced acoustic phenomena, were observed with a portable seismograph near the epicenter. The aftershocks can be classified into two types, one beginning with a sharp impulse and accompanied by a noise as from an explosion, the other characterized by weak forerunners and a sound like an approaching car.—*S. T. V.*

11743. Bachinskii, N. M. Antiseismic measures in the monumental architecture of Central Asia [in Russian]: 48 pp., Moscow, Akad. Nauk SSSR, 1949.

Details of the architectural engineering of buildings, several centuries old, in Central Asia are described. Many are erected on foundations in the shape of inverted pyramids on which is spread a clay mat. Joints of rush and clay which separate the buildings into smaller units, are wide at the base and taper toward

the top. Beams supporting floors protrude beyond the walls allowing for variation of distance between walls. On the whole, the buildings have resisted the effects of earthquakes very well.—*S. T. V.*

11744. Medvedev, S. V. Measures against destructive effects of violent earthquakes [in Russian]: Akad. Nauk SSSR, Vestnik no. 8, pp. 28–33, 1949.

Severe damage often caused by earthquakes prompted the Academy of Sciences of U. S. S. R. to appoint a number of geophysical committees to study the necessary protective measures. The whole area was divided into three zones in accordance with the frequency of earthquakes and their intensity. In studying this problem, it was found necessary to distinguish between the regional seismicity and local conditions increasing or decreasing the seismic danger. The surface layer, upon which the building foundations are laid, has considerable importance, seismic danger being lowest for crystalline formations and highest for quicksand and peat bogs, with many intermediate forms. The height of the water table also influences the seismic effects.

Another approach to the problem under consideration is the determination of the types of structures which embody the greatest resistance to seismic shocks. Instruments are to be developed to indicate the magnification of the ground amplitudes in different stories and in different types of buildings. For example, it has been observed that square or rectangular structures are more resistant than those of L-shape or T-shape. Buildings of one height seem to be more resistant than those with towers.

A number of accelerometers, frequency indicators, velocity indicators, and analyzers have been constructed for studying the behavior of different buildings and different portions of buildings during earthquakes. There seems to be no doubt that structures of steel and of reinforced concrete are the strongest. The necessity of reinforcing brickwork against shearing stresses is also evident. The influence of separating joints in large buildings is also often favorable.—*S. T. V.*

ELECTRICITY

11745. Rooney, W. J. Earth-current results at Tucson Magnetic Observatory, 1932–42, Carnegie Inst. Washington, Dept. Terrestrial Magnetism Researches, vol. 9, 309 pp., 1949.

Earth-current potentials on two lines 60 and 90 km. long were recorded for approximately eleven and one-half years, a full sunspot cycle, thus making possible establishment of correlation with associated phenomena. Tables give the annual means in sunspot number and in range of earth-current potential gradient; Fourier analysis of monthly means of earth-current gradients; diurnal variation in earth-current potential gradient referred to various means; earth-current potential gradient, hourly values for the whole period of observations. The results of the observations are discussed as to the importance of the variations, their relation to solar activity, seasonal changes, comparison with magnetic records, and lunar diurnal variations.—*S. T. V.*

11746. Takubo, Jitsutaro. Versuche über die Dielektrizitätskonstanten einiger Mineralien und über das dielektrische Verhalten derselben bei Erhitzung [Experiments on the dielectric constants of some minerals and on the variation of their dielectric properties due to heating]: Kyoto Imp. Univ. Coll. Sci. Mem., vol. 16, no. 2, pp. 95–154, 1941.

The dielectric constants of minerals and a few liquids were experimentally determined, using the method of Drude with undamped oscillations produced

by a triode tube. A circuit was formed with a condenser inserted in it, the dielectric plate of the condenser being made of the mineral investigated, and conditions of resonance in the circuit observed. The wave length applied was 101.43 cm. and the temperature was first kept at 25° C. For crystalline, anisotropic substances the relation used was: $e=e_1 \cos^2 m+e_2 \cos^2 n+e_3 \cos^2 l$ where e_1, e_2, and e_3 are the dielectric constants measured in the direction of the principal axes, and m, n, l are the angles of inclination of the direction chosen in the experiment.

Sixty-two minerals were investigated, including sulfur, sphalerite, fluorspar, quartz, calcite, aragonite, and leucite. Tables of the results obtained and numerous graphs are included in the paper, which also contains a detailed description of the experimental set-up. When the temperature was varied a sharp change was observed with sulfur at the point of its transformation from rhombic to monoclinic, sphalerite showed a discontinuity at 220° C., probably caused by the appearance of cracks, and aragonite had an abrupt decrease of the dielectric constant at 473° C., perhaps because of its transformation into calcite.—*S. T. V.*

RADIOACTIVITY

11747. Curtiss, L. F. Measurements of radioactivity, U. S. Nat. Bur. Standards, Circ. 476, 84 pp., 1949.

The physical nature of natural and artificial radioactivity, and the detection and measurement of radioactive radiations by their action on photographic emulsions, on certain crystals, or by the ionization of gases are described. Radioactive standards and units used in radioactive measurements are also discussed. A special chapter is devoted to radioactivity in geology, including age determinations by the lead uranium ratio and by helium content, the importance of pleochroic halos in measurements of geologic time, and methods of determination of radium and thorium content in rocks.—*S. T. V.*

11748. Curtiss, L. F., Evans, R. D., Johnson, Warren, and Seaborg, G. T. Units of radioactivity: Science, vol. 110, no. 2864, p. 542, 1949.

A joint committee of the Divisions of Chemistry and Chemical Technology and Mathematical and Physical Sciences of the National Research Council has recommended the following definitions to the Commission on Standards, Units, and Constants of Radioactivity of the International Unions of Chemistry and Physics. Curie, that quantity of any radioactive species undergoing exactly 3.700×10^{10} disintegrations per second. Rutherford, that quantity of any radioactive species undergoing 10^6 disintegrations per second. R. h. m., roentgen per hour at one meter (recommended for quantitative comparison of radioactive sources emitting gamma rays for which disintegration rates cannot be determined).—*M. C. R.*

11749. Curtiss, L. F. The Geiger-Müller counter, U. S. Nat. Bur. Standards, Circ. 490, 25 pp., 1950.

Information regarding the nature, construction, and use of Geiger-Müller counters is summarized. A bibliography is included.—*M. C. R.*

11750. Hine, G. J. Sensitivity of gamma-ray counters: Science, vol. 110, no. 2858, pp. 380–382, 1949.

Methods for increasing counter sensitivity are outlined because even the counters made from high atomic material detect only 0.7 to 2 percent of gamma rays with energies between 0.5 and 3.0 m. e. v. when these penetrate the counter

walls perpendicularly. Organic and inorganic crystals have come into use recently as scintillation counters, the gamma rays absorbed in them producing light flashes amplified by photomultiplier tubes. Among these counters, calcium tungstate crystals show a very great gamma-ray sensitivity because of their high density and high atomic-weight components. Sensitivities of 24, 38, and 36 percent were obtained respectively for Co^{60}, Ra, and I^{131} gamma rays with very polished, clear cystals ⅛ x ½ inch and ⅛ inch thick. The technique used is described. Increased sensitivities can also be obtained by using Geiger-Müller counters end up. Sensitivities of about 2 percent for I^{131} and 4 percent for Co^{60} and Ra have been observed with commercial end-window tubes.—*V. S.*

11751. Kimura, Kiichi and Uemura, Yoshiaki. A counting instrument with linear amplifier: Kyoto Imp. Univ. Coll. Sci. Mem. sec. A., vol. 23, no. 1, pp. 1–6, 1940.

An instrument has been constructed following the original suggestion of Grienacher and Wynn-Williams and Wards but with the following modifications: the counting chamber is a parallel plate condenser having a collecting electrode 2 cm. in diameter, and the inner electrode is surrounded by a circular guard ring, this shielding being found indispensable for accurate measurements. The linear amplifier employs resistance-capacity coupling. Its most critical detail is the first stage, equipped with a RCA–6J7 tube. A grid leak resistance of 10^9 ohms was used, at the first tube, with a grid voltage of about −0.8 volts. A detailed description of the instrument and a wiring scheme are given.—*S. T. V.*

11752. Jurney, E. T. and Maienschein, Fred. The gamma-ray counting efficiency for a lead-cathode G–M counter: Rev. Sci. Instruments, vol. 20, no. 12, pp. 932–934, 1949.

The relative gamma-ray counting efficiency for a Geiger Müller counter with a lead cathode has been experimentally determined as a smooth increase with increasing energy in the range 0.17 to 2.76 m. e. v.—*M. C. R.*

11753. Poole, J. H. J., Delaney, C. F. G., and McCormick, R. C. The possible existence of a fourth natural radioactive series: Royal Dublin Soc. Sci. Proc., vol. 25, new series, no. 9, pp. 101–116, 1949.

Unexplained pleochroic halos in Ytterby mica suggested the possible presence of the neptunium $(4n+1)$ radioactive series. Experiments using both the nuclear plate technique and an ionization-chamber alpha-ray counter in general proved the neptunium series does not exist in mica, at least in amounts comparable with those of the uranium and thorium series.—*M. C. R.*

11754. Picciotto, Edgard. Etude de la radioactivité du samarium par la methode photographique [Study of the radioactivity of samarium by the photographic method]: Acad. Sci. Paris Comptes Rendus, vol. 229, no. 2, pp. 117–119, 1949.

A knowledge of the half life of samarium combined with an isotopic study of samarium and neodimium can serve as a basis of a method of determining the absolute age of rocks. An investigation by the photographic method of the number of particle groups and of the period of $(SO_4)_3\ Sm_2.8H_2O$ showed that Sm emits only one group of alpha particles of 7μ in the Ilford B and C emulsions, and that based on a tentative count of alpha rays of 133 ± 6 per gram per second, the half life of Sm is $(6.7 \pm 0.4)\ 10^{11}$ years. This is in good agreement with Libby's figure of $(6.3 \pm 0.5)\ 10^{11}$ years.—*V. S.*

11755. Holland, H. D. and Kulp, J. L. Alpha activity of rocks and sediments by scintillation counting [abstract]: Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, p. 1896, 1949.

Scintillations produced on a zinc sulfide screen by alpha particles may be used as a quantitative method of determining alpha activity. A scintillation counter with a C–1732 RCA photomultiplier tube may be adapted for low-activity samples by means of a truncated lucite cone. The counter is being used to study the alpha activity and age determination of rocks and ocean-bottom sediments.—*M. C. R.*

11756. Kimura, Kiichi. Study on radioactivity of hokutolite in Taiwan by means of a counter with linear amplifier: Kyoto Imp. Univ. Coll. Sci. Mem., sec. A, vol. 23, no. 1, pp. 7–17, 1940.

Measurements of alpha activity were made on some twenty different specimens of hokutolite, using a counting system with linear amplifier, which permits detection of individual alpha particles in the presence of beta and gamma rays. The number of alpha particles from the surface of a sample was measured with different thicknesses of aluminum foil inserted between the ionization chamber and the sample, with activity of U_3O_8 used as a standard. The alpha activity of hokutolite was found chiefly due to polonium and radium with radium products. The activity of the natural surface of a young mineral is far stronger than that of the interior. The activity of the polonium was found to be $3.8\times10^{-12}g$ and that of the radium $1.3\times10^{-9}g$ with its products being in equilibrium. The Po content is more than 15 times that of direct derivatives of Ra.—*S. T. V.*

11757. Thommeret, J. Evaluation de la teneur en uranium des rayonnements nucleaires [Determination of the uranium content in radioactive substances]: Jour. physique et le radium, vol. 10. nos. 7–8–9, pp. 249–252, 1949.

A procedure is suggested which gives approximate but sufficiently accurate determinations of the radium content of minerals by two measurements with an ordinary Geiger-Müller counter. This method is based on the fact that uranium produces only beta rays while radium and its derivatives produce both beta and gamma rays, and in many minerals the ratio of beta and gamma radiation is a constant capable of being accurately determined.

Details of the procedure and precautions for eliminating errors in measurement are given. The method is accurate within 5–10 percent. For U content greater than 4 percent it is necessary to dilute the sample and for U content less than 0.1 percent the method is ineffective. It is also not applicable to minerals containing thorium.—*S. T. V.*

11758. Kulp, J. L. and Carr, D. R. Surface area of deep sea sediments [abstract]; Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, p. 1902, 1949

Age determination of unconsolidated ocean sediments by the radioactive in-equilibrium method depends on the preferential adsorption of ionium and radium ions on the surface of precipitating particles. As the adsorptive properties depend on the chemical nature and the surface area of the particles, for a constant mineral type the number of ions adsorbed will be proportional to the surface area. The surface areas of about 50 representative core samples obtained by the Emmett-Brunaver gas adsorption method range from 2 sq. m./gm. for fine red silt to 40 sq. m./gm. for very fine inorganic calcium carbonate. Deep-water red clay has a

surface area of about 25 sq. m./gm. and the more common green clay from shallower water ranges between 10 and 15 sq. m./gm.—*M. C. R.*

11759. Ahrens, Louis. Measuring geologic time by the strontium method: Geol. Soc. America Bull., vol. 60, no. 2, pp. 217–266, 1949.

Age determinations by the strontium method can be made on most potassium and cesium minerals, which contain nearly all existing radiogenic lead. Lepidolite has the highest proportion of such strontium, but high concentrations are also frequently found in amazonite, poleucite, hydrothermal pegmatite microcline, zinnwaldite, and some lithium-rich muscovites. A reasonably reliable age can usually be determined from lepidolite without an isotope analysis, but with all other minerals such analyses are necessary. In all, 32 strontium age determinations are known, 30 of which have been made by a spectrochemical method which is described. Included are determinations of $2{,}100\times10^6$ years for some pegmatites from southeastern Manitoba, believed to be greater than any other region on which sufficient data are available. The procedure is rapid but lacks precision, and age reproducibility is only within 10–15 percent. Where comparisons are possible, strontium ages agree reasonably well with lead and helium (magnetite) determinations. The strontium method is probably superior to the lead and helium methods for dating very ancient rocks. It is unsuitable for younger rocks and it is unlikely that ages of less than 50×10^6 years can be measured successfully.—*M. C. R.*

11760. Hurley, P. M. Radioactivity and time: Sci. Am., vol. 181, no. 2, pp. 48–51, 1949.

The following radioactive methods of measuring geologic time are outlined and illustrated: the lead-uranium ratio, magnetite-helium ratio, strontium-rubidium ratio, thorium-uranium ratio, suitable for determinations within the Pleistocene period; C^{14} content in wood, sea shells, and other materials for measurements within shorter periods; and possible future use of K^{40}, which may decay to Ca^{40} or to A^{40}. The present results of measurements of rock ages are summarized in a table of the history of the earth.—*V. S.*

11761. Marble, J. P. Accuracy of the lead method for the absolute measurement of geologic ages [abstract]: Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, p. 1907, 1949.

Basic factors in the method are reviewed.—*M. C. R.*

11762. Morelli, Carlo. L'età della terra [The age of the earth]: Annali Geofis., vol. 2, no. 3, pp. 417–435, 1949.

Attempts to determine the age of the earth from astronomical, geophysical, and biological evidence are reviewed. An age of 3.3 billion years for the earth has been determined from radioactivity measurements. The age of the solar system is not less than 10^{10} years.—*S. T. V.*

11763. Hurley, P. M. Progress report on age measurements. Appendix A to the report of the special committee on the geophysical and geological study of continents, 1948–49: Am. Geophys. Union Trans., vol. 31, no. 1, pp. 142–144, 1950.

