

Geophysical Abstracts 141 April-June 1950

(Numbers 11908-12125)

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

G E O L O G I C A L S U R V E Y B U L L E T I N 9 7 6 - B

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



UNITED STATES DEPARTMENT OF THE INTERIOR

Oscar L. Chapman, *Secretary*

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GEOPHYSICAL ABSTRACTS 141, APRIL-JUNE 1950

By MARY C. RABBITT 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 and with basic earth physics as represented by the fields of gravity, magnetism, electricity, seismology, radioactivity, and heat.

Abstracts in this issue have been grouped in three sections dealing with earth physics, exploration geophysics, and patents. The first section has been further divided into sections on gravity, magnetism, seismology, electricity, radioactivity, heat, volcanology, tectonophysics, and the internal constitution of the earth. The section on exploration geophysics covers gravimetric, magnetic, seismic, electric, and 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, an effort is made to include all significant new material in these abstracts. Where geographic names quoted differ from the decisions of the United States Board on Geographical Names 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 may be obtained free of charge from the Publication Distribution Section of the Bureau of Mines. All others are now out of print. Geophysical Abstracts issued as Bulletins of the Geological Survey (except Nos. 87 and 88 which are out of print) may be purchased as single copies

or by subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. 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 Roland G. Henderson, H. R. Joesting, and Isidore Zietz who have prepared the abstracts signed R. G. H., H. R. J., and I. Z., and Dr. Kumizi Iida of the Geological Survey of Japan who has furnished material from which the abstracts of articles in Geophysical Exploration were made.

EARTH PHYSICS

GRAVITY

11908. Cole, J. H. *Geodesy in Egypt*. Ministry of Finance, Egypt. Survey Department, 163 pp., 1944.

The history of geodetic work in Egypt from its beginning in 1907 to recent time is summarized. A report on gravity measurements is included.

The first accurate determinations of gravity were made in 1908 at Helwan Observatory and seven other stations using a Stuckrath pendulum apparatus. Since 1927, when a similar apparatus was acquired by the Egyptian Government, the network of gravity stations has been extended and many measurements repeated. The most recent determination gave for Helwan Observatory $g=979.288$ gal.—S. T. V.

11909. Baars, B. *Getijden-veranderingen van de zwaartekracht* [Tidal variations of the force of gravity]: *Geol. en Mijnb.*, vol. 12, no. 3, pp. 81-88, 1950.

Recent improvements in the design and construction of gravimeters have made possible an accuracy of 0.01-0.02 mgal. in determination of the force of gravity, and have led to the discovery of periodic variations of this force caused by the sun and the moon. In 1948 a program was organized by B. P. M. to measure accurately the gravity force at 20 to 25 places on the earth's surface. These determinations were to be continuously registered between May 9 and May 23, 1949. The data obtained should aid in an accurate determination of the elastic properties of the earth.—S. T. V.

11910. Lagerquist, P. A. *Einige Experimentaluntersuchungen zur Gravimetrie* [Experimental investigations on gravimetry]: *K. svenska vetensk. Arkiv mat., astron. fys.*, Band 36A, no. 12, 25 pp., 1949.

Investigations of the use of capillary rise of liquids for measuring gravity, as suggested by G. Ising (*see* Geophys. Abstract 11682) are described. Temperature variations of 0.01° C. were found to produce a change in the reading corresponding to a gravity change of 40 mgal. It was also found that unless the inner diameter of the capillary tube is strictly invariable, variation of the wetted perimeter of the meniscus produces a change in gravity readings. Deviation of the tube from the vertical must also be considered.

Petroleum was found to be the most suitable liquid. By adjusting the total volume of petroleum in the special-shaped container in relation to the diameter of the tube, it was possible to reduce the influence of the temperature variation to 20 mgal. per degree centigrade. The temperature of the instrument was kept constant by a double-walled housing filled with ice, and the position of the meniscus was observed through a microscope. The aging of the glass, combined with the change of the volume of the petroleum bulb, caused a slow drift of the instrument, which may be eliminated or substantially reduced by appropriate heat treatment.

In its final shape the new gravimeter was tested both in the laboratory and outdoors and the error of an individual reading was ± 0.2 mgal.

The instrument is adaptable to use on board ship and probably in an airplane. Experimental observations on a small moving cutter showed that the error in an average reading is not greater than ± 3 mgal. and may be further reduced.

Experiments indicated good temperature compensation of an instrument similar to the Thyssen gravimeter, could be achieved by making the spring system partly of quartz, with a positive thermal coefficient, and partly of beryllium-copper alloy, with a negative thermal coefficient. Promising results were shown in experiments to provide temperature compensation of horizontal pendulum instruments as the Ising or Mott-Smith gravimeters by combining different materials in the spring system, by designing the moving system of the instrument so that it is affected by temperature variation in a direction opposite to that of the spring system.—S. T. V.

11911. Volet, Charles. La medida de la gravedad [The measurement of gravity]: Rev. Geoffs., vol. 8, no. 32, pp. 533-544, 1949.

A new method of measuring the force of gravity is suggested. It consists in observation of the vertical trajectory of a body falling in vacuum. The trajectory is cinematographically recorded over a length of about 1.25 m. with highest attainable precision in time and length measurements. The error in length measurements is less than two tenths of a micron. Time measurements are made by modulation of a beam of light by a vibrating quartz crystal, with frequency of 35,000 cycles per second. The error in time measurements can be reduced to a fraction of a millisecond. Experiments with this method in the Laboratory of the International Office of Weights and Measures gave very promising results.—S. T. V.

11912. Cooper, R. I. B. Recent advances in the technique of submarine gravity surveying: Royal Soc. London Proc., ser. A, vol. 197, no. 1051, pp. 523-545, 1949.

The errors of gravity surveying at sea that are the most difficult to estimate are involved in position finding, measurement of speed over the ground, the variations of depth keeping and in the second-order correction. Submarine gravity surveying is also a slow process on account of the time required for an observation with the standard Vening Meinesz pendulum apparatus and the complications of computing the result. During the recent cruise in the English Channel in May 1948 of H. M. Submarine Talent most of these difficulties were overcome by the provision of special instruments that are described here. The most important of these was a stabilizer which, by automatically compensating the effect of sideways accelerations on the pendulums, removed the necessity for certain tedious corrections and enabled the results to be rapidly computed.—*Author's abstract.*

11913. Nishimura, Eiichi. On earth tides: Am. Geophys. Union Trans., vol. 31, no. 3, pp. 357-376, 1950.

The paper is divided into six sections. In the first, the effective modulus of rigidity of the earth's upper mantle (60-1,200 km.) is calculated as 6.17×10^{11} dynes/cm.² By using vector differences between tiltmetric observations at two selected stations, the direct effects of earth tides are almost entirely eliminated and the oceanic effects accurately evaluated. The second section deals with motion of the earth's surface near an active fault. Anomalous tilting diagrams

were recorded at six closely spaced stations in Beppu, Japan. It is found that when the alluvial plain is bent by loading of tidal sea water the fault apparently behaves like the free boundary of an elastic plate so that some points near both the fault and seashore tilt toward the fault rather than toward the bay. In the third section, tiltmeter observation at Barim [Pa-lin] in northwestern Manchuria are used to compute the effective rigidity for the mantle and the earth as 13.95 and 6.56×10^{11} dynes/cm.² respectively. In the fourth section tidal latitude variations are analyzed from data recorded over long periods at six International Latitude Observatories. The mean value of the ratio of observed to theoretical tidal variations is estimated as 1.20. The fifth section discusses an unusually large variation with time in earth tidal amplitude observed at Makimine, Japan. This is considered to be closely related to bending of the earth's crust caused by the load of sea water in Hyūga-nada, an active center of large-scale earthquakes. In the last section, analysis of tiltmetric data at several Japanese stations suggests that the elasticity of the earth's upper mantle in the north-south line is 20 to 30 percent smaller than that in the east-west line.—*M. C. R.*

11914. Niskanen, Erkki. On the elastic resistance of the earth's crust. *Isostatic Inst. Internat. Assoc. Geodesy Pub.* 23, 23 pp., 1949. (Reprinted from the *Annales Acad. Sci. Fenn.*, Ser. A, 3. *Geol.-Geog.*, 21).

The uplift of land in Fennoscandia is studied assuming the earth's crust to be elastic; the subcrustal magma to be highly viscous, incompressible fluid; and the Fennoscandian basin to be caused by a uniformly thick and circular accumulation of ice. Differential equations describing the movement of an elastic medium are solved to obtain a time dependent formula for the deformation of the crust at the center of subsidence.

According to the derived formula, after the melting of the ice cap, the surface will never reach the pre-glacial level. Assuming the relatively high value of 5.4×10^{11} dyne/cm.² for the modulus of rigidity, and an initial subsidence of 800 m., a deflection of about 300 m. will remain at the center. The fact that no such subsidence remains leads to the conclusion that by 6500–6000 B. C. the earth had arrived at the niveau which it could never exceed because of crustal rigidity. The later upheaval is due to slow decay of stresses in the crust. Therefore it is not possible to draw any conclusion as to the order of viscosity of the subcrustal magma from observations subsequent to 6500–6000 B. C. The upheaval prior to this date was violent according to geological facts, lending support to the belief that the viscosity is considerably less than the values calculated from the Fennoscandian uplift phenomenon.—*R. G. H.*

11915. Niskanen, Erkki. On the viscosity of the earth's interior and crust. *Isostatic Inst. Internat. Assoc. Geodesy Pub.* 20, 22 pp. 1948. (Reprinted from the *Annales Acad. Sci. Fenn.*, Ser. A, 3. *Geol.-Geog.*, 15).

The formula derived by Darwin, Chree, Lamb and others describing the reversion of a deformed globe to its original form is applied to the Fennoscandian upheaval to calculate the earth's viscosity. On the assumption that the viscosity of the earth's crust differs from that of the interior, a formula resembling Darwin's is derived which is more in keeping with the view that the viscosity is a function of the radius. When the thickness of the crust is assumed to be zero, the two formulas are identical.

For a homogeneous globe of density 2.7 gm./cm.³ the Darwin formula gives a viscosity of 2.4×10^{22} c. g. s. units. The modified formula gives 1.9×10^{22} c. g. s. units for the interior and 3.8×10^{22} c. g. s. units for the crust, assuming the vis-

cosity of the latter to be twice that of the core. The values are large, but agree with those obtained by other investigators.

It is concluded that in a multilayered earth the viscosity would diminish inwardly from layer to layer.—*R. G. H.*

11916. Tanni, L. I. On the continental undulations of the geoid as determined from the present gravity material. *Isostatic Inst. Internat. Assoc. Geodesy Pub. 18*, 78 pp., 1948. (Reprinted from the *Annales Acad. Sci. Fenn., Ser. A, 3. Geol.-Geog.*, 16).

The main purpose of this publication is to show to what extent the present gravity data are adequate for the determination of the geoid. A thorough discussion is given of the factors affecting the problem.

A mathematical derivation of Stokes' formula for calculating the shape of the geoid from gravity data is given and the error introduced by the approximations involved is estimated to be ± 35 cm. when N , the difference between the geoid and the reference ellipsoid, is 100 meters.

The condensation, inversion, and isostatic compensation methods of reduction are examined critically and it is concluded that complete isostatic reduction is the most suitable treatment of gravity material in geoid determinations. The Pratt-Hayford, $D=113.7$ km., and Airy-Heiskanen, $T=60$ km., hypotheses were used collaterally.

The gravity data employed consisted of several thousand gravimeter observations and records from 13,000 pendulum stations. A card index system was adopted in which the principal data of all pendulum stations of each square degree of coordinates are recorded on the same card. The distribution of measurements is irregular, and the field of square degree anomalies covers only about 8.5 percent of the globe.

The undulations of the actual geoid determined in this investigation are presented in a table and in a contour map. From the 218 points calculated the maximum and minimum values of the continental undulations are about ± 60 meters and on an average about ± 30 meters. In the more central areas the accuracy of the N -values obtained may be ± 10 meters. The geoid sinks with a gentle slope towards the North American coast and closely coincides with the reference ellipsoid on the American continent. However, the lack of gravity observations on the Pacific Ocean makes the geoid determinations more uncertain in America than in Europe.—*R. G. H.*

11917. Tanni, L. I. The regional rise of the geoid in Central Europe. *Isostatic Inst. Internat. Assoc. Geodesy Pub. 22*, 18 pp., 1949. (Reprinted from the *Annales Acad. Sci. Fenn., Ser. A, 3. Geol.-Geog.*, 20).

In a previous publication the author determines the continental undulations of the geoid using a 5° square grid. In this article the author makes use of these mean gravity anomalies and recomputes the geoid on the basis of a $1^\circ \times 1^\circ$ grid spacing. The method of interpolation for the change in grid size is discussed and the basic data for the reduction are made available in a table. Two maps show the compensated and the actual geoids in Central Europe. The probable accuracy of the N values (undulations) is shown to be one or two millionths of the earth's radius.

The method of calculation presented will produce a geoid of sufficient accuracy to be applicable for the reduction of the base lines of triangulation to the ellipsoid.—*I. Z.*

11918. Jeffreys, Harold. On the absolute measurement of gravity: Royal Astron. Soc. Monthly Notices Geophys. Supp., vol. 5, no. 9, pp. 398-408, 1949.

A simplified method is given for finding the corrections for bending and stretching of a pendulum used for making an absolute determination of gravity. It appears that the correction given by Clarke is incorrect and that the value of g for Teddington consequently needs an increase of about 1.7 mgal. Examination of several minor corrections mentioned by Heyl and Cook for the Washington determinations shows that they mount up and that the value given by these authors also needs an increase of about 1.5 mgal. When taken in conjunction with the relative determination by Bullard and Browne, the revised values give a discrepancy of 4.7 ± 1.6 mgal., which is large enough to need attention. An independent determination is desirable.—*Author's abstract.*

11919. Hirvonen, R. A. On the establishment of the values of gravity for the national reference stations. Isostatic Inst. Internat. Assoc. Geodesy Pub. 19, 21 pp., 1948. (Reprinted from the Annales Acad. Sci. Fenn., Ser. A, 3. Geol.-Geog., 17).

In 1946, an adjustment of the gravity values for the national reference stations was made by Morelli. This paper presents a discussion of the adjustment of the same stations using different error equations, thus providing an independent check on Morelli's work. The construction of the error equations is discussed and the resulting gravity data are tabulated. Many values differ from those published by Morelli by an amount which is more than can be tolerated. Unfortunately, Paris, which is gradually replacing Potsdam as the new European center of gravity, is also so affected. The author concludes, unlike Morelli, that the present status of the gravity net is unsatisfactory for establishing standard gravity values for the reference stations. As a consequence, he emphasizes the need for more observatories rather than more elaborate adjustments.—*I. Z.*

11920. Woollard, G. P. The gravity meter as a geodetic instrument: Geophysics, vol. 15, no. 1, pp. 1-29, 1950.

A special Worden temperature-compensated gravity meter with a range of 5,500 mgal. and a reading sensitivity of 0.1 mgal. was used in tying together various primary base stations around the world and in establishing new stations. During a 3-month period, 33 pendulum stations were reoccupied, involving a maximum difference in gravity of 3,800 mgal., and 125 gravity stations were established.

The instrument proved satisfactory for long-range geodetic work and the results appear equal to good pendulum observations. Drift corrections were made on the basis of drift rates established immediately before and after plane flights to stations. Closures after correcting for drift averaged less than 0.4 mgal. and the closure for the world-girdling loop was 0.33 mgal.

Errors of approximately 5 mgal. in the pendulum determinations at Washington (Bureau of Standards) and Teddington (National Physical Laboratory) were discovered by the reoccupation. An error of 15 to 19 mgal. in the Potsdam absolute value was indicated by indirect ties through primary national gravity bases. Most of the primary national gravity bases tied directly to Potsdam agreed among themselves within 1 mgal.; the Bureau of Standards value is essentially a perfect connection with the Potsdam base. Two appendices give the principal facts and descriptions for the new stations.—*H. R. J.*

11921. Hallenbach, Franz. Die Schweydarsche Methode zur Bestimmung der Einfluss der Topographie auf den Schweregradienten (The Schweydar method of computing the topographic reduction to the gravity gradient) : Beitr. angew. Geophysik, Band 10, Heft 3-4, pp. 332-342, 1943.

In computing the topographic reduction to be applied to the measurements of the gravity gradient made with torsion balance, the terrain, surrounding the point of observation, is divided into circular belts by a number of increasing radii and into sectors of different azimuths. On the basis of an accurate levelling of the region to each element a constant factor is ascribed representing its contribution to the value of the gravity gradient.

Quite often the constants obtained in such a manner show a sharp variation of their values called by German authors the "jumping of the constants".

The author recommends in computing the constants that the members with the radii Z_n , Z_{n+2} , Z_{n+4} and so on be used, and later those with Z_{n+1} , Z_{n+3} . As a result smooth curves of the constants are obtained and a precise value of the topographic reduction is obtained. The article contains tables of numerical values used in these calculations.—S. T. V.

11922. Heiskanen, W., and Sala, I. The topographic-isostatic reduction of gravity anomalies by the aid of small scale maps. Isostatic Inst. Internat. Assoc. Geodesy Pub. 21, 23 pp., 1949. (Reprinted from the Annales Acad. Sci. Fenn., Ser. A, 3. Geol.-Geog. 18).

The error of the topographic-isostatic reduction resulting from the use of small scale topographic maps is investigated. With the aid of maps on the scale 1:4,000,000, observations of gravity at 85 Indian, 88 American, and 16 European stations were reduced and the values compared with those previously obtained by rigorous reductions employing large scale maps. The tabulated results indicate that in spite of the small scale, the topographic-isostatic reduction in the zones A-K in the Hayford system can be performed with an accuracy of 5 mgal. When farther zones are taken into account the accuracy is probably 5 to 10 mgal.

Sala applied the method to 250 gravity observations in China and Indochina using the map scale 1:4,000,000. The free air and Bouguer anomalies together with the Pratt-Hayford, Airy-Heiskanen, and Vening Meinesz isostatic anomalies are tabulated and can be compared with rigorous reductions when the latter are available.

The investigation shows that in the absence of large scale maps gravity anomalies can be used, with discretion, for isostatic studies.—R. G. H.

11923. Magnitskii, V. A. On the isolation of the local gravity anomalies [in Russian]: Akad. Nauk SSSR Izv., Ser. geog. i geofiz., vol. 13, no. 6, pp. 556-562, 1949.

Local and regional gravity anomalies may be separated by reducing the observed total anomaly to a new, elevated surface, thus eliminating the influence of local anomalies which decrease with distance much faster than regional anomalies produced by formations of large dimensions. By applying methods developed in potential theory the gravity field can be computed for any height above the earth's surface. The method was applied to the gravity map of the Samarskaya Luka region based on a detailed survey (See Geophys. Abstract 9730). A new map, constructed for a level of 4 km. above the earth's surface, presented a clearer picture of the anomalies caused by deep-seated disturbing bodies and gave better information on the geological structure of the area.—S. T. V.

11924. Schleusener, Alfred. Genauigkeitsgrenzen bei der Bestimmung der mittleren Gesteins Dichte durch Gravimetermessungen [The limits of precision in determinations of average rock density by gravimetric measurements]: Beitr. angew. Geophysik, Band 11, Heft 1, pp. 44-54, 1944.

Determination of rock density by the gravimetric method, using measurements in drill holes along selected profiles, can be unfavorably affected by the unknown vertical gradient resulting from local anomalies. The value of this gradient is known only approximately, though usually assumed as 3086×10^{-6} . The value of g at the point of observation is known only approximately.

If the gravitational field over the surveyed area changes rapidly, the density of the ground may be measured as 2.50 ± 0.01 , when in reality it is 2.40 or 2.60. Only when the selected profile is free of important variations in the value of gravity, are the results of measurements reliable.

Mathematical deduction of the vertical gradient of gravity anomalies is based on the established network of isogams and follows the method of Evjen. Its use decreases the chief sources of errors connected with the determinations of density.

When the differences in density values obtained in different profiles are not greater than 0.04-0.07 the results can be considered reliable and their average used in calculations of the reductions.—S. T. V.

11925. Tsung, F. T. The average specific gravity of the geological formations in Taiwan: Chinese Geophys. Soc. Jour., vol. 1, no. 2, pp. 213-214, 1950.

In connection with gravity surveys in prospecting for oil on Taiwan, numerous density measurement of formations on the island were made, weighing the samples both in air and in water with an analytical balance. It was found that the average specific gravity of Miocene formations is greater than that of the Pliocene, and that the specific gravity of formations in the northern part of the island is much greater than those in the southern part. The density was also measured directly in place by Nettleton's method. The following average specific gravities are given: late Cenozoic coral reef limestone, 2.54; metamorphic, 2.53; igneous, 2.71; basalt, 2.67.—S. T. V.

11926. Cook, A. H. Values of gravity at stations in southern Britain: Royal Astron. Soc. Monthly Notices, Geophys. Supp., vol. 6, no. 1, pp. 9-27, 1950.

Gravimeter observations have been made recently in southern England by four parties: the Anglo-American Oil Co., the Anglo-Iranian Oil Co., the Department of Geodesy and Geophysics of Cambridge University, and G. P. Woollard. Calibrations of the various instruments used are discussed and the observations adjusted to obtain relative values of gravity at key stations common to two or more of the surveys. The positions of these key stations and the calculated differences of gravity between them and the Pendulum House, Cambridge, are: Teddington (N. P. L.), -72.69 ± 0.12 mgal.; Gloucester, -41.07 ± 0.17 mgal.; Worcester, -27.70 ± 0.19 mgal.; Shrewsbury, 52.52 ± 0.22 mgal. Twenty-one of the pendulum stations previously described by Bullard and Jolly have been reoccupied in gravimeter surveys. Comparisons show that the standard deviation of a single pendulum observation is 1.77 mgal. The main conclusion is that the stations in southern Britain are very well connected to Cambridge and the National Physical Laboratory, and therefore form a framework on which the existing and future gravimetric surveys may be based. Gravity differences from Cambridge, rather than actual values of gravity, are given because recent ob-

servations show that the comparisons of English and continental stations must be revised and the hitherto adopted value of gravity for Cambridge may have to be altered.—*M. C. R.*

11927. Browne, B. C., and Cooper, R. I. B. The British submarine gravity surveys of 1938 and 1946: Royal Soc. London Philos. Trans., ser. A, vol. 242, no. 847, pp. 243-310, 1950.

