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

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GEOPHYSICAL ABSTRACTS 139, OCTOBER–DECEMBER 1949

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INTRODUCTION

Geophysical Abstracts are compiled 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. The publication attempts to cover geophysical literature in periodicals, books, and patents dealing with geophysical and geochemical exploration methods and with basic geophysical theory and research, related geological subjects, and technical aids.

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

Geophysical Abstracts 1–86 and 112–127 were issued as Information Circulars by the Bureau of Mines, and 87–111 were issued as Bulletins of the Geological Survey. Beginning with 128, Geophysical Abstracts are published as Bulletins of the Geological Survey.

As long as available, Geophysical Abstracts 124–127 issued as Information Circulars may be obtained free of charge from Publications Distribution Section, Bureau of Mines. All other numbers are now out of print. Geophysical Abstracts issued as Bulletins of the Geological Survey (with the exception of Nos. 87 and 88) may be purchased as single copies or by subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. For subscription, the Superintendent of Documents 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 cover purchase of any other publication from the Superintendent of Documents.

Index.—The annual index of authors ordinarily published with the issue for the last quarter of each year will be combined with a subject index and issued as Bulletin 966–E.

Acknowledgment.—The cooperation of those authors who have sent us reprints of their publications and patent specifications is gratefully acknowledged. Special thanks are due those members of the Geological Survey who have advised and assisted the authors in the preparation of the manuscript.

0. GENERAL GEOPHYSICAL SUBJECTS

11442. B. B. Z. Bergbau-Bohrtechniker-und Erdöl-Zeitung. Das franzosische Erdöl Forschungs Institut [The French Petroleum Research Institute]: Vol. 65, no. 4, p. 15, 1949.

French Government efforts in prospecting for oil both in France and in the colonies are described. The newly created Institut de Petrole will have among other departments a division for scientific and practical research in exploration and utilization of oil resources. Important sources of natural gas have been recently discovered in the Pyrenees and are now being exploited.—*S. T. V.*

11443. Evans, P., and Coates, J. Geophysical prospecting for oil in India: Indian Minerals, vol. 11, no. 2, pp. 92–102, 1949.

When exploration for oil was begun in 1923 in India, the gravitational method was used, and later other geophysical methods were also employed. In the great alluvial plains of India where there are wide areas in which sub-surface geology is unknown, gravitational methods have been employed quite extensively. For detailed work the torsion balance has been found particularly useful in defining an individual structure and has been used for the location of critically important faults beneath alluvium. A pendulum type, relatively portable apparatus developed by the Geodetic Survey of India for measuring gravity is described. The accuracy of the measurements with this instrument approaches one part in a million.—*S. T. V.*

11444. García Rojas, A. Exploración petrolera en el año de 1948 [Exploration for oil in 1948]: Petróleos Mexicanos, no. 72, pp. 123–144, 1949.

Petroleum exploration in Mexico during 1948, including geophysical exploration and exploratory drilling, is summarized. One gravimetric and five seismological crews were active almost continuously in northeastern Mexico near the Texas producing zones. Three seismological crews studied the structures east of the Río San Juan. Electrical methods were used in the Ebano region where oil accumulations are associated with fracture zones. Eleven additional exploration parties operated in northern Mexico, and twelve more in other regions.—*S. T. V.*

11445. Gutenberg, Beno. Approximations in geophysics: Publication dedicated to Ilmari Bonsdorff on the occasion of his 70th anniversary. Veröffentlichungen des Finnischen Geodätischen Institutes Nr. 36, 1949.

The fact that many theoretical formulations and fundamental numerical data in geophysics are based on approximations is not sufficiently realized. Attention is called to such approximations as the neglect of second or higher derivatives in differential equations, use of series where only terms with one or two powers of a quantity are retained, use of standard errors calculated by least squares to indicate accuracy instead of consistency, and the use of least square methods when deviations are systematic. Examples are given to illustrate how incorrect results may be produced by the use of approximations.—*M. C. R.*

11446. Gutenberg, Beno. The structure of the earth: Scientia, 6th ser., 43rd year, pp. 83–86, 1949.

Present knowledge and some hypotheses concerning the structure of the earth are summarized.—*M. C. R.*

11447. Kamenskii, G. N. Prospecting for underground waters [in Russian]: 313 pp., Moscow, Gosgeolizdat, 1947.

This is a treatise on methods of exploration for water to supply inhabited places, exploration for brines for chemical industry, and the evacuation of water from mines. Different types of underground water are described and tectonic and geomorphological indicators of possible accumulation of underground water in a region are discussed. Exploration methods described include the electrical (resistivity) method and electrical and thermal well logging. Several electrical profiles, obtained in practical exploration, are analyzed, and logs of both types are given and interpreted. Methods of exploration of underground reservoirs, determination of their capacity and chemical composition are also discussed. Other chapters deal with hydrogeological investigations for the purpose of drainage, with waters in mines and their evacuation, and connate water in oil-bearing formations and the problems of flooding of oil fields.—*S. T. V.*

11448. Nettleton, L. L. Geophysics, geology and oil finding. Geophysics, vol. 14, no. 3, pp. 273–289, 1949.

This is the address of the retiring president of the Society of Exploration Geophysicists at the March 1949 meeting. Cooperation between

geologists and geophysicists in exploration problems is stressed, and some specific cases where joint consideration of problems is necessary for a solution are outlined.—*M. C. R.*

11449. Schenk, H. G. Applied geology: Geol. Soc. Japan Jour., vol. 53, no. 622–627, pp. 44–50, Tokyo, 1947.

This is an address delivered to the 54th annual meeting of the Geological Society of Japan. The speaker outlined the program of geological and geophysical studies necessary for the development of natural resources of that country, appealing for a more practical application of the work of Japanese scientists.—*S. T. V.*

11450. West, W. D. General report of the Geological Survey of India for the year 1947: India Geol. Survey, Records, vol. 81, no. 1, pp. 1–222, 1948 (1949).

The report gives extensive data on the geological exploration of India. The Geophysical Section activities during the year included the following projects: a magnetic survey near Daltonganj on the magnetite deposit near Gore, in which some 2400 relative magnetic measurements were made, with results that exclude the possibility of a large accumulation of ore; an electrical survey along the Damodar river by the resistivity method of the possibilities of locating coal deposits—incomplete but with encouraging results in some areas; an electrical resistivity survey of the Kamptee coalfield which proved extremely satisfactory and is being continued; an electrical survey in Jodhpur for underground water resources; and geophysical investigations of chromite deposits and graphite occurrences.—*S. T. V.*

11451. Wilson, J. Tuzo. A brief account of the geophysical work of Hans Lundberg from April 1 to September 30, 1948: Canadian Geophys. Bull., vol. 2, no. 3, pp. 23–24, 1948.

In 1948 extensive surveys by electromagnetic and ratiographic methods successfully outlined the important mineralized structure in the Kashabowie copper area, Ontario. Test surveys in the Cobalt area showed the usefulness of the magnetic method in studying the Keewatin formations, where the diabase is magnetic in places. The ratiographic method was helpful in locating faults and delineating known veins. North of the Arctic Circle in the Swedish iron-ore district aeromagnetic surveys were made of 4,320 square miles in less than 3 months. Profiles were flown at three altitudes over the Kiruna-Loussavaara magnetite deposits to obtain data for calculating the vertical extent of the ore bodies.—*V. S.*

11452. Wyckoff, R. D. Geophysical exploration: Petroleum Eng., vol. 21, no. 7, pp. B54–66, 1949.

This is an address before the Division of Production, Group Session on Offshore Drilling at the meeting of the American Petroleum Institute November 1948. An abstract of an earlier publication was published as no. 11218 in Geophysical Abstracts 138.—*S. T. V.*

1. GRAVITATIONAL METHODS

11453. Cagniard, Louis and Gloden, Albert. Déterminations experimentales de l'intensité de la pesanteur au Grand-Duché de Luxembourg [Experimental determinations of the intensity of gravity in Luxembourg]: Inst. Grand-Ducal de Luxembourg, Sect. Sci. Nat. Phys. Math. Archives, new ser., Tome 18, 1948–49, pp. 35–49, 1949.

Gravity differences were measured with a North American gravimeter at 96 stations in Luxembourg between October 6 and 19, 1948. The density of stations was one in 26.9 sq. km. The stations, their geographic coordinates, and gravity differences in milligals related to the central station Luxembourg-Athénée are given in a table. The net has been tied to the German, French, and Belgian nets. In the Paris system, g at Luxembourg-Athénée is 980.980 gals.—*M. C. R.*

11454. Cattala, L. Etudes gravimétriques à Madagascar [Gravimetric studies in Madagascar]: Madagascar Bull. geol., no. 1, pp. 75–87, 1949.

An extended gravimetric survey of Madagascar is planned, beginning with a survey of the southern portion of the island. Topographic and geodetic conditions of this survey are discussed in view of the future computations of corrections to be applied to the measurements. The instrument to be used is a North American gravimeter.—*S. T. V.*

11455. Cizancourt, Henri de. Interprétation géologique des anomalies de la pesanteur en Mediterranée [Geologic interpretation of gravity anomalies in the Mediterranean]: Acad. Sci. Paris Comptes Rendus, vol. 226, no. 26, pp. 2164–2166, 1948.