A correlation of age determinations with direction of structural trends in pre-Cambrian rocks shows an encouraging degree of relationship. Eight groups

of age measurement in millions of years are reported as follows: eastward trending structures in Manitoba, Ontario, and Quebec, 1,950 to 2,400; northward trending structures in Northwest Territories, Manitoba, and South Dakota, 1,300 to 1,400; eastward and various trends in Michigan and southern Ontario, 1,100 to 1,600; northeastward trending structures and so-called Algoman granite in southern Ontario and Quebec, 800 to 1,050; northwestward-trending structure in Llano County, Tex., 1,040 to 1,050; northeastward trends from Vermilion Range in Minnesota through Colorado and New Mexico, 750 to 900; northeastward-trending structures in southern Appalachian pre-Cambrian exposures, 600 to 800; and northeastward-trending and structures of various trends in New Jersey highlands and Adirondacks, 450 to 725 with one measurement of 1,500.—*M. C. R.*

11764. Davis, G. L. and Hess, H. H. Radium content of ultramafic igneous rocks: II. Geological and chemical implications: Am. Jour. Sci., vol. 247, no. 12, pp. 856–882, 1949.

Recently published measurements of the radium content of some ultramafic igneous rocks and of the constituent minerals indicate radium and uranium decrease with increasing mafic character. The hypothesis is suggested that virtually the entire radium content is contained in a small volume of late stage minerals, particularly kämmererite, talc, and tremolite, or possibly entirely in kämmererite. —*M. C. R.*

11765. Hurley, P. M. Distribution of radioactivity in granites and possible relation to helium age measurements: Geol. Soc. America Bull., vol. 61, no. 1, pp. 1–8, 1950.

A much higher rate of alpha-particle emission than that expected from the known total uranium and thorium content has been found for granulated samples of felsic rocks. Presence of radioactive elements as secondary mineral coatings on the surfaces of the granules is suggested by abnormally large residual ranges of the alpha particles. Removal of most of the alpha-particle activity by dilute hydrochloric acid leaves activity corresponding to the low uranium and thorium content found in sandstones and arkoses in which the mineral grains have been rounded and cleaned by attrition. Granite samples from considerable depth show a lower proportion of surface activity than those from the zone of surface-water saturation. A relationship apparently exists between losses of activity by acid treatment and the degree of retentivity of helium. From determination of the helium age ratio before and after acid treatment it is inferred that the helium content of essential rock minerals is commensurate with their age and with the quantity of radio-elements uniformly distributed within them, and not removable by acid. The low ratio of helium to radioactivity for the rock as a whole may be due to loss of helium from highly radioactive areas that are easily affected by acid (and inferentially by ground waters) or to supergene enrichment of radio-elements late in the history of the rock.—*M. C. R.*

11766. Slack, H. A. Radioactivity measurements in the Kirkland Lake area, northern Ontario: Am. Geophys. Union Trans., vol. 30, no. 6, pp. 867–874, 1949.

Measurements of the alpha-particle emission from 316 samples from the Round Lake batholith show a regular increase in radioactivity from south to north. As the batholith is believed to plunge northward, this suggests the top of the batholith is more radioactive than the lower portions. Comparison with average activities for the Cheddar, Bourlamaque, and Elzevir batholiths show all three

have high activity near the rims and lower values toward the centers. This has been interpreted as a migration of the accessory radioactive minerals to the top.

Average values of radioactivity of the acid rocks here are low, that of 74 samples being 1.48 cal./gm. per million years compared with the world-wide average of 5.6 cal./gm. per million years. This is in keeping with the observation that pre-Cambrian granites are less radioactive than younger ones. If high radioactivity is due to rise of radioactive elements during emplacement, deeper parts of the crust may contain less radioactive elements and the average values from surface measurements may be too high to represent the average radioactivity of the crust.

On the basis of crustal constitution as determined seismologically and the average radioactivity here determined it is calculated that 40 percent of the total heat flow from the interior of the earth may be accounted for by the radioactivity of the rocks of the top 36 km. Erosion has removed the more highly radioactive material from the surface and deposited it along the continental edges. These deposits may have determined the location and their relatively greater heat may have assisted in the formation of marginal mountain chains.—*M. C. R.*

GEOTHERMAL STUDIES

11767. Benfield, A. E. The temperature in an accreting earth: Am. Geophys. Union Trans., vol. 31, no. 1, pp. 53–57, 1950.

The possibility is examined that the earth, if it formed by accretion, did so as a molten body rather than as a solid. It is shown that the age of the earth need not be supposed to be seven billion years in order for its surface to have been molten. The outer part of the earth could have been in a molten condition as the process of formation by accretion approached its end. The effect of pressure alone seems to have been inadequate to cause melting in the interior, but the estimate of rise in temperature by compression rests on approximate calculations.—*M. C. R.*

TECTONOPHYSICS

11768. Jardetzky, Wietcheslaw. On the rotation of the earth during its evolution: Am. Geophys. Union Trans., vol. 30, no. 6, pp. 797–817, 1949.

Several models are necessary for the study of the rotation of the earth during its whole evolution. In the liquid state the earth was in a state of zonal rotation similar to that now observed on the Sun, Jupiter, and Saturn. This was maintained after the formation of the crust. Many types of currents are possible in the earth's interior. Those along the parallels, whose angular velocities increase under the crust from the poles to the equator, can explain the spreading of continents and mountain building but others have little influence. The regular zonal currents in the interior of an earth with a thin crust result in a certain mean rotation of the crust around the same axis. Asymmetry of the distribution of masses in the crust and the tendency of the earth to adopt a state of equilibrium corresponding to the position of the instantaneous axis of rotation may have caused a slow secular displacement of the crust in space progressive throughout geological time. The migration of the poles seems to be explained by a theory of Milankovitch relating the displacement of the poles to the direction of the gradient of the moment of inertia.—*M. C. R.*

11769. Wasiutynski, Jeremi. Dzieje powerzchni ziemi w świetle dynamiki planet [The surface history of the earth in the light of planetary dynamics]: Wiadomości muzeum ziemi, Tom 4, pp. 21–32, 1948.

The article is a brief summary of the author's book "Studies in hydrodynamics and structure of stars and planet" (Astrophysica Norvegica, vol. 4, 1946) concerning the orogenic currents believed to be taking place not only in the earth, but also in the interior of the sun, the moon, and other planets. The existence of a vortical inner motion in the mass of the sun is postulated from the presence of a layer of almost pure hydrogen covering the sun's surface to a thickness of $\frac{1}{18}$ of the radius of the sun. This hydrogen is produced by physico-chemical processes in the sun's interior and is carried to the surface by convection and diffusion. Most of the stars also have such hydrogen covers. The phenomena observed when a nova appears are explained as a disturbance of chemical equilibrium in such a star. Vortical cells which in the opinion of many geologists covered the surface of the earth at the beginning of its cooling are cited as an example of parallelism in evolution of different planets. These cells or fields, produced by vortex motion of the still plastic crust formed a pattern of boundary lines very similar to "canals" of Mars. The present surface of this planet must resemble that of the earth during the Proterozoic and Paleozoic eras.—*S. T. V.*

11770. Escher, B. G. Origin of the asymmetrical shape of the earth's surface and its consequences upon volcanism on earth and moon: Geol. Soc. America Bull., vol. 60, no. 2, pp. 352–362, 1949.

This is the presidential address before the International Association of Vulcanology, 1948. The hypothesis is offered that after the moon was torn from the crust, the rest of the crust moved toward the wound, and the movement was braked when a ring was formed. Beneath the moving sialic floes was viscous magma already partly solidified and beneath that less viscous sial. The latter, being less dense, came to the surface and formed a thin cover behind the floes. The following problems are explained by this hypothesis: the asymmetrical shape of the face of the earth; the origin of continents and oceans; the thin sialic layer under the Atlantic and Indian Oceans; the formation of lunar cirques; the much stronger vulcanism on the moon than on the earth.—*M. C. R.*

11771. Schmidt, E. R. A föld felszinenek geomechanikája [Geomechanics of the earth's crust]: Földtani Közlöny, vol. 78, no. 1–12, pp. 94–102, 1948.

The structure of the earth's crust, formation of its oceans and continents are considered to be the result of one and the same geomechanical process. Mechanical forces caused by rotation of the earth are believed the most important factors in the earth's history. These forces cause meridional stresses and ruptures. Displacement of the terrestrial axis of rotation produced diagonal slip lines, as was suggested by B. Rudemann. Further action of the earth's rotation caused the bursting of the crust along the equator, where the centrifugal force is the greatest, an explanation advanced by L. Kobers in his theory of orogenic rings. At this phase in its history the earth ceased to be a mechanical unit and must henceforth be considered as a system of moving bodies acting one upon another and producing deformations along the lines of contact of these bodies owing to pressure forces. The twisting of the southern continents with respect to the northern hemisphere may be explained as a result of the Coriolis force caused by subsequent changes in the position of the earth's axis.—*S. T. V.*

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11772. Roubault, Marcel. La génèse des montagnes [The origin of mountains]: 243 pp., Paris, Presse Universitaires de France, 1949.

The formation of mountains and the origin of relief on the earth are reviewed. Among the topics discussed are: internal structure of the globe and the importance of seismological evidence in its study; the shape of the earth, and the gravitational method of its investigation; isostasy; variation of pressure and density throughout the earth; thermal state of the earth; radioactivity as one of the sources of heat; distribution of mountains; principal types of folds and other tectonic forms; causes of the formation of mountains; and experimental studies of the deformation of rocks.—*S. T. V.*

11773. Rutten, L. M. R. Frequency and periodicity of orogenetic movements: Geol. Soc. America Bull., vol. 60, no. 11, pp. 1755–1770, 1949.

Critical analysis of Stille's theory of short, worldwide, and synchronous orogenetic phases alternating with long anorogenetic periods suggests that facts are not in accordance with this theory. A correlation in time for orogenetic movements in widely separated regions of the earth is often found but is of a very general character and no correlation of sharply limited orogenetic phases can be established over wide areas. Orogenetic activity is not confined to a single short burst but is composed of several active phases of mountain building during a rather long period of general tectonic unrest.—*M. C. R.*

11774. Oulianoff, Nicolas. Les problemes des tectoniques superposées et les methodes geophysiques [Problems of superposed tectonics and geophysical methods]: Soc. vaudoise sci. nat. Bull., vol. 64, no. 273, pp. 213–222, 1949.

Geophysical investigations, seismic and gravitational and sometimes electrical and magnetic techniques, preferably in combination are suggested as means of determining the major alinements of ancient structures, particularly those which have been distorted by later orogeny.—*M. C. R.*

REGIONAL STUDIES

11775. Woollard, G. P., Chairman. Report of the special committee on the geophysical and geological study of continents, 1948–49: Am. Geophys. Union Trans., vol. 31, no. 1, pp. 132–142, 1950.

The following geophysical activities having direct bearing on the study of continents are reviewed: critical evaluation of the world's primary gravity base station values by Hirvonen and Morelli, and check with improved gravity meter by Woollard involving one globe-girdling loop and four trans-oceanic loops; relative gravity measurements at Washington and Teddington; regional gravity mapping in North and South America; airborne and ground magnetic surveys; studies of crustal structure by seismic methods; and radioactive and thermal measurements.—*M. C. R.*

11776. Wilson, J. Tuzo. Recent applications of geophysical methods to the study of the Canadian Shield: Am. Geophys. Union Trans., vol. 30, no. 1, pp. 101–114, 1950.

Geophysical investigations of the Canadian Shield are reviewed. They include gravimeter surveys, airborne magnetometer surveys, radioactive age determinations, the mathematical approach to theories of earth mechanism, seismic measurements of crustal layers, geothermal measurements, studies of the distribution of radioactivity, measurements of the temperature and pressure of deposition of

minerals, and variation of isotopic content of elements. The paper is devoted primarily to methods, but Wilson suggests that present evidence is compatible with the idea that the continent has grown by the accretion of roots of marginal mountain ranges. An extensive bibliography is included.—*M. C. R.*

11777. Reich, H. Geophysikalische Probleme in bayrisch-schwabishen Donau-Raum [Geophysical problems in the Bavarian-Schwäbian Danube basin]: Erdöl u.Kohle, 2d Jahrg., Heft 3, pp. 81–87, 1949.

Magnetic, gravitational, and seismic work in the German forelands of the Alps are summarized. Magnetic anomalies are small throughout the Bavarian-Schwabian plateau and indicate that thick sediments overlie relatively undifferentiated, predominantly granitic crystalline rocks. The gravity pattern is dominated in the south by the negative zone along the Alps and in the north by the positive zone from Würzburg to Karlsruhe. The massifs in the middle belt are isostatically compensated by outlying, smaller, deep-seated masses and thus exert an influence beyond their boundaries. Magmatic concentrations appear to be either small or very deep. Seismic data obtained in 1948 in the Ries area indicate a depth to the upper crystalline surface ranging from 300 meters in the north to 600–700 meters in the south and a Tertiary thickness of from less than 100 to 300 meters. Velocities average 1,800 m./sec. in the Miocene, 2,300 to 2,800 m./sec. in the Mesozoic, and 5,000 to 5,500 m./sec. in crystalline rocks.—*V. S.*

11778. Zwerger, Rudolf von. Der tiefere Untergrund des westlichen Peribaltikums—Beitrag zur Deutung der regionalen storgebiete des Schwere und des Erdmagnetismus [Deeper underground structure of the western Peribaltic—A contribution to the interpretation of the regional gravitational and geomagnetic anomalies]: Berlin, Geol. Landesanstalt, neue Folge, Heft 210, 74 pp., 1948.

Results of the gravitational and magnetic surveys of the Peribaltic are reviewed and a tentative interpretation of the geological significance of the anomalies found in this area is proposed. The Peribaltic is defined as the belt around the crystalline Baltic Shield characterized everywhere by positive magnetic anomalies caused by the insignificant depth of the overburden. The western Peribaltic includes northwestern Germany from 8° to 15° E. longitude.

In the region north of the Elbe positive gravitational anomalies coincide with the magnetic maxima of the Pritzwalk massif and of the main ridge of Mecklenburg. The entire region of positive anomalies is considered to be one body, the east Elbian massif. Transverse dislocations of this massif, conspicuous in the geophysical picture, were produced in the late Mesozoic and Tertiary periods, and are associated with numerous ore deposits. Between this massif and the Lusatian rise is a broad depression which according to gravitational data becomes much narrower southwest of Berlin.

In the east Elbian massif the region around Prigutiz is characterized by thick Tertiary formations which were observed in seismic investigations and confirmed by exploratory drilling. The northwestern edge of this massif shows a decrease of salt deposits, making improbable the presence of any salt domes.

Along the Pomeranian shore and on the island of Rügen gravitational anomalies rapidly increase, suggesting a tectonic relationship with the islands of Fyn and Jutland where gravitational maxima have been discovered.

The Rhenish zone, which is marked by subsidence, is a region favorable for oil accumulation and search for geological structures associated with oil deposits is suggested. Three maps and eleven diagrams illustrate the text.—*S. T. V.*

11779. Geologisches Landesamt. Geotektonische Karte von Nordwest-Deutschland [Geotectonic map of northwestern Germany], scale 1:100,000, 16 sheets, 68 x 70 cm., Hanover, Germany, 1947. Reviewed by Julius Bartels in Jour. Geophys. Research, vol. 54, no. 1, p. 76, 1949.

A geotectonic map has been prepared of an area of about 20,000 square miles in northwestern Germany. It is based on the results of geological and geophysical surveys of 1934–45 and of drilling for oil and iron ore. The upper layers, in general Diluvial and Tertiary, are removed, and in certain areas upper and lower Cretaceous as well. Geophysical data comprise lines of seismic travel-times to a horizontal distance of 4 km. determined by systematic refraction shooting, contours of important subsurface structure derived from bore-hole information and seismic reflection shooting, and results of gravimeter and torsion balance surveys. Special emphasis is placed on the delineation of the numerous salt domes.—*V. S.*

11780. Reich, H. Geophysikalische Karte von Nordwest-Deutschland [Geophysical map of northwestern Germany], scale 1:500,000, 3 sheets, 64 x 70 cm., Reichsamt fur Bodenforsch., Abt. Geophysik, Celle, Germany, 1948. Reviewed by Julius Bartels in Jour. Geophys. Research, vol. 54, no. 1, p. 76, 1949.