Gravity surveys were made at the mouth of the English Channel and from Falmouth south to the coast of Spain and west and northwest around the Hebrides and back through the Irish Sea to test the hypothesis that the edge of the continental shelf is an area of deposition and to investigate the possibility that second-order effects due to accelerations of the submarine introduce errors into gravity measurements at sea.

Three measurements were made at sea during the 1938 expedition and 51 stations at sea were occupied during the 1946 survey. The results are given in tables and charts.

The area has a mean positive anomaly but it is uncertain whether the excess mass is supported by the static strength of the crust or by a dynamic process such as convection currents. Over shallow water at the mouth of the Channel variations were of about the same magnitude as those in southwest England, but over deep water the scatter is nearly twice as great, indicating either complex structure in the basement rocks or variations of several thousand feet in the thickness of deep sea sediments. The increase in isostatic anomalies crossing the edge of the continental shelf is confirmed. A wedge-shaped layer of sediment, as indicated by seismic experiments, would explain these if the density is 2.3 and the wedge is nearly in isostatic equilibrium. Both gravitational and geologic evidence suggests the probable structure of northern Spain is a series of eastward-trending folds. The isostatic anomalies are large, indicating incomplete compensation. Positive anomalies in the Hebrides-west Scotland region increase toward the west but do not extend much beyond St. Kilda. The continuous submergence since the ice age suggested by geological evidence represents a return to isostatic equilibrium but does not explain the cause of the original excess mass.—*M. C. R.*

11928. Coron, Suzanne. La valeur de la pesanteur à Paris dans le système de Potsdam [Value of gravity at Paris in the Potsdam system]: Acad. Sci. Paris Comptes Rendus, vol. 230, no. 12, pp. 1142-1144, 1950.

Gravimetric ties since 1900 between different national base stations and either Paris or Potsdam are analyzed and the most probable value of gravity at Paris, in the Potsdam system, is derived. Hirvonen's Baltic global compensation and Schutte's compensation for central Europe were used.

Applying the method of least squares and assuming for Potsdam $g=981.2740$ gals, g at Paris was found to be 980.9435 ± 0.0003 gals if different weights were assigned to values of the ties, and 980.94335 ± 0.0004 gals, if equal weights were used.—*S. T. V.*

11929. Sans Huelin, Guillermo, and Lozano Calvo, Luis. Las determinaciones de la gravedad en España y el elipsoide terrestre más aproximado al geoide que se deduce de aquellas [Gravity determinations in Spain and the best reference ellipsoid derived from these data]: Inst. Geog. y Catastral Mem., vol. 19, no. 5, 27 pp., 1948.

At present Spain has 208 gravimetric stations on the continent and 24 on the nearby island possessions. Following the arrangement made in 1925 between the

Spanish Geographical Institute and the U. S. Coast and Geodetic Survey, isostatic reductions of the gravity data are made according to the Hayford and Bowie methods, assuming 113.7 km. as the isostatic depth of compensation.

Theoretical values of gravity are computed for the reference ellipsoids of Helmert (1901 and 1915), Bowie (1917), Cassinis (1930), and Heiskanen (1938). Results are presented in a table, indicating for each of the 208 Spanish stations its geographic position, altitude, the measured value of gravity and the theoretical values of g corresponding to the five reference ellipsoids, with the corresponding anomalies. Five maps of Spain showing Bouguer anomalies are included.

Gravitational anomalies in Spain confirm the Defforges rule that Bouguer anomalies are negative for inland stations, positive for islands, and oscillate around zero for coastal regions.—*S. T. V.*

11930. Sans Huelin, Guillermo, and Lozano Calvo, Luis. Red de observaciones con gravímetro en las provincia de Segovia [Network of gravimetric observations in the Provincia de Segovia]: Inst. Geog. y Catastral Mem., vol. 19, no. 2, 42 pp., 1948.

A gravimetric survey of the Provincia de Segovia, Spain, was made during 1945–46 using an Askania electromechanical gravimeter. The pendulum stations of Segovia ($g=979.960$ gals), C. Peñalara ($g=979.773$ gals), and Cercedilla ($g=979.900$ gals) were used as bases. One hundred forty-eight stations were occupied and 45 profiles completed.

The results of the survey are presented in two tables, indicating for each station its position, altitude, assumed density of the ground, theoretical value of gravity computed from the International formula, observed gravity value, Fayé and Bouguer corrections, and final gravitational anomaly. In an additional table the values of gravity, reduced to the geoid, are compared with the theoretical values computed for the Helmert, Bowie, Cassinis, and two Heiskanen reference ellipsoids, and anomalies are computed for each of these ellipsoids. A map of the province with stations indicated and isoanomalies traced is included.—*S. T. V.*

11931. Cunietti, Mariano. 51 misure di gravità relativa eseguite in Italia settentrionale nel 1949 [Fifty-one relative determinations of gravity in northern Italy in 1949]: Riv. Geomin., vol. 10, no. 2, pp. 37–57, 1949.

A detailed report is presented of a gravimetric survey of an area of about 30,000 sq. km. in northern Italy between the Alps and the Po River. The gravimetric station of the Polytechnic Institute of Milan ($g=980.564$ gals) was used as base. Results of the survey are presented in tables, giving for each station its geographic position, altitude, gravity difference compared with the base, Fayé, topographic, and Bouguer reductions, and the Bouguer anomaly. All anomalies except that at Verona were negative. The greatest anomaly was -131.4 mgal. at Tirano. An isoanomaly map of the region is included.—*S. T. V.*

11932. Lagrula, Jean. Nouvelles déterminations de l'intensité de la pesanteur en Algérie, au Maroc et au Sahara [Recent determinations of gravity in Algeria, Morocco, and the Sahara]: Acad. Sci. Paris Comptes Rendus, vol. 230, no. 16, pp. 1478–1480, 1950.

Gravity measurements were made with a Holweck-Lejay pendulum, during 1948–49 at 55 stations in an area of about 1,000,000 sq. km. in Algeria, Morocco, and the Sahara. The altitude of stations ranged from sea level to 1,640 meters.

Results are presented in a table giving for each station its geographic coordinates, altitude, observed value of gravity, the value reduced to sea level, Bouguer

value, value of gravity on the International (Lambert) ellipsoid, and the Fayé and Bouguer anomalies.

La Bouzaréa, Algeria and Berrechid, French Morocco, were used as base stations.—S. T. V.

11933. Pacella, G. B. Determinazioni gravimetriche in Etiopia [Gravity measurements in Ethiopia]: Accad. Naz. Lincei, Cl. sci. fis., mat. e nat., Rend., vol. 4, fasc. 6, pp. 725-729, 1948.

Absolute determinations of gravity were made between 1937-41 at 14 stations in Ethiopia in the area bounded by latitude $8^{\circ}54'$ N. and $11^{\circ}30'$ N. and longitude $38^{\circ}45'$ and $42^{\circ}48'$ E. Altitude of the stations ranged from 800 to 2,900 meters above sea level.

Florence, Italy ($g=980.501$ gals), was selected as the base station. The results are presented in a table, giving for each station the observed values of g , the values of gravity after Fayé and Bouguer reductions, the normal gravity value and the Fayé and Bouguer anomalies. Bouguer anomalies were negative at all stations, ranging from -117 to -257 mgal.—S. T. V.

11934. Chao, J. S. and Tsung, F. T. The gravity measurement in Shanghai City: Chinese Geophys. Soc. Jour., vol. 1, no. 2, pp. 221-227, 1949.

A gravity survey was made over the alluvium covered area of Shanghai during the summer of 1948 using a static gravimeter of the Heiland Research Corporation with a sensitivity of 0.1 mgal. The total number of stations occupied was 163, with Zi-Ka-Wei Observatory ($g=979.437$ gals) as base.

For the calculation of Bouguer anomalies the average density of the ground within the range of elevation differences of the survey was assumed to be 2.2. Results of the survey are presented in a table and on a map contoured at 1-milligal intervals. The greatest anomaly found was 7.7 mgal, and the minimum -6.9 mgal.—S. T. V.

MAGNETISM¹

11935. Bullard, E. C. The magnetic field within the earth: Royal Soc. London Proc., ser. A, vol. 197, no. 1051, pp. 433-453, 1949.

The paper discusses the magnetic effects of internal motions in the core of the earth. It is shown that tidal friction, fluctuations in the rate of rotation, nutation, and the variation of latitude have negligible magnetic effects. Precession is also ineffective if Poincaré's theorem on the precession of a liquid sphere in a rigid shell is applicable to the earth.

Thermal convection is shown to be likely to occur in the core. The conservation of angular momentum will require it to be associated with a radial gradient of angular velocity which will have a large magnetic effect. Its interaction with the dipole field can produce a toroidal field which is many times as intense as the dipole field.

The convective and rotational motions can interact with the dipole and toroidal field in a way that tends to reproduce the dipole field. The complete theory has not been worked out, but it seems likely that the interaction is strong enough to maintain the field. The whole process resembles that occurring in a self-exciting dynamo.

The existence of a strong field in the core removes the difficulties previously found in the theory of the secular variation.—*Author's abstract.*

¹ See also Geophys. Abstracts 11987 and 11988.

11936. Sucksdorff, E. Maamagnetismista ja revontulista unsien tutkimustea valossa [On geomagnetism and the aurora borealis in the light of recent research] : Terra, vol. 59, no. 3, pp. 76-90, 1947.

Celestial bodies are assumed to be magnets. This is positively proven of the Sun, Mercury, Venus, and the Moon, where magnetism is as fundamental as gravity, and is probably being generated by the rotation of atoms and ions in the solar substance of which they are composed. The processes going on in this substance yield as the final products iron and nickel. The process is more advanced in the interior of a cooling celestial body, thus causing a greater intensity of magnetization in the interior of the planets.

If the exterior crust slowly rotates relatively to the magnetic internal core, secular variations of the internal magnetic field are produced. Variations of the external magnetic field are probably caused by the induction effect of electric currents flowing at a height of about 500 km. above the earth's surface and reaching an intensity of 120,000-260,000 amperes, along the auroral zone. Variations of the forms of the auroral zone are attributed to some unknown radiation, which also causes disturbances in the external geomagnetic field. Diagrams and pictures are added to the text and their details discussed.—S. T. V.

11937. Al'thausen, O. N. On certain regularities in production of thermo-remanent magnetism in magnetites [in Russian] : Akad. Nauk SSSR Izv., Ser. geog. i geofiz., vol. 13, no. 4, pp. 359-362, 1949.

The natural magnetization of many geologic formations is much greater than the magnetization produced by the local geomagnetic field. As a possible explanation the hypothesis is advanced that the present magnetic state of these formations, and primarily of their magnetite content, is one of thermo-remanent magnetism produced by the cooling of the earth and corresponding to an earlier much higher level of the geomagnetic field.

To test this hypothesis measurements were made of thermo-remanent magnetism resulting from the cooling of several magnetite samples from different ore deposits of the U. S. S. R. from a temperature above the Curie point to room temperature, while keeping them in a magnetic field. The intensity of the applied magnetic field ranged from 0 to 125 oersteds and the initial temperature was about 600° C.

It is concluded that the final magnetism of the magnetite samples is determined by the intensity of the magnetic field during the cooling. It is hoped that by reversing this relation it will be possible to estimate the intensity of the geomagnetic field of previous geological ages.—S. T. V.

11938. Woo, C. C. Some improvements in La Cour's quartz torsion horizontal intensity magnetometer : Chinese Geophys. Soc. Jour., vol. 1, no. 2, pp. 196-204, 1949.

On the basis of the theoretical analysis of the construction of the La Cour Q. H. M. magnetometer it is concluded that the instrument in its present form will not function properly for certain values of H , because the mechanical torque exerted on the moving system cannot be equilibrated by existing springs.

An improvement is suggested consisting of an arrangement that gives the quartz fibre an additional twist by rotating its top, thus making the deflection of the magnetic needle always equal to 90°.

A description of different parts of the instrument is given as well as a theoretical study of its operation with the changes. Experimental data obtained from

tests of the modified magnetometer were destroyed in the war and cannot be quoted now, but the functioning of the instrument was essentially improved.—*S. T. V.*

11939. Stenz, Edward. First magnetic determinations in Afghanistan: *Geofis. Pura e Appl.*, vol. 15, fasc. 3-4, pp. 181-185, 1949.

The first determinations of magnetic declination in Kabul, Afghanistan, were made on September 10, 1939, using a Zeiss theodolite, provided with a magnetic compass. As a mean of eight determinations, the value of 2.74° E. was obtained.

Determinations of magnetic declination were repeated in Kabul in 1945-47. The values obtained ranged from 2.10° E. to 2.54° E. The inclination was twice determined and the values of $51^{\circ}24'$ and $51^{\circ}21'$ were found.—*S. T. V.*

11940. Princep Curto, J. M. Un ciclo de bahias en el observatorio del Ebro [A cycle of magnetic bays from the records of the Ebro Observatory]: *Rev. Geofis.*, vol. 8, no. 32, pp. 507-522, 1949.

A statistical study of magnetic bays recorded between 1923-33 at Ebro Observatory, Spain, is presented. Daily, yearly, and secular distributions of geomagnetic bays during this period are shown as histograms. Positive bays appear almost exclusively during the night. The greatest number of bays occur during March and October. The duration of observation was too short to permit determination of a secular periodicity. The importance of studying the variation of the total geomagnetic vector rather than the separate components H , Z , and D is emphasized.—*S. T. V.*

11941. Chen, P. C. A detailed geomagnetic survey of Pehpei district, Szechwan, China: *Chinese Geophys. Soc. Jour.*, vol. 1, no. 2, pp. 177-186, 1949.

A geomagnetic survey of Pehpei [Pei-p'ei Kuan-li-chu] district was made between December 1945 and May 1946, using an Askania theodolite magnetometer, a Schmidt magnetometer for D and H measurements, and an Askania earth-inductor for I measurements. The Institute of Physics of the Academia Sinica was used as base. Fifteen stations were occupied. Values for each were obtained by averaging four observations at different times of the day and reducing these to the common epoch 1946.1. The results of these determinations are presented in a table, indicating for each station its position, observed values of D , I , and H , reductions to the mean of the day, and reductions to the chosen epoch. Isogonic, isoclinic, and isodynamic maps of the district are also included.—*S. T. V.*

SEISMOLOGY

11942. Inglada Ors, Vicente. Resultados de las recientes investigaciones sismológicas [Results of recent seismological studies]: *R. acad. cien. Madrid Rev.*, vol. 42, no. 2, pp. 171-221, 1948.

A review of the causes of earthquakes, and seismological interpretations regarding the internal structure of the earth and depth of focus.—*S. T. V.*

11943. Ramirez, J. E. The new seismic station at Galerazamba, Colombia: *Seismol. Soc. America Bull.*, vol. 40, no. 1, pp. 1-5, 1950.

The location and equipment of the new station are described. *See also* *Geophys. Abstract* 11707.—*M. C. R.*

11944. Stoneley, Robert. The effect of a low-velocity internal stratum on surface elastic waves: Royal Astron. Soc. Monthly Notices, Geophys. Supp., vol. 6, no. 1, pp. 28-35, 1950.

The effect on the surface amplitude of Love waves of a low velocity layer of the type envisaged by Gutenberg and Richter is discussed, and it is shown, so far as it is practicable to make a comparison, that a diminution of about 10 per cent in the velocity of distortional waves in the lower half of a surface layer causes no marked change in the amplitude of Love waves. If there is a high-velocity internal layer, Love waves will not exist for waves longer than a certain critical wave length which depends on the parameters of the system. As a limiting case of the three-media systems considered, it is shown that for sufficiently short wave lengths Love waves can be propagated in a two-layer plate with a velocity greater than the velocity of distortional waves in either layer.—*M. C. R.*

11945. Altenburg, K. Dispersion longitudinaler Erdbebenwellen [Dispersion of the longitudinal seismic waves]: *Experientia*, vol. 5, no. 2, p. 68, 1949.

Absorption of elastic waves propagating through a medium is determined by inner friction, heat conductivity, and intramolecular vibration. Variation of the effect of these factors with frequency causes anomalous dispersion of the waves, so that the waves of shortest period have the greatest velocity of propagation. When the period of the wave approaches the relaxation time, absorption and dispersion reach a maximum, transverse waves cannot be propagated, and the velocity of the longitudinal waves sharply decreases. For seismic waves this is noticeable at a depth of 2,900 km. This value, and therefore the diameter of the earth's core, changes with the period of the wave. These phenomena, predicted by the theory of W. Kuhn and A. Ritmann, are confirmed by the analysis of the seismic waves at epicentral distances up to 8,500 and over 10,000 km. Waves of intermediate epicentral distance evidently reach the observation point by another path.—*S. T. V.*

11946. Scholte, J. G. On true and pseudo Rayleigh waves: *K. Nederland. Akad. Wetensch. Proc.*, vol. 52, no. 6, pp. 652-653, 1949.

The change in the form of a plane seismic wave caused by the reflection or refraction at the boundary between two infinitely large media is a function of the angle of incidence. Motion along the boundary surface may be either Stoneley waves or Rayleigh waves. Referring to his study of this problem (*See Geophys. Abstracts* 133, no. 10060) and to a discussion with Prof. Cagniard, the following correction is made as to the kind of seismic waves observed on the surface of the earth: if the density of one medium is very small (atmosphere) a pseudo Rayleigh wave is obtained, almost identical with the theoretical Rayleigh wave. If this medium is ocean water, Stoneley waves are produced.—*S. T. V.*

11947. Due Rojo, Antonio. El nuevo sismografo de la estacion sismologica de Cartuja [The new seismograph of the Cartuja seismological station]: *Rev. Geofis.*, vol. 8, no. 32, pp. 470-474, 1949.

A description is given of a new E-W component seismograph which has been in operation at the Cartuja observatory since July 1949, replacing the old Berchman instrument. The new instrument records waves of periods up to 20 seconds. The weight of the pendulum bulb is more than 4½ tons, which necessitates a strong supporting system of steel beams. The natural period of this pendulum can be made as high as 27 seconds. Frictional resistance is very low and contributes to the fidelity of recorded waves.—*S. T. V.*

11948. Ingram, R. E. Note on the magnification curve of a seismograph recording through a galvanometer: *Seismol. Soc. America Bull.*, vol. 40, no. 1, pp. 21-23, 1950.

A general equation is derived linking the constants of the instrument with the earth period. The equation is useful for forming a quick appreciation of the magnification curve and in designing instruments for particular purposes. If T is the period of a seismograph with damping coefficient h , T_1 the period of the galvanometer with damping coefficient h_1 , T_E the period of earth movement, and T'_E the period of earth movement for which the magnification is a maximum, then

$$3T''^2_E + 4[(2h^2 - 1)T^2 + (2h_1^2 - 1)T_1^2]T''^6_E + [4(2h^2 - 1)(2h_1^2 - 1)T^2T_1^2 + T^6 + T_1^4]$$

$$T''^4_E - T''^4T_1^4 = 0. \quad -M. C. R.$$

11949. Kisslinger, Carl. Velocity of longitudinal waves in some Paleozoic formations in the vicinity of St. Louis, Missouri: *Am. Geophys. Union Trans.*, vol. 31, no. 2, pt. 1, pp. 169-173, 1950.

Longitudinal wave velocities in five Paleozoic formations which outcrop near St. Louis were determined by a series of short range refraction profiles as follows: St. Peter sandstone, 2.85-2.90 km./sec.; Joachim dolomite, 6.06-6.80 km./sec.; Kimmswick limestone, 1.73-2.06 (?) km./sec.; St. Louis limestone, 3.62-3.86 km./sec.; Cherokee formation, 2.16-2.28 km./sec. in blue shale, 2.9 (?) km./sec. in the Cheltenham fire clay member. $MgCO_3$ content is suggested as a possible dominant factor in controlling the velocity of elastic waves.—*M. C. R.*

11950. Martner, S. T. Observations on seismic waves reflected at the core boundary of the earth: *Seismol. Soc. America Bull.*, vol. 40, no. 2, pp. 95-109, 1950.

Ratios of observed ground displacements produced by seismic waves reflected from the earth's core to those produced by direct body waves are definitely larger than expected from currently accepted theory for the $\frac{\text{horizontal displacement}}{\text{period}}$ ratios of $\frac{PcP}{P}$, slightly greater for $\frac{\text{vertical displacement}}{\text{period}}$ ratios of $\frac{PcP}{P}$ and $\frac{\text{horizontal displacement}}{\text{period}}$ ratios of $\frac{PcS}{P}$, and in reasonable agreement for $\frac{\text{horizontal displacement}}{\text{period}}$ ratios of $\frac{ScS}{S}$ and $\frac{\text{vertical displacement}}{\text{period}}$ ratios of $\frac{ScS}{S}$ and $\frac{ScP}{S}$. The discrepancies apparently involve the PcP phase and not the P phase. Angles of incidence of PcP waves at the earth's surface are not in accordance with theoretical values. No single factor of the theoretical formulae for the displacement due to a seismic wave can be changed sufficiently to account for the observed $\frac{\text{horizontal displacement}}{\text{period}}$ ratios of $\frac{PcP}{P}$.—*M. C. R.*

11951. Tolstoy, Ivan and Ewing, Maurice. The T phase of shallow-focus earthquakes: *Seismol. Soc. America Bull.*, vol. 40, no. 1, pp. 25-51, 1950.

A short-period phase, 0.5 sec. period or less, traveling through the ocean with the velocity of sound in water has been identified on a large number of seismo-

grams of earthquakes occurring at sea. This arrival was identified on the Benioff short-period seismograms of the Weston, Fordham, and Ottawa stations for a series of Dominican Republic shocks, and on the Benioff short-period seismograms of the Pasadena network of stations and the Mount Hamilton and Mineral stations for a series of major Japanese and Aleutian shocks.

The existence of this phase had been noted previously by Linahan, who was at a loss to provide an explanation for them. The mechanism of propagation of the *T* phase is discussed and several practical applications are described.—*Author's abstract.*

11952. Ewing, Maurice, Tolstoy, Ivan, and Press, Frank. Proposed use of the *T* phase in tsunami warning systems: *Seismol. Soc. America Bull.*, vol. 40, no. 1, pp. 53–58, 1950.

A striking correlation between the occurrence of a short-period earthquake phase (*T* phase) traveling through the ocean with the speed of sound in sea water and the occurrence of tsunamis has been observed. The characteristics of the *T* phase are described and the data upon which the correlation is based are presented. Although further study is needed, the evidence at hand warrants the inclusion of instruments suitable for recording the *T* phase in tsunami warning systems. It is quite possible that sofar listening stations would be valuable adjuncts in the detection of tsunami-producing earthquakes since they offer the best means of recording the *T* phase.—*Author's abstract.*

11953. Press, Frank, Ewing, Maurice, and Tolstoy, Ivan. The Airy phase of of shallow-focus submarine earthquakes: *Seismol. Soc. America Bull.*, vol. 40, no. 2, pp. 111–148, 1950.