The significance of positive Bouguer anomalies, particularly in the Mediterranean region, is obscure because in both the Airy and Pratt systems of compensation they can lead to solutions which are physically possible but geologically improbable. Deep-focus earthquakes have shown that deformation of the asthenosphere can take place at depths of several hundred kilometers. Application of the general considerations of plastic deformation to deep tectonics suggests localization of deformation in plastic zones and the existence of shear surfaces forming two orthogonal systems with slopes approaching 45° at lower levels. If anticlines and synclines exist at depth, the one characterized by the establishment of an arch attenuating progressively with depth and the other by a deep compressed core and the dying out of folding toward the surface, then because of the increase of density with depth, such synclines would bring lighter layers to the level of layers of greater density, with the inverse being true for anticlines. Such a hypothesis permits explanation of observations in the Mediterranean by isostatic equilibrium.—*V. S.*

11456. Gutenberg, Beno. Isostasy and its meaning: Tellus, vol. 1, no. 3, pp. 1–5, 1949.

The theory of isostasy supposes that in regions which have not been disturbed recently each vertical column of the earth's crust of not too small a cross-section and extending to a depth of about 100 kilometers has approximately the same mass, regardless of the surface condition, continental or oceanic, or of the surface elevation of the region. This

hypothesis is an approximation and its accuracy is analyzed critically in the present article. Both Pratt's and Airy's assumptions are discussed, and the Heiskanen method of calculating residuals is recommended, using the probable thickness of the layers found from seismological evidence combined with the probable values of the density of these layers. Because of the inaccuracies of the basic assumptions, the calculation of isostatic gravity anomalies involves errors far greater than the errors of observation. It is important to note that the belts of large gravity anomalies obtained after isostatic reduction coincide almost everywhere with earthquake belts. The author concludes that the earth's crust as a whole is not in hydrostatic equilibrium. However, there is no doubt that there are large tectonically quiet areas in which the material at a depth of about 100 kilometers is not very far from hydrostatic equilibrium.—*S. T. V.*

11457. Heiskanen, W. Isostatic Institute of the International Association of Geodesy: Geophysica, vol. 2, pp. 12–15, 1947.

The activities and future plans of the Isostatic Institute of the International Association of Geodesy are outlined. The principal tasks of the Institute, which was founded in 1936, are: preparation of the isostatic world maps, isostatic reduction of gravity stations of countries, study of the figure of the earth and of gravity formulas, and study of the isostatic equilibrium and the structure of the earth's crust. The Institute has published world maps for the topographic-isostatic effect of the outermost Hayford zones, three investigations on gravity formulas, and tables for reduction of gravity according to Airy's hypothesis. Heiskanen has completed a catalog of 3,758 isostatically reduced gravity stations of the world. Niskanen has studied the lift of Fennoscandia and the deformation of the earth's crust under the weight of the glacial ice.—*S. T. V.*

11458. Jeffreys, Harold. The figure of the earth: Nature, vol. 162, no. 4128, pp. 915–917, 1948.

Any departure of the earth's external gravitational field from symmetry affects observed gravity, the form of level surfaces which are normal to the direction of gravity, and perturbations of the moon. Free-air reduction is the only way of allowing for variations of height above sea level if the external field is to be correctly determined, as isostatic reduction introduces systematic errors. Mean values of the free air anomaly for gravity observations classified over 10° squares showed considerable irregularity with strong correlation of residuals at stations as much as 10° apart and an appreciable one up to 30°, and even some correlation between adjacent 30° squares. Assuming these correlations to be genuine, four spherical harmonics in gravity of degrees two and three with longitude factors and apparently significant amplitudes were found, as well as small corrections to the mean and the main ellipticity term. Cross-comparisons with recent determinations of gravity at Teddington and Washington indicate the Potsdam value is 10–20 mgal. too high, and a value of 981.2633 0.0022 gal. is obtained by a method of reduction that takes account of the internal correlation of errors.

Data for the moon's motion have been combined with those for the earth, and the final results in a compromise solution are: radius of the

earth=6378.099±0.116 km; ellipticity=297.10±0.36; g=978.0373 (1+(0.0052891±0.0000041) $\sin^2\phi$−0.0000059 $\sin^2 2\phi$); lunar parallax=3422.419″±0.024″; mass of earth/mass of moon=81.278±0.025; precessional constant=0.00327260±0.00000069.—*M. C. R.*

11459. Lagrula, Jean. Nouvelles determinations de l'intensité de la pesanteur en Algérie [Recent determinations of the intensity of gravity in Algeria]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 2, pp. 165–167, 1949.

During 1948 a gravitational survey was conducted in Algeria, with 51 stations occupied. The instrument used was a Holweck-Lejay pendulum. The results are presented in a table giving for every station its geographic position, altitude, topographic and other corrections, and the resulting anomaly.—*S. T. V.*

11460. Lagrula, Jean. Sur l'équilibre isostatique, la sédimentation et les transgressions marines [On isostatic equilibrium, sedimentation, and marine transgressions]: Acad. Sci. Paris Comptes Rendus, vol. 226, no. 16, pp. 1296–1298, 1948.

The requirements of isostatic equilibrium are compared with the effects of sedimentation when the level of deposition corresponds to that of the geoid. If a solid crust 30 km. thick of average density 2.67, a viscous substratum of density 3.27, and sediments 1 km. thick of density 2.27 are assumed, there must be a lack of equilibrium of about 300 meters. It thus appears that sedimentation at the level of the ocean is compatible with isostatic balance only on condition of corresponding marine transgression. The vertical amplitude of this transgression is tentatively calculated on two suppositions. When a decrease in the density of the viscous substratum as a result of radioactivity is assumed [Joly theory] with consequent dilatation of the geoid, the vertical amplitude of marine transgression is 230 meters. Assuming an increase in the density of the continent and its glacial cap, granting a partial fusion of ice, the vertical amplitude is 150 meters. It is concluded that a study of present sedimentary thicknesses can shed light on isostatic equilibrium and on forces that affect it. Studies of the gravitational anomalies of sedimentary basins are considered promising.—*V. S.*

11461. Lagrula, Jean, and Lambert, Alexis. Sur une singularité isostatique en relation avec une fosse de sédimentation néogène dans le basin du Hodna, Algérie [On an isostatic singularity in connection with a trough of Neogene sediments in the Hodna basin, Algeria]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 16, pp. 774–775, 1948.

Pronounced negative Bouguer anomalies, some of them as strong as −100 mgls., were discovered in the Hodna basin, Algeria, by a survey with the Holweck-Lejay gravimeter in 1946. Geological study in connection with the gravity data indicates the thickness of Neogene formations in the northeastern part of the basin containing the anomalies is between 3,000 and 4,000 meters, so that this area is a deep sedimentary trough. When the Bouguer anomalies were reduced by the calculation of isostatic compensation according to the Airy system, the resulting isostatic anomalies over the central part of the Neogene trough reached a maximum of −36 to −48 mgls. for compensation depths of 30 to 60 km. and for a uniform sial density of 2.67, based on Heiskanen's tables.

These anomalies were then recalculated for the local density of the Neogene formations, estimated at 2.17, and were reduced to maximum values of 36 to 45 mgls., for assumed Neogene thicknesses of 3,000 to 4,000 meters. It is concluded that this isostatic feature of the Hodna basin is due to the great thickness and low density of the Neogene formations, and geophysical exploration is recommended in the area of the sedimentary trough to detect anticlinal structures of the type of the known dome at Chott el Hammam.—*V. S.*

11462. Lejay, Pierre. Déterminations de la pesanteur en Corse [Determinations of gravity in Corsica]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 11, pp. 878–880, 1949.

A preliminary gravity network of 24 stations spaced at 15-kilometer intervals was established in Corsica in 1947. General accuracy was indicated by good closure at the base station, Bordeaux observatory. Bouguer anomalies, corrected for relief, are all positive, ranging from +85 mgals on the eastern side of Cap Corse and +78 at Porto on the west coast to +11 mgals at Grossetto [Grosseto-Prugna] in the central mountains, indicating isostatic compensation of Mediterranean depressions and of the island's inland granitic massifs. However, the smallest anomalies do not correspond to the highest altitudes, the value at Popaja [Maison Forestière de Popaja], altitude 1,074 m., being +36 mgals, and isostatic reduction is not likely to eliminate steep gravity gradients, particularly along the western coast between Porto and Sagone, north of Ajaccio, so that strong local influences are evident.—*V. S.*

11463. Lejay, Pierre. Mesures de pesanteur exécutées dans l'ouest de la France [Measurements of gravity in western France]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 19, pp. 935–937, 1948.

The observed gravity values and Bouguer anomalies, determined for 94 stations in Normandy, Brittany, and Poitou in 1947, are tabulated with reduction to the geoid and correction for topography.—*V. S.*

11464. Lejay, Pierre. Remarques sur la Note précedénte et valeur de la pesanteur à la station fondamentale marocaine [Remarks on the preceding note and value of gravity at the base station of Morocco]: Acad. Sci. Paris Comptes Rendus, vol. 229, no. 1, pp. 19–20, 1949.

J. Martin's determination of gravity for the base station of Toulouse, $g=980.4442$ gals, made it possible to verify the calibration of the two Holweck-Lejay gravimeters used by the author in his surveys, using measurements made with them at this station and at the Paris observatory, $g=980.943$ gals. It was found that the provisional constant of one of the instruments had to be corrected by 8 percent, whereas that of the other was precise within about 1 percent. The determination of gravity for the base station of Berrechid, Morocco, with both these instruments gave a value of 979.5629 gals, in good agreement with Reignier's figure of 979.5622 gals obtained with a Mioni pendulum. This work extends the system of tested gravity determinations from Greenland to Morocco, over a range of 2500 mgals. Together with international ties established by J. Martin, it permits calculations

assuring a uniform validity of data in the French net.—*V. S.* (For previous note *see* Geophysical Abstract 11466.)

11465. Martin, Jean. Liaisons gravimétriques internationales [International gravimetric ties]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 8, pp. 658–660, 1949.