Data obtained from magnetic, gravimetric, and seismic surveys between 1934–45 covering an area of nearly 30,000 square miles in northwestern Germany are mapped on 3 sheets. Vertical intensities measured with a Schmidt field balance are plotted in isoanomaly lines from −100 to +230 gammas on the magnetic map. Bouguer anomalies with contours 2 mgal. apart ranging from −10 to +50 mgal. are shown on the gravimetric map. The seismic map gives travel times for a 4-kilometer standard distance, drawn in isochrones 0.1 second apart and ranging from 2.0 to less than 1.0 second over the local salt domes.—*V. S.*

11781. Pettersson, Hans. Exploring the bed of the ocean: Nature, vol. 164, no. 4168, pp. 468–470, 1949.

The results of the Swedish deep-sea expedition of 1947 on the schooner Albatross are reported briefly. The records included the continuous bottom profile of 20,000 nautical miles registered by an ultrasonic echograph, more than 400 oscillograms from explosions in depths between 300 and 3,500 fathoms, 200 long cores from depths between 2,000 and more than 4,000 fathoms, 10,000 temperature readings, and 4,000 samples of sea water.

Explosion echoes gave an apparent thickness of 12,000 feet of sediments in the Atlantic in contrast to less than 1,000 feet in the Pacific and Indian Oceans. Two unexpectedly high geothermal gradients, 22 and 26 meters per degree centigrade, were obtained in sediments in the central and western Pacific. Measurements of radium and uranium content in large-volume samples of sea water confirmed earlier results from more limited material.—*M. C. R.*

11782. Tolstoy, Ivan, and Ewing, Maurice. North Atlantic hydrography and the Mid-Atlantic Ridge: Geol. Soc. America Bull., vol. 60, no. 10, pp. 1527–1540, 1949.

The outstanding features of the area are the conspicuously flat plain between Bermuda and the Azores (roughly between 29°–40° N. lat. and 50°–56° W. long.), and a similar plain at the same depth east of the Azores in the northern Canary basin. Small sea mounts which occur throughout the area appear to increase toward the southern limit of these plains. The mid-Atlantic Ridge, at 1,600

fathoms or less, has two strongly contrasting types of topography. The central backbone consists of a series of parallel ridges trending northeastward while the flanks are a succession of smooth shelves between 1,600 and 2,500 fathoms. Interpretations are based largely on data from cruises of the Atlantis.—*M. C. R.*

EXPLORATION GEOPHYSICS

GENERAL

11783. Bailey, F. G. Worldwide exploration progress: Petroleum Engineer, vol. 21, no. 13, pp. B63–66, 1949.

A review of papers on petroleum geology and geophysical exploration presented at the 18th session of the International Geological Congress, August, 1948, London.—*V. S.*

11784. Browne, B. C. Geophysical surveys and their utilization: Nature, vol. 164, no. 4177, pp. 859–860, 1949.

The papers on geophysics presented at the meeting of the British Association for the Advancement of Science at Newcastle in 1949 are outlined.

B. C. Browne reviewed gravity work in the British Isles. Several thousands of gravimeter measurements have been made, and it is now possible to obtain a fairly accurate picture of the trend of Bouguer anomalies over most of the Midlands and southern England. In general, the agreement with known geology is good. L. H. Tarrant described gravity and magnetic exploration for oil over 6,000 square miles between Birmingham, Bath, Hertford, and Dover in southern England. About 25 percent of this region is found to have a considerable thickness of Upper Carboniferous, and the oil and coal potentialities justify further investigation.

J. Satterly reported on geophysical research in Canada. A transcontinental gravity traverse has been recently carried out from Halifax to Vancouver; gravity, aeromagnetic, and radioactive surveys were made in various areas; rockbursts in mines are being used for seismic studies; and polar investigations are progressing.—*V. S.*

11785. Bruckshaw, J. M. Recent advances in geophysical prospecting: Petroleum, vol. 12, no. 1, pp. 3–7, 1949.

Recent advances in gravitational, magnetic, seismic, and electrical prospecting are essentially adaptations of existing methods to new environments, such as applications at sea and in the air, rather than the development of fundamentally new methods or greatly improved instruments. The technique and equipment for use of telluric currents in the investigation of deep-seated basement rocks are outlined.—*V. S.*

11786. Eby, J. B. The progress of science in petroleum exploration: Oil, vol. 8, no. 10, pp. 13–14, 1948.

The development of geophysics in application to oil exploration is sketched briefly through the main phases of progress in gravitational, seismic, and geochemical methods.—*V. S.*

11787. Eckhardt, E. A. Geophysical activity in 1948: Geophysics, vol. 14, no. 4, pp. 477–485, 1949.

The magnitude, character, and geographic distribution of geophysical exploration in the oil and mining industries throughout the world in 1948 are summarized.—*M. C. R.*

11788. Mintrop, Ludger. Wirtschaftliche und wissenschaftliche Bedeutung geophysikalischer Verfabren zur Erforschung von Gebirgschichten und nutzbaren Lagerstätten [Economic and scientific value of geophysical methods in exploration of geologic formations and deposits of minerals]: Berg-u. Hüttenm. Monatsh., vol. 94, no. 8–9, pp. 189–211, 1949.

The development of magnetic, seismic and gravimetric methods of geophysical exploration and their application in various parts of the world are reviewed.

Geophysical methods of exploration can be used to obtain scientific information as is indicated by the use of the gravimeter in studying the form of the geoid, and modern seismographs combined with accurate time measurement in obtaining information on the deeper structure of the earth's crust. Observations of the Helgoland explosion and of the Messina earthquake of December 28, 1908, are cited [*see* Geophys. Abstracts 139, no. 11531].—*S. T. V.*

11789. Trefethen, J. M. Geology for engineers, 620 pp., New York, Van Nostrand Co., 1949.

The fundamentals of geology are outlined for the engineering student. One chapter deals with different methods of geophysical exploration in engineering including such problems as determination of depth, subsurface structure exploration, location and delineation of geological formations, and subsurface water studies.—*S. T. V.*

11790. Yale, M. V. Geophysics as a factor in the oil industry: World Petroleum, vol. 19, no. 11, pp. 50–51, 1948.

The development of geophysics as an aid to oil exploration is sketched briefly, and the work of a geophysical exploration company including composition of crews, qualifications of personnel, and innovations in equipment is described to illustrate current practices.—*V. S.*

11791. Cox, Harris. Geophysical exploration in the Paraguayan Chaco: Petroleum Engineer, vol. 21 no. 5, pp. B11–17 1949.

The conditions of geophysical exploration for oil in the Paraguayan Chaco during 1945–48 are described with reference to climate, terrain, communications, water supply, and labor.—*V. S.*

11792. Cumming, J. L. El petróleo, su origen, geologia y métodos de exploración [Petroleum, its origin, geology, and methods of exploration]: Petroleos Mexicanos, no. 74, pp. 13–31, 1949.

Theories of the origin and geological occurrence of petroleum are reviewed. The gravitational, seismic, and electrical methods of prospecting are described. Gravitational methods have been successfully used in the plains along the Gulf of Mexico and in the northeastern states of Tamaulipas and Tabasco. Both refraction and reflection seismic surveys have been successfully made in several areas. Statistical data on petroleum reserves in Mexico and elsewhere are included.—*S. T. V.*

11793. Greenman, W. G. Petroleum exploration in Arctic Alaska: Petroleum Engineer, vol. 21, no. 13, pp. B7–12, 1949.

The effect of climate, permanently frozen ground, transportation, and labor on the exploration of Naval Petroleum Reserve No. 4 is discussed. Exploration methods have included aerophotographic mapping, aeromagnetic reconnaissance, geologic studies, gravimetric and seismic surveying, and test drilling.—*V. S.*

11794. Dixey, F. Modern methods of mineral exploration: Nature, vol. 164, no. 4161, pp. 171–174, 1949.

A discussion of papers on gravitational, magnetic, seismic, electrical, radioactive and geochemical methods of mineral exploration and on aerial photography, presented at the Fourth Empire Mining and Metallurgical Congress in London and Oxford in July 1949.—*V. S.*

11795. Joubin, F. R. Modern methods of mineral exploration in Canada: Fourth Empire Min. Met. Cong., July, 1949, paper no. C4, 20 pp., 1949.

A section on modern geophysical techniques based on the material in A. A. Brant's article "Some limiting factors and problems of mining geophysics, with particular reference to Canadian conditions" is included. [*See* Geophy. Abstract 137, no. 11135].

In addition statistical data on mineral exploration in Canada and information on governmental organizations engaged in geophysical work are given.—*S. T. V.*

11796. Nel, L. T., Simpson, D. J., and DeVilliers, John. Modern methods of mineral exploration in South Africa. Fourth Empire Min. Met. Cong., paper no. C2, 23 pp., 1949.

Methods of geophysical exploration and their use in South Africa are briefly reviewed. Magnetic surveys have been successfully used in the Witwatersrand gold fields, where the Witwatersrand system which includes the auriferous conglomerates also includes several magnetic shales, and have led to the discovery of another potential gold field in Orange Free State. Magnetic surveys have also been used to delineate coal fields by detecting the presence of lavas as opposed to sediments, in diamond prospecting because boundaries of the kimberlite pipes can be traced owing to the presence of magnetite and ilmenite, and in locating nickel ores, which are magnetic, and chrome ores, which have associated magnetite. Resistivity surveys have been used to locate pyrite deposits developed in schists, the depth of alluvial tin deposits, schist horizons which carry tungsten, and the approximate depth of a vermiculite deposit.—*S. T. V.*

11797. Sullivan, C. J. Mineral exploration in Australia: Fourth Empire Min. Met. Cong., paper no. C3, 25 pp. 1949.

Geophysical surveys carried out in different regions of Australia for gold, copper, zinc, lead are reviewed without giving details of individual projects.—*S. T. V.*

11798. Dessau, G. The Geophysical Section of the Geological Survey of India: Indian Minerals, vol. 2, no. 3, pp. 167–178, 1948.

Activities of the Geophysical Section of the Geological Survey of India during the first three years of its existence are reviewed by the Geophysicist-in-charge. These included construction and adaptation of equipment for geophysical survey-

ing, and the beginning of some surveys of limited scope such as a spontaneous polarization survey for pyrite deposits, electrical resistivity surveys near dam sites and coal deposits, and for underground water.—*S. T. V.*

11799. McCaslin, L. S., Jr. Sun completes base for geophysical operations: Oil and Gas Jour., vol. 48, no. 3, pp. 105, 111, 1949.

The organization and the chief problems of the research laboratories and shops of the new central base for the geophysical operations of the Sun Oil Co., Beaumont, Tex., are described briefly.—*V. S.*

GRAVIMETRIC METHODS

11800. Garcia Rojas, Antonio. Exploraciones gravimétricas de tipo industrial [Gravitational methods used in industrial exploration]: Ciencia, vol. 9, no. 1–3, pp. 51–65, 1948.

The gravitational method of exploration is described and typical examples taken from Mexican practice show the application of this method in the petroleum industry.—*S. T. V.*

11801. Romberg, Frederick. La inspeccion con medidor gravitacional conduce al descubrimento de minerales [Prospecting with gravimeter reveals the presence of minerals]: Bol. Minero, no. 590, pp. 296–302, 1949.

Gravimetric methods of prospecting used in search for oil are contrasted with those used in prospecting for minerals. As an example a gravitational survey of Houston-Thomas prospect, New Mexico is described in detail.—*S. T. V.*

11802. Barbosa Braga, E. Investigações do sub-solo pelos métodos geofisicos [Subsurface exploration by geophysical methods]: Portugal Inst. Geografico e Cadastral Bol., vol. 3, pp. 97–125, 1943.

During a gravitational survey in the Marinha Grande province, 123 stations were occupied using the Eötvös torsion balance. The surveyed area is characterized by an exceptional regularity of subsurface strata forming a slightly inclined plain of considerable extent and uniform composition. This makes possible a comparison of the observed and theoretically computed gradients of gravity at different points in the area. Agreement between these values was close. A gravimetric map of the surveyed region is appended. The second section of the article contains a discussion of the resistivity method of geophysical exploration and a description of the Megger used in these investigations, again referring to conditions in Marinha Grande province. Numerous measuring schemes are discussed and the corresponding examples calculated.—*S. T. V.*

11803. Carreño, Alfonso de la O. Estado actual de la investigacion gravimétrica en la republica Mexico [Present state of gravimetric exploration in Mexico]: Ciencia, vol. 7, no. 7–8, pp. 243–255, 1946.

Gravimetric surveys in Mexico are conducted by the Geographic Institute of the National University, the Exploration Division of Petroleos Mexicanos, and the Division of Geography of the Department of Agriculture. Work began in 1899 with pendulum instruments. In 1910 a Sterneck instrument was obtained and an absolute determination of gravity made at the base station of Tacubaya. Up to the present 77 stations have been occupied. Petroleos Mexicanos has occupied 35,000 stations with a torsion balance and more than 20,000 with a Mott-Smith gravimeter. Gravitational surveys will soon be extended to the

Atlantic coast and the Mexican network tied to the Antilles-Caribbean network.—*S. T. V.*

11804. Brown, Hart. A precision detail gravity survey, Jameson area, Coke County, Tex.: Geophysics, vol. 14, no. 4, pp. 535–542, 1949.

Because conventional gravity surveys had indicated no significant anomaly, an experimental high density gravity survey was made of about 20 square miles surrounding the discovery well at Jameson. A station density of 15 per square mile was used and measurements made with great precision. Maps of observed and residual gravity with contour intervals of 0.1 mgal. show a maximum with axis trending north and small minimum axes surrounding the gravity maximum. The discovery well is about halfway between the maximum and eastern minimum axes. Subsequent drilling of some 36 field wells has provided data for an accurate reef map and it seems evident that the gravity anomalies are primarily due to the replacement of the normal Pennsylvanian shale section by the limestone reef. A reef of the general magnitude of that at Jameson buried about a mile deep could account for most of the observed maximum if the reef has a density of 0.22 gm./cm.^{3} greater than the surrounding medium, but the minima cannot theoretically have been produced by the reef itself or anything below it.

Since completion of this survey, five crew years of surveys seeking reefs by the same technique have been conducted. Evidence indicates that the majority of limestone reefs will not produce the desired anomalies because they are too deeply buried, too broad compared to their thickness, or because the gradation from reef limestone to normal shale covers too wide a band. However, many reefs do produce measurable anomalies, and gravity surveys using closely spaced, high precision data may be a valuable tool in certain areas, especially when combined with otherwise inconclusive geological data.—*M. C. R.*

11805. Garcia Siñeriz, José. Investigación geofisica en Larache [Geophysical exploration in Larache]: Rev. Geofis., vol. 8, no. 29, pp. 1–12, 1949.

An extensive gravimetric survey in search for possible oil accumulating structures was made in 1947 in the region between Larache, Alcazarquivir and the French Morocco border. A total of 380 stations was occupied and 420 gravity determinations were made with a new Nørgaard gravimeter. Profiles were 100 to 200 meters apart. The results are presented as five graphs of the profiles, and a gravimetric map, several geological cross-sections, tables of readings, and computed reductions. Several promising structures were located.—*S. T. V.*

MAGNETIC METHODS

11806. Henderson, R. G., and Zietz, Isidore. The computation of second vertical derivatives of geomagnetic fields: Geophysics, vol. 14, no. 4, pp. 508–516, 1949.

Second vertical derivatives of magnetic fields are often useful in interpreting magnetic anomalies because of their high resolving power and delineating properties, and because they facilitate the continuation of fields towards sources. Formulas which permit their ready computation are developed with the aid of solutions to the Laplace equation in terms of a Fourier-Bessel expansion.