An extension of the theoretical work of Lamb and Pekeris shows that a prominent phase (Airy phase) consisting of a group of waves of period 9–11 seconds, traveling across the ocean with a velocity of approximately 0.7 of the speed of sound in water, should be present on the seismograms of shallow-focus submarine earthquakes. This arrival corresponds to normal mode propagation at a stationary value of group velocity through the acoustic system consisting of the ocean and the rigid ocean bottom.

A phase fitting this description has been observed on the Milne-Shaw instruments at Bermuda for a series of Dominican Republic shocks. The Wenner seismographs at Huancaayo recorded the Airy phase of a shock southwest of the Galapagos Islands.

The study of the Airy phase of a sufficient number of sea quakes would provide information concerning the nature of the ocean bottom since the latter affects both the periods and velocities of the Airy phase.—*Author's abstract.*

11954. Caloi, Pietro, Marcelli, L., and Pannocchia, G. Sulla velocità di propagazione delle onde superficiali in corrispondenza dell' Atlantico [*Velocity of the propagation of surface waves under the Atlantic Ocean*]: *Annali Geofis.*, vol. 2, no. 3, pp. 347–358, 1949.

The velocities of both Love and Rayleigh waves were determined from the seismograms of about fifty stations for the earthquakes of April 24, 1947 on the mid-Atlantic Ridge. These velocities, both west and east of the Ridge, were very close to those found for the Pacific, casting some doubt on the hypothesis of continental drift.—*S. T. V.*

11955. Di Filippo, Domenico. L'onda "G" di Gutenberg nel terremoto delle Azzorre del 25 novembre 1941 [Gutenberg's *G*-wave in the Azores earthquake of Nov. 25, 1941]: *Annali Geofis.*, vol. 3, no. 1, pp. 39-45, 1950.

The direct *G*-wave and G_2 , G_3 , G_4 , and G_5 were clearly recorded on Rome seismograms of the earthquake near the Azores on Nov. 25, 1941. From records of several European and American stations, the travel time of the direct wave was found to be $t_{sec} = (\Delta^\circ/0.0405 \pm 0.00039) - (0.026 \pm 0.513)$ sec, and the velocity 4.5 km./sec.—*S. T. V.*

11956. Agamennone, Giovanni. Spoglio del materiale del 1947 pervenuto all'Ufficio Centrale di meteorologia e geofisica [Data on seismic events during 1947 obtained by the Central Office of Meteorology and Geophysics]: *Soc. Sismol. Italiana Boll.*, vol. 41, no. 1, pp. 30-56, 1948.

This is a summary of data on seismic events received by the Italian Central Office of Meteorology and Geophysics during 1947, collected from both seismological stations all over Italy and private persons. Some 38 earthquakes were noticed during this year, most of them of a very feeble intensity. Only the earthquake of March 11, felt in southern Italy, reached intensity 8. The summary gives the time of the shocks observed in different localities, their duration and a brief characterization. No information on epicenters of the earthquakes is given.—*S. T. V.*

11957. Agamennone, Giovanni. Il terremoto delle Prealpi Carniche del 4 maggio 1934 [The earthquake of May 4, 1934 in the foothills of the Alpi Carniche] *Soc. Sismol. Italiana Boll.*, vol. 41, pp. 1-14, 1948.

The earthquake of May 4, 1934 was outstanding in its intensity (reaching 7 of the Mercalli scale) and area of propagation. It was felt at distances up to 180 km. and was recorded by seismographs at distances up to 1,000 km.

Using Gassmann's formula, the depth of focus was found to be 5-10 km., which is in agreement with data for other earthquakes in this region (except the depth of 14-18 km. for the earthquake of November 18, 1936 found by Caloi). It was impossible to use the data of the Italian seismological observatories on the time of arrival of different phases because of uncertainty of these data, nor could the angle of emergence of seismic waves be utilized because of the very small initial displacements.—*S. T. V.*

11958. Imamura, Akitsune. Land deformations associated with the recent Tōkaidō earthquake: *Acad. Japan Proc.*, vol. 21, no. 3-10, pp. 193-196, 1945 (1947).

Immediately following the destructive earthquake of December 7, 1944 off the coast of Tōkaidō, a resurvey was made of the Mikura-Kakegawa-Omaesaki lines. Precise leveling had been done several times on these lines since 1902 and revised just before the quake. Changes in height of as much as 113 mm. for several points over a horizontal distance of about 20 km. were established. Displacement of the bench marks for previous periods since 1900, indicate that the tilt of the Tertiary block preceding the earthquake was a forerunner of the shock. The data are referred to an arbitrary base and are relative. The precision of the leveling is not indicated.—*S. T. V.*

11959. Nagata, Takeshi, and Okada, Atsushi. Land deformation of Muroto Point before and after the Nankaido great earthquake on Dec. 21, 1946: Tokyo Univ. Earthquake Research Inst. Bull. vol. 25, pts. 1-4, pp. 85-89, 1947.

Four precise levelling surveys were made following the earthquake along lines which had been completely or partly surveyed in 1895, 1929, and 1935. It is concluded that the neighborhood of Muroto Point [Muroto-hantō] had been tilting S. 10° E. with nearly constant velocity of 0.0001'' per day until at least 1935 and probably until just before the earthquake. The abrupt tilting motion accompanying the earthquake exceeded 7''. Since the earthquake the area has been rapidly tilting in a S. 10° E. direction with a velocity which is gradually decreasing with time but which is larger than that before the earthquake.—*M. C. R.*

11960. Pamir, H. N. Une ligne séismogène en Anatolie septentrionale [A seismotectonic line in northern Anatolia]: Istanbul Üniv. Fen Fakültesi Mecmuası, ser. A, vol. 9, no. 3, pp. 143-158, 1946.

The origin of violent earthquakes in Anatolia during 1939-45 is discussed. The strongest of these was the first earthquake of December 27-28, 1939 which reached intensity 11 on the Mercalli-Sieberg scale and caused the death of 40,000 persons. Strong aftershocks were felt during January and February 1940, and during 1942-44 numerous earthquakes of intensity 10 occurred in adjoining regions.

The earthquake of December 1939 was caused by a deep tectonic dislocation and produced on the surface a continuous rift 360 km. long, trending northwest from Erzincan through the valleys of Çobanlı and Kelkit to the plains of Susehri. Subsidence on one flank of the rift was in many places as much as one meter; the horizontal opening near Beşadiye was 3.7 meters. The later shocks are attributed to a series of secondary tectonic movements, some of great intensity, but all of the same character as the first.—*S. T. V.*

11961. Heinrich, R. R. The Mississippi Valley earthquake of June 30, 1947: Seismol. Soc. America Bull., vol. 40, no. 1, pp. 7-19, 1950.

The epicenter of the earthquake of June 30, 1947 ($04^{\circ}23'53.1''$ G. c. t.) was located near the confluence of the Meramec and Mississippi Rivers a few miles south of St. Louis, Mo. The earthquake originated in a basement zone of transitional structure between major tectonic elements, and seems to be genetically related to those along the Ste. Genevieve fault, the Duquoin flexure, and the northeastern Ozark flank. The earthquake occurred as the Mississippi River at St. Louis was reaching the crest of one of the largest floods in history, but whether or not the flood triggered the earthquake cannot be determined.—*M. C. R.*

11962. Ol', A. I. Microseisms and solar activity [in Russian]: Priroda, no. 2, pp. 3-6, 1950.

Bath's suggested correlation between microseismic activity and the path of the cyclones in the Northern Hemisphere is questioned. From the observations of L. A. Vitels, it is concluded that the curve of the variation of microseisms is identical with that of the intensity of cyclones, but not of their path. This curve is probably related to variation of sun spots. The necessity of further study of the problem is stressed.—*S. T. V.*

11963. Kishinouye, Fuyuhiko, and Ikegami, Ryohei. A study of microseisms after A. W. Lee's method: Tokyo Univ. Earthquake Research Inst. Bull., vol. 25, pts. 1-4, pp. 43-48, 1947.

Studies of microseisms at Tokyo do not confirm results elsewhere that direction of travel can be clearly determined.—*M. C. R.*

11964. Ylinen, J. Mikroiseismin ja sään välisestä yhteydestä [Relationship between microseisms and weather] [In Finnish with German abstract]: Terra, vol. 61, no. 1, pp. 52-59, 1949.

The seismograms of the Helsinki Observatory were compared with the meteorological data related to wind conditions on the Atlantic coast of Norway. The entire length of the coast line was divided into six sections, the corresponding velocity of the wind computed from the isobars, and "pressure factors" were assigned to observed wind directions ranging from zero for wind blowing perpendicularly from the coast toward the ocean to four for wind directed toward the continent. Wind velocities were multiplied by the pressure factors, the products added for all six sections, and the result assumed to be representative of surf action. Comparison with the corresponding seismograms showed that in most cases the maximum amplitude of microseismic waves was observed six to twelve hours after the maximum surf, except when the center of the barometric maximum was over the continent. An increase in the period of the microseisms with increasing amplitude was also observed.—*S. T. V.*

ELECTRICITY

11965. Mironov, A. T. Electrodes for electrical measurements in sea water [in Russian]: Akad. Nauk SSSR Doklady, vol. 70, no. 5, pp. 825-827, 1949.

PbSO₄ is recommended for electrical measurements in sea water. It has a self-potential of only a few millivolts and this potential difference remains constant. PbSO₄ plates from old storage batteries may be used or plates covered with a film of PbSO₄ may be prepared from the lead sheaths of cables. By treating the plates in a bath of sea water, it is possible to obtain electrodes showing a constant difference of potential of only a fraction of a millivolt.—*S. T. V.*

RADIOACTIVITY

11966. Festa, C., and Santangelo, M. La radioattività della terra [Radioactivity of the earth]: Annali Geofis., vol. 2, no. 4, pp. 503-517, 1949.

The distribution of radioactive elements in the crust and interior of the earth and its effect in problems of age and internal heat determinations are reviewed.—*S. T. V.*

11967. Slätis, Hilding. Experiments in the possibility of increasing the efficiency of gamma-counters: Rev. Sci. Instruments, vol. 20, no. 5, pp. 353-354, 1949.

Several modifications of the design of Geiger-Müller counters made during experiments in the Nobel Institute for Physics in Stockholm are described. A higher efficiency of the counter was obtained by the introduction into the tube of a system of absorbing solid bodies in the form of concentric rings supported

by mica plates. The anode wire was of tungsten and was kept stretched by a spring, and the individual rings were kept at potentials corresponding to their position in an undisturbed electrical field created between the charged wire and the cylinder. Good plateaus and resolving times were thus obtained. The efficiency of the counter having three ring systems with twenty-four rings in each system was two and one-half times that of a conventional counter of the same size. The resolving time of the new counter was found to range from 1 to 6×10^{-4} seconds.—*S. T. V.*

11968. Reynolds, G. T. Liquid scintillation counters: *Nucleonics*, vol. 6, no. 5, pp. 68–69, 1950.

The scintillation properties of a series of solutions were investigated, among them solutions of dibenzyl in ether, naphthalene in benzene, xylene, and terphenyl in m-xylene, in benzene, in toluene, and in cyclohexane. The terphenyl solutions seem to be the most appropriate for the purpose. Pulse heights equal to those of good stilbene crystals can be obtained from clear solutions of terphenyl. Because large cells of clear solutions are so simply prepared, it will now be possible to replace counters previously requiring very large, fast detectors.

Results of experiments with different solutions are given, and a graph shows the effect of concentration of terphenyl in m-xylene on the functioning of the counter.—*S. T. V.*

11969. Ives, R. L. Laboratory power supply for vibrator-type portable Geiger-counters: *Econ. Geology*, vol. 45, no. 3, pp. 245–248, 1950.

Vibrator-type counters operating from two 3-volt flashlight cells may be powered in the laboratory from a simple inexpensive transformer-rectifier-filter device. The power supply consists of a small step-down transformer which reduces the line voltage to about six volts and isolates the power line from the output. The rectifier is a medium-current bridge-type selenium unit and the filter a 1,000 microfarad dry electrolytic unit, both standard radio parts. A circuit diagram is given.—*M. C. R.*

11970. Ageno, Mario, Chiozzotto, Mario, and Querzoli, Ruggero. Sulla nuova tecnica dei contatori a scintillazione [A new technique in the design of the scintillation counters]: *Accad. Naz. Lincei. Cl. sci. fis., mat e nat. Rend.*, vol. 6, fasc. 4, pp. 453–457; fasc. 5, pp. 626–631, 1949.

The properties of scintillation counters, the influence of surrounding temperature, and the relation between the intensity of irradiation and the intensity of the current generated in the photo-tube are reviewed.

The small dimensions of crystals present limitations to the sensitivity of the counters in cases of weak radioactivity. An attempt was made to replace the solid crystals by solutions of different salts. The intensity of scintillation caused by thorium salt was found to be influenced by the kind of solvent used. The scintillating solution was placed in a flat container in front of the photo-tube and was irradiated by thorium salt; the tube was cooled by solid CO_2 . The best results were obtained with the solution of naphthalene in xylo.—*S. T. V.*

11971. Damon, P. E. Radioactivity and mineralization in rhyolite porphyry: *Geophysics*, vol. 15, no. 1, pp. 94–101, 1950.

Measurements of hard gamma radiation from the pre-Cambrian rhyolite porphyry of the Bourbon, Mo., well core indicate a direct relationship between

mineralization and radioactive content, low activities being associated with high mineral density. Mineral density is directly related to iron content and steadily increases with depth. The low radioactivity of mineralized sections may be the result of leaching out of the potassium content.—*M. C. R.*

HEAT

11972. Casertano, Lorenzo. Sul contributo termico derivante dalle disintegrazione radioattive nella terra [The contribution of heat derived from disintegration of radioactive substances in the earth]: *Geofis. Pura e Appl.*, vol. 15, fasc. 1-2, pp. 54-59, 1949.

The amount of heat resulting from radioactive disintegration of potassium is discussed. Urry's formula is found very convenient for the computation of the heat produced, but with certain changes in the value of the numerical constants.

From a critical analysis of some twenty data obtained by different scientists Urry's formula is written as:

$$H = 2.1 \times 10^{-6} N + 23.95 \times 10^{-6} a$$

in which H is the number of calories produced by a gram of K_2O ; N is the number of alpha particles emitted, and a is the K_2O content in a gram of the substance under investigation. In the proposed formula the K content of the crust to a depth of 40 km. is assumed as 2.58×10^{-2} gr./gr., and specifically 3.99×10^{-2} for granite; 1.09×10^{-2} for calcareous formations, and 0.27×10^{-2} for arenaceous rocks.—*S. T. V.*

11973. Thomson, J. E. Geology of the main ore zone at Kirkland Lake: Ontario Dept. Mines Rept., vol. 57, no. 5, pp. 55-62, 1950.

As part of the geological study of the main ore zone at Kirkland Lake, Ontario, geothermal measurements were made to depths of 7,200 feet in the Lake Shore and Wright-Hargreaves mines. The accuracy of the temperature measurements is estimated as $\pm 0.1^\circ F$. At depths of less than 3,500 feet points of equal temperature do not lie on planes parallel to the surface. Thus, the heat flow is not strictly perpendicular to the surface, and temperature gradients may be quite different at nearby points. Below 3,500 feet reliable temperature gradients may be calculated. The average temperature gradient below 3,500 feet was $1^\circ F$. per 140 feet, or $4^\circ C$. per 252 feet.—*S. T. V.*

VOLCANOLOGY

11974. Perret, F. A. Volcanological observations, 162 pp., Carnegie Institution of Washington, Pub. 549, 1950.

This is a condensed record of personal observations over a period of some forty years of volcanological studies. It includes descriptions, illustrated by numerous pictures, of volcanic eruptions of widely different types in different parts of the world, which were observed at close range. Among other subjects discussed are: the causes contributing to formation of a volcano; volcanic liquid and gases; electric and atmospheric phenomena observed during an eruption; volcanic ash and its composition; gravitational and volcano-seismic phenomena; prediction of eruptions; and suggestions for observing volcanic eruptions, including instruc-

tions for use of photographic equipment, thermometric instruments, apparatus for gas collection, sound recording, and study of lava samples.—*S. T. V.*

11975. Fries, Carl, Jr., and Gutiérrez, Celedonio. Activity of Parícutin volcano from August 1, 1948 to June 30, 1949: *Am. Geophys. Union Trans.*, vol. 31, no. 3, pp. 406-418, 1950.

During the period covered by this report, Parícutin's activity continued on about the same scale as the previous two years. The quantity of ash erupted decreased, but eruption of vapor and bombs continued with roughly the same intensity as the previous year. Changes in the outward form of the cone were slight. Lava continued to issue without interruption from the vent formed at the northeast base of the cone in Feb. 1948, and the vent area at the southwest base of the cone remained inactive. The rate of lava flow between August and January was moderate to great but the volume decreased notably early in February and remained smaller until the end of June.—*M. C. R.*

11976. Pough, F. H. The geologic history of Parícutin: *New York Acad. Sci. Trans.*, ser. 2, vol. 11, no. 2, pp. 28-33, 1948.

An account is given of the formation and early activity of the volcano Parícutin on the basis of photographic records assembled into a film.—*V. S.*

11977. Vlodavets, V. I. The volcanoes of the Soviet Union [in Russian]: 162 pp., Moscow, Geografizdat, 1949. Reviewed in *Vses. Geogr. Obsch. Izv.*, vol. 82, no. 1, 1950.

General questions of volcanism, properties of magma, genesis of geysers and hot springs are briefly discussed. The book is chiefly devoted to a description of the present and past volcanic activity in the U. S. S. R. Detailed descriptions are given of activity in Kamchatka Peninsula, the Kuril Islands, the Caucasus, Lake Baikal region, Central Asia and northeastern Siberia. An extensive bibliography is included.—*S. T. V.*

11978. Goguel, Jean. Introduction à l'étude mécanique des déformations de l'écorce terrestre [Introduction to the study of mechanics of the deformations of the crust of the earth]: *Memoires pour servir à l'explication de la carte géologique détaillée de la France*, 523 pp., 1948.

The second edition of this work takes into account the most recent studies on the subject and the investigations of the American scientists, which were unavailable in France during the publication of the first edition.

The book is divided into five parts. The first part deals with the mechanics of the earth, including astronomical and geodetic data on its dimensions and shape, distribution of mass in its interior, isostatic compensation and its geological significance, earth tides, pressure and temperature distribution, sources of heat development, and propagation of seismic waves. The second part is devoted to the theory of elasticity and a discussion of experimental studies on the plastic behavior of the earth's mass. The third part is a mathematical study of elastic, plastic, and viscous deformations. Simple geological deformations such as that of a stratified formation, warping of a thick bed, or genesis of faults and geological deformations of greater extent are analyzed, in parts four and five.—*S. T. V.*

TECTONOPHYSICS

11979. Glaessner, M. F. Geotectonic position of New Guinea: Amer. Assoc. Petroleum Geologists Bull., vol. 34, no. 5, pp. 856-881, 1950.

Available data on geotectonic relations in the New Guinea area are reviewed to provide a basis for discussion of the fundamental structural features and dynamics of that part of the Pacific margin. The island is tentatively divided into twelve structural zones. Its present geographical unity has been superimposed on a heterogeneous foundation mainly by very young upwarping and downwarping in a direction parallel to the Pacific border. Southern and central New Guinea are essentially Australian, and represent parts of marginal areas which are elsewhere submerged as parts of the continental shelf. Western New Guinea is strongly influenced by the structural trends of the East Indies. The area between Australia proper and the Pacific border is a major geosynclinal belt. Northern and eastern New Guinea forms part of the Melanesian structural belt. Geologic and gravimetric studies in New Guinea and New Zealand may make it possible to test theories which have directly or indirectly made assumptions on the nature and age of structural elements in this area.—*M. C. R.*

11980. Hess, H. H. and Buell, M. W., Jr. The greatest depth in the oceans: Am. Geophys. Union Trans., vol. 31, no. 3, pp. 401-405, 1950.

Review of information concerning the deepest soundings in the oceans suggests that previously accepted values for the Emden and Ramapo deeps are somewhat in error and that the Cape Johnson deep in the Mindanao trench is probably the deepest valid sounding thus far obtained. The Cape Johnson soundings, some 45 miles north of the Emden deep, indicate a depth of 5,740 fathoms.—*M. C. R.*

INTERNAL CONSTITUTION

11981. Bullen, K. E. Compressibility-pressure hypothesis and the earth's interior: Royal Astron. Soc. Monthly Notices, Geophys. Supp., vol. 5, no. 9, pp. 355-368, 1949.

The hypothesis has been set down that at pressures ranging from 0.4×10^{12} to at least 3.6×10^{12} dynes/cm.² (the latter being the pressure at the earth's center) the compressibility k^{-1} of a substance at temperatures of the order of those in the earth's deep interior is essentially independent of its chemical composition. A simple form of the hypothesis to the effect that k and dk/dp (where p denotes pressure) change continuously and smoothly throughout the earth below a depth of 1,000 km. has been discussed in relation to seismic data. The hypothesis entails an abnormally large density gradient in the lowest 200 km. of the earth's mantle, and in the earth's inner core, and that these two regions are not chemically homogeneous. It entails that the density near the earth's center lies between about 16 g./cm.³ and 20 g./cm.³ (apart from a possible accumulation of even denser material very close to the center). The hypothesis in its simplest form would require the earth's density to be a little higher in the region above the 1,000-km. level than the figures given in a previous model. The hypothesis would entail that the inner core is solid, capable of transmitting S waves at a speed not less than about 4.9 km./sec. and probably less than 6.0 km./sec.—*Author's abstract.*

11982. Bullen, K. E. An earth model based on a compressibility-pressure hypothesis: Royal Astron. Soc. Monthly Notices, Geophys. Supp., vol. 6, no. 1, pp. 50-59, 1950.

In an earth model based on the compressibility-pressure hypothesis, there is a sharp increase of density from 3.36 to 3.57 g./cm.³ at a depth of 80 km. and thereafter a fairly steady density gradient to a depth of 2,700 km. The gradient increases sharply between 2,700 and 2,900 km., being 5.57 g./cm.³ at the base of the mantle. Density within the central core ranges from 9.74 to 12.00 g./cm.³ at a depth of 4,980 km. and then increases sharply to between 17 and 18 g./cm.³ at the center. *S* waves would be transmitted through the inner core at speeds of about 5 km./sec.—*M. C. R.*

11983. Bullen, K. E. On the constitution of Mars: Royal Astron. Soc., Monthly Notices, vol. 109, no. 6, pp. 688-692, 1949.