Measurements made in 1949 to tie the gravity stations in the Paris-Brussels-London-Glasgow section of the international net are reported, together with values previously accepted for some of the ties. A Western gravimeter with a sensitivity of 0.05 mgls. and a range of 785 mgls. was used, and transportation over long distances was by airplane.—*V. S.*

11466. Martin, Jean. Liaisons gravimétriques internationales et détermination de la base française Paris-Toulouse [International gravimetric ties and determination of the French base Paris-Toulouse]: Acad. Sci. Paris Comptes Rendus, vol. 229, no. 1, pp. 18–19, 1949.

Gravity differences between Paris-Milan and Paris-Madrid determined with a new "Western" gravimeter, as well as those determined previously for other international ties with an older instrument using the constant of weight given by the manufacturer, differed from the values established by other investigators generally with free pendulums. The discrepancies of 1.2 to 7.9 mgals. were proportional to the gravity differences measured. As the relative excess of gravity shown by the older instrument was 0.00608, the constant of this gravimeter was changed by 6 percent from 0.6703 to 0.6752 mgal. per division, and an adjustment was made likewise for the other instrument. Recalculation on the basis of this correction, brought the author's values for European base stations to a good agreement with those of other investigators. The change thus appearing justified, corrected values are given for French reference stations: Toulouse 980.4442, Pic du Midi [Pic du Midi de Bigorre] 979.7475, Saint-Genis-Laval 980.6193, and Clermont-Ferrand 980.5812 gals.—*V. S.* (For previous international ties see Geophysical Abstract no. 11465.)

11467. Nørgaard, G. Gravity values on the western coast of Greenland: Geodaetisk Inst. Skr., ser. 3, no. 14, pp. 1–28, 1948.

Gravity measurements were made during the summer of 1946 at 41 stations on the western coast of Greenland between Nanortalik, latitude 60° N., and Thule, about 76½° N. Two torsion type gravimeters constructed at the Geodetic Institute in Copenhagen were used. The probable error of a single measurement is estimated to be ±0.35 mgl. or less. Results of the survey are presented in tables. Free air and Bouguer anomalies were negative except at Nanortalik, the minimum Bouguer anomaly being −79.9 mgls. at Qutdligssat. A decrease of about 1 mgl. per km. toward the inland ice was noticed in the southern part of the surveyed area. The value of gravity at Ivigtut, base station of the gravimetric network of Greenland, was determined as 981.9600 gals. Gravity differences of 288.2 mgl. between Copenhagen and Stockholm and 369.27 mgl. between Copenhagen and Oslo were measured in 1945 and 1946. When referred to Pillar 1 at Copenhagen (g=

.981.55809 gals) g at Stockholm is thus 981.8462 gals, at Oslo 981.9268 gals.—*S. T. V.*

11468. Pawłowski, Stanisław. Badania gravimetrem Nørgaarda w srodkowej Polsce [Gravity surveys with the Nørgaard gravimeter in central Poland]: Poland Instyt. geolog. Biul. 47, geofiz. ser. no. 4, 76 pp., 5 plates, 1948.

A gravimetric survey with 402 stations occupied was made from April to June 1947 in the region around Łódź, central Poland. The base station was Łódź where the most probable value of g is 981.16375 gals. Preceding the survey a thorough test of the gravimeter was made, especially its behavior under changing temperature and pressure. The gravimeter observations are presented on graphs and maps. The mean error of the single observation is estimated as ± 0.2 mgl. Negative gravity anomalies were found along the profile Pomorzany-Grabów-Solca-Aleksandrów-Chojny, and positive anomalies in the region of Dobroń-Puczniewo-Poddębice. Other local anomalies of great intensity were also discovered.—*S. T. V.*

11469. Richards, T. C. and Malone, A. B. A gravity survey of southern Andros Island and the adjoining marine area in the Bahamas: Monthly Notices Royal Astron. Soc. Geophys. Supp., vol. 5, no. 8, pp. 336–342, 1949.

Gravitational data for 89 stations in the area extending south-southwest from the southern half of Andros Island toward Cuba are presented. Bouguer anomalies for land observations were calculated assuming that the topography may be approximated by an infinite slab of material of density 2.3 from the height of the station to sea level, and for sea stations the observed value was reduced to sea level and attraction of water allowed for by assuming its density to be 1.05 and the depth everywhere equal to the value found at the station. Isogams indicate a general northwest-southeast trend parallel to the known regional gravitational trend of Florida, suggesting that the Bahama Islands can be regarded as part of the Florida platform. Near Cuba the contours more nearly parallel the Cuban gravitational trend. Thus Cretaceous-Eocene diastrophism in Cuba appears to have affected the southwest marginal zone of the Great Bahama Bank. There is a tendency toward a regional high along a NNW–SSE axis in southern Andros Island. The marked falling off in gravity at the edges of the platform may be due to faulted conditions or to dipping flanks of major structural features.—*M. C. R.*

11470. Thyssen-Bornemisza, Stephan von. Über die Möglichkeit den vertikalen Schweregradienten mit Gravimeter zu messen [On the possibility of measuring the vertical gradient of gravity with a gravimeter]: Beitr. angew. Geophysik, vol. 11, pp. 36–43, 1944.

Variations of gravity with changing height were investigated using Graf-Askania small size gravimeters. Measurements were made both outdoors under conditions approaching usual field conditions and in buildings, with variations in height ranging from 25 to 150 centimeters. Comparison of the results with theoretically computed changes in gravity shows that the accuracy in many cases is sufficiently high for determination of the vertical gradient of gravity. Certain cases of excessive deviations in readings should be attributed to minor instrumental drawbacks, such as falling off of battery voltage, which can be eliminated or

substantially decreased. For field work a height variation of about 5 meters between the stations would be sufficient to determine a vertical gradient with an accuracy of ±10 Eötvös.—*S. T. V.*

11471. Volta, Luigi. Considerazioni intorno ad una formula del Somigliana sulla gravitá terrestre [Concerning the formula of Somigliana of the terrestrial gravity]: Istit. Lombardo Rend., vol. 77, no. 2, pp. 469–477, 1944.

Heiskanen's 1939 and Somigliana's 1942 formulas for the intensity of gravity on the surface of the geoid are critically analyzed. The geoid is assumed to be a triaxial ellipsoid. In spite of the accurate results obtainable from Heiskanen's formula, as shown on several examples, the Somigliana formula is preferred for its convenience in calculations, and for its precise values of gravity at all points of the surface of the geoid.—*S. T. V.*

2. MAGNETIC METHODS

11472. Alldredge, L. R., and Keller, Fred. Preliminary report on magnetic anomalies between Adak, Alaska, and Kwajalein, Marshall Islands: Am. Geophys. Union Trans., vol. 30, no. 4, pp. 494–500, 1949.

A continuous record of variations of the total magnetic field intensity was taken along a single flight line from Adak Island in the Aleutian Islands, to Kwajalein, Marshall Islands, during the summer of 1947. Anomalies as large as 750 gammas extending over distances of twenty to thirty miles were found over open ocean areas between Adak and Midway, where ocean depths range from 2,000 to 3,000 fathoms. Magnetic anomalies were observed over known shallow areas, the most striking being those over Midway, Wake, Rongelap, and Kwajalein. A survey at an altitude of 1,500 feet above sea level was made over Bikini Atoll and the adjacent seamount. A broad negative anomaly of 750 gammas was recorded over Bikini, with several superimposed localized anomalies. Several profiles and two contour maps of Bikini Atoll and of the adjacent seamount giving the total intensity anomalies are included.—*S. T. V.*

11473. Bruckshaw, J. M. and Robertson, E. I. The magnetic properties of the tholeiite dykes of north England: Monthly Notices Royal Astron. Soc. Geophys. Supp., vol. 5, no. 8, pp. 308–321, 1949.

Field investigations and laboratory measurements of the magnetization of the various members of the tholeiite dike system in northern England show that they possess abnormal magnetic polarization. The direction of residual magnetism is roughly in the opposite direction to that of the present earth's field. Minor deviations may be due to flow of the molten material below the Curie point.—*M. C. R.*

11474. Bryliński, Émile. Sur le couple exercé par un champ magnétique sur un moment magnétique [On the couple exerted by a magnetic field on a magnetic moment]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 7, pp. 426–427, 1948.

The formula $M=HN \sin \alpha$, given by the theory of magnetic masses for the couple M exerted by a uniform magnetic field H on a magnetic moment N, is considered uncertain because no magnetic masses exist in reality. To give the expression a more concrete character, the problem is treated in terms of a current in a rectangular circuit placed in a field

of magnetic induction making an angle with the circuit. The equation of the force acting on an element of the current then shows that the forces in the horizontal sides of the circuit balance each other whereas the forces in the vertical sides form a couple perpendicular to the field of magnetic induction. The moment of this couple is $M=BN \sin \alpha$, where B is the induction field and N is the moment Si of the current i around the circuit of surface S. This formula, holding for electromagnetic units, is further generalized for application to other systems by an expression of the field of magnetic induction in terms of a uniform magnetic field on the basis of the law of Biot and Laplace.—*V. S.*

11475. Dauvillier, Alexandre, and Henry, Pierre. Sur la théorie gyromagnétique [On the gyromagnetic theory]: Acad. Sci. Paris Comptes Rendus, vol. 229, no. 8, pp. 458–460, 1949.