The accuracy of the methods is investigated by comparing the approximate values with those rigorously computed for simple idealized fields. The accuracy of the derivatives is a function of the size of the grid spacing as well as of the

accuracy of observations. The effect of the size of grid spacing is illustrated with contoured maps.

Investigation of the relations between second vertical derivative fields and certain types of residual fields shows that they differ by a numerical factor having the dimensions of the reciprocal of length squared.—*R. G. H.*

11807. Henderson, R. G., and Zietz, Isidore. The upward continuation of anomalies in total magnetic intensity fields: Geophysics, vol. 14, no. 4, pp. 517–534, 1949.

The continuation of total magnetic intensity anomalies from data observed on lower levels is effected successfully for contours exhibiting two- and three-dimensional features. Comparisons between observed and computed anomalies are presented in the form of contour maps and profiles. The mathematical formulas necessary for the upward continuation of the field are presented and the numerical evaluation of the resulting surface integrals is described. In general, the success in field extensions depends on the accuracy of observations, the number of points used in computing, the areal extent and the complexity of the anomaly.

Observations at higher levels are concluded to be unnecessary because almost identical results may be obtained by computing and at a much lower cost.—*I. Z.*

11808. Rumbaugh, L. H., and Alldredge, L. R. Airborne equipment for geomagnetic measurements: Am. Geophys. Union Trans., vol. 30, no. 6, pp. 836–848, 1949.

The modified magnetic airborne detector AN/ASQ–3A, associated instrumentation for geophysical exploration, and reduction of data as used by the U. S. Geological Survey, Naval Ordnance Laboratory, Office of Naval Research, and the Naval Petroleum Reserves are reviewed. A modified system capable of recording the entire magnetic vector field rather than field intensity alone, and associated instrumentation to record pitch and roll of the aircraft frame with respect to the vertical and its orientation with respect to true north are reported nearly ready for flight testing.—*M. C. R.*

11809. Oil. Gulf's airborne magnetometer may revolutionize oil exploration: vol. 8, no. 5, pp. 13, 37–38, 1948.

An account is given of the procedures of aeromagnetic exploration, synchronous shoran mapping, the principles of the Gulf airborne magnetometer, and the history of its development.—*V. S.*

11810. Lundberg, Hans, and Wilson, B. T. The airplane dominates in modern exploration methods: Eng. and Min. Jour., vol. 151, no. 2, pp. 106–107, 1950.

The advantages of the airborne magnetometer and a new airborne electromagnetic method in determining geologic structures and discovering minerals in unexplored areas are reviewed and the latter method briefly described. In the electromagnetic surveys, an alternating electromagnetic field is created by a large coil wound around the fuselage of the plane. During flight this electromagnetic field induces in the ground secondary alternating fields which vary in intensity and travelling time depending on the distance to and the conductivity of the ground. The effects of these secondary fields are recorded by a special receiving unit built into the wings. Changes in conductivity produced by ore bodies or structures of lower or higher conductivity cause variations in the secondary field intensities and in the time it takes for a signal to reach the receiver.

This method makes it possible to detect sulfide bodies and major shear zones.—*M. C. R.*

11811. Petroleum. The airborne magnetometer: Vol. 12, no. 12, pp. 316–317, 1949.

Aeromagnetic surveys are outlined briefly with respect to instruments, methods of operations, flight techniques, and interpretation of data.—*V. S.*

11812. Alldredge, L. R. and Dichtel, W. J. Interpretation of Bikini magnetic data: Am Geophys. Union Trans., vol. 30, no. 6, pp. 831–835, 1949.

An interpretation of the magnetic contour map of Bikini resulting from the aeromagnetic survey in 1947 in terms of possible basement structure has been made by use of model techniques. Zero permanent magnetization and uniform susceptibility were assumed, and a model composed of a mixture of foundry clay, ground magnetite, linseed oil, and glycerine was built up, the model scale factor being approximately 1/48640. A uniform field of 345 milligauss with dip angle of +13.5° and declination of 5° E, the present average field, was applied by a 20-foot three dimensional coil system with the model placed in the center, the north-south gradient of less than three gammas per mile being neglected. A magnetic susceptibility of 0.008 used throughout the model work was derived, assuming a 30-mile separation of fringe-peaks, basement material within 7,000 feet of sea level on the basis of seismic evidence, an applied field of 34,000 gamma, and a central negative peak of 700 gamma.

The resulting magnetic anomaly recorded by a miniature magnetometer showed where model and full scale data differed. Suggested changes were made, always keeping the seismic profiles invariant. The final model shows the basement rising to its highest peak, about 5,000 feet below sea level, approximately one mile northeast of Bikini Island and a string of topographic highs around the atoll fringes with major peaks near each island with the one exception of Cherry Island. The original magnetic anomaly map, magnetic contours resulting from the final model, and a basement relief map are shown.—*M. C. R.*

11813. Balsley, J. R., James, H. L., and Wier, K. L. Aeromagnetic survey of parts of Baraga, Iron, and Houghton Counties, Michigan, with preliminary geologic interpretation: U. S. Geol. Survey Geophys. Inv. prelim. map, 1949.

The total magnetic intensity of an 800 square mile area in the central part of the northern peninsula of Michigan is shown by a series of 45 north-south magnetic profiles obtained on traverses flown about 500 feet above the ground. The magnetic pattern consists of linear anomalies trending essentially east, predominantly positive in the northern area where they are probably caused by Keeweenawan "traps", and in the southern area where they are related to greenstones and magnetic slates. In the central area negative anomalies are caused by diabase dikes with inverse remanent magnetization and very strong positive anomalies are associated with anticlines of a magnetic "slate".—*M. C. R.*

11814. Bourret, Weston. Aeromagnetic survey of the Allard Lake district, Quebec: Econ. Geology, vol. 44, no. 8, pp. 732–740, 1949.

An airborne magnetometer survey of a large anorthosite body in Saguenay County, Quebec containing ilmenite-hematite deposits was undertaken to determine the regional limits of ilmenite-hematite mineralization and to prospect for additional deposits. Over 4,500 linear miles of magnetometer traverse were

flown at a nominal 500-foot elevation. Large massive deposits in all instances gave negative anomalies, 3,000 to 5,000 gammas below the average plateau level, with very sharp gradients. Some ilmenite-rich anorthosite also produced negative anomalies but with less steep gradients. The strong negative anomalies are attributed to the effect of negative polarization in the ore body itself. Strong positive anomalies, often of the order of 4,000–5,000 gammas, at the granite-Morin series contact are probably due to concentrations of disseminated magnetite in the hybrid rocks of the contact zone.—*M. C. R.*

11815. Hurley, P. M. Airborne magnetic survey in Maine: Eng. and Min. Jour., vol. 150, no. 8, pp. 52–55, 1949.

An aeromagnetic survey of a 1,200-square-mile area in northwestern Maine was made in July 1948 as a rapid method of narrowing down areas of possible mineral occurrence. As asbestos, copper, chromite, and talc in nearby areas were known to be close to mafic or ultramafic bodies that normally show up in magnetic contrast, attention was centered on strong magnetic gradients. All anomalies were explained geologically except one inaccessible peak in Moosehead Lake. The magnetic contours conform almost identically with dikes in the belt of mixed sediments and igneous rocks and proved a most useful guide for plotting location of intruded masses beneath the overburden. Sections of ultramafic bodies with asbestos and talc mineralization were uniformly associated with magnetic peaks. Other highs resulted from ultramafic rocks in some places bordered by talc-carbonate zones. The magnetic survey also helped to distinguish a granite-gneiss contact by the difference in the magnetic patterns over the two bodies, the former producing more closed contour patterns, the latter intricate and continuing convolutions.

Curves are given for the vertical magnetic response from the vertical component of induced polarization above magnetite bearing bodies of small cross-section. In regions of high latitude the total field and the vertical component may be considered the same as an approximation.—*M. C. R.*

11816. U. S. Geological Survey. Total intensity aeromagnetic maps of Indiana. Geophysical Investigations preliminary maps, scale 1 inch=1 mile, contour interval=10 gammas, 1949 and 1950.

The following maps have been issued in the series of county maps based on a state wide aeromagnetic survey by the Geological Survey in cooperation with the Division of Geology of the Indiana Department of Conservation: Benton, Fulton, Jasper, Lake, LaPorte, Newton, Pulaski, Starke, and White Counties by W. J. Dempsey, J. R. Henderson, and R. T. Duffner, 1949; Posey County, by J. R. Henderson and J. L. Meuschke, 1949; Cass, Elkhart, Marshall, and St. Joseph Counties by Dempsey, Henderson, and Duffner, 1950; and Daviess, Dubois, Martin, Pike, Spencer, and Warrick Counties by Henderson and Meuschke, 1950.

The total magnetic intensity at about 1,000 feet above the surface of the ground is shown by contour lines. The purpose of the survey was to obtain information on the configuration of the crystalline basement rocks, variations in their composition, and relations to structures in the overlying sedimentary rocks, and to study the magnetic expressions of large-scale features, such as the regional tilt of the surfaces of the basement rocks. The survey may also aid in the search for geologic structures favorable to the accumulation of petroleum.—*M. C. R.*

11817. U. S. Geological Survey. Total intensity aeromagnetic maps of Minnesota. Geophysical Investigations preliminary maps, and accompanying profiles, scale 1 inch=1 mile, contour interval=50 gammas, 1949.

The following maps and profiles of a 9,250 square-mile area in north central Minnesota have been issued based on an aeromagnetic survey by the Geological Survey in cooperation with the Minnesota Geological Survey: Wadena County and part of Hubbard County, Todd County by J. R. Balsley, M. E. Hill, and J. L. Meuschke; southern Beltrami, northern Cass, central Cass, southern Cass, northern Crow Wing and part of Itasca, southern Crow Wing, part of Hubbard, western Itasca, eastern Morrison, and western Morrison Counties by J. R. Henderson, M. E. Hill, and J. L. Meuschke.

The total magnetic intensity at about 1,000 feet above the surface of the ground is shown. Larger trends are shown on magnetic contour maps, but comparatively small anomalies are shown as magnetic profiles. The purpose of the survey was to delineate major magnetic trends associated with known deposits of iron ore and to indicate areas under the glacial overburden which may be favorable for additional exploration.—*M. C. R.*

11818. U. S. Geological Survey. Total intensity aeromagnetic maps of Missouri. Geophysical Investigations preliminary maps, scale 2 inches=1 mile, contour interval=50 gammas, 1949.

The following maps of approximately 2,500 square miles of southeastern Missouri have been issued based on an aeromagnetic survey by the Geological Survey in cooperation with the Missouri Geological Survey: part of St. Clair, Coldwater, Des Arc, DeSoto, Farmington and part of Crystal City, Fredericktown, Ironton, and Richwoods quadrangles by W. J. Dempsey and R. T. Duffner.

The total magnetic intensity at about 1,000 feet above the surface of the ground is shown by contour lines. The survey was made to obtain information on the structure of the crystalline basement rocks, variations in their composition, and their relation to structures in the overlying sedimentary rocks, some of which may be favorable for the occurrence of lead deposits.—*M. C. R.*

11819. Weiss, Oscar. Aerial magnetic survey of the Vredefort Dome in the Union of South Africa: Mining Engineering, vol. 1, no. 12, pp. 433–438, 1949.

An aerial magnetometer survey was made over the Vredefort dome, where Witwatersrand beds surround a granite plug 25 to 30 miles in diameter. A narrow belt of sharp negative anomalies (−1,000 to −2,000 gammas) follows the outcrop of the Lower Witwatersrand shales, although elsewhere these same shales cause positive anomalies. The width of the belt is 13,000 to 28,000 feet, increasing with intensity. The negative polarization may have been caused by heat and stresses connected with the doming. The anomalies become weaker where the Karroo sediments and dolerite sills begin to cover the shales, and become positive where the shales disappear beneath the sediments. This is attributed to faulting which has truncated the nearly vertical shales at depth.—*M. C. R.*

11820. Good, S. E., and Pettijohn, F. J. Magnetic survey and geology of the Stager area, Iron County, Mich.: U. S. Geol. Survey Circ. 55, 4 pp., 3 maps, 1949.

As part of a general restudy of the Iron River-Crystal Falls district, most of the Stager area was surveyed with a Wolfson magnetometer, with readings made at 100-foot intervals along traverses approximately 200 feet apart. Magnetic values are shown as departures measured in gammas from the Iron County standard. The contours are parallel to the strike of the beds and magnetic "crests" are associated with a magnetic slate member of the hanging wall strata and the iron-formation.—*M. C. R.*

SEISMIC METHODS [3]

11821. Berson, I. S. Indicator curves of the average seismic velocities in stratified media [in Russian]: Akad. Nauk SSSR Izv., ser. geog. i geofiz., vol. 13, no. 2, pp. 129–142, 1949.

Differences in velocities in vertical and horizontal directions frequently found in seismic prospecting may indicate either anisotropy or simple stratification, with each layer being completely isotropic. The effective and average velocities in a stratified medium are analyzed, assuming the measurements are made along lines either parallel or perpendicular to the stratification, and introducing the indicator curve or the polar diagram of the velocity variation with direction. Analysis of the corresponding shapes of these indicator curves will then make it possible to decide if the medium is anisotropic or composed of parallel isotropic strata. The possibility, long ago surmised by practical seismologists, is confirmed that one thin (10–20 cm.) layer with much higher velocity can so affect the seismic data that the medium appears anisotropic although it is essentially isotropic.—*S. T. V.*

11822. Howell, B. F. Jr. Ground vibrations near explosions: Seismol. Soc. America Bull., vol. 39, no. 4, pp. 285–310, 1949.

To increase knowledge of the basic seismic forms to be expected on the record of explosions, measurements were made at 14 locations along a line 97 to 3,284 meters from a series of small blasts. Recording was by three electromagnetic induction seismometers, two horizontal and one vertical; three amplifiers, and a recording oscillograph. The following pulses were recognized on the records: P, the first to arrive; P_3, a compressional pulse arriving later than P; X_1 X_2 X_3, assumed to be body waves traveling along deeper paths than P and P_3; C, resembling Leet's "coupled" wave, but confined almost entirely to the longitudinal component; T, motion on the transverse component arriving nearly coincident with C; H, similar to Leet's hydrodynamic wave, with direct elliptical motion in a vertical plane; and R, a Rayleigh type motion. No satisfactory theory for C, H, and R is known.—*M. C. R.*

11823. Handley, A. J. Geophysical reflections [in English and Spanish]: Petroleo Interamericano, vol. 7, no. 12, pp. 54–55, 57, 1949.

To aid geologic interpretation of seismic reflections in exploration it is considered desirable to run velocity tests in all dry holes and calibrate reflection times in terms of geologic interfaces. A common practice is to place the seismic reflection record along the time axis, and the electrical well log along the depth axis on the graph of the velocity test so that reflection times can be related to log data. In many areas reflections have been correlated more closely with the self-potential

[3] See also Geophys. Abstracts 11704, 11710–11712.

curve than with the resistivity curve, confirming the observation that velocity changes depend on density variations, as the self-potential curve is more representative of porosity, and thus of density, than the resistivity curve. Accordingly reflections should be studied with reference to any pronounced self-potential kicks, correlated through several holes, and be traced to the corresponding geologic horizons.—*V. S.*

11824. Petroleo Interamericano. Surface seismic shooting [in English and Spanish]: vol. 7, no. 9, pp. 54–55, 1949.

A description of the Poulter method.—*V. S.*

11825. Texas Oil Journal. New method of seismic exploration may cut costs and speed search for new oil: Vol. 15, no. 8, pp. 10–11, 26–27, 1948.