An earth model based on a compressibility-pressure hypothesis fits theories that the density change at the boundary of the earth's central core is purely a pressure phenomenon and that the earth and Mars are of the same primitive composition. The best fit is found if Mars is assumed to have an inner core in the same proportion by mass as in the earth and if the material in the inner core of the earth is chemically distinct from the material below the crust. The moment of inertia and ellipticity of Mars lend some support to these suggestions.—*M. C. R.*

11984. Ramsey, W. H. On the compressibility of the earth: Royal Astron. Soc. Monthly Notices, Geophys. Supp., vol. 6, no. 1, pp. 42-49, 1950.

An attempt is made to show how the compressibilities found by seismological means can be understood on the basis of the atomic theory of solids, with the investigation confined to those aspects of the problem which do not require a detailed knowledge of the interaction between ions and which are comparatively insensitive to chemical composition. The constant α in the relation $k=k^0-\alpha p$ expressing the bulk modulus as a linear function of pressure is found to lie between 3 and 4. This constant decreases at every transition to a metallic phase but the decrease is very small. Values of α in the core and mantle are approximately equal. The sudden increase in velocity of longitudinal waves at the inner core must then be ascribed to an increase in rigidity, leading to the conclusion that the core is solid.—*M. C. R.*

11985. Ramsey, W. H. On the nature of the earth's core: Royal Astron. Soc. Monthly Notices, Geophys. Supp., vol. 5, no. 9, pp. 409-425, 1949.

In a previous paper the author has suggested that the density jump at the boundary of the earth's core is due to a phase transition under pressure, and not to the appearance of a new material such as iron. A metallic type of structure was proposed for the material in the core. In the present paper the transition to the metallic phase is explained in greater detail. Seismological data are used to prove that the core cannot be composed of either iron or an alloy of iron and nickel. It is shown how the theory removes certain difficulties arising from the hypothesis of an iron core, and how it can account for features not hitherto explained.—*Author's abstract.*

11986. Bullard, E. C. The transfer of heat from the core of the earth: Royal Astron. Soc. Monthly Notices, Geophys. Supp., vol. 6, no. 1, pp. 36-41, 1950.

The dynamo theory of the origin of the earth's magnetic field requires a motion of the material of the core which may possibly be the result of thermal convection. As neither the temperature, rate of heat generation, nor conductivity of the core is known, any discussion must be inconclusive. It is possible to choose a set of constants which would not cause convection and which could not be shown to be inadmissible, but there is no difficulty in choosing admissible constants which will give convection. These conditions are more easily satisfied if the heat is removed from the core by convection in the mantle than if it is transported by conduction because the temperature of the core is then lower and there is a greater range between the heat flow necessary to maintain the adiabatic gradient and the maximum amount that can plausibly be supposed to arrive at the surface of the earth.—*M. C. R.*

11987. Elsasser, W. M. Causes of motions in the earth's core: Am. Geophys. Union Trans., vol. 31, no. 3, pp. 454-462, 1950.

Secular variation of the earth's field may be attributed to motions in the fluid, electrically conducting core. Fluid motions on the earth are of two general types, being either of thermal or of gravitational origin, but thermal convection seems to be the only satisfactory mechanism for motion in the core. If 5 to 10 percent as much radioactivity as is found in the crust were concentrated in the inner core, convection would take place. Three models of a convective core are suggested: one in which the heat supplied to the lower boundary of the liquid layer exceeds the amount that can be carried away by conduction alone; another in which the heat flow in the mantle adjacent to the core is in excess of purely conductive heat transport in the core itself; and a third in which the heat supplied at the lower boundary is carried to the upper boundary by convection and then carried away by the mantle. No choice among them can be made. The effects of gravitational perturbations by the moon and sun, such as tides in the core, effects of the equinoctial precession, and slowing down of the earth's rotation by tidal friction, are not sufficient to explain motions of the magnitude observed in secular variation.—*M. C. R.*

11988. Elsasser, W. M. The earth's interior and geomagnetism: Rev. Modern Physics, vol. 22, no. 1, pp. 1-35, 1950.

This review summarizes the state of knowledge of the earth's fair interior, omitting the information that pertains to the crust proper. Seismic and geochemical data and the mechanical and thermal properties of the interior are reviewed. The last section is devoted to an exposition of the mechanics of terrestrial magnetism as developed by Bullard and Elsasser. See also Geophys. Abstracts 11476 and 11987.—*M. C. R.*

11989. Jeffreys, Harold. Dynamic effects of a liquid core: Royal Astron. Soc., Monthly Notices, vol. 109, no. 6, pp. 670-687, 1949.

The effect of the inertia of the earth's core may be neglected in discussions of the semidiurnal, fortnightly, and semiannual tides, but must be considered for those depending on terms of the forms zx , zy in the gravitational potential. A theory of these is developed for an earth model of the Wiechert type, with a fluid core, and applied to the free variation of latitude and the lunar nutation. With a rigid shell, a fluid core would produce a shortening of the free period, contrary

to observation; but with a shell of rigidity of 1.9×10^{12} dynes/cm², the motion induced in the core is much less than with a perfectly rigid shell, and agreement between theory and observation can be obtained with a rigidity differing little from what was found satisfactory when the inertia of the core was neglected.

Fluidity of the core has been seen to be capable of reducing the amplitude of the lunar nutation by about three times as much as the present discrepancy between theory and observation. Allowance for elasticity of the shell reduces this; allowance for the obliquity of the ecliptic further reduces the correction for the nutation in latitude, but increases that for the nutation in longitude. Even for the nutation in latitude the correction remains too large, but possibly not too large for the excess to be due to inaccuracies of the Wiechert model.—*M. C. R.*

11990. Lozano Calvo, Luis. Sobre la densidad y presiones en lo interior de la Tierra [Density and pressure in the interior of the earth]: *Rev. Geofís.*, vol. 8, no. 32, pp. 431–448, 1949.

A critical analysis is made of different equations for determining density as a function of depth, as derived from discontinuities in the structure of the crust revealed by seismological observations. Among those considered are the Wiechert, Marsh, Boaga, Stieltjes, Azcona y Masia, Haalck, Bullen equations. Two equations are proposed, one for the crust, another for the core.—*S. T. V.*

EXPLORATION GEOPHYSICS

GENERAL

11991. Archie, G. E. Introduction to petrophysics of reservoir rocks: *Am. Assoc. Petroleum Geologists Bull.*, vol. 34, no. 5, pp. 943–961, 1950.

The term petrophysics is suggested for the physics of particular rock types in comparison to geophysics which pertains to the physics of larger rock systems. The petrophysics of reservoir rocks here discussed include those physical properties which are related to pore and fluid distribution. Porosity, permeability, capillary pressure, hydrocarbon saturation, fluid properties, electrical resistivity, self-potential, and radioactivity of different types of rocks are investigated separately and in relation to each other as they pertain to the detection and evaluation of hydrocarbon-bearing layers. A tentative petrophysical system is presented, revolving mainly around pore-size distribution which defines the capillary-pressure curve, porosity, and permeability.—*M. C. R.*

11992. Kunz, Bruno. Der Gradient in der Geophysik [The gradient in geophysics]: *B. B. Z. [Bergbau-Bohrtechniker-und Erdöl-Zeitung]*, Jahrg. 65, Heft 10, pp. 4–5, Heft 11, pp. 6–7, 1949.

The gradient, as used in geodesy and geophysics, is defined and illustrated using measurements of temperature, gravity and other physical properties. The relation between the gradient and the numerical value and direction of a physical quantity itself is discussed.—*S. T. V.*

11993. Hysom, R. L. The search for oil: *The Colorado Engineer*, vol. 46, no. 4, pp. 9–11 and 38, 1950.

The North American gravity meter is described and the use of a helicopter in gravitational surveys is outlined.—*S. T. V.*

11994. Geoffroy, P. R. and Koulomzine, T. Need for new policies and new tools in mining geophysics: Canadian Min. Met. Bull., vol. 43, no. 458, pp. 313-315, 1950.

There is an immediate need to develop new tools and methods in mining geophysics, comparable to the progress in petroleum exploration. Measurement of physical properties in diamond-drill holes is suggested. Induced potential and spontaneous polarization have already yielded positive results, and magnetic and gravimetric measurements are also feasible. Radioactive methods are another possible development.—*M. C. R.*

11995. Kelly, S. F. Geophysical and geological approach to mining problems: Mining World, vol. 11, no. 11, pp. 37, 38, 40, and no. 12, pp. 40, 44, 46, 1949.

The fundamentals of the gravimetric, magnetic, seismic, and electric methods of exploration are briefly outlined. The types of problems to which each is applicable, and the geological circumstances which must be considered in deciding what techniques should be applied to derive the maximum geological information are described.—*M. C. R.*

11996. Lundberg, Hans. Current trends and progress in mining geophysics: Colorado School of Mines Quart., vol. 45, no. 4A, pp. 41-47, 1950.

Since World War II developments in geophysical exploration have been completely revolutionized. Developments in aviation and electronics have made possible magnetic surveys from the air and soon gravity surveys will also be made in this way, requiring only 1/50 to 1/150 of the time necessary to do the same work on the ground. The cost of an airborne survey is as low as 1/100 of the cost of similar survey on the ground. The possibility of flying at different heights permits a three dimensional geophysical picture of the region, important in determining the depth of disturbing bodies. Airborne methods lend themselves best to regional surveys, although detailed studies of small areas are also quite easily accomplished.—*S. T. V.*

11997. Raggatt, H. G. Depletion of mineral resources—A challenge to geology and geophysics: Australian and New Zealand Assoc. Adv. Sci. Rept., 26th meeting, pp. 109-133, 1948.

Large quantities of minerals consumed during the Second World War accelerated depletion of resources to such an extent that the known deposits of many minerals will be exhausted in the foreseeable future. New, more effective methods of exploration for minerals must be discovered and used.—*S. T. V.*

11998. Kelly, S. F. Geophysics in the exploration, exploitation, and conservation of water; Mines Mag., vol. 39, no. 11, pp. 13-21, 1949. (Presented at the First Pan-American Engineering Congress, Rio de Janeiro July 1949, and accepted for publication in full in the Annals of the Congress.)

Geophysical exploration for water may be either indirect by mapping structural features affecting a known or presumed aquifer or direct, by detecting water itself, usually as a water-table in alluvium, gravels, and glacial till because of the better electrical conductivity of water-soaked formations and increased velocity with which they transmit seismic waves. In the exploitation

of water resources, observations of electrical resistivity, natural formation potentials, radioactivity, thermal gradient, hole diameter, and fluid flow when integrated with geologic data may furnish information regarding positions of cement casings, and liners, and porosities of formations, inflow of saline water, loss of water through creviced formations, sources of contamination, depth to and thickness of water-producing horizons, and possibility of increasing yields by deepening wells. Electrical and seismic methods are used also for determining depth to and characteristics of bedrock. This information may be used in guiding locations of proposed water tunnels, and facilitating choice of dam sites. Typical electrical resistivity surveys for water in Palestine, Spain, Uganda, and Peru are described, as well as surveys for dam and bridge sites and activities of geophysical units of the Geological Section of the South African Engineering Corps.—*M. C. R.*

11999. Beck, A. F. Western Canadian plains—A new challenge to geophysics: Canadian Min. Met. Bull., vol. 43, no. 455, pp. 132–134, 1950.

A review of the electric, magnetic, gravity, and seismic methods and the problems of operation in the western Canadian area.—*M. C. R.*

12000. Evans, P., and Coates, J. Geophysical prospecting for oil in India: Indian Minerals, vol. 2, no. 4, pp. 219–225, 1948.

This is a continuation of a previous article by the same authors, (*See Geophys. Abstract 11443*), describing the work of government and private organizations in search for oil in India. In the extensive geophysical surveys of the vast alluvial areas of India, a preliminary gravity survey is usually made and areas are then selected for more detailed investigation by seismic methods. Seismic investigations of this type were conducted in 1931 in the Punjab and in 1938 in the Assam areas without obtaining the desired structural information. With shallow structures, as near Dignoi in Assam, successful electrical surveys have been made.

Magnetic methods are not used in prospecting for oil because the sedimentary rocks with which oil is usually associated contain only a small proportion of magnetic minerals.—*S. T. V.*

12001. McGee, D. A., Seale, Tom, Finley, J. C. Oil in the Gulf of Mexico: Oklahoma Acad. Sci. Proc., vol. 29, pp. 60–61, 1950.

Oil along the Texas and Louisiana coasts is produced almost exclusively from salt dome structures, varying in character from very shallow, piercement type domes to large, deep-seated salt masses. Seismic work off the Louisiana coast has demonstrated that salt domes of the same general type and character as those found on land extend out to a distance of at least thirty miles from the shore. Exploration work is now being carried on at distances greater than this. Gravimetric data indicate the presence of salt domes out to and possibly seventy-five miles beyond the shore. It seems logical to assume that the total oil reserve in this area will exceed that of the coastal land area.—*S. T. V.*

12002. Macelwane, J. B. Survey of geophysical education in the United States and Canada in 1948: Geophysics, vol. 15, no. 2, pp. 257–263, 1950.

A total of 150 universities and colleges teach at least one course in geophysics, according to replies to a questionnaire sent to 426 institutions. The types of geophysics courses offered at each institution are tabulated.—*H. R. J.*

12003. Monges Lopez, Ricardo. El Instituto de geofísica de México [Geophysical Institute of Mexico]: Ciencia, vol. 9, no. 11-12, pp. 321-322, 1949.

A National Institute of Geophysics has recently been established as a separate scientific organization associated with the University of Mexico. The Institute will have six sections: Seismology, Geomagnetism, Geodesy, Geomechanics, Volcanology, and Applied Geophysics. The last section will prospect for underground water and oil in cooperation with Petroleos Mexicanos. The Section of Geomechanics will be the center of studies concerning soil mechanics and its applications in civil engineering. Sections of Oceanography and Meteorology are planned for the future.—*S. T. V.*

12004. Informaciones y Memorias de las Sociedad de Ingenieros del Peru. El Observatorio Geo-físico de Huancayo [The geophysical observatory of Huancayo]: Vol. 5, no. 8, p. 348, 1949.

The Huancayo Observatory and its equipment are briefly described. Magnetic, meteorological, seismological and ionospheric investigations are carried on.—*S. T. V.*

12005. Jaroszewicz-Halicka, Antonina. Prace nad organizacją w Warszawie Międzyuczelnego Instytutu Geofizyki [Organization of the Interdepartment Geophysical Institute of Warsaw]: Wiadomości museum ziemi, vol. 4, pp. 273-274, 1949.

The Geophysical Institute of Poland, now being reorganized, will have two research centers—one devoted to applied geophysics at Kraków, associated with the local school of mines, the other at Warsaw. The latter will have three sections for studies of the crust of the earth, the atmosphere, and the hydrosphere, and will operate the meteorological observatory at Swirdze and the seismological observatory.—*S. T. V.*

GRAVIMETRIC METHODS

12006. Garcia Rojas, Antonio. Exploración Gravimetrica [Gravimetric exploration]: Petroleos Mexicanos, no. 78, pp. 13-38, 1950.

The basic principles of geophysical exploration by gravimetric methods are discussed. A brief description of the Mott-Smith gravimeter is given and the corrections to be applied to its readings are defined. Reductions leading to the determination of the gravitational anomalies of a surveyed region are also discussed. The interpretation of a gravimetric survey is explained by several examples from Mexican practice.—*S. T. V.*

12007. Kato, Motohiko. On the first and the second differential coefficients of potentials of the arbitrary distributed masses [in Japanese]: Geophys. Exploration, vol. 2, no. 3, pp. 6-10, 1949.

In gravitational or magnetic prospecting, the first and the second differential coefficients of potentials of arbitrarily distributed masses must often be calculated. This calculation is ordinarily complicated, but it can be done simply and with sufficient accuracy by assuming a sphere. Errors when a sphere is assumed are the same in two dimensions.—*M. C. R.*

12008. Cantos Figuerola, José. Investigación hidrologica en Ciudad Real [Hydrological investigation around Ciudad Real]: *Rev. Geofis.*, vol. 8, no. 32, pp. 449-459, 1949.

Gravimetric and electrical-resistivity surveys were made near Ciudad Real, Spain, in search for water. The region surveyed is an area of about 225 sq. km. situated south and west of the Río Guadiana at altitudes of 600 to 715 meters above sea level. Two Nørgaard gravimeters were used in gravitational survey, and 124 stations were occupied, about half of them several times. An arbitrary point on the Madrid-Toledo railroad, where g was determined as 978.756 gals, was selected as a base. Bouguer reductions were computed with the density of the ground assumed as 2.0. Anomalies range from 0 to 12 mgal.

Because the ancient impermeable formations covered by Tertiary strata have greater density, it was believed that gravity minima indicate a deepening of the subterranean basins and thus a greater probability of water reservoirs.

The results of the gravitational survey were checked by the electrical method with two profiles: one, 16 km. long with 49 points of measurements, the second, 13 km. long with 24 points. Electrical sounding revealed an impermeable layer at depths of 110 to 150 m. The greatest depth was found at the station having the minimum value of gravity, in good agreement with the gravitational measurements. The article contains graphic and geological maps of the region, two cross sections through geological formations, and graphs presenting the results of electrical measurements over two profiles.—*S. T. V.*

12009. Innes, M. J. S. An investigation of the applicability of gravimetric and magnetometric methods of geophysical prospecting: *Canadian Min. Met. Bull.*, vol. 42, no. 448, pp. 378-384, 1949.

Test surveys were made with both gravity meter and magnetometer over known sulfide concentrations at East Sullivan, Val d'Or, Quebec where the topographic relief is less than 50 ft., the depth of the overburden varies between 0-50 feet, and the average contrast between sulfide body and the surrounding rocks is 0.5. Observations were made at 260 gravity and 190 magnetic stations along north-south grid lines. Stations were 50 feet apart near the ore body, and 100 feet elsewhere. The gravity pattern shows three highs, two over known ore bodies, and a low over the syenite bounding the area. Magnetic highs were associated with mineralized zones. The survey showed that both methods are useful in delineating sulfide deposits under conditions such as those at East Sullivan.—*M. C. R.*

MAGNETIC METHODS

12010. Branham, C. A. A brief commentary on magnetic surveying in the Appalachian area: *Appalachian Geol. Soc. Bull.*, vol. 1, pp. 275-276, 1949.

Magnetic surveying as a method of reconnaissance in studies of structural geology of a region is suggested and described.—*S. T. V.*

12011. Ballarin, S. Isoanomale magnetiche relative ad una massa omogenea di forma parallelepipedica magnetizzata uniformemente dal campo magnetico terrestre [Magnetic isoanomalies caused by a homogeneous parallelepiped uniformly magnetized in the geomagnetic field]: *Riv. Geomin.*, vol. 9, no. 1, pp. 3-31, 1948.

Interpretation of a magnetic survey can be made more easily by a comparison of the isoanomalies obtained with those generated by simple geometric bodies placed in different positions underground.

The computations of isoanomalies are given for parallelepipeds of various dimensions, uniformly magnetized and variously placed with respect to the magnetic field of the earth. The magnetic potential at a point in space by an elemental strip is determined and the disturbing potential produced in this point is found by integrating over the volume of the parallelepiped. This makes possible the finding of the anomalies of the horizontal and vertical components of the geomagnetic vector, as well as anomaly of the declination. Several tables containing the necessary numerical values for calculations are given to facilitate the solution of special problems.—*S. T. V.*

12012. Cassinis, R. I magnetometri a induzione [Induction magnetometers]: *Riv. Geomin.*, vol. 10, no. 2, pp. 59-72, 1949.

Several saturation magnetometers developed in the United States and used in airborne surveying are described. Special attention is given to Gulf magnetometer as described by R. D. Wyckoff (*See Geophys. Abstracts 8501, 8508, 8670, and 10021*).—*S. T. V.*

12013. Bemrose, John, Heggblom, J. C., Holt, T. C., Richards, T. C., and Watson, R. J. Bahamas airborne magnetometer survey: *Geophysics*, vol. 15, no. 1, pp. 102-109, 1950.

An airborne-magnetometer survey of an area of about 85,000 sq. mi., sponsored jointly by five companies, was flown between May and November 1947. The organization of the survey and some of the technical phases of the operation are described briefly in this paper. (For abstract published in advance of full text, *see Geophys. Abstract 10769*.)—*M. C. R.*

12014. Wier, K. L. Comparisons of some aeromagnetic profiles with ground-magnetic profiles: *Am. Geophys. Union Trans.*, vol. 31, no. 2, pt. 1, pp. 191-195, 1950.

Typical aeromagnetic total-intensity profiles are compared with ground-magnetic vertical-intensity profiles over the same geologic structures in the Iron River district in the northern peninsula of Michigan. Aeromagnetic profiles are strikingly smoother than the ground-magnetic profiles, chiefly because of the merging of adjacent anomalies and a decrease in intensity at greater altitudes. Depth rules applied to aeromagnetic data usually give estimates that are too great because of the complex character of most aeroanomalies.—*M. C. R.*

12015. Cook, K. L. Magnetic surveys in the Iron Springs district, Iron County, Utah: *U. S. Bureau of Mines Rept. of Inv.* 4586, 77 pp., 1950.

During 1944 and 1945 the Bureau of Mines made magnetometer surveys of some of the principal iron ore deposits of the Iron Springs district, Iron County, Utah, in a belt 23 miles by 3 miles. Most of the large ore bodies are pods of replacement ore in a limestone bed at the margins of three igneous intrusions. The magnetic surveys were confined to these marginal zones. The ore is a mixture of hematite and from 14 to 58 percent magnetite.

About 62,000 magnetometer stations were occupied along a total of 300 traverse miles, and anomalies of over 1,250 gammas were usually found over near-surface ore bodies. Outcropping ore bodies were surveyed to determine their attitude and size, other geologically favorable areas were explored for new ore bodies, and 36 holes in 10 different ore bodies were drilled to correlate the geology and geophysics and check estimates of size and depth of ore.

Forty-five magnetic anomalies were found, 13 caused by outcropping commercial ore bodies and 5 by concealed ore bodies discovered largely by the magnetic survey. The rest are in untested areas of little or no exposed ore, 6 probably, and another 9 possibly over large replacement ore bodies, and 6 are probably caused by unexposed magnetite veins of possible commercial importance.