The gyromagnetic hypothesis formulated by P. M. S. Blackett does not appear supported by recent observations on terrestrial and stellar magnetism. E. Sucksdorff has found from the data of Sodankylä Observatory for 1914–34 that magnetic disturbances decreased notably when the moon, Venus, or Mercury were in the vicinity of the sun-earth axis, as if the planets had a screening effect on solar corpuscular emission travelling in a straight line. Because such an effect could not be produced by physical bulk but by a field of force, the magnetic moments of Mercury and Venus were calculated by Blackett's formula as 4×10^{21} and 4.7×10^{22} gauss cm.^{3}, respectively, that of the moon having been previously determined as 2×10^{21} gauss cm.^{3} These moments are so small, 10^4 times less for Mercury than for the earth, that they are not likely to account for the screening effect. On the other hand, the ferromagnetic hypothesis gives for these planets moments of the same order as that of the earth, namely 17×10^{23} gauss cm.^{3} for the moon. Studies of stellar magnetism likewise seemingly fail to support the gyromagnetic theory. Thiessen has reported what appears to be a temporary disappearance of the sun's general magnetic field, and Babcock has observed an inversion of the polar field of some stars of type *A*.—*V. S.*

11476. Elsasser, W. M. Non-uniformity of the earth's rotation and geomagnetism: Nature, vol. 163, no. 4140, pp. 351–352, 1949.

New geophysical information indicates that the secular deceleration of the earth's angular momentum is produced by two independent agencies, the oceanic tide and a still obscure effect in the earth's central core, with some reason for believing an appreciable fraction of the retarding torque operates in the core. Maps of secular geomagnetic variation for 1912–1942 recently published by the Carnegie Institution of Washington show many centers of secular variation which undergo rapid changes of intensity and displacements of position and also a general drift of the whole secular variation pattern from east to west at an estimated 0.5° per year. If secular variation is the result of fluid motions in the core, these observations must be interpreted as representing a bodily displacement of the core in the direction from east to west and the direction of drift indicates a lag of the core behind the rotation of the earth. If the core rotates more slowly than the solid mantle, angular momentum migrates from the mantle into the core because of

eddy friction at the core boundary. The core must lose angular momentum which is impossible unless there is a direct gravitational interaaction between the core and the moon such that lost angular momentum can reappear in the orbital motion of the moon. Existence of the westerly drift motion corroborates theories connecting geomagnetism with fluid motions in the core by revealing the existence of a power supply for the maintenance of such motions throughout the life of the earth. The magnetic field in the interior of the core is much stronger than the field outside and energy of the internal field is supplied directly by fluid motion. Numerical estimates suggest that the conversion into magnetic field energy replaces mechanical friction in the core as the agent producing the retarding torque.—*S. T. V.*

11477. Fleming, J. A. Oceanography and geomagnetism: Jour. Marine Research, vol. 7, no. 3, pp. 147–153, 1948.

The desirability of making magnetic investigations of large oceanic areas is stressed as a means of completing information on the geomagnetic field and as an aid in determining geologic structure.—*S. T. V.*

11478. Gião, Antonio. Sur le champ magnétique à l'intérieur de la terre [On the magnetic field at the interior of the earth]: Acad. Sci. Paris Comptes Rendus, vol. 226, no. 16, pp. 1298–1300, 1948.

The author's previously deduced formula for the internal magnetic field generated in a spherical mass by its constant rotation is used to derive expressions of the variation of the components of this field with depth. It is found for radial distances of the order of several kilometers from the surface the horizontal component always diminishes inward whereas the vertical component generally increases in the same direction. The use of these expressions for the calculation of the values of the components of the geomagnetic field is indicated for the depths of 1,463 meters in Transvaal and 1,300 meters in Lancashire, where experimental measurements were made in mines.—*V. S.*

11479. Gião, Antonio. Sur les rapports entre gravitation et électromagnétisme déduits des équations de Codazzi. Application au champ électromagnétique général des astres [On relationships between gravitation and electromagnetism deduced from equations of Codazzi. Application to the general electromagnetic field of heavenly bodies]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 9, pp. 742–744, 1949.

The proportionality between the magnetic moment and the angular momentum of rotating spherical masses, previously deduced by the author from his theory of unitary field, is derived from Codazzi's compatibility equations. These are written for the external metric of space-time in terms of the Riemann-Christoffel tensor and are applied to the particular case of quasi-static fields with the aid of formulas binding electrical and magnetic fields to external metric tensors in the author's unitary theory. The generalized treatment is then applied to rotating spherical bodies that are not permanently magnetized, to show the fundamental character of the generation of magnetism by rotation. The calculation, combined with the equation relating gravity and the external metric of space-time, makes it further possible to obtain the expression of the electrostatic field of heavenly bodies, which is produced by the gravitation of their mass.—*V. S.*

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11480. Gold, T. Rotation and terrestrial magnetism: Nature, vol. 163, no. 4144, pp. 513–515, 1949.

This is a report of a Geophysical Discussion of the Royal Astronomical Society on February 25, 1949, devoted to the present state of theories relating rotation and terrestrial magnetism and their experimental and observational justification. Four conditions for a new fundamental law were suggested: It must be possible to consider separately the contribution to the total field which arises from any one mass element; the law must not give preference to one particular inertial frame over all others; there must be no distinction between the effects on a mass of a gravitational field or of an acceleration; the law should result in a field of the right order of magnitude and symmetry for the earth. Means of verifying such a law were discussed but the experimental approach is severely handicapped because no actual physical quantity has been suggested which might be related by means of a new law to the magnetism of large rotating bodies.—*M. C. R.*

11481. Graham, J. W. The stability and significance of magnetism in sedimentary rocks: Jour. Geophys. Research, vol. 54, no. 2, pp. 131–167, 1949.

An investigation was made of the ability of sedimentary rocks to retain directions of magnetization through long intervals of geologic time. Angular relations of the directions of residual magnetization to the bedding in deformed structures, or in beds that were laid down in a random manner were observed during field work extending over large areas and on rocks as old as the Silurian. Systematic relationships were found which indicate the directions of magnetization have remained permanent over periods ranging from 15,000 to over 200,000,000 years.—*M. C. R.*

11482. Joesting, H. R., Keller, Fred, and King, Elizabeth. Geologic implications of aeromagnetic survey of Clearfield-Philipsburg area, central Pennsylvania: Am. Assoc. Petroleum Geologists Bull., vol. 33, no. 10, pp. 1747–1766, 1949.

An aeromagnetic survey was made in November 1946 of a 1785 square mile area in central Pennsylvania lying mainly within the Allegheny Plateau but including also a small portion of the Valley and Ridge province. The major features of the aeromagnetic map are two prominent highs southwest of Curwensville and south of Karthaus, respectively, a marked southeast gradient in the southeast part of the area, and a general northeast alinement of the main magnetic trends. These are believed to reflect inhomogeneities in a geologically complex basement. Analysis of magnetic results also indicates that the basement structural trends diverge somewhat from surface structure and that the basement surface is not deformed concordantly with the highly folded Paleozoic rocks in the Valley and Ridge portion of the area. The basement is estimated to be at a depth of 19,000 to 22,000 feet beneath the surface in the west-central part of the area. Inconclusive evidence suggests the basement may be deeper southeast of the Appalachian front rather than northwest as is generally supposed.—*M. C. R.*

11483. Johnson, E. A., Murphy, Thomas, and Michelson, P. F. A new high sensitive remanent magnetometer: Rev. Sci. Instruments, vol. 20, no. 6, pp. 429–434, 1949.

An apparatus designed to measure small magnetic moments such as are found in samples of a few cubic centimeters of magnetically polarized clay or rock has been constructed for use in a mobile field laboratory. The instrument is capable of measuring magnetic moments as small as 2×10^{-8} c.g.s. unit per cc. In the range from 20 to 10^{-4} c.g.s. units, an accuracy of 2 percent in intensity and 0.2° in direction may be obtained. A sample of 25 to 50 cc. volume is rotated over a pickup coil and the induced alternating voltage after amplification is measured in both intensity and phase and the direction and intensity of magnetization determined. The apparatus is calibrated with a needle magnet of known magnetic moment. The theory of the instrument and a wiring diagram and characteristic graphs of the instrument are given. The instrument has been used successfully in New England and the western States.—*S. T. V.*

11484. Jones, W. M. Geomagnetic latitudes and regional anomalies in New Zealand and the South Pacific: New Zealand Jour. Sci. Technology, vol. 30, no. 2, sec. B, pp. 118–123, 1948.

Diagrams have been prepared for the New Zealand region 34°–48° S., 166° E.–180°, showing the geomagnetic parallels at 10° intervals, from which the value at any point can be read off to about 5′, and for a portion of the South Pacific, 0°–75° S., 150° E.–155° W. which will enable estimation within about half a degree. The axis pole was taken as 78.5° S., 111° E. (Bauer's value for epoch 1922). Regional anomalies in New Zealand, in respect to the theoretical field from the centered dipole, for inclination and horizontal force, are illustrated by a comparison of this field with the actual distribution observed by Farr. Observed inclinations are everywhere greater than the computed, the differences ranging from about 1° at North Cape to more than 2° at Stewart Island. Values for horizontal intensity are about the same in central Otago. Farther north the observed values become steadily greater than the computed, the difference reaching some 1,700 gammas in North Auckland, and to the south they become less, by some 350 gammas in Stewart Island.—*M. C. R.*

11485. Martyn, D. F. Daily magnetic variations near the equators: Nature, vol. 163, no. 4148, pp. 685–686, 1949.

Large daily magnetic variations, both solar and lunar, approximately twice those found in other tropical regions were discovered after the establishment of the Huancayo Observatory. McNish's qualitative modification of the Balfour-Stewart-Schuster dynamo theory to allow for the non-coincidence of the earth's magnetic and geographic axes would explain enhanced magnetic variation in the areas between the magnetic and geographic equators but would not account for the large increases found. Re-examination of the Chapman and Egedal data for equatorial regions shows approximate symmetry is obtained when the magnitude of the variations is plotted against latitude measured from the equator midway between the magnetic (0° inclination) and geomagnetic (earth's dipole axis) equators. The observed anomalies

require the existence in the ionosphere of a narrow region of high electric conductivity about 15° of latitude wide encircling the earth midway between the magnetic and geomagnetic equators.—*M. C. R.*

11486. Mayr, Giovanna. Effetti del campo magnetico sulla cristallizzazione di alcuni sali paramagnetici [Effect of the magnetic field on the crystallization of some paramagnetic salts]: Istit. Lombardo Rend., vol. 78, no. 1, pp. 458–471, 1945.