The development, principles, advantages and procedure of the Poulter method of surface shooting in seismic exploration are outlined.—*V. S.*

11826. World Petroleum. New method of seismic exploration for oil: Vol. 19, no. 13, pp. 52–53, 1948.

The Poulter method of seismic exploration is described. For a complete description of the method, *see* Geophysical Abstract 11539.—*V. S.*

11827. Guseman, L. F. Geophysics accepts a challenge: Oil, vol. 8, no 12, pp. 16–17, 1949.

The development of marine seismic exploration is traced briefly from initial near-shore work in calm weather, with bottom charges and position fixing from land, to the current use of drag cables for geophones, refined techniques, larger boats, and radar for surveying, permitting faster and more accurate work farther offshore and in rougher weather. In the Gulf of Mexico surveys are now made at distances of 50 to 75 miles from land.—*V. S.*

11828. Petroleum World. Sea-borne seismic work under way off California coast: Vol. 45, no. 8, pp. 15–17, 1948.

Brief remarks on present and past seismic exploration off the California coast, the equipment used, the monthly costs per crew, comparison of operations with those in the Gulf of Mexico, and potentialities of the continental shelf.—*V. S.*

11829. Agnich, F. J. Geophysical exploration for limestone reefs: Geophysics, vol. 14, no. 4, pp. 486–500, 1949.

The value of various geophysical methods in locating limestone reefs is discussed. Adequate appraisal of the gravity method is impossible because of the small amount of drilling that has been done. Effectiveness of the seismic refraction method depends on the thickness of the reef and the velocity differential between the reef and the surrounding materials. The greatest success in locating reefs has been by use of the reflection survey.

In west and central Texas, usable reflections are not obtained from the reef surface and the problem must be worked in an indirect manner. Where off-reef sediments are predominantly shales, appreciable structure may be developed above the reef by differential compaction, but the structural effect will be slight or absent where the reef is surrounded by sands or limestone. Thus knowledge of the off-reef sediments is necessary to know what significance should be assigned to small, shallow, closed areas. If the reefs have a considerably greater velocity

than the off-reef sediments, deep reflections will indicate false closures. A time isopach map between a shallow and a deep reflection will show an amount of thinning much greater than expected and the results can be interpreted as indicating reefs. Where no appreciable velocity contrast exists and where shallow folding due to compaction is present, an isopach between a horizon above the reef and one below will show a thick section. Such a thick section below a shallow fold will be strongly indicative of the presence of a reef.—*M. C. R.*

ELECTRICAL METHODS

11830. Fiano, R. G. Casi particolari di curve indicatrici nei metodi di prospezione elettromagnetica [Special cases of the indicatrix curve in electromagnetic prospecting methods]: Annali Geofis., vol. 2, no. 3, pp. 359–369, 1949.

This article continues C. Aquilina's study (*see* Geophysical Abstracts 134, no. 10339) on the use of the indicatrix curve in electromagnetic prospecting, to the cases in which the primary field is directed horizontally. The secondary magnetic field is represented by two coils both placed in vertical planes in different relative positions and at different heights over the plane of the ground. Eleven arrangements of the coils represent a body buried at different depths and with varying dips. The corresponding equations of the indicatrix curves are derived, their coefficients calculated and the graphs of the curves are given. The purpose of the study is to facilitate the interpretation of the curves obtained in the field by providing approximations corresponding to known geophysical conditions.—*S. T. V.*

11831. Belluiĝi, Arnoldo. Inductive coupling of a homogeneous ground with a vertical coil: Geophysics, vol. 14, no. 4, pp. 501–507, 1949.

The analytical solution is given for the problem of the electromagnetic field of a harmonically varying magnetic pole at or above the surface of an earth of uniform electrical conductivity. Assuming a magnetic susceptibility of unity everywhere, the boundary conditions permit complete solutions for the horizontal component, H_ρ, and the vertical component, H_z, of the magnetic vector.

The tangential and radial components of the magnetic field produced over the ground by a harmonically varying magnetic dipole at the surface are expressed in terms of $H\rho$ and $\partial H\rho/\partial\rho$. Expressions are given for the ratio of the components of the varying fields to the corresponding components of the stationary fields produced by a magnetic pole or a magnetic dipole. At great distances from the source these ratios approach 2.—*I. Z.* and *R. G. H.*

11832. Gilchrist, Lachlan, Rostoker, Normon, and Bernholtz, Ben. Distribution of potential in a two-layered medium due to an internal source and sink and the determination of the approximate average resistivity of the medium: Canadian Jour. Research, sec. A, vol. 28, no. 1, pp. 1–27, 1950.

A brief review of resistivity investigations is presented including various electrode arrangements on the upper surface of a two-layered medium. The formulas relating interbowl resistance R and resistivity ρ are given for each case. However, it is emphasized that they apply rigorously only to a homogeneous medium. An interpretation based upon these formulas becomes, then, an interpretation of the divergences of experimentally determined values of R and ρ from values calculated for a homogeneous medium. As R for the homogeneous medium is affected by uncertainties, more adequate formulas are required.

Single drill holes, and drill holes in pairs have been used extensively to introduce sources and sinks into layered media. In this type of exploration the formulas for a homogeneous medium are also inadequate; nevertheless informing compari-

sons of experimentally measured values of R with calculated values are sometimes possible.

In the mathematical development of satisfactory formulas for a source or sink in a two layered earth, two approaches are presented: the method of electrical images; and solution of the Laplace equation subject to prescribed boundary conditions. Either approach leads to identical series representations of the distribution of electrical potential in the layers. Theoretical and experimental results involving the use of the derived formulas are presented in the form of curves, from which it is observed that the potential distribution changes in such a manner as to reveal the approximate position of the interface. Also theoretical curves of interdrill hole resistance plotted against depth for various ratios of overburden resistivity to lower layer resistivity can be used to obtain the approximate depth of the interface. At depths sufficiently remote from the overburden, the influence of the upper layer becomes small and simpler formulas can be used.

It is important in resistivity measurements that the sink and source be of equal magnitude and that an infinite plane bisecting the region of exploration be the equipotential face of zero value.—*R. G. H.* and *I. Z.*

11833. Lipskaĭa, N. V. The pattern of the electric field produced by a point source as observed on the earth's surface near a buried conductive sphere. [in Russian]: Akad. Nauk SSSR Izv., ser. geog. i geofiz., vol. 13, no. 5, pp. 409–427, 1949.

The common practice in electrical surveying, when calculating the intensity of anomalies caused by underground bodies, of allowing for the influence of the earth's surface by doubling the anomaly calculated for an infinite space results in serious errors when the depth of the disturbing body is small. An accurate solution when the inhomogeneity is spherical and has a very high conductivity as compared with that of the surrounding medium is obtained by the method of electric images, successively applied. The solution is given as three consecutive approximations of increasing accuracy. The convergence of the approximations is proven. The point electrode as the source of the electric field was chosen because the solution can be easily extended to the problem of linear electrodes or to combinations of several point electrodes.

The method suggested by B. Riemann for a more general problem of two electrically charged bodies, placed in any relative position has been followed. From the general formula particular solutions were derived and numerical values computed for four depths of the disturbing sphere. The results are presented in the form of graphs. From these equipotential lines on the earth's surface are traced. Finally the apparent resistivity of the ground is calculated and the results are compared with the data determined by A. S. Semenov and later experimentally checked by him on a model. The values are in good agreement with the theoretically accurate results, beginning with the third approximation. The first approximation, often made in practical work, can result in an error of as much as 40 percent, if the depth of the disturbing body is not great.—*S. T. V.*

11834. Petrucci, G. L'importanza della rappresentazione dell' andamento del campo elettrico nella prospezione con il metodo dei potenziali naturali [Importance of the analysis of the variation of the electrical field in prospecting by the self-potential method]: Riv. Geomin., vol. 9, no. 2, pp. 83–88, 1948.

The self-potential method is based on the fact that many kinds of ore deposits, such as iron, lead, copper, and graphite generate by oxidation electrical currents

in the ground. But electrical currents can also be produced by decomposition of the surrounding rocks or by contact of geological formations of different chemical composition causing very similar variations of the electrical potential on the surface. Further with stratified ore deposits the self-potential method does not allow a clear geological interpretation.

If instead of tracing the self-potential diagram, the curve of the variation of the electrical field along the same profile is constructed, it becomes possible to discover stratified deposits because the intensity of the electric field at a point represents practically the rate of variation of the potential per meter, whereas the potential at the same point is the result of the algebraic summation of all the variations along the profile from the point of departure. Electrical field intensity is determined by the electrical conditions in the immediate vicinity of the point, the potential is the final result of all preceding points. Several curves of the electrical field and of the potential obtained when prospecting for stratified anthracites are reproduced. Parallel analysis of these curves shows the advantages of using the curve for the electrical field, as it is more accentuated and more sensitive to local influences.—*S. T. V.*

11835. Calhoun, J. C., Jr. Correlation of formation-resistivity factor with porosity: Oil and Gas Jour., vol. 48, no. 26, p. 95, 1949.

For a porous body, containing only straight parallel capillaries in which the resistivity is measured with electrodes placed at the ends of the system, the equation $F=\rho_\omega/\rho_\omega'=1/\Phi$ is derived, where F is the resistivity factor, Φ the porosity, $\rho\omega$ is the resistivity of section when fully saturated with a saline solution, and ρ_ω' the resistivity of the saline solution itself. However, the general formula for any shape of capillaries is $F=\Phi^{-m}$, in which m depends upon the amount of cementation, and usually ranges between 1.3 and 2.5. Thus material of ordinary porosity cannot be expected to conduct electricity in direct proportion to the volume of conducting fluid it contains but will be something less than this maximum because of the irregular pore geometry, with the exponent m being the measure of this irregularity. Graphs of $\log F=-m \log \Phi$, are given for values of m ranging from 1.0 to 2.0.—*V. S.*

11836. Kruger, F. C. and Lacy, W. C. Geological explanation of geophysical anomalies near Cerro de Pasco, Peru: Econ. Geology, vol. 44, no. 6, pp. 485–491, 1949.

Spontaneous polarization and resistivity surveys of an area containing scattered outcrops of gossan at Venencocha on the northwest side of the Cerro de Pasco vent indicated two conspicuous anomalies. Diamond drilling in the area yielded little or no sulfides, so a petrologic study of the cores was undertaken. Similarities in outlines of the spontaneous polarization equipotentials and the distribution of alunite and of the resistivity survey and the distribution of quartz suggest a cause-effect relationship. It is suggested that a body of sulfides that existed above the present surface was removed by erosion and glaciation leaving only the underlying portion of its halo of alteration.—*S. T. V.*

11837. Metzger, A. A. T. Contributions à l'étude électrique des depôts quaternaires [Contributions to the question of electric exploration of Quaternary deposits]: Géol. Finlande Bull. no. 144, pp. 3–8, 1949.

Procedures used in the determination of the thickness of unconsolidated formations overlying "crystallophylien" horizons by electrical methods are described. It is necessary to distinguish between the moraines formed during glaciation and

the deposits of sand, clay, or gravel of postglacial origin. The resistivity of these sediments is determined by their water content and mineralization, the water content being highest in the clay deposits and sometimes completely lacking in gravel and sand deposits. The potential-drop ratio method was used with alternating current of 200 hertz frequency, produced by a small gasoline motor coupled to a generator, or by an oscillator. In resistivity measurements Wenner's scheme was usually employed with very short electrode separation, never exceeding one tenth of the supposed thickness of the formation. A report on such measurements made on different terrain and in different regions of Finland is presented and the results are reproduced in graphs and charts. These findings were in many cases checked by drilling and consequent electrical logging of the drill holes. The results of the eletrical measurements were quite satisfactory.—*S. T. V.*

11838. Perret, W. R. Electrical resistivity exploration as a complement to boring in deep alluvial deposits: Internat. Conference on Soil Mechanics and Foundation Engineering, 2d, Rotterdam 1948, Proc., vol. 7, pp. 80–84, 1949.

Electrical resistivity surveys were made to delineate the subsurface structure along the levees on the east bank of the Mississippi River, and especially to determine the interface between the younger alluvial deposits and the Tertiary marine clay which underlies the lower Mississippi Valley. Resistivity-depth measurements using the Wenner configuration were made at 1,000 foot intervals and the depth to the Tertiary clay was determined at 194 places. This determination was based on the fact that clays in which permeability is low and soluble minerals are prevalent have high conductivity, whereas clean river sands have low conductivity. Interpretation of the measurements was by the curve-matching method, using two- and three-layer standard curves. The results of check tests by borings agreed with the data obtained from electrical measurements within 3.5 percent.—*S. T. V.*

11839. Fritsch, Volker. Mitteilung über einige in dem letzten Jahren durchgeführte Untersuchungen auf dem Gebiete der Funkgeologie [Note on some recent investigations by the radio wave method]: Schweizer. min. pet. Mitt, vol. 29, no. 1, pp. 19–42, 1949.

Geophysical investigations by the radio wave method in exploration for coal, potassium, and iron ores and studies of geological structure around dam sites are reviewed.

Radio waves of different frequencies have been used, their transmission through the ground measured, and the damping capacity of different geological formations observed as a function of the resistivity and dielectric constant. Transmissibility of the ground near potassium mines in Germany was found especially great, being 14 kilometers for a frequency of 3,000 kilohertz with a transmitter of only 15 watts. For other formations this transmissibility is smaller, but measurable in kilometers for those not containing too much water. The method is especially well adapted for hydrological exploration. With capacity substituted the method has been successfully used for deep sounding. For shallow layers resistivity measurements with very high frequency were used and special equipment developed for this purpose.—*S. T. V.*

RADIOACTIVE METHODS

11840. Western Miner. New use for Geiger counter: vol. 22, no. 8, p. 96, 1949.

Progress in the adaptation of the Geiger-Müller counter to prospecting for radioactive minerals is reported. New techniques in constructing electronic circuits have made possible the design of portable models weighing 6 to 11 pounds

and a pocket model weighing 1 pound. A counter has also been designed which can be lowered in a drill hole on a cable over 1,000 feet long without interference with the voltage pulse of the G–M tube.—*V. S.*

11841. Aliverti, Giuseppina. Considerazioni, sui metodi di misura della radioattivita in uso nella prospezione geofisica [Methods of radioactivity measurement in geophysical prospecting]: Riv. Geomin., vol. 10, no. 1, pp. 13–16, 1949.

Radioactive methods used in prospecting for oil, in exploration of geological structures, and in searching for radioactive minerals are reviewed. Included also are methods for measuring the radioactivity of soil for K^{40} content. Results of the radioactivity determinations of different minerals and rock formations are given. The possibility is mentioned of using the secondary radiation, induced by an initial neutron irradiation of the rock, in prospecting for manganese, gold, tungsten, copper, arsenic, sodium, potassium, and phosphorus.—*S. T. V.*

11842. Marcuse, H. Uranium—Mineral of the future: Min. Geol. Jour., vol. 3, no. 6, pp. 7–8, 1949.

This is a resumé of a booklet prepared by the Australian Commonwealth Bureau of Mineral Resources for guidance of prospectors for radioactive minerals in Australia.—*S. T. V.*

WELL LOGGING

11843. Doll, H. G., Legrand, J. C., and Stratton, E. F. Electric logging systems [in English and Spanish]: Petroleo Interamericano, vol. 7, no. 12, pp. 66–71, 1949.

Factors affecting resistivity logging of bore holes are pointed out briefly, and the operation and suitable application of the single-electrode and the four-electrode (normal and lateral) systems are explained and illustrated by diagrams. Usually, two different arrangements are run in the same hole to obtain complete data, as some of them are more adequate than others for thin or thick strata, for small or great mud invasion, and for shallow or deep investigation.—*V. S.*

11844. Stick, J. C. Jr., Baker, J. S., and Norelius, R. G. New electrical logging techniques in California: Tomorrow's Tools Today, vol. 13, no. 2, pp. 17–21, 1947.