Strikes of all the ore bodies were indicated by trend and dips estimated from the shape of anomalies, although less reliably for concealed ore bodies. Lengths and apexes of ore bodies near the surface were predicted accurately. Depth and thickness of steeply dipping ore bodies near the surface sometimes could be predicted. Depths of undrilled probable ore bodies could be predicted qualitatively, but if the downdip extent was found by one drill hole, accurate predictions for the rest of the ore body were possible.—*H. R. J.*

12016. Melchiori, G. Erdmagnetische Untersuchungen Sedimentärer Eisenerzvorkommen von Nurra, Sardinien [Geomagnetic investigations of sedimentary iron ore deposits at La Nurra, Sardinia]: *Beitr. angew. Geophysik*, Band 10, Heft 3-4, pp. 312-331, 1943.

Magnetic prospecting for iron ore in La Nurra, Sardinia, was carried out in great detail with 7,931 stations occupied in an area covering some 3,000 sq. km. A Schmidt magnetic field balance was used. In the surveyed area lenticular ore bodies of siderite and lepto-chlorite with accessory magnetite of relatively weak magnetic susceptibility are found. The presence of a sufficient amount of magnetite, however, made it possible to obtain a satisfactory magnetic picture with pronounced contrasts. Iron ores of not less than 1,700,000 tons were discovered. The presence of ore bodies was fully confirmed by subsequent drilling. Details of the magnetic measurements, profiles, and results of the exploration in the form of geological maps of the region are included.—*S. T. V.*

12017. Ermert, E. A. Magnetometrische Untersuchung eines Syenitganges am westlichen Witwatersrand [Magnetic exploration of a syenite reef at western Witwatersrand]: *Beitr. angew. Geophysik*, Band 11, Heft 2, pp. 121-134, 1944.

Several dikes with sufficient magnetite to be traced by a field balance were discovered by a magnetic survey of the western Witwatersrand. These dikes, when the surrounding rock is dolomite, act as underground dams, forming underground reservoirs of water which must be avoided in mining operations. The magnetic polarity of the dikes is commonly opposite to that of the shales and the earth's field.—*S. T. V.*

SEISMIC METHODS

12018. Heroy, W. R., and Arnett, R. A. Seismic surveying: *Appalachian Geol. Soc. Bull.*, vol. 1, pp. 265-274, 1949.

The basic principles of seismic methods of exploration are presented. The necessary equipment, including special trucks, drilling rigs, and so on, is described and information on the organization of an exploration party is given.—*S. T. V.*

12019. Green, C. H. The relationship of research and field operations in seismic explorations: *Colorado School of Mines Quart.*, vol. 45, no. 4A, pp. 1-9, 1950.

An historical outline of changes in methods and techniques of exploration geophysics, especially seismic exploration, is presented. The necessity of continuous

integration of various methods of exploration is now generally agreed upon, as well as the coordination of geology with geophysics. The necessity of scientific research for future progress in geophysical exploration is emphasized. This research must be of two kinds: short-range, in the form of improvements in equipment design and field instrumentation; and fundamental investigations, in the fields of geology, physics, and seismology. These should be carried on apart from production operations and without restrictions.—*S. T. V.*

12020. Anderson, H. H. A hazard in oil exploration: *Explosives Engineer*, vol. 27, no. 6, pp. 179-183, 1949.

One of the dangers in seismic exploration is the hazard of induced electrical energy in the firing line of the blaster. Such extraneous electricity may originate from current induced from the boat's radio and transmitting antennae in the absence of any physical connection, from static electricity in the ground and in the equipment, or from electrical charges in the atmosphere. Detonation of the blasting cap may be also produced if lightning strikes nearby.

Hazards from stray currents can be greatly decreased by adoption of a few preventive practices, such as keeping the blasting line in serviceable condition, leaving shunts on all caps in place until final connections are ready and short-circuiting the firing line itself.—*S. T. V.*

12021. Schoff, S. L. Seismograph shooting and water wells: *Oklahoma Acad. Sci. Proc.*, vol. 29, p. 44, 1948.

Occasional reports indicate that seismic shooting by oil surveying parties adversely affects some water wells, the usual report being that the yield of water is reduced or that the water has become muddy. Most of the reports of well failure as a result of seismic shooting cannot be confirmed because little information is available on the relation of water well and the shot hole. It seems improbable that failure can occur where there is a substantial distance between the shot hole and water well. It is likely that only in wells fed through open cracks could an adverse effect be observed as a result of the closing of joints.

It is also known that some water wells are "shot" to improve their yield so that seismic shooting may sometimes improve rather than harm water wells.—*S. T. V.*

12022. Tartakovskii, B. D. On the theory of propagation of plane waves through homogeneous strata [in Russian]: *Akad. Nauk SSSR Doklady*, vol. 71, no. 3, pp. 465-468, 1950.

When plane waves are propagated through n homogeneous plane strata the coefficients of reflection and refraction taking place on each stratum can be determined from a system of $2(n+1)$ equations containing the potentials of the direct and returning waves at each of the separating planes. Solution of this system of linear equations can be substantially simplified because all but three members in each line of the determinant are equal to zero, and certain recurrent relations between the coefficients of adjoining equations can be established, which make possible the evaluation of the determinant.

General formulas, giving the values of the reflection and refraction coefficients, entering into consecutive equations, are derived. The correctness of these expressions is checked in some special cases, such as perpendicular arrival of the incoming wave.—*S. T. V.*

12023. Trappe, F., and Zettel, W. Ein neuartiger elektrischer Feldseismograph [A new type electrical seismograph for field use]: *Beit. angew. Geophysik.*, Band 10, Heft 3-4, pp. 259-264, 1943.

A new seismograph for use in seismic exploration is described. Because of transportation difficulties, the mass of the pendulum is very small, and the magnification is electrodynamic. The weight of the instrument is only 6 kg., including a watertight housing. The principal element of the seismograph is a coil oscillating in the annular slot of an iron-clad magnet with an adjustable core. Displacement of the coil generates an electromotive force which is measured by an oscillograph. The instrument has very little friction, and is aperiodic owing to very strong damping. It is especially adapted for registration of reflected waves or later-arriving refracted impulses. Characteristic curves of the seismograph are given and several sketches illustrate the description.—*S. T. V.*

12024. Hattori, Yasumasa. On the transmission of the shot-instant in seismic refraction method [in Japanese]: *Geophys. Exploration*, vol. 2, no. 3, pp. 14-15, 1946.

The accuracy of time transmission of various methods is discussed. At the instant when the transmission line around the charge without any current flowing was broken by the explosion, a large electromagnetic force in the broken wire was observed. An arrangement for shot-instant transmission over a single communication line, using a thyratron, is shown.—*M. C. R.*

12025. Clewell, D. H. and Simon, R. F. Seismic wave propagation: *Geophysics*, vol. 15, no. 1, pp. 50-60, 1950.

Seismic reflection energy is usually in the frequency range of 20 to 100 cycles per second. The general absence of reflected energy below 20 c.p.s. is attributed to the fact that wave lengths in this range are large compared to thicknesses of reflecting bed and are transmitted efficiently, returning to the surface only by refraction. As the frequency increases, wave lengths become comparable to the discontinuities represented by stratification and more efficient reflection takes place. At still higher frequencies absorption and scattering by small irregularities form an effective cut-off. Improvements of the resolving power of the reflection seismograph will probably result from techniques which shorten and simplify the input signal rather than from efforts to widen the band of usable frequencies. Elimination of non-linear displacements in the vicinity of the shot point is an obvious approach.—*M. C. R.*

12026. Morris, George. Some considerations of the mechanism of the generation of seismic waves by explosives: *Geophysics*, vol. 15, no. 1, pp. 61-69, 1950.

When an explosive is detonated, the walls of the shot hole are subjected instantaneously to pressures of several hundred tons per square inch. This sudden impact on the walls causes a shock wave which spreads out spherically. The initial stresses greatly exceed the strength of the medium and cause fracturing of the ground, but as the pulse moves outward, the stresses decrease and at the critical radius where the stresses just equal the elastic limit, the pulse becomes an elastic pulse. It is then transmitted appreciably unchanged through the ground.—*M. C. R.*

12027. Savitt, C. H. Reflected energy variations resulting from small changes in shot hole and spread locations: *Geophysics*, vol. 15, no. 2, pp. 219-226, 1950.

Examples of seismograms and cross sections are presented to illustrate changes of considerable importance resulting from relatively minor displacements of shot holes and spreads. Records are exhibited from continuous profiling lines which were shot from separate lines of shot holes on opposite sides of a single line of spreads, as well as from lines which were shot from a single line of holes but which were recorded simultaneously on separate parallel spreads. A comparison of the results of conventional spread arrangements and of the parallel line or "H" spread technique as used in difficult areas is made.—*Author's abstract.*

12028. Shock, Lorenz. The progressive detonation of multiple charges in a single seismic shot: *Geophysics*, vol. 15, no. 2, pp. 208-218, 1950.

The relative efficiencies of various sizes of explosive charges for the generation of seismic energy were investigated and a procedure devised whereby a number of charges of the most efficient size would be detonated progressively in such a manner that the energy from all the individual charges would arrive simultaneously at the recording position. The results of investigations of this system of progressive detonations, using both horizontal and vertical spacings of the individual charges, are presented and its possible application in reflection and refraction seismic surveys is discussed.—*Author's abstract.*

12029. Iida, Kumizi. Rate of changes in elastic wave velocity with pressure [in Japanese]: *Geophys. Exploration*, vol. 2, no. 3, pp. 11-13, 1949.

The subject is considered assuming Birch's theoretical treatment based on Murnaghan's theory of finite strain. The rate of change in elastic wave velocity of rocks several hundred meters beneath the earth's surface is less than 1 per cent, but that of rocks with elasticity smaller than 10^9 c.g.s. is 10 per cent or more. These facts must be considered in the interpretation of results of seismic prospecting.—*M. C. R.*

12030. Epinat'eva, A. M. On certain types of diffracted waves recorded on seismograms [in Russian]: *Akad. Nauk SSSR Izv., Ser. geog i geofiz.*, vol. 14, no. 1, pp. 89-95, 1950.

During seismic exploration of several areas in southern U. S. S. R., waves which had been diffracted over a portion of their path were discovered on the seismograms. This diffraction is attributed to the presence of limestone layers at depths of 0.5-10 meters. Diffracted waves in turn give rise to other waves, such as Mintrop waves. The appearance of diffracted waves instead of ordinary Mintrop waves is most often associated with an abrupt reduction of intensity and a decrease in the frequency of vibrations. Body waves and surface Mintrop waves were identified among these diffracted waves. Where diffracted waves show greater intensity, the refracting boundaries of limestone strata were nearer the surface and nearer to each other. When the refracting boundaries are deeper, no diffracted waves can be detected on the seismograms because of their rapid attenuation with increasing distance.—*S. T. V.*

12031. Krey, Theodore. Zur Frage der Anerkennung und Bewertung von Reflexionen [The recognition and evaluation of reflections]: *Erdöl u. Kohle*, 3d Jahrg., Heft 1, pp. 14-16, 1950.

In seismic prospecting it often becomes quite difficult to determine the nature of certain indications obtained from the seismograms. An objective method is presented, based on the theory of probability in evaluating such characteristics of seismic phenomena as the phase relationships of different waves, the ratio of their amplitudes, and similar data. If the computed probability of the coincidence of certain characteristics is 10 per cent or less, it can be concluded that the identity of these characteristics is the result of a causal relation. If this probability is found to be over 50 per cent, the events are considered not related. The method is inconclusive if the probability is between 10 and 15 per cent. Several examples are presented from seismic reflection surveys.—*S. T. V.*

12032. Krouskij, L. Bestimmung des wahren Einfallens und der wahren Tiefe reflexionsseismisch ermittelter Schichten [Determination of the slope and true depth of layers from seismic reflection data]: *Erdöl u. Kohle*, 2d Jahrg., Heft 11, pp. 489-490, 1949.

A graphic method of determining the slope and the depth of a reflecting horizon from the data obtained by star shooting is presented. For the geometrical construction involved at least four points of observation are necessary and the velocity of propagation of the seismic waves must be known.—*S. T. V.*

12033. Ricker, Norman and Lynn, R. D. Composite reflections: *Geophysics*, vol. 15, no. 1, pp. 30-49, 1950.

A method of reflection prospecting has been developed based on use of the *PS* phase, a disturbance which has traveled from the shot to the reflecting bed as a dilatational wave and from the reflecting bed to the earth's surface as a shear wave. The phase is found in the otherwise quiet region between dilatational waves and ground roll, is often outstanding in simplicity and prominence, and may be correlated from hole-to-hole and spread-to-spread. Test surveys in the Homer and Cotton Valley area, Louisiana, were made to evaluate the method. Two methods of interpretation were used, an empirical method depending on knowledge of the depth of the reflector at certain control stations from well logs or other data, and a rational method which involves determination of wave velocities and approximate depth of reflector from refraction studies. The composite reflection method seems to be applicable in regions where an unconsolidated layer extends downward from the surface to a single hard bed serving as a reflector.—*M. C. R.*

12034. Poulter, T. C. The Poulter method of geophysical exploration: *Geophysics*, vol. 15, no. 2, pp. 181-207, 1950.

The techniques involved in use of the method are described. *See also* *Geophys. Abstract* 11539.—*M. C. R.*

12035. Poulter, T. C. The Poulter seismic method: *Canadian Min. Met. Bull.*, vol. 43, no. 457, pp. 259-267, 1950.

A complete description of the method is given. (*See also* *Geophys. Abstract* 11539). During the summer of 1949 seismic studies using this method were

undertaken on the Taku Glacier. Longitudinal, transverse, and Rayleigh waves were identified on the records. Velocities of these in the solid blue ice were 12,900, 6,620, and 5,800 ft./sec. respectively, and the velocity of longitudinal waves in névé was 3,600 to 5,000 ft./sec. Four lines of stations were occupied from which it was possible to construct vertical cross sections of the glacier.—*M. C. R.*

12036. Slotnick, M. M. A graphical method for the interpretation of refraction profile data: *Geophysics*, vol. 15, no. 2, pp. 163-180, 1950.

A graphical method for interpreting refraction profiles which has been used for many years, is consistent with the accuracy of the data, and which has met with success in its application and results is outlined and illustrated. The procedure is as follows. O and O' are the shot points. The line OQ is drawn at an angle α with the vertical in which α is $\sin^{-1} v_1/v_{2u}$. The first section of the time-distance curve through O or O' defines v_1 and the slope of the second segment of the time-distance curve through O' gives $1/v_{2u}$. The line $O'Q$ is similarly drawn at an angle α' with the vertical where α' is $\sin^{-1} v_1/v_{2a}$, v_1 being the same as above and $1/v_{2a}$ the slope of the second section of the time-distance curve through O . The angle of dip is $\phi = (\alpha' - \alpha)/2$, and the critical angle of the interface $\theta = (\alpha + \alpha')/2$. The point P is determined so that QP equals QO , and $\pi = O'P/v_1$ is computed, $O'P$ being found by scaling. The difference $t = T - \tau$ in which T is the travel time O to O' is found, and then $a = (v_2 t - d)/2(v_2/v_1 - v_2/v_3)$, in which d is the scaled-off distance OP , is computed. The points A and A' are found by scaling so that $OA = PA' = a$, and the line AA' is the trace of the desired interface.—*M. C. R.*

12037. Agocs, W. B. Computation charts for linear increase of velocity with depth: *Geophysics*, vol. 15, no. 2, pp. 227-236, 1950.

Computation charts are presented which reduce or eliminate calculations of correlation and wave-front depth charts. A series of depth charts are made for particular values of the velocity increment solving the time-depth relation for all possible initial velocities of the equation $y = (V_0/k)(e^{kt} - 1)$. From these charts, the average velocity-depth curves are obtained, and also the velocity function to be used on a project determined from velocity shooting by comparison to the theoretical average velocity-depth curves. For wave-front depth charts, a series of families of curves are plotted for the full range of velocity increments and all initial velocities for the equations of the instantaneous center of the wave front, $z = (V_0/k)(\cosh kt/2 - 1)$, and the radius of the wave front, $r = (V_0/k)(\sinh kt/2)$. The relation between k and $e^{kt/2}$ for a range of times is plotted, and therefrom a value of $e^{kt/2}$ obtained for the particular velocity increment for the solution of the equation $\tan \theta/2 = \tan \theta_0/2 \cdot e^{kt/2}$. Finally, curves for a series of $\tan \theta/2$ against initial velocity curves are plotted for a series of step out times, and therefrom the value of $\tan \theta/2 = \tan \theta_0/2 \cdot e^{kt/2}$, or the angle of dip, θ , is obtained. This latter family of curves can be used to determine the variation of dip with variation in initial velocity in highly folded areas. The latter set of curves is useful for the construction of a time-step-out time-dip-depth-offset chart which is used for direct plotting of offset-depth-dip positions of reflecting horizons, or as a trace-analysis underlay chart.—*Author's abstract.*

12038. Rice, R. B. A discussion of steep-dip seismic computing methods, Pt. 2: Geophysics, vol. 15, no. 1, pp. 80-93, 1950.

Comparison of several commonly used steep-dip seismic computing methods (*see* Geophys. Abstract 11090) has been extended to the case of a second parabolic velocity function considerably "faster" than that previously used, and to the computation of the profile of a reflecting horizon through a fault zone. Two other straight path methods which assume that the isovelocity layers are parallel to the reflecting horizons and three purely mathematical methods designed to produce certain results and not readily interpretable from a physical standpoint are also considered. It is concluded from these studies that it is possible to formulate workable computing methods to produce any desired results but that there is not yet sufficient data from steep-dip areas to establish any one method as superior to all others from an empirical point of view.—*M. C. R.*

12039. Hazebroek, P. Note on the analysis of oblique reflection data: Geophysics, vol. 15, no. 1, pp. 70-79, 1950.

The inclination and vertical plane of the ray at the surface can be determined from the time differences observed on two seismograph spreads laid out to form a cross. If the distance between shot point and center of spread, total travel time, and velocity distribution are known, a unique solution for the depth of the reflection point and the dip and strike of the reflecting layer is possible. A rigorous geometrical solution of the problem is given, assuming a linear increase of velocity.—*M. C. R.*

12040. U. S. Waterways Experiment Station. Critical study of shallow seismic exploration in the limestone areas of the Ozark Highlands: Tech. Mem. 199-1, 69 pp., 1943.

The detailed results of foundation exploration by boring and seismic refraction methods at several proposed dam sites in the limestone regions of the Ozark Plateau are reported. At some sites, weathering was characterized by deep overburden and thick zones comprised of rock pinnacles and clay-filled fissures; at other sites the weathering was less deep and the transition zones between overburden and sound rock were relatively thin. At all sites fresh rock was near the surface in the stream bed, and the flood plains consisted of alluvial silts, sands, and gravel.

From this study the conclusion is drawn that in deeply weathered limestone regions, seismic exploration will not yield definite depths to firm rock, nor can the seismic refraction method identify cavernous conditions below apparently sound rock. In areas where the weathering of the limestone is shallow and in the flood plains, seismic exploration is considered satisfactory and usable, since the rock depths are in close correlation with those shown by borings.—*S. T. V.*

12041. U. S. Waterways Experiment Station. Seismic and resistivity exploration methods: Tech. Mem. 198-1, 85 pp., 1943.

Comparative tests of the seismic refraction and electric resistivity methods of geophysical exploration of subsurface conditions in the alluvial valley of the Mississippi River were made near Marion, Ark., Round Lake and Rolling Fork, Miss. At each of these sites, the materials composing the alluvium and the top of the underlying Tertiary formations were known from borings.

Of the twelve seismic refraction profiles obtained, only two yielded data from which the depth to Tertiary formations could be accurately determined. For the other ten profiles the seismic velocity in the overlying saturated alluvium was almost equal to that in the topmost Tertiary materials, thereby rendering the data uninterpretable. The seismic method is thus not suitable for use in the alluvial valley of the Mississippi.

Of the fifteen electric resistivity profiles which were situated close to borings, the depth to Tertiary formation was determined with an average error of ± 11 percent, in comparison with borings depths. The results of the resistivity method, therefore, are considered to be adequate for the purposes of engineering problems concerned with determining suitable locations for levees, combating underseepage at levees, and in general for planning improvements in which depth and composition of alluvium are important considerations.—*S. T. V.*

ELECTRICAL METHODS

12042. Jemma, Raimundo. La geofísica aplicada a la técnica [Geophysics applied to industry]: *Industria Minera.*, no. 97, pp. 24-27, 1950.

This is a brief summary of geophysical prospecting by electrical methods as applied to prospecting for oil and minerals, or for investigations of geological structure near dam sites or around important industrial buildings.—*S. T. V.*

12043. Kiyono, Takeshi and Ito, Junji. A contribution to the theory of electro magnetic prospecting [in Japanese]: *Geophys. Exploration*, vol. 2, no. 2, pp. 1-4, 1949.

The magnetic field due to a point-current-source placed on the earth's surface was considered, and the isodynamic lines on a plane of finite height above the surface were obtained.—*M. C. R.*

12044. Enenstein, B. S. Electromagnetic processes in circuits employed in prospecting by electrical methods [in Russian]: *Akad. Nauk SSSR Izv., Ser. geog. i geofiz.*, vol. 13, no. 5, pp. 434-439, 1949.

If a cable, grounded at both ends, receives at its midpoint an impulse of rectangular wave shape, the current flowing into the cable and through it into the ground increases from zero to a final value in a very short time, after which a direct current is established. In spreading through the ground the impulse changes its rectangular wave shape. The time interval τ , elapsing until at a certain point of the ground the current reaches its maximum, can be represented by Tikhonov's formula $\tau = 0.314x^2/S$, where x is the distance in kilometers of the point in the ground from the feeding electrode, and S the specific resistivity of the ground in ohm-meters.

The rectangular impulse sent into the cable is produced by a thyatron generator. The time until the current reaches its maximum is about 10^{-7} sec.

Electrical processes taking place in different members of the measuring apparatus were investigated theoretically and experimentally and it is concluded that the value of the specific resistivity of the ground obtained in these measurements is often affected by serious errors. To obtain the correct values of the resistivity the following precautions are to be followed: the feeder line must have an independent switch, readings of the potential value must be made only after the lapse of an interval not less than 5, sometimes 10 seconds, in accordance with the resistivity of the ground and the spread of electrodes. The ground is

not a linear conductor, as is often assumed, and therefore an induced electromotive force in it cannot be neglected.—*S. T. V.*

12045. Niem, G. de Das elektrische und magnetische Feld einer punktförmigen Stromquelle [Electrical and magnetic field of a point source]: Beitr. angew. Geophysik, Band 10, Heft 3-4, pp. 265-272, 1943.