Experiments show that a magnetic field acting during the crystallization of some paramagnetic salts has an orienting effect so that the polycrystalline material has greater magnetic susceptibility in the direction in which the field acts.—*S. T. V.*

11487. Mayr, Giovanna. Effetto del campo magnetico agente durante la cristallizzazione da fusione di alcuni metalli [Effect of a magnetic field during the crystallization of some molten metals]: Istit. Lombardo Rend., vol. 78, no. 1, pp. 511–519, 1945.

Magnetically anisotropic metals solidified in the field show different values of susceptibility in the direction parallel to the field and at right angles to it. Bismuth initially fused and later solidified in a magnetic field shows, in the solid state, a magnetic susceptibility four to five percent higher in the direction at right angles to the direction of the magnetic field and a correspondingly lower one in the direction of the field.—*S. T. V.*

11488. Mayr, Giovanna. Eventuali cause di errore nello studio del comportamento magnetico di una sostanza [Possible sources of error in determination of magnetic behaviour of a substance]: Istit. Lombardo Rend., vol. 79, no. 1, pp. 261–272, 1946.

The magnetic properties of certain substances, especially hydrates, and their variation during the process of solidification from the original liquid state often give contradictory results as the result of the formation at the moment of solidification of allotropic modifications of the substance or its combination with a varying number of molecules of the water of crystallization. Because similar experiments are frequently performed in geophysical studies of the thermo-remanent magnetism of different rocks, it is not sufficient to ascertain only the chemical purity of the investigated substance, but it is also necessary to determine the structure of the solidified substance. The magnetic field, acting during the process of solidification in some cases can favor the formation of a definite physico-chemical combination.—*S. T. V.*

11489. Newton, H. W. Observational aspects of the sunspot-geomagnetic storm relationships: Monthly Notices Royal Astron. Soc. Geophys. Suppl., vol. 5, no. 8, pp. 321–336, 1949.

International magnetic character figures were used to investigate the statistical rise of geomagnetic activity for the solar disk passage of four area groupings of sunspots from 1914 to 1944. A definite increase of geomagnetic activity was found centered about two days after the date of central meridian passage of giant sunspots exceeding 1,500 millionths of the sun's hemisphere. This relationship diminished with decreasing size of the spot and for the area group 750–500 practically disappeared. The

correlation is strengthened by restricting the analysis to sunspots known to be specially flare active, and a peak of geomagnetic activity is found for minor, naked-eye sunspots, around 500 millionths. Examination of the 27-day recurrence tendencies of geomagnetic activity associated with the various sunspot groupings indicates the apparent recurrence associated with passage of giant spots is actually due to the occurrence of new flares, in contrast to the strong and precise recurrence tendency of smaller storms, especially those without *SC* onset and not apparently dependent on sunspot or solar flare incidence.—*M. C. R.*

11490. Olczak, Tadeusz, and Skorupa, Jan. Zdjecia inclinacji magnetycznej na Mazowszu w 1946 R [The results of measurements of magnetic inclination in the Mazowsze region in 1946]: Poland Instyt. geolog. Biul., ser. geofiz., no. 3, pp. 1–26, 1948.

Results of the measurements of the magnetic inclination made in 1946 in the Mazowsze region, central Poland, are presented and analyzed. During this survey, 275 stations were occupied, and the "Askania" earth inductor with Edelmann's string galvanometer was the main instrument used. The observed inclination and values reduced to 1946.5 epoch are presented in tables and two maps show contours of the inclination and of its anomalies. In the western part of the area, the trend of the variation is roughly northeast with a zero variation around Wyszogród. In the eastern part of the area, the greatest variation occurs near Świder and contours have a more nearly east-west trend.—*S. T. V.*

11491. Peters, L. J. The direct approach to magnetic interpretation and its practical application: Geophysics, vol. 14, no. 3, pp. 290–320, 1949.

The solution of the inverse potential problem and its practical application in the interpretation of field data which have a scalar potential distribution are discussed in terms of the interpretation of magnetic data. Methods developed for direct calculation of basement relief, the derivation of the potential and the horizontal components of the magnetic field from the vertical intensity, the continuation of the field upward, the continuation of the field downward toward its source, the calculation of derivatives of the vertical intensity with special attention to the second and fourth, and the estimation of depths to igneous basement rocks are described. To illustrate the practical applications of the theory, a series of six maps shows the magnetic intensity in the Sand Hills area, Ward and Crane Counties, Texas, the second and fourth vertical derivatives, the calculated magnetic intensity on the basement surface and the calculated relief of the basement. A bibliography of the interpretation of potential fields is appended.—*M. C. R.*

11492. Procopiu, Stefan. Une nouvelle théorie élémentaire des courbes d'aimantation [A new elementary theory of magnetization curves]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 6, pp. 475–476, 1949.

A new formula is deduced for the intensity of magnetization of ferromagnetic substances in weak fields H: $J=H^3\ (a-bH^2)$, where the coefficients a and b satisfy the relationship $a/b=(5/3)\mathrm{H}_c^2$, H_c being the average coercive field about which the fields of elementary particles of the substance are distributed in Maxwellian fashion. This formula expresses more closely the observations of K. Sixtus on certain alloys than the Rayleigh formula $J=aH+bH^2$, and appears more accurate for

weak fields. It shows that for an alternating field H the initial intensities of magnetization are inversely proportional to the squares of coercive fields. Experiments are believed necessary to test the relations between a and b and to determine whether these coefficients depend on temperature as well as on H_c.—*V. S.*

11493. Reulos, René. Rotation et magnétism [Rotation and magnetism]: Acad. Sci. Paris Comptes Rendus, vol. 226, no. 18, pp. 1433–1434, 1948.

It is concluded from the parallelism between an electromagnetic field and a mechanical field of inertia that Faraday's law of induction is transposable into mechanics and expresses the work of forces of inertia along a closed circuit. On the basis of this principle an apparatus is designed by means of which it is possible to treat a field of rotation as a magnetic field and a magnetic field as a field of rotation by obtaining the same effect from either. A flat coil is rotated at a velocity ω about a symmetrical axis in its plane, with wire endings connected to a collector. The rotation space is then demagnetized, and when no current is discernible the coil is rotated at a velocity Ω about an axis perpendicular to the first axis. The resulting flux of the vector $R=2\Omega$ varies sinusoidally and produces a force which can be considered both as electromotive and as "gravito-motive," since it acts on the gravitational mass of the electron. Expressed in mechanical units of potential, this force is: $F=d\phi/dt$ erg/gram. For a coil of n windings of an average surface S, the work per electromagnetic unit will be: $F=10^{-8}2n\ (m/e)S\Omega\omega$ volts, where m is the mass of an electron and e is its charge in electromotive units. This apparatus can be used for measuring the e/m ratio and for related studies.—*V. S.*

11494. Sâlceanu, Constantin. Champ magnétique produit par la rotation d'une masse gravitationelle douée d'une charge electrique de volume [Magnetic field produced by the rotation of a gravitational mass possessing a spatial electrical charge]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 13, pp. 624–626, 1948.

A theoretical basis is supplied for the relationship $P/U=Q/M$, derived by S. Procopiu from P. M. S. Blackett's formula for the magnetic field of a rotating mass, M being the mass, P its magnetic moment, U its angular momentum, and Q its electrical charge expressed in electromagnetic units. It is assumed that the mass is gravitational and spherical, that the charge is spatial and homogeneous, and that the magnetic field is produced by the rotation of the charge. Calculations are made of P and U for an elementary circular ring of rectangular cross section, with further integration for a spatially charged sphere.

As a result, it is found that $P/U=0.5(Q/M)$. The same relationship can also be expressed as a ratio of the average electrical charge μ, expressed in electromagnetic units per unit of volume, to the mass density of the sphere ρ: $P/U=0.5\ (\mu/\rho)$.

For the earth $P/U=1.1\times10^{-15}$ according to Blackett, and $M=6\times10^{27}$ gr., so that the spatial terrestrial electrical charge is 1.32×10^{12} e. m. u. The average spatial charge of the earth per cubic centimeter, computed on the basis of a terrestrial volume of 1.08×10^{27} cm.^{3}, is 1.2×10^{-14} e. m. u.,

a figure not much different from the value of the average surficial charge of the earth per square centimeter. As the spatial electrical charge of the earth is thus 2×10^8 times greater than its surficial electrical charge, it is possible that rotation of the spatial charge causes terrestrial magnetism.—*V. S.*

11495. Thellier, Émile and Thellier, Odette. Sur les propriétés magnétiques des roches éruptives pyrénéennes [On the magnetic properties of Pyrenees eruptive rocks]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 25, pp. 1958–1960, 1949.