Difficulty in interpreting electrical resistivity logs in California oil fields, where formation waters sometimes have a high and fluctuating resistivity, may be overcome by estimating the water saturation of sand formations in wells from log curves of mud invasion, the idea being that water-saturated sand has a higher permeability to such invasion than sand containing oil. The resistivity of the mud is lowered at the time of drilling by suitable treatment to a value below that of formation water. The lateral depth of invasion is determined by a series of shallow-penetration resistivity logs progressively increasing the penetration depth until a measurement is made of the uncontaminated formation. The sections of logs with a resistivity sufficiently high to indicate possible oil sand are then examined to determine whether the resistivity recorded by the shallowest curves has been reduced by penetration of the mud filtrate. If this resistivity has not been reduced, the sand is likely to contain oil. Sands selected as promising must be further graded by comparing their true resistivities to eliminate those which may be silts.—*V. S.*

11845. Wyllie, M. R. J. Statistical study of accuracy of some connate-water resistivity determinations made from self-potential log data: Am. Assoc. Petroleum Geologists Bull., vol. 33, no. 11, pp. 1892–1900, 1949.

The usefulness and limitations of self-potential logs for determining connate-water resistivity are shown by statistical comparison between 39 values computed from routine logs of Illinois, Oklahoma, and Kentucky oil fields and the measured resistivities. In general, the theoretical interpretation of the electrochemical e. m. f. gives correct connate-water resistivities only for self-potential kicks referring to thick, relatively low-resistivity formations and those with little shale interbedding. Computed resistivities average somewhat too high for grossly pointed or very serrated self-potential kicks. Significant correlation was found between the magnitude of the errors and the resistivities of Aquagel muds used in logging. No significant relation was found between the errors and the salinity of the connate-waters studied. No satisfactory explanation has been found for the abnormally low computed resistivities in the McClosky producing zone.—*M. C. R.*

11846. Mercier, V. J. Well logging in limestone areas, radioactive vs. electrical: Tomorrow's Tools Today, vol. 13, no. 1, pp. 4–7, 1947.

The advantages and limitations of radioactive and electrical logs of wells in limestone are discussed briefly with respect to the nature of strata, detection of oil or gas, persistence of vertical variations laterally to provide good correlations, suitability for various bore-hole conditions, locations of porous strata, economy of operation, and simplicity of interpretation. Radioactive logging is apparently more versatile and generally more usable than electrical logging in limestone areas.—*V. S.*

11847. Tiratsoo, E. N. Radioactivity well logging: Petroleum, vol. 11, no. 1, pp. 2–6, 26, 1948.

The nature of radioactivity is explained. The theory and practice of gamma-ray and neutron logging of wells are discussed and illustrated by examples of log curves, and useful applications of logs are listed.—*V. S.*

11848. Faul, Henry, Tittle, C. W., and Goodman, Clark. Neutron logging of drill holes [abstract]: Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, pp. 1886–1887, 1949.

Distribution of thermal and indium resonance neutrons and intensity of secondary gamma radiation have been measured in continuous media and in simulated drill holes, cased and uncased, empty and water-filled. Water, barite-drilling mud, water-saturated sand, moist sand, and brine-saturated sand were investigated. Neutron distributions in water and drilling mud (density 1.4) are nearly identical.

In a 6-inch well, the intensity of neutron-capture gamma rays increases with hydrogen content at points within 16 inches of the neutron source and decreases at more distant points. Absolute gamma intensity is greatly reduced by introduction of nonhydrogenous absorbers (as lead and boron) between logging probe and formation. The slope of logarithmic intensity against distance remains virtually constant. It changes with the hydrogen content of the formation and offers a means of quantitatively estimating porosity behind casing despite extraneous absorption. Hydrogeneous material between probe and rock increases the slope. Two or three inches of mud seriously impairs the sensitivity.—*M. C. R.*

11849. Tittle, C. W., Goodman, Clark, and Faul, Henry. Nuclear radiations in well logging [abstract]: Geol. Soc. America Bull., vol. 60, no. 12, pt. 2, pp. 1923–1924, 1949.

Applications and limitations of radioactivity-logging techniques have been defined largely by experience. Laboratory studies are now being made of the slowing down and diffusion of neutrons, the production and absorption of gamma rays from inelastic scattering and radiative capture of neutrons, and the distribution and absorption of neutrons and of gamma rays under conditions simulating field operations. It is tentatively concluded that the possibilities and limitations of present logging techniques can be established; that increased knowledge of subsurface conditions should result from improvements in present operating procedures; and that neutron flux measurements, when made simultaneously at several points along the axis of the drill hole in the vicinity of a porous formation, can, under favorable conditions, distinguish between oil (and/or fresh water) and salt water.—*M. C. R.*

11850. Bush, R. E. Radioactivity well log interpretation in the East Texas Field: Tomorrow's Tools Today, vol. 13, no. 2, pp. 13–16, 1947.

Gamma-ray and neutron logs in the East Texas Field may aid the reworking of wells flooded by the water drive for maintenance of reservoir pressure. Three generalized cross sections from west to east show that the Eagleford shale is pinched out against the Austin chalk half way across the field and that the producing Woodbine sand is directly below them. Advantageously, the Eagleford shale registers high radioactive intensities, the top of the Austin chalk is marked by a distinct break in these intensities, and the Woodbine sand gives low values. However, the producing sand is broken by non-continuous shale lenses, as shown on a north to south section, and logging is essential in every well reworked. Examples are given of the use of logs in plug-back and deepening operations and of gamma-ray neutron logging in a cased-in well. Combined logging is found advantageous because the neutron curve gives high values for chalk, indicates fluid-bearing portions of the sands, defines bottom of casing and top of liner, and singles out washed-out shale sections.—*V. S.*

11851. Bush, R. E., and Campbell, J. L. P. Limestone completions through radioactivity logs: Tomorrow's Tools Today, vol. 14, no. 1, pp. 4–9, 1948.

Six examples of interpretation of electrical and radioactivity logs in the limestone and sandstone areas of eastern Texas, northern Louisiana, and Arkansas show the advantages of combining these logs for oil-well completions. A low neutron value indicates fluid without differentiating between salt water, fresh water, and oil, whereas low resistivity usually signifies salt water, so that a zone with a low neutron value and high resistivity may contain oil, but a zone with high neutron and resistivity values is likely to be dense. Similarly, a self-potential log alone may be insufficient to distinguish between porous limestone and sandstone, and resistivity indications of oil or gas in limestone, used singly, may be obscured by the effects of a dense cap or intermediate streaks. The combination of the two logs tends also to reduce errors in measurements of depth of formation.—*V. S.*

11852. Campbell, J. L. P., and Winter, A. B. Dry gas sand location by neutron logs: Tomorrow's Tools Today, vol. 13, no. 1, pp. 22–23, 31, 1947.

Dry gas sands have recently been found to appear as high intensities on the gamma ray curve in many areas. Examples of logs illustrate detection of these sands from high neutron values in a faulted area, a Woodbine sand, and a salt dome. The best indications are obtained when the fluid content of the gas sand is less than one gallon of gasoline per 1,000 cubic feet, as wetter sands register insufficiently distinctive neutron intensities. A limiting factor in detection is the water trapped during well-cementing and completion operations because its invasion of formations may cause variations of log values.—*V. S.*

11853. Mercier, V. J. Radioactivity logs don a "new look": Tomorrow's Tools Today, vol. 14, no. 1, pp. 30–32, 1948.

Two types of new forms for radioactivity logging have been developed to meet specific requirements of different localities and take account of advancing techniques. They may be used for recording the gamma-ray curve, the neutron curve, or both curves on a combination log, and are suitable for use at a scale of 1 inch per 100 feet, 2 inches per 100 feet, and 5 inches per 100 feet. The form entries deserving note are discussed, and examples are given of a combination log typical of the Gulf Coast and of the mid-Continent region.—*V. S.*

11854. Norelius, R. G. Improved radioactivity logging for California: Tomorrow's Tools Today, vol. 13, no. 3, pp. 11–13, 1947.

Relatively unsatisfactory radioactivity logs in California are found to be due to a lower general level of radioactivity than in rocks of the Gulf Coast and the mid-Continent, and a smaller contrast in radioactivity between formations. To offset this the speed of logging has been reduced to increase the time for which emission is averaged at each point, and the sensitivity of equipment has been increased by using longer or larger ionization chambers. Both measures improve directly the log's accuracy because the deflection of the recording pen is directly proportional to both the number and intensity of gamma rays passing through the ionization chamber per second. Curves show the decline in the percentage of meaningless variations with an increase in the number of the gamma rays counted. The improved logs obtained with new instruments and suitable logging speeds are shown. These logs are now comparable in accuracy to logs in other regions.—*V. S.*

11855. Woodward, M. E. Oil wells with new life through radioactivity logs: Tomorrow's Tools Today, vol. 13, no. 3, pp. 18–19, 34, 1947.

The usefulness of radioactivity logs in work-over operations is illustrated by their application in the Government Wells Field of south Texas, discovered in 1928 and originally worked on the basis of drillers' logs and core information. The field has produced primarily from the Government Wells sand at an average depth of 2,200 feet, and work-over operations involve the Cole sands at about 1,580 to 1,850 feet. The sands themselves are low in radioactivity, but the contaminating shales and their components—ash, silt, and organic material—register moderate to high values on logs, making correlations possible. The logs of 4 wells are discussed in connection with plug back operations performed with their aid, and samples of log curves are shown.—*V. S.*

11856. Carlson, R. F. Portable mud-logging equipment in Elk City field: Oil and Gas Jour., vol. 48, no. 26, pp. 68–69, 1949.

Trailer-borne mud-logging equipment, including a fluorescence-measuring device, a drilling-time indicator, and a gas analyzer, used in the Elk City oil field, Oklahoma, furnishes general daily reports on formations penetrated in a well and detailed summaries of lithology, mud history, bit record, drilling rate, and oil and gas content of the mud and cuttings. In the gas analyzer air is forced through thoroughly mixed cuttings and any picked-up gas is carried over an ignition element which is an arm of a Wheatstone bridge. Burning of a combustible gas heats the elements and unbalances the bridge by a change of resistance, thus registering on a galvanometer the amount of gas present. A change of voltage across the bridge controls the temperature of the element and permits distinguishing between gases by their ignition temperatures.—*V. S.*

11857. Nichols, P. B. Geolograph aids drilling operations [in English and Spanish]: Petroleo Interamericano, vol. 7, no. 8, pp. 42–43, 1949.

The geolograph is an automatic recorder of the rates of penetration of the bit during rotary drilling of wells. It traces a continuous log on a 24-hour strip-chart divided into 1- or 2-minute divisions, indicating by a separate line the length of time necessary to drill each successive foot. The construction and uses of the instrument are described. The geolograph can serve for determining formation tops, thicknesses of beds, zones of porosity in limes and dolomites, packer points in drill-stem testing, and other drilling factors. The drilling-rate curve has been found often closely to parallel the self potential of the electric log.—*V. S.*

TECHNICAL AIDS

11858. Aslakson, C. I. Velocity of electromagnetic waves: Nature, vol. 164, no. 4173, pp. 711–712, 1949.

The velocity of propagation of ultra-high-frequency radio waves, used in geodetic measurements by shoran, has been determined as 299.792 km./sec. This value is close to those recently found by Essen, Bergstrand, and Jones and Cornford, but different from the generally accepted value of 299.776 km./sec. of Anderson and others. The minimum sum distances between the two ground stations were determined analytically as an aircraft flew across the line between the stations. The velocity assumed in the design of the shoran computer was 299.776 km./sec., and 47 lines were measured, varying from 67 to 367 miles in length. The actual velocity was determined in two ways. The first was based on a comparison of 6 shoran-measured distances with proper values of U. S. Coast and Geodetic Survey triangulations and the calculation of increments to the assumed computed velocity. In the second, the remaining 41 lines were adjusted by a method of least squares, introducing a multiplier for determining the ratio of the increase in length of all these lines to produce the minimum necessary correction. Both methods gave the same value of velocity.—*V. S.*

11859. Halliday, D. J. Geodetic measurements by radar: Nature, vol. 164, no. 4180, pp. 1005–1006, 1949.

The precision of geodetic measurements by radar was determined experimentally in Italy in 1945 by flying circular arcs at altitudes from 10,000 to 15,000 feet, centered upon a ground radar beacon, while recording the distance from a second beacon at regular intervals of 1 to 2 seconds, and then computing the geodetic distance between the two beacons from the radius of the arc and the minimum

recorded distance from the beacon. Calculations included corrections for altitude and for refraction. Comparison with measurements by triangulation showed the radar determinations to be accurate within 1 part in 25,000 and 1 part in 30,000 in the two tests. Limited accuracy is attributed to lack of knowledge concerning variations in refraction and hence in velocity of wave propagation—*V. S.*

11860. Mott, P. G. Aerial surveying, applications in petroleum exploration and exploitation, pts. 1–2: Petroleum, vol. 11, no. 9, pp. 197–201, 203, no. 10, pp. 231–233, 1948.

Applications of aerophotogeology to petroleum exploration in undeveloped areas, production of contoured maps by photogrammetric methods for geologic mapping, and reconnaissance work for exploitation purposes are described.—*V. S.*

11861. Western Miner. Aerial survey: vol. 22, no. 10, pp. 77–79, 1949.

The procedures of mapping from aerial photographs, their advantages, accuracy, instruments used, climatic conditions, operation of the Bausch and Lomb Multiplex stereoprojection unit and applications to geologic surveying are outlined.—*V. S.*

11862. Haskell, N. A. A substitution method for the absolute calibration of vibration pick-ups: Geophysics, vol. 14, no. 4, pp. 558–561, 1949.

A method of calibration similar to that used in acoustic measurements in fluid media may be used for electro-mechanical devices intended to measure the vibrations of a solid medium. The relations between input and output currents and voltages in four-terminal networks of bilateral impedances make it possible to derive a relation between the velocity response of a reversible vibration pick-up and the velocity output when used as a source of mechanical vibrations. Any vibration pick-up may be calibrated in absolute terms as a function of frequency by purely electrical measurements (input current and output voltage) made on the given pick-up, an auxiliary reversible pick-up, and a variable frequency driver.—*M. C. R.*

11863. Stripling, A. A., Broding, R. A., and Wilhelm, E. S. Elevation surveying by precision barometric means: Geophysics, vol. 14, no. 4, pp. 543–557, 1949.

A barometer of high sensitivity designed for use as an elevation meter is described. Changes in atmospheric pressure corresponding to changes in elevation are measured by measuring the changes in volume of an isothermal gas chamber required to maintain the chamber at atmospheric pressure. Changes equivalent to elevation differences of 0.1 foot are detectable. Two field techniques are described, and a typical survey around an 8-mile loop of 13 stations is presented in which the closure is 1.2 feet, and the average error is 0.8 foot.—*M. C. R.*

11864. Powell, C. Radio aids to oil exploration: Petroleum, vol. 12, no. 12, pp. 305–310, 312, 1949.

In the Decca Navigator or QM method of radio position fixing, a chain of three or four transmitters is set up at known points on the earth's surface and a receiver and special map with lines of constant phase difference are carried by the ship, plane, or vehicle using the chain. The method was originally developed for the British Admiralty during the Second World War.—*V. S.*

11865. World Petroleum. New system aids marine surveys: Vol. 19, no. 7, pp. 56–57, 1948.

The radio system of long-range accuracy surveying (Lorac), developed by J. E. Hawkins for marine seismic exploration, is operated with the use of two transmitting stations on land and two receiver sets and phase meters with counters on the survey boat. Position is determined by reading two counter dials and finding the intersection of two corresponding lines on a special chart plotted on the local map. Lorac operates on medium frequencies requiring no special height in receiving antennas and is expected to permit reliable surveys up to distances of 100 miles on sea and land.—*V. S.*

11866. Deegan, C. J. Helicopters now routine in oil exploration: Oil and Gas Jour., vol. 48, no. 31, pp. 79–81, 1949.

The use of helicopters in seismic and gravity exploration for oil is described. It is reported that 1,334 gravity stations have been occupied in a month with an average of 21.4 flying days. To speed location of ground positions, experiments are being made on the development of a lightweight shoran set.—*V. S.*

11867. Frank, Marco. Nuovo sistema di facsimile [New method of reproduction]: Annali Geofis., vol. 2, no. 4, pp. 532–544, 1949.