Electrical and magnetic fields produced on the earth's surface by a point source placed on surface are determined. The earth is considered as a homogenous conducting semispace, and the point source is represented by a metallic hemisphere with dimensions which are small compared to the distances considered. If direct current is considered, the electric field produced at any point is determined by the potential at this point, and the magnetic field is derived from Maxwell's fundamental equations. For alternating current, a differential equation in polar coordinates is derived for the electromagnetic conditions produced at a point. Solutions of this equation are given for the steady, quasi-stationary, and the transient states. In the last, the amplitude of the wave equation is represented in a complex form. Use of polar coordinates makes it possible to apply this method to a stratified medium.—*S. T. V.*

12046. Semenov, A. S. The theory of the method based on charged bodies applied to equipotential conductors [in Russian]: Vses. Nauchno-Issled. Geol. Inst. Geofiz., no. 13, pp. 3-56, 1948.

In many electrical prospecting methods it is important to have at least the approximate picture of the field patterns generated by unknown bodies of different shapes. Field patterns forming around the following bodies are computed and presented in form of graphs and tables: sphere, linear conductor stretched parallel to the ground, elongated and flattened ellipsoids of revolution, rectangular plate placed parallel to the earth's surface.

Equations of the potential function for the above cases are given, as well as the values of the gradients along certain characteristic lines, such as the axes of symmetry. The final section gives deviations of the computed results from those obtained for bodies slightly differing in shape from the assumed.

Master charts and tables of characteristic values as functions of the geometric parameters of the bodies under consideration are included.—*S. T. V.*

12047. Tikhonov, A. N., and Mukhina, G. V. Determination of alternating electrical field in a stratified medium [in Russian]: Akad. Nauk SSSR Izv., Ser. geog. i geofiz., vol. 14, no. 2, pp. 99-112, 1950.

An analysis is presented of an alternating electrical field generated by a point dipole in a layer of depth l , with electrical conductivity σ , overlying non-conductive semispace. This is analogous to a dipole placed on the earth's surface in a region where the upper layer of the ground is conductive and the underlying formations are nonconductive. Boundary conditions for the Maxwell equations of the unknown field are that the field intensity near the dipole is that of the dipole, and the field intensity at infinity is zero. Variation of the tangential components of the electrical and of the magnetic vectors is continuous. It is also assumed, as the general property of the field, that the intensities of the current I_0 and of the electrical and magnetic fields are represented by expressions containing the factor $e^{-i\omega t}$ where t is time, and ω the frequency of the

pulsations. The solution of the differential equations is expressed in cylindrical coordinates. Graphs representing the variation of the amplitude and the phase of the electrical field with distance from the dipole are given for several values of l .—*S. T. V.*

12048. Yüngül, Sulhi. Interpretation of spontaneous polarization anomalies caused by spheroidal bodies: *Geophysics*, vol. 15, no. 2, pp. 237-246, 1950.

The theoretical spontaneous polarization anomaly of a conducting sphere buried in a homogeneous and isotropic earth is analyzed mathematically, and a method is derived for determining the location, depth and dip of spheroidal ore bodies. The equipotential lines of the field data are smoothed and profiles are taken parallel to the straight line between positive and negative centers. The loci of the zero points and the loci of the minimum points intersect this line in points from which the desired quantities can, with the aid of accompanying graphs, be readily determined. Because of electrocapillary action and telluric potentials, topographic corrections are necessary when the surface has a steep slope. A regional potential, which is due to telluric currents, is corrected in a similar manner to that used in gravity interpretation. Examples are given in which the method is applied to two observed spontaneous polarization anomalies.—*R. G. H.*

12049. Schenk, Erwin. Zur Bedeutung und Auswertung von Unstetigkeiten in Diagrammen geoelektrischer Vertikalsondierungen [The importance and the interpretation of discontinuities in diagrams obtained in geoelectrical deep exploration]: *Beitr. angew. Geophysik*, Band 10, Heft 3-4, pp. 287-307, 1943.

The necessity of changing the position of the electrodes in exploring deep formations by electrical-resistivity methods often results in discontinuities in the recorded curves. Such discontinuities are usually eliminated by extending separate branches of the recorded curves parallel to the corresponding portions of adjoining curves, and the resulting composite curve is used as the basis for interpretation of field data. This procedure frequently leads to contradictions and errors. An investigation in connection with the detailed electrical exploration of an area around a dam site, well explored geologically, indicated that these discontinuities in the diagrams may be produced by changing the depth of the potential electrodes, by changing their distance apart, by changing the current electrode separation, or by the presence of structural discontinuities underground.

Changing the depth of the electrodes from 0.3 to 2 meters, always assuring a good electrical grounding, resulted in discontinuities in the diagrams which could not be eliminated by translation or extension of individual curves. The same effect was observed when the separation of the potential electrodes was changed. Discontinuities caused by increasing the separation of the current electrodes, however, can be eliminated by a translation of the individual curves.

Schenk concludes that Wenner's procedure combined with changes in electrode separation, will result in errors whenever there are inhomogeneities of the ground and recommends use of Schlumberger's scheme. He also recommends that no change be made in the electrode position and the use of a ratio of potential to current electrode separation up to 1/60. If a change becomes necessary it is advisable to repeat measurements at several points of the former arrangement.—*S. T. V.*

12050. Schenk, Erwin. Über den Einfluss von Schollengrenzen auf geoelektrische Vertikalsondierungen [On the influence of boundaries between layers on vertical electrical soundings]: *Beitr. angew. Geophysik*, Band 11, Heft 1, pp. 83-102, 1944.

The influence of subsurface stratification on the results of vertical geoelectrical sounding is studied. Faults are indicated as discontinuities and changes of curvature in the diagrams. This may lead to erroneous interpretation of the measurements because the curves are then typical of multiple stratification when in reality the measurements encompass only two or three layers. A procedure is given for eliminating these discontinuities and interpreting correctly the diagrams. Near-surface inhomogeneities produce a curve of a new type when the distance between the measuring electrodes is increased, whereas a greater spacing of feeding electrodes results in a displacement of the graph. The determination of the depth is contingent on the position of the electrodes. In general three types of diagrams can be obtained in vertical sounding. The proposed method makes possible not only determination of the depth of horizontal strata but also indicates the possible location of other buried electrically-conductive bodies.—*S. T. V.*

12051. Kiyono, Takeshi. Theoretical study on the ground resistivity method of electrical prospecting: *Kyoto Univ. Fac. Engineering Mem.*, vol. 12, no. 2, pp. 29-59, 1950.

Wenner's electrode arrangement is analyzed and the resistivity curve is determined theoretically for the constant-depth profile. The two-dimensional approximation is adopted and the theory of functions of complex variable is applied. This makes it possible to transform the boundary of the ore body to a simpler one and in many cases the potential can be easily calculated. The following cases are analyzed: the ore body is a perfect conductor or perfect insulator and has the shape of a semi-infinite plate of given thickness lying at a known depth; the ore body is a similar semi-infinite plate buried in a vertical position; the ore body is a thin horizontal or vertical plate of finite dimensions; the ore body is a circular cylinder, either a perfect conductor or a perfect insulator; the ore body is a circular cylinder with finite conductivity; the disturbing body is an anticline or a syncline.—*S. T. V.*

12052. Makino, Naofumi. On the apparent resistivity curves for underground layered structures [in Japanese]: *Geophys. Exploration*, vol. 2, no. 3, pp. 18-21, 1949.

A new explanation is proposed for apparent resistivity curves which have abrupt breaks. An abrupt change in the resistivity is presumed to take place when the potential drop between two points on the interface exceeds a definite threshold voltage like the decomposition voltage of water. Field data indicate the new theory to be satisfactory. Apparent resistivity curves when the electrodes are arranged at the bottom of a river were derived using the Bessel function. Numerical examples were calculated and found to be in good agreement with field data.—*M. C. R.*

12053. Kiyono, Takeshi, Inagaki, H., and Shibata, B. Resistivity curves for semi-circular disc [in Japanese]: *Geophys. Exploration*, vol. 2, no. 3, pp. 16-17, 1949.

The apparent resistivity curves for Wenner's electrode system when a perfectly conducting or insulating semicircular disc is buried in a vertical position,

were computed. These curves were compared with theoretical curves obtained by one of the authors and satisfactory coincidence between the two was found.—*M. C. R.*

12054. Kurata, Nobuo, Ochiai, Toshiro, and Murashita, Toshio. Electric resistivity curves as the index of geological conditions [in Japanese]: *Geophys. Exploration*, vol. 2, no. 3, pp. 26-29, 1949.

A description is given of geological conditions for which resistivity curves obtained by the Lee method in prospecting for underground water show distinguishable and characteristic forms.—*M. C. R.*

12055. Sato, Konosuke. On the "mean" 3-electrode method [in Japanese]: *Geophys. Exploration*, vol. 2, no. 2, pp. 5-6, 1949.

Various electrode spacings and configurations may be employed in resistivity methods. The "mean" 3-electrode method is proposed in this paper. ρ_{123} is the apparent resistivity of three electrode spacings which are so arranged that the power electrode C_1 and the potential electrodes P_1 and P_2 are three points (1, 2, 3) on a straight line and the power electrode C_2 is at infinity. ρ_{231} is the apparent resistivity of three electrode spacings which are arranged C_1, P_1 , and P_2 at three points (3, 2, 1).

The $\rho_{123} = 4\pi a (V_{12} - V_{13})/I$ and $\rho_{231} = 4\pi a (V_{32} - V_{31})/I$. The apparent resistivity of the "mean" 3-electrode is defined as $(\rho_{123} + \rho_{231})/2 = 2\pi a (V_{12} + V_{32} - 2V_{13})/I = \rho_{12}(a) + \rho_{23}(a) - \rho_{13}(2a)$ where $\rho_{12}(a)$ is the apparent resistivity of two electrode spacings at points 1 and 2 and $\rho_{13}(2a)$ is the apparent resistivity of two electrode spacings at point 1 and 3. By this method, the effect of underground irregularities near both side electrodes is decreased.—*M. C. R.*

12056. Nakabayashi, Kazutaka. Generating mechanisms of spontaneous polarization: (2) Some examples in Manchuria [in Japanese]: *Geophys. Exploration*, vol. 2, no. 3, pp. 22-25, 1949.

Summarizing the results of spontaneous polarization surveys in 35 districts in Manchuria, the author finds that all massive bodies or continuous veins of pyrite, pyrrhotite, chalcopyrite and graphite give a strong spontaneous polarization potential, and ore bodies of galena, stibnite, and manganese ores sometimes produce a potential not so strong but sufficient for exploration.

In natural sulfide ore bodies, the H ions and the HS ions in the surrounding water are supposed to have an important role in the generation of spontaneous polarization. Some impregnation deposits of pyrite show very strong spontaneous polarization potential, and sometimes remarkable anomalies are found even in oreless zones.

Distributions of potential difference measured at the surface may be attributed not only to oxidation and reduction of ore bodies but also to electrochemical actions between the ore body and underground water, polarization potentials resulting from differential concentration of ions in water near the mineralized zone, streaming potential of underground water passing through the capillary pores of the rocks, and polarization potential resulting from differential concentration of ions in water affected by the rocks.—*M. C. R.*

12057. Chang, T. H. Application of Wenner's method: *Chinese Geophys. Soc. Jour.*, vol. 1, no. 2, p. 228, 1949.

The Wenner method, with electrode spacing of 50 meters, was used to determine the depth of Quaternary gravel overlying Tertiary rocks in Laochunmiao oil

field, taking advantage of the sharp difference in resistivity (190 ohm-meters for the gravel, 15 ohm-meters for the Tertiary). Certain difficulties resulted from irregularities of the contact and the rugged topography, but a definite relation was established between the measured apparent resistivity and the thickness of the gravel determined by drilling. Graphs of the results computed from Roman's tables and the results of drilling are included.—*S. T. V.*

12058. Spicer, H. C. Investigation of bedrock depths by electrical resistivity methods in the Ripon-Fond du Lac area, Wisconsin: U. S. Geol. Survey Circ. 69, 37 pp., 1950.

Resistivity measurements were made in east-central Wisconsin, chiefly Fond du Lac County, to determine depths to bedrock, using the Earth-Resistivity Apparatus, a modification of the Gish-Rooney instrument. Depth profiling was used with the Lee electrode configuration. Depths to pre-Cambrian rocks, identified by their higher resistivity, determined by this method range from 355 to more than 1,000 feet, and in general were in good agreement with those found by drilling. Field measurements indicate that with favorable surface conditions resistivity methods may be used here to locate pre-Cambrian rocks to depths of about 1,500 feet.—*M. C. R.*

12059. Goguel, Jean. Essai d'interprétation de la prospection géophysique de la Bresse et du Bas Dauphiné [A tentative interpretation of the geophysical survey of Bresse and Bas Dauphiné]: Bur. Recherches géol. et géophys. Pub. 6, 79 pp., 1948.

A geophysical survey, including gravimetric and electrical measurements, was made in the provinces of southeastern France. Gravimetric measurements were made by the Thyssen gravimeter with a density of one station to 5 sq. km. and precision of determinations about 1 mgal. The central part of Bresse was explored also by a torsion balance. Electrical exploration was by the potential-profile method and, in regions around metallic outcrops, by resistivity measurements. The supposed Oligocene depression extending from Alès to the Swiss plateau must be rejected as contrary to findings of the survey, but no substitute theory can be proposed at the present. Numerous examples of the analysis of geophysical data from the geologic point of view, illustrated by detailed maps, diagrams, and profiles are included.—*S. T. V.*

RADIOACTIVE METHODS

12060. Hatsuda, Zin'ichiro. On the radioactive exploration [in Japanese]: Geophys. Exploration, vol. 2, no. 3, pp. 1-5, 1949.

A review of radioactive exploration, including description of methods and apparatus and discussion of the effects of moisture, temperature, and atmospheric pressure.—*M. C. R.*

12061. Stead, F. W. Prospecting for uranium with portable Geiger-Müller equipment: Upper Peninsula of Michigan Mineral Industries Conference, Michigan Coll. Min. and Technology, Conference on radioactive ores, May 6, 1949, pp. 27-28.

The Geiger-Müller counter is the most reliable prospector's tool in searching for uranium ores. Radioactive elements can be identified by several methods, using the detection of alpha, beta, or gamma rays, the most favorable being the

counting of gamma rays. This method, however, requires comparison of the unknown material with known standards. Use of an ionization chamber or of the proportional counter requires a more sensitive amplifier and presents difficulties in insulating the detector because of high input resistance. To obtain dependable results in the field the Geiger counter must be tested often by using a standard sample. It should be borne in mind that gamma rays cannot penetrate any considerable thickness of solid materials. About 50 percent of the gamma radiation from a radioactive ore originates in the outer two inch layer of the ore.—*S. T. V.*

12062. Kemp, C. E. Geiger counter reconnaissance in Upper Michigan: Upper Peninsula of Michigan Mineral Industries Conference, Michigan Coll. Min. and Technology, Conference on radioactive ores, May 6, 1949, pp. 25-26.

Investigations with a Geiger counter on the western half of the Upper Peninsula of Michigan in search for uranium ores are briefly reported. The instrument was also found to be useful in correlating and distinguishing various types of rocks. It is suggested that the Geiger counter can be used not only in prospecting for uranium but also for rapid geological reconnaissance work in general.—*S. T. V.*

12063. Almeida Rolff, P. A. M. de. Minerais radioativas, notas sobre sua prospecção. [Radioactive minerals, notes on prospecting for them]: Rev. da Escola de minas, vol. 14, no. 9, pp. 13-15, 1949.

The article gives a short description of different methods of prospecting for uranium or thorium containing minerals. Methods based on fluorescence, scintillation, radioactivity are described as well as their application in different regions of Brazil.—*S. T. V.*

12064. Lutz, W. Die Schnellanalyse von Kaliflötzen durch gamma-strahlungsmessung mit Zählrohren in Horizontalbohrungen unter Tag [The rapid analysis of potassium deposits by gamma-radiation measurements using counters in horizontal drill holes underground]: Beitr. angew. Geophysik., Band 10, Heft 3-4, pp. 273-286, 1943.

A method is described of determining the K_2O content of a potassium deposit by using a Geiger-Müller counter. The number of impulses produced by gamma radiation of a deposit is shown to be proportional to the average K_2O content in a sphere of about 56 cm. radius surrounding the counter.

Experiments demonstrated such measurements to be in good agreement with the results of chemical analyses. A standard Geiger counter with a tube of about 35 mm. diameter and 320 cm. length was employed in these experiments, and K_2O contents ranging from a fraction of one percent to 62 percent measured.

The method can be applied only when the deposit is free of other sources of gamma rays, such as radium or thorium salts.—*S. T. V.*

12065. Lutz, W. Die Schnellanalyse von festen und flüssigen Kaliprobe durch gamma-strahlungsmessungen mit Zählrohren über Tag [Rapid analysis of solid and fluid samples containing potassium by measuring overground the gamma radiation with a counter]: Beitr. angew. Geophysik., Band 11, Heft 1, pp. 55-72, 1944.

If measurements of potassium content are made in a drill hole, the impulse number read on the gamma counter is proportional only to the potassium content

of the surrounding formation. The same measurement, made above ground, results in a reading which can be correctly interpreted only by using an empirical formula containing the density of the sample, which is often unknown. A theoretical relationship is derived, replacing the empirical formula, and confirmed on nine samples, each weighing 30 kg. The error of the determination may be as low as ± 0.5 percent of K_2O with a duration of the measurement of 16½ minutes. This error can be decreased to 0.25 percent with 20 minutes measuring time. The theory of the method is presented and the counter employed is described.—S. T. V.

12066. Lesage, M., Rogozinski, A., and Voisin, A. Sur la construction des compteurs Geiger-Müller du type métallique [Construction of Geiger-Müller counters of all-metal type]: *Jour. Physique et Radium*, vol. 10, no. 6, pp. 212-214, 1949.

A Geiger-Müller counter of exceedingly simple design and construction, especially adapted for field work, is described. The principal tube is made of a cylindrical drawn brass pipe 1 mm. thick, the axial wire is of tungsten 0.1 mm. in diameter, and a mixture of alcohol and argon is used as filling gas. Nickel or copper may be used for the tube, and molybdenum or stainless steel for the wire. Details of the manufacturing procedure are given.—S. T. V.

12067. Brownell, G. M. Radiation surveys with a scintillation counter: *Econ. Geology*, vol. 45, no. 2, pp. 167-174, 1950.

A portable scintillation counter for rapid and accurate measurements of radiation intensities has recently been developed and tested. The instrument is about one hundred times more sensitive than portable Geiger counters.

On the basis of data from radiation surveys over pitchblende deposits in the Lake Athabaska region, maps were made showing "isorads" or zones of equal radiation intensity in units of 5×10^{-4} milliroentgens per hour, which provided a pattern of the vein system and located new veins.—S. T. V.

12068. Kolmogorov, A. N. Determination of the coefficient of thermal diffusivity of the soil [in Russian]: *Akad. Nauk SSSR., Ser. geog. i geofiz.*, vol. 14, no. 2, pp. 97-98, 1950.

A method is presented for determining the coefficient of thermal diffusivity of soil from observations of temperature, corresponding to four moments of time, at two points of different depths. Results obtained by this method are more reliable than those from determination of the phase displacement of the temperature waves, varying with depth. The determination of the wave form becomes very unreliable because of the rapid decrease of the temperature variation.

The proposed method is based on the expression of the amplitude of temperature wave, varying exponentially with the depth of the point. Harmonic variation of the temperature with a period of 24 hours is assumed.—S. T. V.

WELL LOGGING

12069. Tainsh, H. R. Tertiary geology and principal oil fields of Burma: *Am. Assoc. Petroleum Geologists Bull.*, vol. 34, no. 5, pp. 823-855, 1950.

The chief Tertiary geological features of Burma and the geological history of the period as indicated by stratigraphical and structural evidence are sum-

marized. The Chauk and Lanywa oil field, which are on one major dome but separated by the Irrawaddy, and the Yenangyaung field are described.

In both areas Schlumberger resistivity and self-potential surveys were used for detailed correlations between wells, and for fixing the depths and throws of the various faults. It was not found possible to use the resistivity logs to give any indication of the fluid content of the sands, in part because of the low salinity of the formation water, and the thinness of the sands. A reduction of resistivity of one sand downdip, recently noted, is presumably due to an increasing connate water content and is being further investigated.

The average temperature gradient in the Yenangyaung field as measured with the Schlumberger recorder is 1° F. per 100 feet with a temperature of 115° F. at 3,000 feet.—*M. C. R.*

12070. Spradlin, V. E. The relation of the initial production to true resistance in the Southeast New Castle field, Cleveland and McClain Counties, Okla.: *Oklahoma Acad. Sci. Proc.*, vol. 29, pp. 45-49, 1950.

The purpose of this paper is to determine whether the true resistivity value alone could be used in determining the initial production from the limestone reservoirs in the Southeast Newcastle field. To obtain the true resistivity of the producing formation the method outlined by H. Guyod was used and the results were compared with statistical data on the initial productivity of ten oil wells of this field. It is concluded that no direct relations can be established between the true resistivity and production. Wells with the lowest resistivity may be dry in one case and fairly good producers in another. Similarly one well with a true resistivity of 937 ohm-meters was dry, another with 950 ohm-meters had the initial production of 531 barrels. Only a certain tendency can be established for higher initial production to be associated with higher resistivity values.—*S. T. V.*

12071. Milne, W. P. Relation of electric log resistivities in limestone to oil production: *Oklahoma Acad. Sci. Proc.*, vol. 29, pp. 50-56, 1950.

The correlation between the productivity of a well drilled in limestone and the deviations from the apparent parallelism of the second and third resistivity curves on electrical log diagrams is studied. The chief factors causing such deviations are the effect of the contact between two different formations on the electric log, mud invasion, and the chemical composition of the fluid in the formation, salt water tending to give a negative deviation, and oil a positive one.

For the study of this relationship a special function is introduced equal to the average deviation divided by the square root of the difference of the average square of the deviation and the deviation squared.. Computing this function for the Phillips no. 2 Kosar well 4-14N-4W of the West Edmond pool, Mississippi, figures were obtained which were well within the limits of the necessary accuracy. It is concluded that the suggested method of investigation has unlimited possibilities making possible future prediction of the fluid content in advance of drilling.—*S. T. V.*

12072. Ray, H. W. Radioactivity well logging proves effective in the northern Colorado-southern Wyoming area: *Tomorrow's Tools Today*, vol. 16, no. 1, pp. 28-32, 1950.