The permanent specific magnetization and coefficient of magnetic susceptibility of Pyrenees ophites, peridotites, and Cretaceous dike rocks, part of a suite of rocks previously described by A. Lacroix, have been studied to aid the delineation of the saliferous Triassic Keuper strata, which have been shown to be well suited for magnetic investigation (*see* Geophysical Abstracts 137, no. 11035). With the exception of avezacites and picrite, the peridotites and the dike rocks are weakly magnetic in comparison with the ophites. The latter are characterized by a high susceptibility and a permanent magnetization often greater than the magnetization induced in a terrestrial field of the intensity of about 0.45 oersted. The ophites thus appear to be the case of most anomalies in the region. No definite correlation was found between the magnetic susceptibility of the rocks and their mineralogical composition, possibly because ferromagnetic minerals are accessory minerals in these rocks and are, moreover, rapidly affected by the general changes often typical of Pyrenees rocks. This may also account for the weak susceptibility of peridotites and dike rocks.—*V. S.*

11496. Toperczer, Max. Die erdmagnetische anomalie von Wundschuh [The geomagnetic anomaly of Wundschuh]: Österr. Akad. Wiss. Mathnaturwiss. Kl., Anz., vol. 84, no. 10, pp. 71–72, 1947.

In 1939 a precise magnetic survey was carried out around Wundschuh in the district of Graz, Austria, with 210 stations occupied. A strong anomaly was found extending over an area 1.5 kilometers by 0.8 kilometer. The vertical anomaly shows three consecutive maxima from northwest to southeast of 487, 616, and 589 gammas. The depth of the upper boundary of the disturbing body has been determined as 75, 40, and 50 meters respectively. It is considered probable that the observed anomaly was caused by an intrusion of basaltic masses.—*S. T. V.*

11497. U. S. Coast and Geodetic Survey. Magnetic declination in Texas, 1945 by N. F. Eaton, U. S. Coast and Geodetic Survey Serial 717, 67 pp., 1949.

All available measurements of magnetic declination in Texas are presented in a form usable with a minimum of computation and estimation. The book contains tables of secular changes of magnetic declination, a list of 355 magnetic stations and their description, geographic coordinates, exact indication of the point of measurement, dates of observations, values of magnetic declination on January 1, 1945, and an explanation of tables and charts. An isogonic chart of Texas, showing the lines of equal magnetic declination for January 1, 1945, is appended.—*S. T. V.*

11498. U. S. Coast and Geodetic Survey. United States magnetic tables and magnetic chart for 1945 by S. A. Deel and H. H. Howe: U. S. Coast and Geodetic Survey Serial 667, 1949.

This is the latest in a series of publications, issued at 10-year intervals, summarizing the results of magnetic observations in the United States. It differs from its predecessors in that although it contains results of all repeat observations made by the Survey it omits all nonrepeat stations for which 1935 values were published in Serial 602 and includes instead a special chart for reducing these 1935 values to 1945.—*M. C. R.*

3. SEISMIC METHODS

11499. Agocs, W. B. Curves for the rapid determination of refraction seismograph velocity intervals and critical distances: Geophysics, vol. 14, no. 3, pp. 361–368, 1949.

A method is given whereby families of curves may be calculated and used for the rapid determination of the thickness of velocity horizons. The range of velocities considered is 5,000 ft./sec. to 20,000 ft./sec. The curves may also be used to determine the critical distance of shooting for a particular marker horizon if the sectional velocities and their intervals are known approximately. An example is given.—*M. C. R.*

11500. Banerji, S. J. On some observations of microseisms in India, with particular reference to the theory of microseisms [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus, no. 9 bis, pp. 30–32, 1949.

Previous studies of microseisms in India are reviewed. Experiments in in model tanks are described showing how pressure caused by forced oscillations on the surface of the water varies at different depths. When the wave length is very small compared to the depth of the water, the maximum disturbance of pressure is close to the surface, the minimum at a point halfway between the surface and tank bed, and a second lesser maximum exists at the tank bed. Such a variation is explainable only if the compressibility of the water is taken into account. The minimum is due to the interaction of waves going down and those reflected upwards. Using hydrodynamics equations, it is shown that the disturbance of the sea bed is proportional to the elevation of the waves on the sea surface. The order of variation of pressure is adequate for the production of microseisms of observed magnitudes.—*M. C. R.*

11501. Boone, A. R. A report on the Poulter method of exploring for underground petroleum reserves: Explosives Eng., vol. 27, no. 1, pp. 7–10, 27–28, 1949.

The Poulter method of surface shooting is described. For a complete description of the method *see* Geophysical Abstract no. 11539.

11502. Carder, D. S., and Werner, F. H. Seismograph station near Hungry Horse Dam, Montana: Seismol. Soc. America Bull., vol. 39, no. 1, pp. 27–31, 1949.

A seismograph station was established by the U. S. Bureau of Reclamation in November 1947 near the site of the Hungry Horse Dam on the south fork of Flathead River in northwestern Montana to obtain infor-

mation on the location of active faults and on the stresses that may be set up in the dam by an earthquake. The station is equipped with a Benioff small-model three-component film-recording seismograph and a strong-motion seismograph. *V. S.*

11503. Castelluccio, Domenico. Il metodo dell' onda di spessore infinitesimo per l'analisi dei fenomeni di propagazione per onde [Wave of infinitely small width as a method of studying phenomena of wave propagation]: Istit. Lombardo Rend., vol. 79, no. 1, pp. 273–308, 1946.

To study undulatory phenomena which are functions of only one independent variable besides time, the author devised the method of waves of infinitely narrow width and used it in analyzing the problems of plane, cylindrical, or spherical waves, propagating through a medium which may be either homogenous in all directions and all points or may change its properties from point to point or from instant to instant in accordance with a given law. The method is similar to calculation by finite differences and can be advantageously used in studying seismic phenomena in stratified or anisotropic layers. Basic equations for the refraction, absorption, and reflection of such waves are derived. Graphic procedures can be helpful in applications of this method.—*S. T. V.*

11504. Chakrabarty, S. K. Response characteristics of electromagnetic seismographs and their dependence on the instrumental constants: Seismol. Soc. America Bull., vol. 39, no. 3, pp. 205–218, 1949.

The equations of motion of the seismometer and galvanometer have been derived in the most general form, taking into consideration all the forces which influence the system except that produced by hysteresis. A general solution has been obtained for the case in which the seismometer support on the earth is subjected to a sustained harmonic displacement, and expressions for both the transient and the steady term have been found. The response characteristics, especially the magnification and phase shifts, have been deduced in the general form from which their variation with the period of each motion, as well as that of the instrumental constants can be easily deduced. Simple tests for the determination of the dynamic magnification of the seismograph have been derived, making it possible to keep a regular check on the response of the seismograph. The equations have been derived for the Benioff seismographs, but equations for other electromagnetic seismographs can be easily deduced therefrom.—*M. C. R.*

11505. Cohick, K. S. Correlation possibilities in the Sacramento Valley: Geophysics, vol. 14, no. 3, pp. 337–340, 1949.

Five profiles 2 to 8 miles apart obtained in routine seismic shooting near Elk Grove were studied for reflection correlation. Over a very limited rather ideal area it appears possible to make jump correlations wish a fair degree of reliability, but the method becomes unreliable when attempts are made to extend the area.—*M. C. R.*

11506. Cortright, W. D. Complications in basement reflection correlation: Geophysics, vol. 14, no. 3, pp. 341–345, 1949.

An anomalous early leg on the *Z* bed or basement reflection is illustrated by records from the East Hanford area, California. Possible

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explanations are the varying character of the rocks of the basement contact zone, presence of a local hard sandstone or basal conglomerate in the lower sediments, irregular distribution of a regolith member, or differential erosion of the basement rock. The erratic character and intermittent occurrence of the *Z* bed reflection do not prevent extended use of this reflecting band as a basis for regional mapping of the top of the basement horizon.—*M. C. R.*

11507. Coulomb, Jean. Études sur l'agitation microséismique [Studies of microseisms] [abstract]: Union Geod. et Geophys. Internat., Assoc. Séismol. Comptes Rendus no. 9 bis, pp. 10–12, 1949.

Work at the Institut de Physique du Globe at Paris is summarized. This includes the studies of P. Bernard which were published shortly after those of Ramirez, and the microseism studies at three stations near Paris during 1945–46 under the auspices of the Office National Météorologique. In the latter, it was established that a dozen kilometers is the limit for identification of microseisms, that the "cold microseisms" are due to convection currents in the seismograph enclosure, that the rotation of the wind is an important factor in microseism generation, and that microseism storms correspond to lows over the continental platform.—*M. C. R.*

11508. Coulomb, Jean. Sur la formation des trains de microséismes [On the formation of microseism trains]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 22, pp. 1163–1164, 1948.

In the analysis of the propagation of elastic waves in the ocean and ocean bottom made by Press and Ewing (*see* Geophysical Abstracts 134, no. 10320), the curve of wave dispersion was shown to have two branches, one of which has a minimum group velocity and the other both a minimum and a maximum. Observations indicated that the periods associated with all three points, and particularly with the maximum, are likely to predominate in microseisms. In this paper it is shown that if the analysis of the second branch of the curve is carried beyond the maximum calculated by Press and Ewing, a minimum is soon found. Further, if the ratio of the velocities of transverse to sound waves is taken as $\sqrt{3}$ instead of $\sqrt{2}$, the maximum and minimum almost coincide, forming an abrupt break. Microseism periods associated with this break predominate because, statistically, the frequency of periods associated with the maximum-minimum break is greater than the frequency of periods associated only with a maximum.—*V. S.*

11509. Darbyshire, J. The correlation between microseisms and sea waves [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus No. 9 bis, pp. 19–20, 1949.