A new apparatus for reproducing graphs, meteorological data, seismograms, and similar material has been built on an electromechanical principle. Among its advantages are the immediate visibility of the material without photographic processes, and the ability to produce several copies simultaneously. The frequency modulation of the carrier wave may be as high as 3,500 cycles per second. Transmission of signals may be either by telegraph line or radio. A detailed description of the apparatus, including eight wiring diagrams and six pictures, is given.—*S. T. V.*

PATENTS

MAGNETIC METHODS

11868. Magnetic field angular gradientometer. James H. Stein, Toms River, N. J.: U. S. patent 2,490,102, issued December 6, 1949.

A device for measuring, in one operation, the angular gradient between two selected magnetic field components, said device comprising a rigid support having two magnetometers mounted at opposite ends thereon; an indicator having a rotatable circular scale mounted on its axis and a pointer mounted concentric to the axis of said scale; a control means associated with one of said magnetometers for aligning said magnetometer and said scale of said indicator in response to data therefrom, and means associated with the other of said magnetometers for aligning said other magnetometer and said pointer of said indicator in response to data therefrom. Claims allowed, 6.

11869. Magnetometer. Jacob H. Rubenstein, Buffalo, N. Y.: U. S. patent 2,493,779, issued January 10, 1950.

In a magnetometer having a pair of longitudinally spaced antenna members having high permeability and concentrating an external magnetic field in the space therebetween to provide oppositely polarized opposed ends, and a member for indicating changes in said field, the combination therewith of means actuating said indicating member in response to said changes, comprising a vane of magnetizable material pivoted at one side and having its free side interposed between

said opposed ends of said antenna members, and a permanent magnet fixed to the pivoted side of said vane and arranged outside of said gap and polarizing said vane whereby said vane is swung toward one or the other of said opposed ends of said antenna members in response to changes in polarity thereof. Claims allowed, 4.

11870. Method and apparatus for determining magnetic properties of well cores. Henry N. Herrick, Berkeley, and William M. Schaufelberger, Whittier, Calif., assignors to California Research Corp., San Francisco, Calif., a corporation of Delaware: U. S. patent 2,500,680, issued March 14, 1950.

The method of determining the relation between the azimuthal relation of a predetermined point on the surface of a well core which is asymmetrically magnetized in an unknown direction, and the N–S magnetic axis of said core, comprising the steps of placing said core adjacent one of a pair of similar longitudinally aligned oppositely connected coils, rotating said coils about their longitudinal axis substantially at right angles to the approximate direction of the magnetic axis of said core, determining values of potential induced in said nearest coil at various azimuthal positions of said core, and observing the angular relation between those potential values which indicate the actual N–S magnetic axis and the said predetermined point on the surface of said core whereby its original position in the earth may be determined. Claims allowed, 2.

SEISMIC METHODS

11871. Apparatus for seismic prospecting. Raymond U. McKinney, Nowata, Okla., assignor, by mesne assignments, to Seismograph Service Corp., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,490,461, issued December 6, 1949.

Seismic prospecting apparatus comprising shot point and recorder stations in spaced relationship, a source of elastic waves at said shot point station, means at said shot point station for energizing said source, means for driving a record strip at said recorder, means including a timing motor for recording on said record strip spaced timing lines, means for recording on said record strip the instant of creation of said elastic waves, a first relay at said recorder station for controlling the operation of said first-mentioned means, adjustable means associated with said timing motor for periodically energizing said first relay in response to rotation of said timing motor, a second relay for preventing the energization of said first relay until said means for driving said record strip is energized, and means for adjusting said adjustable means so that the instant of creation of said elastic waves as recorded on said record strip coincides exactly with one of said timing lines produced on said record strip. Claims allowed, 10.

11872. Hydrophone. Eugene Merten, Houston, Tex., assignor to Shell Development Co., San Francisco, Calif., a corporation of Delaware: U. S. patent 2,490,595, issued December 6, 1949.

An apparatus for use in underwater seismic surveying operations, said apparatus comprising a fluid-tight housing having a cavity formed in the walls thereof, a resilient pressure responsive diaphragm closing said cavity in fluid-tight manner, a rod affixed at one end to the center of said diaphragm substantially perpendicularly thereto, magnet means having an annular air gap mounted in said housing, a coil coaxially affixed to said rod near the free end thereof, spring means affixed to said housing and the free end of said rod resiliently supporting said coil for axial motion in said gap, an axial passage in said magnet means

forming guide means surrounding said rod, there being a close clearance between said passage and said rod to permit axial movement while substantially preventing transverse movement of said rod, whereby diaphragm deflections are transmitted to said coil solely in the direction of the axis of said rod, insulated conductor means passing through the walls of the casing and electrically connected to said coil, a chamber in said housing, communication means between the chamber and the cavity in the housing wall, port means in said housing wall to said chamber, and expansible diaphragm means closing said port means. Claims allowed, 3.

11873. Method and apparatus for detecting waves. Alexander McLean Nicolson, New York, N. Y.: U. S. patent 2,499,605, issued March 7, 1950.

A method of investigating the characteristics of an inhomogeneous medium comprising, simultaneously propagating a plurality of wave front components through the medium from a common origin, disposing wave responsive means at at least two points on the surface of the medium that are spaced apart with respect to the directions of propagation of two of said wave front components, obtaining indications of the order of arrival of said two wave front components at said respective wave responsive means, moving at least one of said wave responsive means to different points on the surface of said medium that are spaced apart from the other of said wave responsive means with respect to the directions of propagation of said two wave front components, and repeating said propagating and indicating obtaining steps while said one wave responsive means is located at said different points until a reversal in the order of arrival of said two wave front components at said respective wave responsive means occurs. Claims allowed, 8.

11874. Testing device for seismic signal apparatus. James E. Hawkins, Tulsa, Okla., assignor to Seismograph Service Corp., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,493,534, issued January 3, 1950.

The method of testing a seismic wave amplifier equipped with gain control facilities, which comprises generating a seismic wave train in the earth, detecting said wave train, distorting the relative amplitudes of the different components of said wave train, generating a signal representative of the degree of distortion of said different components of said wave train, synchronously recording said distorted wave train and said signal, synchronously reproducing said recorded wave train and said signal, varying the relative amplitudes of the components of said reproduced wave train in accordance with said reproduced signal, thereby substantially to eliminate the distortion of the relative amplitudes of the components of said wave train, impressing said reproduced wave train with the amplitude distortion eliminated therefrom upon said amplifier, and indicating the response of said amplifier to said wave train impressed thereon. Claims allowed, 12.

11875. Seismograph gain control system. Edwin J. Shimek, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,495,390, issued January 24, 1950.

A seismograph amplifier comprising a pair of vacuum tubes arranged in balanced circuit relation, grid-biasing means for applying between the respective signal grids and cathodes of said tubes a bias for operation of each tube at the same point on their respective characteristic curves, means including a resistor having a midportion connected to the cathodes of said tubes and the respective end portions connected to the signal grids of said tubes, a source of direct current

potential connected to the respective end portions of said resistor to bias said tubes respectively in opposite senses and away from said point of said characteristic curves for raising the transmission level of seismic signals to a predetermined value by unbalancing said circuit relation, the output circuit of said vacuum tubes including a source of anode potential and a pair of similar resistors each connected to one of the anodes of said vacuum tubes, a bridge circuit having a first diagonal capacitively connected to the anode sides of said similar resistors, said bridge having a second diagonal, one end of which is connected to ground, and means including an amplifier having an input circuit connected to the other end of said second diagonal and responsive to output signals from said amplifier above a predetermined minimum level for applying a direct current biasing potential in opposition to said source of direct current potential simultaneously to change the bias on said tubes in directions for operation of each nearer said point on said characteristic curves to control the amplitude of the output signals, said bridge being adjustable to balance out any difference in anode currents due to characteristic curves for the respective tubes of different amplitude. Claims allowed, 2.

11876. Apparatus for recording time intervals. Arthur F. Hasbrook, San Antonio, Tex., assignor to Olive S. Petty, San Antonio, Tex.: U. S. patent 2,496,392, issued February 7, 1950.

In a system for marking timing indicia on seismic records and the like, the combination with devices responsive to electrical signal impulses for recording time lines on a record at intervals determined by the period of said impulses, of a pulse source for generating a first series of electrical impulses at a predetermined frequency, electronic means responsive to said first series of impulses for generating a second series of impulses at a frequency which is a sub-multiple of the frequency of said first series of impulses, and means impressing on said recording devices energy representative of both said first and second series of impulses to effect distinctive marking of time lines at intervals corresponding to the intervals between said second series of impulses. Claims allowed, 6.

11877. Seismic exploration system for determination of strata dips. Alexander Wolf, Houston, Tex., assignor to Texaco Development Corp., New York, N. Y., a corporation of Delaware: U. S. patent 2,496,648, issued February 7, 1950.

A method of seismic prospecting wherein it is desired to record seismic waves propagated to the surface at an angle to the vertical and to eliminate waves propagated to the surface at a different angle, which comprises positioning a pair of seismic wave detectors in separated relation at the earth's surface, generating seismic waves at a point on the earth's surface, recording the outputs of said detectors in the form of parallel opaque tracks on a moving film, the width of each track indicating the output of a detector at any instant, subsequently converting said tracks to electrical currents having amplitudes corresponding to a characteristic of said tracks, and measuring the difference in said currents. Claims allowed, 5.

11878. Electromechanical transducer. Alfred L. W. Williams, Cleveland Heights, Ohio, assignor to the Brush Development Co., Cleveland, Ohio, a corporation of Ohio: U. S. patent 2,497,108, issued February 14, 1950.

An electromechanical transducer comprising: an elongated element of electromechanically sensitive dielectric material convoluted into a space the largest

dimension of which is a small fraction of the length measured along said elongated element to provide an electromechanical response significantly greater than that of an element of the same material and cross-sectional shape having a length equal to said largest dimension but having a straight configuration. Claims allowed, 14.

11879. Electromechanical transducer. Charles Revell Holden, deceased, late of Altadena, Calif., by Cora E. Holden, executrix, Altadena, Calif., assignor to William H. T. Holden, New York, N. Y.: U. S. patent 2,498,737, issued February 28, 1950.

In a piezo-electric transducer, a metallic housing comprising two sections, a plate of piezo-electric material yieldingly clamped between said sections, annular grooves on both sides of said plate circumscribing a central area thereof and increasing the freedom of movement of said central area with respect to the remainder of said plate, a plurality of disc-shaped piezo-electric members of substantially identical dimensions and piezo-electric properties stacked upon each other and in contact with one side of said circumscribed area of said plate, a terminating piezo-electric disc in contact with said stack of discs of substantially the same diameter and piezo-electric properties, but one half the thickness of said first-named discs, an electrically conducting coating completely surrounding said terminating disc, an electrode yieldingly engaging said conducting coating, a source of high-frequency energy having two terminals, conductors connecting one of said terminals to said electrode and the other of said terminals to said metallic housing, means for circulating an electric conductive cooling and insulating fluid in and about the section of said housing containing said discs, and means for circulating a fluid to be treated in and about the other section of said housing. Claims allowed, 36.

11880. Coupling means for seismometers. Floyd J. Williams, Dallas, Tex., assignor to Geophysical Service, Inc., Dallas, Tex., a corporation of Delaware: U. S. patent 2,501,558, issued March 21, 1950.

A seismometer including a transformer core at least part of which lies outside of the seismometer case, a winding on the transformer core connected to receive electrical signals from the seismometer, and a removable portion in the transformer core outside of the seismometer case and adapted to be removed and replaced to permit the insertion and removal of a secondary winding on the transformer core. Claims allowed, 4.

RADIOACTIVE METHODS

11881. Method and apparatus for producing neutrons. Winfield W. Salisbury, Cedar Rapids, Iowa, assignor to Collins Radio Co., Cedar Rapids, Iowa, a corporation of Iowa: U. S. patent 2,489,436, issued November 29, 1949.

Apparatus for generating neutrons comprising, an evacuated receptacle having a wall portion thereof formed of a metal which when heated is pervious to deuterium, means to apply deuterium to the surface of said wall portion which is external to said receptacle, means to heat said wall portion to render it pervious and to cause said deuterium to appear at the surface of said wall portion which is interior of said receptacle, and an electrode system within said receptacle for ionizing deuterium which seeps through said wall portion and for accelerating the deuterium ions into high velocity collision with said deuterium and thereby to produce neutrons. Claims allowed, 15.

11882. Radiation counter tube. Frank E. Dudley, Philadelphia, Pa.: U. S. patent 2,489,627, issued November 29, 1949.

In a radiation counter tube, a tubular electrode having internal equidistant spaced longitudinal ribs of arcuate cross section, a central electrode extending longitudinally through the tubular electrode and an envelope surrounding the electrodes. Claims allowed, 6.

11883. Radiation detecting apparatus. Albert Ghiorso, Berkeley, Calif., and Carroll M. Gordon, San Pablo, Calif., assignors to the United States of America as represented by the United States Atomic Energy Commission: U. S. patent 2,490,298, issued December 6, 1949.

In combination, radiation detecting means including an electrode, a stationary chamber, a plate detachably affixed to said chamber and adapted to support said means as a unit, thereby to position the electrode within said chamber, gas supply means connected to said chamber, a material transfer compartment spaced from said chamber, a passageway connecting said chamber and compartment, a movable sealing member adapted to establish a seal between said compartment and said passageway and a movable cover for said compartment. Claims allowed, 16.

11884. Voltage control and stabilizing circuits. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,493,535, issued January 3, 1950.

The method of detecting radiation wherein an instrument capable of detecting radiations encounters regions of varying temperature which comprises impressing a direct current potential on an electrode of a radiation detector of the counter type to yield current pulses, as a result of radiations, and varying the potential impressed on the electrodes of said detector directly as a function of the temperature encountered by said detector, thereby maintaining detector in effective operating condition. Claims allowed, 4.

11885. Radiation counter. Herbert L. Anderson, Hartford, Conn., and Philip G. Koontz, Fort Collins, Colo., assignors to the United States of America as represented by the United States Atomic Energy Commission: U. S. patent 2,494,641, issued January 17, 1950.

A device for indicating the intensity of beta rays, comprising a cathode in the form of a thin walled envelope of material of low absorption for beta rays, and of uniform outer thickness and uniform diameter throughout substantially its entire length, and an anode and ionizable medium contained in said envelope, wherein the cathode is a unitary cup-shaped member having a thickened wall portion adjacent to the closed end thereof. Claims allowed, 16.

11886. Coincidence proportional counter. John Morris Blair, Stillwater, Okla., and James M. Hush, Lincoln, Nebr., assignors to the United States of America as represented by the United States Atomic Energy Commission: U. S. patent 2,495,650, issued January 24, 1950.

Apparatus of the kind described comprising a gas-filled chamber, hydrogenous material in said chamber from which to produce recoil protons, and two aligned counter ionization units spaced from and in line with said hydrogenous material, said units being connected into a coincidence circuit so that only pulses originating from ionization in both units at the same time are counted. Claims allowed, 16.

11887. Radiation alarm and measurement device. Everett W. Molloy, Pasadena, Calif., and William W. Hinch, Denver, Colo., assignors to the United States of America as represented by the United States Atomic Energy Commission: U. S. patent 2,496,886, issued February 7, 1950.