Radioactivity logs in the northern Colorado and southern Wyoming area have proved reliable and both gamma ray and neutron curves are being extensively used to provide information on formation thickness, extent of possible porous zones, relative amount of porosity, and position of casing with respect to formation. Close correlation was found between the radioactivity log and the core analysis. Examples of the interpretation of radioactivity logs from different wells and their correlation with logs obtained by other methods are given.—*S. T. V.*

12073. McGaha, S. W. Radioactivity well logging moves north to Canada's fields: *Tomorrow's Tools Today*, vol. 15, no. 4, pp. 28-33, 1949.

Radioactivity well logging is now used in the development of the oil producing areas of western Canada. Drilling difficulties are overcome by the valuable formation data provided, after the casing has been set, by gamma ray and neutron curves. The sandstones, limestones, and shales, together with the dense, low fluid zones, can be easily identified by this means and the curves correlated with electrical logs, drilling time, core analyses, and lithological information. Ten pairs of gamma ray and neutron curves with parallel interpretation of their peculiarities on the basis of exploration results are described.—*S. T. V.*

12074. Campbell, O. E. A method of prospecting for Kansas "shoestrings": *World Oil*, vol. 129, no. 5, pp. 62-64, 1949.

Analysis of fluorologs of both a producing well and an adjacent dry hole in Anderson County, Kans. suggests a systematic method of exploration for "shoe-string" fields. The fluorolog of the producing well showed an average oil intensity of 1 blau and a mineral intensity of 50 blaus down to the producing sand while the dry hole log showed 18 and 32 blaus respectively. Detailed analysis of the data showed the excess mineralization was of secondary origin indicating the presence of a plug which blocked direct ascent of seepages, deflecting them to side paths. The presence and general location of shoestring accumulations can be determined from samples taken from a depth of 4 feet, but for detailed mapping, shallow holes 10 to 50 feet deep may be fluorologged—*M. C. R.*

TECHNICAL AIDS

12075. Müller, Max. Ein Präzisionszeitskalenschreiber mit dekadischer Frequenzunterteilung für Zeitmarkierung und Frequenzmessung [An accurate time recorder with decimal subdivision of frequencies for the recording of time and measurement of frequency]: *Geofis. Pura e Appl.*, vol. 15, fasc. 3-4, pp. 220-226, 1949.

Precise measurement of frequency is of prime importance in surveying by electrical methods when using alternating current of low frequency. A new method of accurate measurement and recording of electrical frequency, is described. The apparatus employed consists of a time recorder with decimal frequency subdivisions in five steps. Its oscillating circuit contains a thyatron, synchronized by a timing fork, with impulses produced in zero points, which increases the precision of the instrument. The oscillation wave is recorded photographically, and the corresponding time interval is registered simultaneously on the same film. The range of the scale can be adjusted to 0.001, 0.01, 0.1, 1.0, and 10 seconds.

Descriptions of the various component parts of the installation, wiring diagrams and graphs characterizing the instrument are given. The apparatus has been constructed for field use, and is sturdy and easily transportable.—*S. T. V.*

12076. Guerra Peña, Felipe. Introducción a la fotogeología [Introduction to photogeology]: Assoc. Mexicana Geólogos Petroleros Bol., vol. 2, no. 1, pp. 55-70, 1950.

Photogeology or aerophotostereogeology is defined as the complex of methods used for geological interpretation of photographs taken from the air. This is especially valuable in inaccessible regions covered with forests or snow as it eliminates much topographic work and makes possible obtaining a general picture of the area without great loss of time and money. Another advantage is its freedom from restrictions often imposed by the owners of the properties involved. A brief description of the techniques employed in the field and in the photographic laboratory is given.—*S. T. V.*

12077. Glenn, Alfred H., and Bates, Charles. The meteorological and oceanographic aspects of geophysical prospecting: Geophysics, vol. 15, no. 2, pp. 247-256, 1950.

Short-range forecasts of weather and wave conditions in specific areas can now be made with considerable accuracy. The application of oceanography to the study of modern and ancient reefs, strandlines, and stratigraphic traps is suggested.—*H. R. J.*

PATENTS

GRAVITY METHODS

12078. Stabilized vertical pendulum. Fay E. Null, Dayton, Ohio: U. S. patent 2,511,869, issued June 20, 1950.

In a pendulum apparatus, a triangular pendulum, a motor supporting said pendulum by the apex of the latter from the drive shaft of the motor, acceleration-responsive members mounted on the two lower corners of said pendulum at right angles to its axis, means for summing up the acceleration responses of said acceleration-responsive members, means for amplifying the summed up responses and means for applying the amplified responses to said motor to rotate in a direction opposite to that of the forces causing the acceleration responses. Claims allowed, 11.

MAGNETIC METHODS

12079. Magnetic flux measuring apparatus. Ernst H. Plesset, Los Angeles, Calif., assignor to the United States of America as represented by the U. S. Atomic Energy Comm.: U. S. patent 2,506,433, issued May 2, 1950.

Apparatus for measuring the magnetic flux density variation along a predetermined path which apparatus comprises a search coil, means for moving said search coil along said predetermined path transverse to the direction of the lines of force of the magnetic field, means for maintaining the axis of said search coil substantially parallel to a fixed line transverse to said path during the movement thereof, an oscilloscope having two sets of electron beam deflecting means, means for applying to one set of said deflecting means a first potential which is a function of the position of said search coil along said predetermined path, a condenser, means coupling said search coil and said condenser for developing a charge on said condenser which is a function of the variation of the density of the magnetic flux through said search coil, and means for applying to the other set of deflecting means a second potential which is a function of the charge on said condenser. Claims allowed, 5.

SEISMIC METHODS

12080. Seismic prospecting method. Cornelius G. Dahm, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,503,904, issued Apr. 11, 1950.

A method of obtaining seismic data where there is a sharp change in the elastic constants in the strata adjacent the earth's surface without material change in the density of the material in such strata, which comprises exploring with seismic waves said strata to determine the range of depth in which said change in elastic constants occurs, generating seismic waves below said range of depth, detecting seismic waves at points deeper in the earth than where said change in elastic constants occurs, and recording said waves in correlation with time. Claims allowed, 3.

12081. Apparatus for examination of materials by elastic waves. Marcel Meunier, Cuesmes, Belgium, assignor to Ateliers de Constructions Electriques de Charleroi, Brussels, Belgium, a Belgian société anonyme: U. S. patent 2,505,867, issued May 2, 1950.

In the art of elastic waves, apparatus for examination of material objects by means of ultra-sonorous waves, comprising a device for emitting ultra-sonorous waves, said emitting device including a tubular support having an open end, a crystal mounted in said support near the other end thereof, said crystal being adapted to produce ultra-sonorous waves, and a sheath lining the inside of said support, said sheath being composed of a material adapted to absorb ultra-sonorous waves, said support being so arranged that a beam of ultra-sonorous waves produced by said crystal and emitted from the open end of said support will strike the surface of the object at an acute angle of incidence smaller than the angle of total reflection, said sheath absorbing any reflected waves entering the open end of said support, a device for receiving the waves of said beam passing through said object, said receiving device including another tubular support having an open end, a crystal mounted in said other support near the other end thereof, said crystal being adapted to respond to ultra-sonorous waves, and a sheath lining the inside of said other support, said sheath being composed of a material adapted to absorb ultra-sonorous waves, said other support being so arranged that a beam of ultra-sonorous waves from said emitting device passing through said object will enter the open end of said other tubular support and excite the crystal therein, said receiving device being so placed that said beam passing directly through said object will enter axially into said other support, and means for measuring the intensity of the excitation of said crystal in said receiving device. Claims allowed, 2.

12082. Vibrator type multiple-shot blasting unit. Frank C. Gibson, Broughton, Pa., and Frederick W. Brown, Los Angeles, Calif.: U. S. patent 2,506,587, issued May 9, 1950.

In combination a first switch connected between an input and a means for multiplying voltage, said first switch connecting said input to said voltage multiplying means only when said first switch is operated, a second switch connected to said voltage multiplying means, a condenser and an output, said second switch in its normal position acting to connect said condenser to said voltage multiplying means and said second switch in its operated condition acting to connect said condenser to said output. Claims allowed, 10.

12083. Seismograph compositing system. Robert W. Olson, Dallas, Tex., assignor to Geophysical Service, Inc., Dallas, Tex., a corporation of Delaware: U. S. patent 2,509,651, issued May 30, 1950.

In a multiple recording circuit that includes a plurality of circuits for supplying signals to be recorded and a plurality of recorder-operating circuits, a compositing circuit connected between at least three signal supply circuits and two recorder-operating circuits that includes two balanced bridge circuits, each of said balanced bridge circuits being comprised of one of the recorder-operating circuits and three fixed resistors connected in series across it, each resistor having a resistance equal to the resistance of the recorder-operating circuit; connections between one signal supply circuit and the diagonal corners of one of the bridge circuits; connections between another signal supply circuit and the diagonal corners of the other bridge circuit; and connections between the third signal supply circuit and the remaining pair of diagonal corners of each of the two balanced bridge circuits. Claims allowed, 2.

ELECTRICAL METHODS

12084. Electronic detector. Claude R. Daum and Louis Thomas Cleaver, Denver, Colo., assignors to the United States of America as represented by the Secretary of the Interior: U. S. patent 2,503,247, issued Apr. 11, 1950.

In combination a probe having a U-shaped magnetic core with a center portion and two legs, an input coil wound about the center portion of said core, two output coils each wound about one of the legs of said core and near the ends thereof, a compensating coil wound about the center portion of said core and in substantial axial registry with said input coil, a power supply for causing an alternating current to flow through said input coil, said alternating current causing an alternating flux to flow in said core, said output coils and said compensating coil being so connected that the voltage induced in the output coil adds each to the other while the voltage induced in said compensating coil subtracts from that produced by the output coils to produce a combined output voltage, means connecting said combined output voltage to an amplifying means, said amplifying means including electrical discharge means having at least a cathode, anode and control electrodes, means for applying an input signal to said control electrode, means whereby a negative bias is applied to said control electrode with respect to said cathode so that only the positive peaks of said input signal applied to said control grid will cause a current to flow between said cathode and anode whereby a distinctive electrical signal having harmonics is produced, means capable of transforming said distinctive electrical signal into an audible signal of similar characteristics, means for applying said distinctive electrical signal to said means for producing an audible signal. Claims allowed, 2.

RADIOACTIVE AND THERMAL METHODS

12085. Alternating current ionization chamber. Robert E. Fearon, Tulsa, Okla., assignor to Wells Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent, 2,502,617, issued Apr. 4, 1950.

A detector of ionizing radiation comprising in combination means defining a closed circulatory system, at least a portion of which is adapted to admit ionizing radiation, an ionizable medium in said system, means for circulating said medium in the system to expose it to the admitted radioactive ionizing emanations, said means being adapted to impart surges to said ionizable medium that are separated

by uniform time intervals, means for de-ionizing said medium before it enters the portion adapted to admit ionizing radiation, means for separating the ions produced by said radiation when the medium enters that portion, means for collecting one group of the separated ions, and means for measuring the alternating component of the electrical current produced by the collection of said ions as a measure of radiation. Claims allowed, 9.

12086. Method and apparatus of measuring the activity of radioactive materials. Gregory H. Wannier, Pitman, N. J., assignor to Socony-Vacuum Oil Co., Inc., a corporation of New York: U. S. patent 2,502,683, issued Apr. 4, 1950.

An apparatus for measuring the activity of a sample of radioactive material that comprises a counter tube, means defining a window in the counter tube, means transparent to radiation emitted by the sample for sealing said window, a sample holder disposed adjacent said window, said sample holder having a concave recess in the side thereof adjacent to and in axial alignment with said window, a coating of the radioactive material on the surface defining the concave recess, the curvature of the recess bearing a relation to the axial distance between the sample and the window such that the solid angle subtended by the window at any point on the concave surface of the sample is a constant. Claims allowed, 3.

12087. Geiger counter and gas atmosphere therefor. Lloyd G. Shore, Chicago, Ill., assignor to Radiation Counter Laboratories, Inc., Chicago, Ill., a corporation of Illinois: U. S. patent 2,503,302, issued Apr. 11, 1950.

A self-quenching Geiger counter containing oxygen, nitrogen, xenon, and argon in such proportions that their partial pressures in millimeters of mercury are as follows when the total gas pressure is about 740 mm. of mercury:

O₂—trace to 30

N₂—trace to 30

Xe—at least $\frac{1}{2}$

A—balance

Claims allowed, 3.

12088. Method and apparatus for detecting ionizing particles. Elizabeth R. Graves, Santa Fe, N. Mex., assignor to the United States of America as represented by the U. S. Atomic Energy Comm.: U. S. patent 2,506,419, issued May 2, 1950.

A device of the character described having in subcombination, an electrode assembly comprising three inherently rigid generally planiform elements in mutual parallel spaced relation to provide a pair of outer electrodes and an electrode disposed centrally therefor, said centrally disposed electrode being provided with an area of reduced thickness to permit passage of ionizing particles therethrough while providing an effective ion shield, one of said outer electrodes being provided with a collimated portion of sufficiently smaller area than the reduced thickness area of said centrally disposed electrode to confine particles emitted therethrough to said reduced thickness area, the inner surface of said collimator area being provided with a thin sheet of material adapted to pass ionizing particles while providing an ion shield, and means associating with said collimated electrode for the mounting of an ionizing particle emitter contiguous to the outer surface thereof. Claims allowed, 3.

12089. Amplifying and quenching circuits for radiation detectors. Donald G. C. Hare, Roslyn, N. Y., assignor to Texaco Development Corp., New York, N. Y., a corporation of Delaware: U. S. patent 2,503,730, issued Apr. 11, 1950.

In combination, a radiation detector of the counter type, an electronic discharge tube having its plate connected to the anode of the detector, means for impressing a high direct current voltage for the operation of the detector on the anode of the detector and the plate of said tube, a second electronic discharge tube, said first and second tubes being interconnected in multivibrator relationship, means to impress an operating direct current voltage on the plate of the second tube, said operating voltage being independent of that impressed on the anode of the detector and the plate of the first tube, whereby, on discharging the detector, a negative pulse is supplied to the control grid of the second tube and a positive pulse from the plate of the latter to the control grid of the first tube through the multivibrator connections to cause said first tube to pass current and lower the potential on the detector anode, causing the detector to quench, and means to take a pulse from an electrode of one of said tubes. Claims allowed, 3.

12090. Radiation measurement. Bruno B. Rossi, Winchester, Mass., and James S. Allen, Champaign, Ill., assignors to the United States of America as represented by the U. S. Atomic Energy Comm.: U. S. patent 2,506,435, issued May 2, 1950.

In radiation measurement apparatus, in combination: a radiation counter having an anode, a cathode and an ionizing medium between said electrodes; and a source of direct voltage having superimposed thereon voltage pulses of alternately positive and negative phase coupled to said electrodes, the voltage pulses having an amplitude sufficient to alternately impress on said electrodes a voltage above the sparking potential and a voltage below the extinction potential thereof. Claims allowed, 3.

12091. Neutron meter. Lynn H. Stauffer, Rotterdam Junction, and Thoma M. Snyder, Schenectady, N. Y., assignors, by mesne assignments, to the United States of America as represented by the U. S. Atomic Energy Comm.: U. S. patent 2,506,944, issued May 9, 1950.

A neutron meter comprising a plurality of spaced regions containing a gaseous boron compound, at least one intermediate region formed of a non-gaseous hydrogen containing compound, and means for measuring the ionization of said gaseous boron compound. Claims allowed, 7.

12092. Method of geophysical prospecting. Bruno Pontecorvo, Montreal, Quebec, Canada, assignor to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,508,772, issued May 23, 1950.

A method of geophysical prospecting that comprises irradiating formations surrounding a drill hole about which information is desired with radioactive radiation, measuring radiation that returns from said formation, at a series of spaced points that differ in their distances from the source of radiation by regularly spaced intervals, sequentially selecting signals indicative of measurements made at the different points, and graphically representing said sequentially selected signals in correlation with the distances between source and detectors for selected depths of the source in the drill hole to form a continuous curve graph-

ically representative of the decay in intensity of the returning radiation as the distance from the primary source of radiation increases. Claims allowed, 2.

12093. Alpha ray source and method of producing same. Marietta Blau 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 2,510,795, issued June 6, 1950.

The method of producing an alpha ray source which includes, depositing radium emanation in a solid state in a finely divided solid supporting material and maintaining said emanation in a solid state until decay thereof to radium D and polonium has taken place for most of the said emanation. Claims allowed, 9.

12094. Radiographic scanning unit. Herman F. Kaiser, Washington, D. C.: U. S. patent 2,511,853, issued June 20, 1950.

A radiographic device for examining a test object comprising a source of radiation, means forming the incident radiation into a relatively thin collimated planar beam, means supporting the test object, means for sweeping the beam of incident radiation across the test object in a direction normal to the plane of the beam to irradiate a single line portion of the test object at a time, and means sensitive to the emergent radiation for detecting said radiation. Claims allowed, 5.

12095. Device for comparing with a common physical receiving means, two radiations of similar character and subsidiarily recording the ratio between said radiations. Etienne Vassy, Paris, France: U. S. patent 2,512,122, issued June 20, 1950.

In a device of the type described, in combination, a single receiver adapted to be struck by a pair of separate beams of radiations to be compared, a rotary obturating means adapted when rotated to cut off each of said beams from said single receiver in alternating sequence, a single path electronic amplifier including an output electronic tube, said amplifier being fed from said receiver, a pair of triode electronic tubes having the grid circuits thereof supplied in parallel by the anode circuit of said output tube, means synchronized with said rotary member for alternately biasing said triodes to cut-off in synchronism with the cutting off of said beams, a high voltage source supplying said triodes, a pair of load resistances and a potentiometric gain-balancing means inserted between said high voltage source and the anodes of said triodes, a pair of diode tubes across each of said load resistances respectively, each having its cathode connected to the anode of the respective one of said triode, a pair of condensers having a first electrode thereof connected to the anode of a corresponding one of said diode and the other electrode thereof grounded, an indicating device connected to said first condenser electrodes, and resistance-capacitance filter means inserted between said first condenser electrodes and said indicating device, whereby a voltage drop appears between the terminals of said indicating device whenever the amplified pulses from said electronic amplifier differ in amplitude due to a difference in the respective amplitudes of both said beams of radiations. Claims allowed, 4.

12096. Neutron detection. Kenneth C. Crumrine, Bellaire, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,512,769, issued June 27, 1950.

In a neutron detector, a housing, a wire anode, a cathode and a gas in said housing, said cathode comprising a sheetlike metal member having a coating

on at least part of its surface of a substance capable, when bombarded by neutrons, of ejecting alpha particles to ionize said gas, said coating being composed of minute particles of said substance in an adhesive binder and having a surface area several times the area of the coated portion of said member, said particles averaging 1 mil in grain size. Claims allowed, 5.

12097. Radioactive measuring. Gerhard Herzog and Allen D. Garrison, Houston, Tex., assignors to Texaco Development Corp., New York, N. Y., a corporation of Delaware: U. S. patent 2,512,773, issued June 27, 1950.

A radiation detecting device comprising a sealed casing, a cathode member and an anode member within the casing and adapted to be connected to a source of high potential, and a gaseous filling within the casing, said filling consisting of a rare gas selected from the group consisting of argon, neon and krypton containing from 0.1 percent to 10 percent of anhydrous ammonia. Claims allowed, 6.

12098. Temperature responsive measuring apparatus. Edgar M. Smith, Trenton, N. J., assignor, by mesne assignments, to Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., a corporation of Delaware: U. S. patent 2,509,046, issued May 23, 1950.

A potentiometric measuring circuit for measuring the voltages of two thermocouples differing so that similar variations in their cold junction temperatures produce a greater difference in the voltage of one thermocouple than in the voltage of the second thermocouple, with scale suppression and cold junction temperature compensation differences between the measurements, said circuit including a slide-wire resistance, a resistor having a resistance which varies with its temperature, and resistance material in series with said resistor and varying in resistance with its temperature, a source of current and an adjustable resistance included in said circuit and creating regulable current flows through said slide-wire resistance and through said resistor and resistance material, a contact adjustable along said slide-wire resistance, a current responsive device, two thermocouples and means for connecting said thermocouples one at a time in said circuit in series with said device between said contact and said resistance material, said one thermocouple being connectable to said resistance material at the end of the latter remote from said resistor, so that the voltage of said one thermocouple and said current source tend to produce current flows in opposite directions through said resistance material and resistor, and said second thermocouple being connectable to said resistance material at the end of the latter adjacent said resistor so that said second thermocouple and said current source tend to produce current flows in opposite directions through said resistor, the variations in resistance of said resistor and resistance material due to ambient temperature changes being so related to the changes in the voltages of said thermocouples produced by their respective cold junction temperature changes resulting from said ambient temperature changes as to compensate for variations in the cold junction temperature of each thermocouple when that thermocouple is connected in said measuring circuit. Claims allowed, 3.

12099. Temperature responsive measuring apparatus. Charles A. Vogelsang, Erdenheim, Pa., assignor, by mesne assignments, to Minneapolis-Honeywell Regulator Co., Minneapolis, Minn., a corporation of Delaware: U. S. patent 2,509,048, issued May 23, 1950.

A potentiometer measuring circuit for measuring the voltages of two thermocouples differing in their cold junction temperature compensation requirements

with a scale suppression difference between the measurements, said circuit including a slide-wire resistance and a resistance section including in series a resistor having a resistance which varies with its temperature, resistance material varying in resistance with its temperature, and a resistance element, the resistance of which does not vary with its temperature and which is large in comparison with the sum of the resistance of said resistor and resistance material, means comprising a source of current and an adjustable resistance included in said circuit for creating and regulating current flow through said slide-wire resistance and resistance section, a contact adjustable along said slide-wire resistance, a current responsive device, and means for connecting said thermocouples one at a time in series with said device between said contact and said resistance section, one of said thermocouples being connectable to said section at one end, and the other of said thermocouples being connectable to said section at the other end of said resistance material, the variations in resistance of said resistor and resistance material due to ambient temperature changes being so related to the changes in the voltages of said thermocouples produced by their respective cold junction changes resulting from said ambient temperature changes as to compensate for variations in the cold junction temperature of each thermocouple when that thermocouple is connected in said measuring circuit and circuit calibrating means comprising a standard cell and switch means for operatively connecting said device and said cell in series with one another between the terminals of said resistance element. Claims allowed, 3.