Visual comparison between records of wave height on the Atlantic coast of the British Isles and microseisms at Kew appeared to show that microseisms are caused mainly by waves in the coastal region and no clear indication was obtained of any microseismic activity attributable to waves in deep water. Yet a 2:1 relationship between wave and microseism periods and theoretical demonstration of pressure variation of twice the wave frequency which did not vanish with depth counterbalance these observations. Analyses of wave and microseismic spectra

of two storms in which there was a single depression 1,000 to 1,200 miles from the west coast of the British Isles were used to distinguish microseisms generated in different areas. In one case the evidence was not conclusive that microseisms were generated by wave interference in deep water since there was a possibility they were generated in shallow water near Greenland, but in the second example a sharp increase in microseism activity was attributed to waves in depression moving rapidly over deep water north of Azores where conditions were such as would cause interference between two trains of waves of appropriate period travelling in opposite directions.—*M. C. R.*

11510. Debrach, J. Note préliminaire sur l'agitation microséismique au Moroc [Preliminary note on microseisms in Morocco] [abstract:] Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus No. 9 bis, p. 33, 1949.

Microseisms registered on the Mainka seismographs at Averroës Observatory since 1937 were generally weak, with a maximum in winter and practically nothing in summer. The strongest microseisms occur at the same time as strong swell on the Atlantic shore of Morocco and variations in amplitude of the two are simultaneous. Occasional microseism storms preceding swell may be related to swell on neighboring coasts, especially Portugal.—*M. C. R.*

11511. Deegan, C. J. New seismic shooting method demonstrated at San Antonio: Oil and Gas Jour., vol. 47, no. 28, pp. 214, 421, 1948.

The Poulter method of surface shooting is described. For a complete description of the method *see* Geophysical Abstract no. 11539.

11512. Dobrin, M. B., Perkins, Beauregard, Jr., and Snavely, B. L. Subsurface constitution of Bikini Atoll as indicated by a seismic-refraction survey: Geol. Soc. America Bull., vol. 60, no. 5, pp. 807–828, 1949.

A seismic refraction survey of Bikini Atoll in connection with 1946 atomic bomb tests indicated the existence of three zones with different sound velocity beneath the lagoon floor: an upper layer averaging 2,500 feet in thickness in which the speed is 7,000 ft./sec., a layer 5,000 to 10,000 feet thick with a velocity of 11,000 ft./sec., and below that a zone of undetermined thickness with velocity of 17,000 ft./sec. A recent 2,556-foot boring on Bikini appears to confirm the conclusion from seismic data that the uppermost zone consists of diverse calcareous materials normally found at shallow depths in and around atolls. A vertical velocity survey to 1800 feet in the same hole showed a continuous transition from 7,000–11,000 ft./sec. indicating substantially the same rock materials to the top of the 17,000 ft. sec. layer and the change in velocity is due to progressive compaction and cementation. The 17,000 ft./sec. zone appears to be igneous basement. Its top surface has considerable relief, and is characterized by a prominent nose plunging to the southeast through the center of the atoll, the highest portion being about 7,000 feet below sea level near the center, and the greatest observed depth about 13,000 feet at the southeast edge of the atoll. Seismic data require relative subsidence in thousands of feet for all possible histories of Bikini and tend to favor the theory first proposed by Darwin that atolls are formed by long-continued subsidence of initial noncalcareous islands or shallow banks.—*M. C. R.*

11513. Gassmann, Fritz. Über kleine Bewegungen in nicht follkommen elastischen Körpern [Concerning small movements in not fully elastic bodies]: Schweiz. Bauzeitung, Bd. 67, no. 4, pp. 55–56, 1949. Reprinted as Inst. Geophys. Zurich Mitt. no. 11, 1949.

In the theory of the mechanics of continua there are several techniques for calculating the behavior of a solid departing from a perfectly elastic behavior, especially as a result of viscosity. The best known among these techniques are shown to be only special cases of one general method. This is developed for isotropic media and is applied in particular to investigate the propagation of plane, homogeneous waves. The relationship between states of elastic stress and of deformation is analyzed, the equations of motion in a visco-elastic medium are deduced, and consideration is given to conditions in a solid isotropic body as treated by H. Jeffreys and by K. Sezawa.—*V. S.*

11514. Gherzi, E. Microseisms: Correlation of microseisms and meteorological data [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus no. 9 bis, pp. 26–28, 1949.

The origin of "group microseisms" may be attributed to vibrations in the cyclone column over the sea surface. Lack of microseisms could then be explained as the result of a decrease or sudden cessation of such vibrations. The disappearance of microseisms when the cyclonic low is over land is also explainable. It is suggested that the action of the steering upper air mass crushing the cyclonic convection chimney could start the vibrations existing most of the time in the chimney and by means of these rhythmical pressure changes over the ocean cause the group microseisms.—*M. C. R.*

11515. Giorgi, Maurizio. Su alcuni aspetti caracteristici dei microsismi a Roma in relazione con fattori meteorologici [Some characteristic features of the microseisms observed in Rome in relation to meteorological factors]: Annali Geofis., vol. 2, no. 1, pp. 24–39, 1949.

Microseisms recorded at seven Italian observatories were studied in relation to meteorological factors in the Mediterranean basin, over the Atlantic Ocean, and over the European continent from February to October 1948. Striking differences in amplitudes of the waves were observed at stations situated relatively near to one another. Thus Catania and Messina stations, both on the island of Sicily, regularly showed differences in amplitudes in the ratio of 2.5 to 1.0. Such differences in amplitudes are attributed to differences in geological structures on which the observatories are erected, as predicted by the theoretical studies of A. W. Lee. Several examples of prolonged microseisms of regular character recorded at Rome were compared with the corresponding meteorological disturbances over the Atlantic Ocean or the Mediterranean. Microseisms related to barometric disturbances over the Atlantic Ocean show periods of seven to eight seconds and in violent storms even nine seconds. Meteorological disturbances over the Mediterranean basin cause microseisms with periods of two to four seconds, and cold fronts over the Tyrrhenian Sea cause very pronounced waves of three second periods. The article contains facsimiles of numerous seismograms and seven meteorological maps.—*S. T. V.*

11516. Goranson, R. W. Effect of pressure on physical phenomena in the crust: Am. Geophys. Union Trans., vol. 30, no. 2, pp. 187–189, 1949.

Experiments on the deformation of steel, tungsten, quartz, and Pyrex glass under hydrostatic pressure plus an added unidirectional thrust indicate that under sufficiently high confining pressures accompanied by increasing temperature, materials reach their yield point and relieve nonuniform stress distribution by flow long before slowly applied stresses accumulate sufficiently to reach rupture strength. Earthquakes at depths of 380 km., under confining pressures greater than 100,000 bars and at high temperatures, are therefore more probably caused by abrupt volume changes resulting from temperature-pressure phase transitions than by sudden failure.—*V. S.*

11517. Gutenberg, Beno and Richter, C. F. Seismicity of the earth, 273 pp., 34 maps and figs., Princeton, Princeton University Press, 1949.

The volume is intended to evaluate the present relative seismicity of various parts of the earth and to discuss the geography and geological character of the zones and areas of seismic activity, including correlation with mountain structures, oceanic deeps, gravity anomalies, and active volcanoes. Material in earlier publications of the same title has been thoroughly corrected and revised and much new material added. Extensive tables give the location of earthquakes in geographical order and grouped according to depth. Separate chronological lists of 98 great shallow shocks between 1904 and 1947 and 361 major shallow shocks from 1918 to 1946 are believed to be practically exhaustive.—*M. C. R.*

11518. Hardtwig, Erwin. Die Mikroseismik und ihre Anwendung zum Abschätzen der Dicke der Kontinentalschollen [Microseisms and their application to the determination of the thickness of the continental masses]: Geofis. Pura e Appl., vol. 14, no. 3–4, pp. 203–224, 1949.

The relation between the amplitudes and the periods of microseismic waves during several intense microseism storms and the meteorological data for the same intervals was investigated on records of the Stuttgart Seismological Observatory. Surf action is accepted as the most probable cause of microseisms rather than the theory relating microseismic phenomena to the appearance of strong atmospheric lows over ocean areas. On this basis, an investigation of the microseismic waves, similar to Rayleigh waves, spreading over the European continent from surf along the Norwegian shore led to the conclusion that the thickness of the vibrating layer of the crust is slightly more than forty kilometers.—*S. T. V.*

11519. Hardtwig, Erwin. Über die Verlängerung der Periode seismischer Wellen [On the lengthening of the period of seismic waves]: Geofis. Pura e Appl., vol. 13, no. 3–4, pp. 74–87, 1948.

Seismic waves of all types show a lengthening of periods with increase of distance from the focus, as well as a decrease of amplitude and disappearance of sharp peaks. Seismic waves of a complex character take a simple sinusoidal wave form at a sufficient distance. These phenomena are neither predicted nor explained by existing seismological theories. The discrepancy may result from the assumption of a constant density

in the differential equations of wave motion or from the fact that the earth is not a perfectly elastic but a visco-elastic medium. The theoretical analysis of the problem shows that both factors must be taken into account if a satisfactory explanation of the phenomena is to be found.—*S. T. V.*

11520. Higgins, G. E. A note on multiple reflections: Geophysics, vol. 14, no. 3, pp. 357–360, 1949.

During seismic investigations in Trinidad in 1938–39 and 1946–47 steep offshore dips were recorded from seismic profiles run on land near the Gulf of Paria. No known fault or hydrographic feature from which the energy might have been returned exists. Trinidad's most troublesome problem, "coning", is manifested as a curving or arcing of the strike lines of the plotted seismic dips about the shot point, in some cases indicating a series of circular basins along the seismic profile with each shot point or series of consecutive shot points being the center of a basin. Attempts to ascertain the cause have been unsuccessful. A survey in an area where well control was available showed some of the apparent coning effect was valid as the reflections appeared to be coming from sand horizons which were cross-bedded within the formation, but the most severe coning could not be checked.—*M. C. R.*

11521. Housner, G. W., and McCann, G. D. The analysis of strong-motion earthquake records with the electric analog computor: Seismol. Soc. America Bull., vol. 39, no. 1, pp. 47–56, 1949.