Apparatus for the detection and measurement of radioactivity comprising, in combination, an ionization chamber circuit adapted to produce a direct voltage proportional to the radioactivity under measurement, an electronic tube having a control-grid connected to the positive ion collector of the ionization chamber, a cathode and a plate, a plate load resistor connecting said plate to a source of plate supply voltage, a resistor and a glow discharge tube connected in series, with each other and in parallel with at least a portion of said plate load resistor, a condenser connected in parallel with said glow-discharge tube, a calibrated variable direct voltage source connected in series opposing with said direct voltage produced by said ionization chamber circuit, and means for impressing the resultant net voltage of said series combination of direct voltage sources between the control-grid and cathode of said electronic tube. Claims allowed, 9.

11888. Radiation detecting apparatus. Max D. Liston, Wilton, Conn., assignor to The Perkin-Elmer Corp., Glenbrook, Conn., a corporation of New York: U. S. patent 2,497,129, issued February 14, 1950.

In a detecting means, the combination of a source of rays, an element receiving rays from the source and generating a voltage in response thereto, a member interposed between the source and the element and operating to intercept the rays at a low and uniform frequency, an interrupter in circuit with the element and periodically interrupting the current produced by the voltage generated by the element, means receiving the interrupted current and amplifying it, a rectifying device receiving the output from the amplifying means and operating in timed relation to the interrupter to cause the voltage generated by the element to be reproduced although amplified, a second rectifying device directly receiving substantially the entire unaltered output of the first rectifying device and operating in timed relation with and at the same frequency as the member to cause the voltage generated by the element in response to the rays to produce a direct current output, and filter means connected to and receiving the entire output of the second rectifying device and passing said direct current output only. Claims allowed, 6.

11889. Detector for high energy radiation. Albert M. Skellett, Madison, N. J., assignor to National Union Radio Corp., Orange, N. J., a corporation of Delaware: U. S. patent 2,498,461, issued February 21, 1950.

Apparatus for detecting high energy radiation arising from an external source, comprising an evacuated device having a pair of conductive members defining a gap, at least one of said members having a coating of secondary electron-emissive material, means to excite said members with a high frequency voltage, at least part of the wall of said device being pervious to the said radiations from said external source to permit them to enter said gap. Claims allowed, 16.

11890. Neutron detection. Gerhard Herzog, Houston, Tex., and Kenneth C. Crumrine, Tulsa, Okla., assignors to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,499,311, issued February 28, 1950.

In neutron detection apparatus having a source of neutrons which simultaneously emits gamma rays, the combination which comprises at least two propor-

tional counters spaced at different distances from the source, means for applying an actuating voltage across the counter near the source and means for applying a higher actuating voltage across the counter remote from the source. Claims allowed, 8.

11891. Exploring for radioactive bodies. Ladislas Goldstein and Boris Pregel, New York, N. Y., assignors to Canadian Radium & Uranium Corp., New York, N. Y., a corporation of New York: U. S. patent 2,499,489, issued March 7, 1950.

A method of detecting the presence of a mass of radio-active material which emits gamma rays and which is located sufficiently close to the surface of the earth to emit said gamma rays upwardly into the atmosphere, which consists in moving an aircraft over the region to be explored, said aircraft being thus moved at an altitude within the upward range of said gamma rays, supporting a detecting ionization chamber on said aircraft to receive said gamma rays within said ionization chamber, maintaining a gaseous filling in said detecting ionization chamber in excess of normal atmospheric pressure, maintaining a difference of potential between the wall of said detecting ionization chamber and an internal electrode thereof to extract the ions which result from said gamma ray ionization so that said ions are extracted at said wall and at said internal electrode to produce a flow of detecting ionization current between said wall and said internal electrode in a predetermined circuit relative to said internal electrode, substantially shielding said detecting ionization chamber from alpha rays, determining the stray ionization in said detecting ionization chamber which results from cosmic rays and other stray rays by determining the respective stray ionization current in said detecting ionization chamber which corresponds to the stray ionization which is produced by said stray rays, observing the increase in the flow of said detecting ionization current which is produced by the gamma ray radiation which is to be detected, said aircraft being moved at a speed which is sufficiently low in proportion to CR to produce said increase in said flow of current during a period which can be readily observed, C being the capacity between said wall of said detecting ionization chamber and said electrode, R being the resistance of the circuit in which said detecting ionization current flows. Claims allowed, 5.

11892. Linear integration meter. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,499,953, issued March 7, 1950.

A device for indicating the counting rate of a detector of penetrative radiation which comprises a resistance and a condenser connected in series with the output of said detector to form an integration circuit having a short time constant, a second resistance adapted to form with said condenser an integration circuit having a higher time constant, means for changing from one time constant to the other while simultaneously correcting for the leakage across said condenser, and means for measuring the voltage collected on said condenser due to the pulses of the detector, said means comprising a voltage connected so as to buck the voltage on the condenser, voltage dividing means for adjusting said bucking voltage to balance the condenser voltage and means for indicating the amount of adjustment of said voltage dividing means necessary to balance the condenser voltage. Claims allowed, 3.

11893. Geiger-Mueller counter structure. Herbert Friedman, Arlington, Va.: U. S. patent 2,500,941, issued March 21, 1950.

A detecting element for a radiographic exposure meter comprising, a Geiger-Mueller counter having a coaxial anode and a cathode, an envelope therefor, and a gaseous filling of substantial pressure therein, said cathode having an active surface containing a photosensitive silver halide. Claims allowed, 7.

11894. Method and apparatus for measuring radiation. Marcel J. E. Golay, Long Branch, N. J.: U. S. patent 2,502,319, issued March 28, 1950.

The method of measuring radiation with the substantial elimination of drift which comprises periodically interrupting the radiation to be measured, producing a fluctuating radiation voltage, the amplitude of fluctuation of which is caused by and is a function of said interrupted radiation, interrupting a fixed beam of radiation in time relationship with the interruptions of said radiation to be measured, producing a synchronizing fluctuating voltage having a substantially constant amplitude of fluctuation and having its phase determined by the interruptions of said fixed beam, superposing said fluctuating radiation voltage on said synchronizing voltage and rectifying said superposed voltages to produce a direct electrical current providing a measure of said radiation. Claims allowed, 21.

11895. Geiger-Müller counter for radioactive emission. Lewis Malter, Princeton, N. J., assignor to Radio Corp. of America, a corporation of Delaware: U. S. patent 2,502,331, issued March 28, 1950.

The method of eliminating spurious counts by a Geiger-Müller counter tube which tube includes an anode and a cathode, comprising: the applying of heat to said cathode in an amount sufficient to reduce the internal tube impedance substantially and in an amount less than results in substantial cathode thermal electron emission. Claims allowed, 7.

WELL LOGGING

11896. Methods of and apparatus for transmitting intelligence to the surface from well bores. Ralph W. Goble, Denver, Colo., and Gordon Jackson, Long Beach, Calif., assignors, by direct and mesne assignments, to Eastman Oil Well Survey Co., Dallas, Tex., and Denver, Colo., a corporation of Delaware: U. S. patent 2,492,794, issued December 27, 1949.

An apparatus adapted to be lowered into a well bore for signalling to the surface the attainment of a predetermined compass position of an element within said well bore including, a metallic conductor extending through said bore, an electrical switch unit including a metallic housing attached to said conductor and having fixed circuit closing contacts which are normally in electrical disengagement and which are movable circumferentially within said bore when the conductor is rotated, said switch unit also having a gravity responsive movable contact member adapted to engage the fixed contacts to close the circuit therebetween when said contacts move into alignment with said gravity responsive contact member, whereby said circuit is closed when the fixed contacts assume a predetermined known compass position, a radio frequency transmitter mounted within the metallic housing electrically connected to said switch unit and actuated when the contacts of said switch are in circuit closing position to transmit radio waves of a fixed frequency, whereby said transmitter is operated only when the

fixed contacts of the switch unit are in a known predetermined compass position, and means for coupling the transmitter to the metallic conductor to impress the radio frequency waves on said conductor so that said waves are guided by the conductor and transmitted to the surface thereby and also whereby absorption of the radio frequency electrical energy by the surrounding earth is reduced, said coupling means comprising a longitudinal supporting member of electrical insulating material secured to the lower portion of the metallic housing, an electrical conductor extending longitudinally through the support and having one end electrically connected to the transmitter with its opposite end extending outwardly along the exterior surface of the member and with the extremity thereof electrically connected to the metallic housing within which the transmitter is mounted. Claims allowed, 11.

11897. Well logging detector calibration. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,493,346, issued January 3, 1950.

The method of logging a bore hole which comprises passing through said hole means for detecting variations in the natural gamma radioactivity of the formations surrounding said hole, continuously measuring in the close vicinity of said detecting means direct radiation from a radioactive source passed through the hole with said detecting means, and noting variations in the measurements of the radioactivity from said source caused by changes in a characteristic of said hole. Claims allowed, 11.

11898. Voltage control and stabilizing circuits. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,493,536, issued January 3, 1950.

In apparatus for radioactivity well logging, an instrument housing containing a radiation detector of the counter type, a voltage divider and means for supplying a high direct current potential thereto, a tap on said voltage divider connected to an electrode of said detector, and means for varying the ratio of resistances in said voltage divider with changes in temperature whereby the potential applied to the detector electrode is varied to maintain effective operating conditions at varying temperatures. Claims allowed, 5.

11899. Apparatus for logging wells in terms of drilling rates. John T. Hayward, Solomons, Md.: U. S. patent 2,494,092, issued January 10, 1950.

In the system of rotary drilling of a well employing a rotating drilling string having a drilling tool attached to the lower end thereof and a feed mechanism attached to the upper end thereof for advancing said drilling tool through earth formations by a plurality of intermittent advancing movements at varying rates, apparatus for logging the well in terms of the average drilling rate, comprising, a record-receiving means driven by said feed mechanism in synchronism with the progressive advance of said drilling tool, an averaging device having means responsive to said drill feeding movements and to the related rotational movements of said drilling string to thereby continuously produce an output corresponding to an average of the rates of said drill feeding movements over successive drilling intervals, and means for recording said output on said record-receiving means. Claims allowed, 5.

11900. Apparatus for perforating well casings and well walls. Morris Muskat, Oakmont, and Floyd W. Parker and William L. Kehl, Penn Township, Allegheny County, Pa., assignors to Gulf Research & Development Co., Pittsburgh, Pa., a corporation of Delaware: U. S. patent 2,494,256, issued January 10, 1950.

Apparatus for shooting holes in a well pipe or well wall comprising an explosive charge having a cavity facing the wall of the well, the length of said explosive charge being in the range 1½ to 3 times its diameter, means for supporting and positioning the charge with respect to the well wall and means for initiating the detonation of the explosive charge. Claims allowed, 21.

11901. Core barrel. Benjamin W. Sewell, Tulsa, Okla., assignor to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,494,363, issued January 10, 1950.

A pressure retaining coring assembly to recover a core on the surface of the ground at the same pressure the core left the formation, comprising a string of drill tubing, a core barrel adapted to be lowered into and raised completely out of the string of drill tubing during normal drilling operations, a bit having a passage in the center thereof attached to the end of the drill tubing to cut a core, the core when cut passing upwardly through the passage in the bit and into the lower end of the core barrel, a valve means arranged adjacent the lower end of the core barrel adapted when open to pass said core barrel and when closed to seal the lower end of said core barrel, said core barrel passing through said valve during the coring operation, and means carried by said core barrel for breaking off the core below said valve at the end of said coring operation. Claims allowed, 4.

11902. Side wall sample taker. Neville B. Brimble, Houston, Tex.: U. S. patent 2,495,439, issued January 24, 1950.

A sample taking device comprising an anchor having means thereon engageable with the walls of a well bore to support the anchor therein, a deflector connected to the anchor and downwardly movable relative thereto, said deflector and anchor being provided one with a diagonal slot and the other with a cross pin movable in the slot and forming means for moving the deflector laterally relative to the anchor, and adjacent one side of the bore, upon such downward movement, a core forming tool containing a sample chamber and having a universal connection with the deflector and arranged to be deflected by said deflector into said side of the bore and means having a universal connection with the tool for rotating said tool to form a core from said side wall. Claims allowed, 3.

11903. Radiant energy activation. Shelly Krasnow, Arlington County, Va., and Leon F. Curtiss, Montgomery County, Md., assignors, by mesne assignments, to said Krasnow: U. S. patent 2,495,736, issued January 31, 1950.

In a method for indicating conditions within a borehole, the steps of introducing radioactive material in such manner that the said material is retained within the borehole, and of subsequently measuring the radioactive intensity at different portions of the borehole, the measurement so obtained indicating the locality of the material retained, the locality of the said material serving to indicate conditions within the borehole. Claims allowed, 11.

11904. Shield for well logging instruments. Daniel Silverman, Tulsa, Okla., assignor to Stanolind Oil and Gas Co., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,495,781, issued January 31, 1950.

In apparatus for logging wells including an elongated instrument housing containing an irradiation source emitting penetrating nuclear radiations, the improvement comprising a separable cylindrical shield of a radiation-absorbing substance adapted to surround the exterior of said housing, and interengaging projections on said housing and shield for positioning said shield on said housing adjacent and surrounding said irradiation source as said housing is raised through said shield. Claims allowed, 5.

11905. Geometrical determination of dip and strike of cored strata. Philip Subkow, Los Angeles, Calif.: U. S. patent, 2,496,422, issued February 7, 1950.

A method for determining the dip of strata, which comprises taking a plurality of differently deviated cores from the same or substantially parallel strata, determining the inclination and direction of the axes of such cores as taken, establishing the apparent angle of dip of the core strata in each of said cores, establishing the axes of said cores in space in the said direction and at the said inclination, determining the angle of dip of said core strata for various bearings of the dip of the core strata when said core strata are rotated about the axis of their respective cores when so directed and inclined, establishing the bearing and angle of dip of each of said core strata at which said angle and bearing of dip of each of said core strata are equal, and thus determining the bearing and angle of dip of the strata from which the cores are taken. Claims allowed, 12.

11906. Apparatus for logging boreholes. Theodore A. Huber and George E. Cannon, Houston, Tex., assignors, by mesne assignments, to Standard Oil Development Co., Elizabeth, N. J., a corporation of Delaware: U. S. patent 2,497,990, issued February 21, 1950.

An apparatus for determining the thickness of a mud sheath deposited on a portion of the wall of a borehole penetrating subsurface formations, comprising a body adapted to be lowered into the borehole, a first pair of spaced arms pivotally mounted on said body and presenting a knife edge capable of penetrating the mud sheath, biasing means arranged to bias the arms outwardly to force said arms through the mud sheath and into contact with the faces of the formations penetrated by the borehole, a second pair of spaced arms pivotally mounted on said body and presenting a surface area incapable of penetrating the mud sheath, biasing means arranged to bias outwardly the said second pair of arms and maintain them in contact with the exposed face of the mud sheath, a first indicating system operatively connected with the first pair of arms for producing an indication which is a function of the lateral extension of the first pair of arms and hence the true diameter of the borehole and a second indicating system operatively connected with the second pair of arms for producing an indication which is a function of the lateral extension of the second pair of arms and hence the apparent diameter of the borehole. Claims allowed, 1.

11907. Electrical well logging system. Philip W. Martin, Huntington Park, Calif.: U. S. patent 2,501,953, issued March 28, 1950.

In a system having a part lowerable into a well and connected with the surface by a circuit for obtaining information of conditions, the combination of: means at the surface of the ground for transmitting a lower frequency electrical current and a higher frequency electrical current through said circuit to the locality of the part in the well; modulator means carried by said part in the well responsive to two different conditions for utilizing said lower frequency current to modulate said higher frequency current in accordance with said conditions, said modulator means having a first portion responsive only to positive portions of a wave of said lower frequency current as modified by the first condition to be measured, and a second portion responsive only to negative portions of said wave as modified by the second condition to be measured; and means operatively connected to said circuit at the surface, said means operating in synchronism with said lower frequency current to segregate and separately indicate the respective values imposed on said higher frequency current by said modified positive and negative portions of said wave. Claims allowed, 3.

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