WELL LOGGING

12100. Radioactive borehole logging. Arnold J. F. Siegert, Syracuse, N. Y., and Bob E. Watt, Houston, Tex., assignors to Texaco Development Corp., New York, N. Y., a corporation of Delaware: U. S. patent 2,504,888, issued Apr. 18, 1950.

The method of logging a borehole traversing subsurface formations which comprises passing through said hole a source of gamma rays capable of penetrating said formations to induce neutrons therefrom, and measuring variations in the intensity of the induced neutrons reaching the hole from said formations as the source and neutron detector are moved through the hole. Claims allowed, 9.

12101. Well logging. Gerhard Herzog, Houston, Tex., assignor to Texaco Development Corp., New York, N. Y., a corporation of Delaware: U. S. patent 2,506,149, issued May 2, 1950.

In logging involving the detection of variations in radiation along a borehole, the improvement which comprises passing a chain of spaced radiation detectors along the borehole so that the responses of the individual detectors to radiation from the same level in the borehole are displaced in time and automatically combining the individual responses from that level by automatically accumulating in the neighborhood of the surface of the ground the responses as a series of condenser charges. Claims allowed, 16.

12102. Transmitting of information in drill holes. Serge A. Scherbatskoy, Tulsa, Okla., assignor to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,507,351, issued May 9, 1950.

An apparatus for transmitting data from a well surveying subsurface instrument to a recording system located on the surface of the earth which comprises means for producing electrical signals varying in sympathy with the variation of

a physical property of the strata traversed by the well, means for simultaneously producing a succession of ultra high frequency electromagnetic impulses of equal duration, said means including an electronic timer adapted to produce electrical impulses of equal duration and at varying intervals of time, means for connecting said electronic timer to the means which produces electrical signals varying in sympathy with the variation of a physical property of the strata traversed by the well, an oscillator, a modulator, means for connecting the output of said modulator to said oscillator, means for connecting the output of said electronic timer to said modulator, and means for connecting the output of said oscillator to a directional antenna whereby the ultra high frequency electromagnetic impulses controlled by said electronic timer and produced by the oscillator will be directionally radiated up the drill hole from the subsurface instrument. Claims allowed, 1.

12103. Time-locking instrument for surveying inclination and direction of boreholes. Charles Trotter and Yrjo Pajari, Sudbury, Ontario, Canada: U. S. patent 2,508,899, issued May 23, 1950.

In a surveying instrument of the type described having an outer frame, an inner frame pendulously suspended from the outer frame, and a case pendulously suspended from the inner frame, a time-piece movement encased within the case, a driving gear, an axle within the driving gear, a plurality of flexible fins extending radially from the said axle, the said axle being operable frictionally to transmit torque to the driving gear in one direction and slidably rotate within the driving gear in the opposite direction, a protrusile pin carried by the case, a protractor locking lever attached to the axle, said lever being shaped and located for co-action with a protrusile pin, a protractor having grooves on its inner periphery to receive the said protrusile pin, means to eject the said protrusile pin whereby the spherical case is locked in its pendulously static position within the protractor, said protractor being integral with the inner frame, means to retract the said protrusile pin to allow free pendulous action of the spherical case within the protractor. Claims allowed, 9.

12104. Gun perforator. James O. Tow, Huntington Park, Calif., assignor to McCullough Tool Co., Los Angeles, Calif., a corporation of Nevada: U. S. patent 2,509,657, issued May 30, 1950.

In a gun mechanism for perforating well casing, the combination of: a gun body having a propellant chamber with a propellant charge therein, a gun barrel, and a projectile therein, with walls forming an ignition passage leading from the interior of the barrel ahead of said projectile into said propellant chamber and means for limiting the rearward movement of said projectile; a firing charge in the gun barrel ahead of the projectile; and means for exploding said firing charge whereby combustion products therefrom will travel through said ignition passage and ignite said propellant charge. Claims allowed, 10.

12105. Coring and fluid sampling device. Ferdinand W. Rolshausen and Saint E. Swain, Houston, Tex., assignors to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,509,883, issued May 30, 1950.

An improved sample taking device adapted for movement along a drill stem and for simultaneously taking a side wall fluid sample and a side wall core sample through a core bit attached to a drill stem comprising, in combination, an elongated cylindrical body defining a fluid sample chamber in the lower end thereof, releasable latching means arranged at the upper end of said body to

latch it to said drill stem, a tubular shaped core barrel provided with notches in its upper end and having a longitudinal fluid passage in its walls extending from the lower end into the upper end thereof, means journalling the upper end of said core barrel to the lower end of said body, said journalling means having fluid passages therein adapted to establish fluid communication between said sample chamber and the fluid passages in said core barrel when the latter is in a core sampling position and to prevent said communication when the core barrel is moved along the drill stem, a spring arranged to bias the free end of said core barrel away from the longitudinal axis of said body, and releasable means arranged for latching said barrel with its longitudinal axis parallel with the longitudinal axis of said body including an annulus slidably arranged on said body and downwardly extending members secured to said annulus arranged to engage said notches on the core barrel. Claims allowed, 1.

12106. Radiological well logging. Kenneth C. Crumrine, Bellaire, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,509,908, issued May 30, 1950.

A device for logging a borehole comprising a housing adapted to be lowered and raised through said hole, a source of neutrons and a detector of neutrons in said housing, said detector being responsive to neutrons from said source scattered in said formations and returned to said hole, a sleeve immediately surrounding and continuously movable with said housing and adapted to occupy most of the annular space between said housing and the wall of the hole, said sleeve being formed of a material such as aluminum substantially transparent to said neutrons, and means for recording the output of said detector. Claims allowed, 5.

12107. Rock coring method. William S. Walls, Bartlesville, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware: U. S. patent 2,510,300, issued June 6, 1950.

In cable tool coring operations employing a drilling fluid having an oil base the method of reducing the free water content of the drill cuttings present in the bore comprising the step of adding a quantity of at least one of the water absorbing clays from the group consisting of bentonite and bauxite in the form of small pieces to the drilling fluid in the bore, said water absorbing material being in particle sizes sufficiently large to enable it to pass through the oil phase and reach the bottom of the bore and in sufficient quantity to prevent the formation or maintenance of a mud phase in the bore. Claims allowed, 5.

12108. Side wall coring tool. Charles O. Denning and John R. Yancey, Houston, Tex., assignors to A-1 Bit & Tool Co., Inc., Houston, Tex., a corporation of Texas: U. S. patent 2,510,386, issued June 6, 1950.

A core taking device for wells comprising; a whip stock including a shell having a side opening and a deflector in the shell; an operating string having a rotatable connection with the whip stock; a core taker including a barrel and a driving stem adapted to be lowered through the operating string into co-acting relation with the deflector to deflect the barrel through the opening, said driving stem having an inlet opening in communication with said operating string and a side outlet opening; a tubular valve in the stem; frangible means normally holding said valve in position to close said side outlet opening; a tubular screen connected to the valve and extending up into the driving stem; a driving connection between the string and stem whereby the stem and barrel may be rotated. Claims allowed, 6.

12109. Side wall sample taken. Maurice P. Lebourg, Houston, Tex., assignor to Schlumberger Well Surveying Corp., Houston, Tex., a corporation of Delaware: U. S. patent 2,511,408, issued June 13, 1950.

A device for taking samples of the formations traversed by a borehole comprising a gun body having an aperture extending completely transversely therethrough adapted to be lowered into a borehole, a hollow sample-taking projectile in said aperture and of substantially the same length as said aperture, and cooperating means on said gun body and on said projectile forming a chamber between the ends of said aperture for receiving an explosive charge and providing an acting surface on the projectile for said explosive charge for propelling said projectile from said aperture. Claims allowed, 10.

12110. Radiological well logging. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware; U. S. patent 2,512,020, issued June 20, 1950.

A method of logging a borehole which comprises passing through said hole a source of neutrons whereby neutrons in penetrating the walls of the hole liberate gamma rays, and simultaneously measuring the intensity of said liberated gamma rays which pass from the hole walls into the hole to zones spaced equidistantly from and at opposite sides of said source. Claims allowed, 10.

12111. Well survey method and apparatus. Robert Earl Fearon, Tulsa, Okla., assignor to Well Surveys Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,513,086, issued June 27, 1950.

In a device for geophysical exploration which includes a measuring instrument adapted to be lowered into a drill hole to measure phenomena indicative of the character of the surrounding strata and a recorder on the surface for recording said measurements, the improvement that comprises, as means to connect the measuring instrument and the recorder, a means at the measuring instrument to generate oscillations, means to modulate the amplitude of said oscillations in accordance with the magnitude of the measurement being made, means to generate oscillations of a frequency different from the first mentioned oscillations and of a constant amplitude, means to impress both of said oscillations upon the surrounding earth at the measuring instrument, means at the surface of the earth to detect both of said oscillations, means to divide the amplitude of one of said detected oscillations by the amplitude of the other and means to operate a recorder in accordance with the quotient so obtained. Claims allowed, 5.

TECHNICAL AIDS

12112. Correcting pendulum grade-angle measurements. Daniel Silverman, Joseph D. Eisler, and Julian F. Evans, Tulsa, Okla., assignors to Stanolind Oil and Gas Co., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,503,422, issued Apr. 11, 1950.

In surveying apparatus, including, in combination, a gravity-responsive pendulum, a support for said pendulum adapted for transportation along a traverse and for orientation according to the grade angles encountered, torsion means suspending said pendulum from said support and exerting on said pendulum a torque such that the pendulum angle relative to said support is less than the corresponding grade angle, a rotatable follower arm pivoted in said support concentrically with but independent of said pendulum, an integrator adjusting

member displaceable linearly perpendicular to the following arm direction for zero grade angle, and means controlled according to said pendulum angle for actuating said member and rotating said follower arm through twice said pendulum angle, the improvement comprising a variable coupling between said member and said follower arm, which coupling comprises a lever pivoting about a point spaced from the axis of rotation of said pendulum, said lever being coupled to said displaceable member and slidably coupled to said follower arm, the spacing of said pivoting point being so related to the length of said follower arm as to make the displacements of said member proportional to the sine of the grade angle throughout a substantial range. Claims allowed, 5.

12113. Pendulum system for grade-angle measurements. Daniel Silverman, Joseph D. Eisler, and Julian F. Evans, Tulsa, Okla., assignors to Stanolind Oil and Gas Co., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,503,423, issued Apr. 11, 1950.

In an elevation meter of the type described, apparatus for producing a displacement proportional to the sine of a grade angle comprising, in combination, a gravity-responsive pendulum, a support for said pendulum adapted for transportation along a traverse and for orientation according to the grade angle encountered, a pair of torsion fibers suspending said pendulum from said support and exerting on said pendulum a torque such that the pendulum angle relative to said support is less than the corresponding grade angle, a rotatable follower arm pivoted concentrically with but independent of said pendulum, an integrator-adjusting member displaceable linearly perpendicular to the follower arm direction for zero grade angle, said member being coupled to said arm by a coupling adapted to make the displacement of said member proportional to the sine of the corresponding arm angle, and means for actuating said follower arm and said member including: a mirror on the pendulum axis, a light source unit and a photocell unit cooperating with said mirror, one of said units being fixed and the other mounted on said arm, whereby, in maintaining light from said source reflected by said mirror onto said photocell unit, said arm rotates through twice the mirror angle; said mirror being spaced away from said pendulum at a position along the length of one said fibers where the angle of rotation of said fiber is substantially one-half the corresponding grade angle. Claims allowed, 2.

12114. Apparatus for calibrating vibration equipment. Welcome W. Bender, Jr., Baltimore, William B. Bergen, Glenarm, and William G. Purdy, Baltimore, Md., assignors to the Glenn L. Martin Co., Middle River, Md., a corporation of Maryland: U. S. patent 2,505,601, issued Apr. 25, 1950.

A calibrating device capable of producing motion of sinusoidal form of variable amplitude including a housing, a vibrating table, and table vibrating means, comprising a slotted disc having a rack attached thereto, and positioned to rotate within a Scotch yoke having horizontal and vertical guide members, supporting members positioned to support the vibrating table on the top member of said Scotch yoke, an outer shaft journaled to be rotated by energy transmitted through an attached flywheel, said shaft being adapted to rotate said disc, an inner shaft mounted to rotate angularly within said shaft, a pulley having a slotted flange attached to said inner shaft adjacent said flywheel and secured thereto by adjustable securing means for positioning the flange relative to the flywheel and a gear secured to the inner shaft positioned to engage said rack to afford external adjustment of the eccentricity of the slotted disc relative to said Scotch yoke. Claims allowed, 6.

12115. Pendulum inclinometer. Ronald L. R. Cockerell, Regina, Saskatchewan, Canada: U. S. patent 2,505,884, issued May 2, 1950.

An inclinometer comprising a base having a pair of fixed parallel arms rising therefrom, a cylindrical casing positioned between said arms and formed with a viewing opening in its peripheral wall, axial bearing means on said casing having outer portions supportably engaging the related arms and maintaining said casing in fixed relation to said arms and said base, said axial bearing means having inner portions projecting into said casing from opposite sides thereof, a pendulum axle positioned between and having its ends journaled in said inner portions, a disk fixed on said axle intermediate its ends and in spaced relation to the opposite sides of said casing, a cylindrical calibrated rim fixed on the periphery of said disk with its side edges positioned close to the sides of the casing and with its calibrations visible through said viewing opening, and a pendulum weight fixed to said disk. Claims allowed, 3.

12116. Pulse-reflection distance-measuring system. Henry O. Wright, Suffern, N. Y., assignor to Bell Telephone Laboratories, Inc., New York, N. Y., a corporation of New York: U. S. patent 2,507,746, issued May 16, 1950.

A radio distance-measuring system comprising a transmitter of substantially constant pure carrier frequency radio-wave energy, means for actuating said transmitter to emit short pulses of radio-wave energy at regularly recurrent time intervals, said intervals being at least of sufficient length to permit a transmitted pulse to travel to a reflecting surface at the maximum distance to be measured and to return by reflection to the system before the next successive pulse is emitted, means separate from and having no effect upon the output of said transmitter, for producing electrical wave energy of a heterodyne frequency continuously varying over a predetermined range of frequencies during each said time interval, means for receiving reflections of said transmitted pulses from a surface the distance of which is to be measured, means for combining said received reflected pulses and said heterodyne frequency energy and detecting the beat-note frequencies therebetween, means for determining the frequencies of said beat-notes to obtain an indication of the distance of said reflecting surface. Claims allowed, 6.

12117. Transducer for ultrasonic waves. Howard H. Claassen, Norman, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware: U. S. patent 2,507,770, issued May 16, 1950.

In combination, a member adapted to vibrate at ultrasonic frequencies, said member having a resonant frequency, a body of conductive liquid in intimate contact with one face of said member, an electrode in contact with another face of said member, and another electrode spaced from said member and engaging said liquid body. Claims allowed, 5.

12118. Underwater meter-leveling device. Arnold H. Goetsch, Houston, Tex., assignor, by mesne assignments, to La Coste and Romberg, Austin, Tex., a partnership: U. S. patent 2,507,900, issued May 16, 1950.

In a device of the class described, a support, a base, means for resiliently urging the support to spaced relation from the base, and additional means for adjustably applying tension between the support and base at a plurality of points to vary the angular relation therebetween and level the support. Claims allowed, 5.

12119. Radio object position indicator using colors for distance indication. Waldemar A. Ayres, Kew Gardens Hills, N. Y., assignor to The Sperry Corp., a corporation of Delaware: U. S. patent 2,508,358, issued May 23, 1950.

Object locating apparatus comprising a source of electromagnetic energy, scanning means including a directional antenna connected to said energy source for successively irradiating objects disposed in space, a receiver connected to receive electromagnetic energy reflected from said objects, circuit means controlled from said receiver and responsive differently to received reflected energy depending on the ranges of the objects from said apparatus, means including a cathode ray tube controllable in synchronism with said scanning means and connected to said circuit means for providing indications of the positions of the objects, and chromatic means controllable in synchronism with said circuit means and co-operable with said cathode ray tube for rendering said position indications of said objects colored in accordance with the respective ranges of the objects. Claims allowed, 25.

12120. Method and means for automatic tracking and/or ranging. Milton H. Gross, Berkeley, Calif., assignor to the United States of America as represented by the Secretary of War: U. S. patent 2,508,384, issued May 23, 1950.

In a radio detection system transmitting successive pulses of energy and receiving echoes from a target, the delay of said echoes with respect to said pulses being proportional to the range of said target, and transforming said echoes into deflections of an electron beam having a sweep synchronized with said pulses, those steps in the method of automatically following changes in the range of said target which include, adjusting the phase of said sweep relative to said pulses until the delay of the initial deflections relative to said pulses corresponds to the initial range of said target, generating an electrical quantity proportional in amount and polarity to the deviation from said initial range, and altering the phase of said sweep with respect to said pulses by means of said electrical quantity to compensate for said deviation. Claims allowed, 10.

12121. Frequency-modulated direction- and range-finding apparatus. Martin V. Kiebert, Jr., Arlington, Va.: U. S. patent 2,508,400, issued May 23, 1950.

In an echo-ranging system having a transmitter station for detecting the presence of at least one target at a distance from the station, in combination, a master control oscillator, additional oscillator means operatively connected to and controlled by said master oscillator for producing a control signal varying linearly with time, means for generating high frequency oscillations, means connected to said generating means and said additional oscillator means for utilizing said control signal for frequency modulating said high frequency oscillations, rotatable antenna means including transmitting and receiving reflectors, means for rotating said antenna means, said means for generating high frequency oscillations being operatively connected to said transmitting reflector for energizing the same and transmitting a beam wave of frequency modulated radiant energy, a mixing circuit operatively connected to said means for generating high frequency oscillations and to said receiving reflector for producing at least one signal of a beat frequency substantially proportional to the time of propagation of said wave over twice said distance, a mixer operatively connected to said mixing circuit and energized by the beat frequency signal, a cathode ray tube having an intensifier grid, a search oscillator connected to said mixer and to

said additional oscillator means, said search oscillator being constructed and arranged to periodically generate an additional signal covering a predetermined range of frequencies at a period controlled by said additional oscillator means, said mixer supplying an output signal of a frequency which is the algebraic sum of the frequencies of the beat frequency signal and additional signal applied thereto from the mixing circuit and the search oscillator respectively, a filter interconnecting said mixer and said intensifier grid for passing said output signal to said grid only when said output signal has a predetermined frequency, blanker means operatively connected to said intensifier grid and to said additional oscillator means and controlled by the latter, sweep generator means for said cathode ray tube operatively connected to and controlled by said additional oscillator means, and means operatively connected to said rotating means for rotating the sweep of said cathode ray tube in synchronization with said antenna means thereby to provide a sweep having an instant setting corresponding to the instant setting of said rotatable antenna means. Claims allowed, 8.

12122. Differential altimeter. William Shockley, Madison, N. J., assignor to Bell Telephone Laboratories, Inc., New York, N. Y., a corporation of New York: U. S. patent 2,509,889, issued May 30, 1950.

An altimeter comprising a vessel and a conduit immediately attached thereto, said conduit providing inlet and outlet means for said vessel and having a uniform inside dimension throughout its length, two thermally sensitive resistors each having the characteristic of rapidly varying in resistivity with change of temperature axially mounted in said conduit, means in said conduit forming oppositely disposed nozzles between said resistors, each of said nozzles being adjacent and directed toward an individual resistor, a heating coil axially mounted in said conduit between said nozzles, said resistors being connected in a Wheatstone bridge circuit, current supply means for said bridge, and means connected to said bridge circuit to indicate the difference in temperature of said resistors as determined by the flow of heat from said heating coil through one of said nozzles to the resistor adjacent thereto or through the other of said nozzles to the resistor adjacent thereto in response to the flow of air into and out of said vessel due to changes in pressure. Claims allowed, 1.

12123. Dynamic galvanometer. Edward W. Kellogg, Indianapolis, Ind., assignor to Radio Corp. of America, a corporation of Delaware: U. S. patent 2,510,585, issued June 6, 1950.

A galvanometer comprising means for obtaining a magnetic field, an armature support positioned in said field, an actuating coil wound on said support, means for flexibly mounting said armature support for rotation at a plurality of bearing points, said mounting preventing lateral displacement of said armature, a mirror mounted on said armature support externally of said magnetic field, and a line damper mounted on the end of said armature support. Claims allowed, 15.

12124. Time interval measuring device. Earl G. Newsom, Dayton, Ohio: U. S. patent 2,511,868, issued June 20, 1950.

A radio circuit for measuring short time intervals, comprising a power supply, a voltage divider connected across said power supply, a load circuit connected across said voltage divider, a fixed resistor in said load circuit, a rheostat in series with said fixed resistor in said load circuit and having a scale, an adjustable arm for varying the resistance introduced by said rheostat in said load cir-

cuit, a switch having a movable switch arm adapted for sweeping across a plurality of switch contacts, a first capacitor connected between said switch arm and ground, a ground contact engageable by said switch arm for grounding both plates of said capacitor and effecting substantially the complete discharge thereof, a second contact engageable by said switch arm, a variable resistor connected to said second contact, a tap adapted for being adjustably positioned along said voltage divider and connected to said second switch contact through said variable resistor, a second capacitor connected between the junction of said variable resistor with said tap and ground, a third switch contact engageable by said switch arm, and a balancing meter connecting said third switch contact with the junction of said fixed resistor with said rheostat in the load circuit of said voltage divider for indicating a potential balance between said first capacitor and said rheostat upon the adjustment of said rheostat arm upon said rheostat so that the rheostat scale reading is a measurement of the time interval during which said first capacitor is charged. Claims allowed, 11.

12125. Vibrating table. Cyril Maurice Grahame Calver, Bushey, England: U. S. patent 2,512,304, issued June 20, 1950.

A vibration test machine comprising in combination a vibratory table, a carriage for the table permitting movement of the latter in two planes angularly displaced, at least two rotary shafts, each having an eccentric coupling to the table, with the two shafts disposed with their axes angularly displaced with respect to one another at the required angle, and means to adjust the eccentricity of the coupling between each shaft and the table. Claims allowed, 11.

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The first part of the paper discusses the importance of the research and the objectives of the study. It then proceeds to a literature review, followed by a description of the methodology used. The results of the study are presented in the next section, followed by a discussion of the findings and their implications. The paper concludes with a summary of the main points and suggestions for future research.

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