An electrical analog computer has been constructed at the California Institute of Technology, Pasadena, to facilitate analyses of the accelerograms of strong motion earthquakes and thus to further research on dynamic earthquake stresses in structures. The apparatus reduced the time required to analyze an acceleration record by a factor of 30 or more and makes possible the study of multiple-degree-of-freedom structures with damping. The use of this computor for earthquake stress analysis is illustrated by examples of calculations for a single-degree-of-freedom and a four-degree-of-freedom structure with viscous damping.—*V. S.*

11522. Jenneman, V. F. Microseisms at Corpus Christi [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus No. 9 bis, p. 24, 1949.

In connection with the U. S. Navy Hurricane Microseismic Research Project, a tripartite station of three Sprengnether seismographs was set up at Corpus Christi, Tex. Microseisms recorded at this station were frequently of moderate or strong intensity and of shorter period than usual, 1.3 second microseisms occurring most frequently. Other types recorded were those of periods 0.15 second or less, 0.8 second, 2 seconds, 6 seconds, and 20 seconds. The instruments were set on loose, fine sand which may be the cause of the prevalence of high frequencies. Work at the station consists of finding the direction of approach and velocity of microseisms and correlation of microseisms with meteorological phenomena.—*M. C. R.*

11523. Kastrop, J. E. The Poulter method of geophysical seismic exploration: *World Oil*, vol. 128, no. 9, pp. 53–54, 56, 58, 60, 1949.

Development and testing of the method are described. *See also* Geophysical Abstract no. 11539.

11524. Kawasumi, Hiroshi. Seismology in Japan, 1939–1947: Seismol. Soc. America Bull., vol. 39, no. 3, pp. 157–167, 1949.

Organizations engaged in seismological research, seismological observatories and types of instruments, important seismological investigations, and destructive and semidestructive earthquakes in Japan and vicinity from 1939 to 1947 are briefly summarized.—*M. C. R.*

11525. Leet, L. Don. Microseisms at Harvard [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus no. 9 bis, p. 15, 1949.

The sense of rotation of particle in the path of Rayleigh waves has been used to determine the direction of approach of microseisms. Case history studies suggest microseisms at Harvard come from the pressure discontinuity along the cold front associated with deep barometric lows along the coast. Microseisms of appreciable magnitude may also come from such a cold front pressure discontinuity without a low. It is proposed that microseisms are generated when a pressure gradient of magnitude as yet undefined but ordinarily maintained only over water-covered areas moves over the crust and kneads the surface layers in such a way as to set up these vibrations.—*M. C. R.*

11526. Lehmann, Inge. The reliability of European seismological stations: Geodaetisk Inst. København Meddelelse no. 22, 66 pp., 1949.

In Jeffreys' determination of weights to be attached to P observations, the reliability of a station was defined as the ratio of the number of P residuals between and including ± 4 seconds to the whole number. Standard errors were derived assuming a normal law of error with chance uniformly distributed up to a few times the standard error superposed on it, and weights varying with the value of the residual were determined. In the present study, in which data from the International Seismological Summary for 1930–33 were used, the reliabilities of 16 European stations were first found by determining a corrected residual (one from which systematic error was eliminated by subtracting the mean of P residuals for all 16 stations). This same mean was also used to find the corrected residuals and reliabilities of other European stations. It is found that the accuracy with which a station observes P is not always the same but depends on the earthquake. Satisfactory weights cannot be determined by statistical methods.—*S. T. V.*

11527. Longuet-Higgins, M. S. The generation of microseisms by sea waves [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus no. 9 bis, pp. 17–18, 1949.

Miche has shown that in a stationary wave motion there are second-order pressure variations (proportional to the square of the wave height) of twice the wave frequency and not attenuated to zero in infinite depth. There is also a fluctuation in the mean pressure on the bottom. Extension of Miche's results shows that this type of pressure fluctuation only occurs when there is interference between wave groups of the same frequency travelling in opposite directions. Assuming incompressibility, the mean pressure between two wave trains of the same frequency travelling in opposite directions fluctuates with a frequency double that of either wave train and amplitude proportional to the product of wave

amplitudes. Pressure variations capable of generating microseisms are therefore transmitted to the sea floor even in deep water under certain conditions of wave interference such as probably arise in the neighborhood of fast moving depressions or in coastal regions if there is any reflection of energy from shore. This theory explains the generation of microseisms in deep water as observed by Banerji, Ramirez, and Gilmore, why storms of equal intensity do not necessarily generate microseisms of equal magnitude, and accounts for the period of microseisms being considerably smaller than that of large sea waves.—*M. C. R.*

11528. Macelwane, J. B., Robertson, Florence, Volk, J. A., and Ramirez, J. E. Investigation of the nature and origin of microseisms of frequency two to three cycles per second at Florissant, Missouri, under contract between Saint Louis University and the U. S. A. Office of Naval Research [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus no. 9 bis, p. 25, 1949.

A tripartite seismographic station with base lines ranging from 200 to 300 meters in length was constructed at Florissant, Missouri. Each of the three vaults is equipped with a three-component seismograph of very high sensitivity utilizing a capacity bridge modulated carrier wave pick-up and amplifying system designed by J. A. Volk. All nine traces are recorded photographically by a special tape recorder with paper speeds adjustable for 3 cm./sec. to 10 cm./sec.

11529. Madwar, M. R. Ten years of microseisms at Helwan [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus no. 9 bis, p. 29, 1949.

Microseisms at Helwan rarely exceed 0.4 microns. Some large microseisms between December 1938 and January 1948 were undoubtedly related to the passage of depressions along the Mediterranean coast 200 km. north of Helwan as the intensity varied with the depth of the depression.—*M. C. R.*

11530. Matsuzawa, Takeo, Satō Kōnosuke, and Hukunaga, Mitsuo. Über die Bewegung des seismographischen Pendels [On the movement of the seismograph pendulum]: Tokyo Imp. Univ., Fac. Sci. Jour., sec. 2, vol. 5, no. 3–4, pp. 47–57, 1939.

In theoretical investigations of the movement of the seismograph it is usual to neglect the component of the ground motion parallel to the position of rest of the pendulum, but in violent shocks this simplification is inadmissible. In the present study a solution of the problem is presented in general form. Beginning with the known differential equation of the motion of a free pendulum, the stability of this motion is analyzed under the action of disturbing impulses directed parallel to the plane of equilibrium position of the pendulum. The conclusion is that, when the ratio of the natural frequency of the pendulum to the frequency of the disturbing impulses is small, an additional oscillation of a long period and of a small amplitude is superposed on the oscillations of the seismograph and the center of the oscillation of the pendulum slowly drifts right and left around the position of rest.—*S. T. V.*

11531. Mintrop, Ludger. On the stratification of the earth's crust according to seismic studies of a large explosion and of earthquakes: Geophysics, vol. 14, no. 3, pp. 321–336, 1949.

Analysis of the records of the Helgoland explosion of April 18, 1947 at 19 stations gave the following longitudinal velocities: 3.5 (sedimentary), 5.2 (granite), 6.5 (basalt), 8.1 (peridotite), and 9.2 km./sec. (perhaps pyroxenite). A depth of 57 km. for this last interface was determined from time-distance curves of both reflected and refracted waves. Other reflections indicate a disturbed zone between 110 and 118 km., and interfaces at 170 and 183 km. Time-distance curves from the Helgoland blast and the 1908 Messina earthquake show eight interfaces at depths of 4, 13, 28, 57, 110, 118, 170, and 183 km., the longitudinal velocities being 3.5, 5.2, 6.5, 8.1, 9.2, about 7, 11.0 and 16.3 km./sec. respectively. The 7 km./sec. velocity is estimated on the assumption that the 110–118 km. zone is a plastic layer. A number of reflections occur beneath the 16.3 km./sec. layer and the velocity may be about 9 km./sec., in close agreement with results obtained by other investigators assuming velocity increases gradually with depth from the base of the crust. Transverse wave velocities were 2 (sedimentary), 2.9 (granite), 3.6 (basalt), 4.5 (peridotite), 5.0, 6.2, and 8.8 km./sec., the velocity within the disturbed zone being unknown. The author concludes that the plastic layer between 110 and 118 km. represents a globe-girdling belt, the depth corresponding to the depth of the isostatic surface calculated by Hayford and Helmert.—*M. C. R.*

11532. Munk, W. H. Note on period increase of waves: Seismol. Soc. America Bull., vol. 39, no. 1, pp. 41–45, 1949.

Formulas derived by the author, J. T. Wilson, and C. Eckart to express the increase in the period of an individual wave conserving its identity in propagation over a distance are discussed. Wilson's application of theoretical equations for group- and wave-velocities to Love waves, which are identifiable more definitely than the tsumani and other waves studied by the author, represents a marked improvement over the latter's method of determining these velocities from empirical data. However, both resulting formulas, being based on assumptions of periodic, sinusoidal waves, are unsuitable for close approximations near the wave front, where they were applied. A more suitable approximation involving use of the Airy integral has been discussed by Jeffreys, Pekeris, and Eckart. Eckart pointed out that near the wave front the disturbance is determined by the oscillation of the Airy integral, and the wave length increases as the cube root of time. Application of the Airy integral to Love waves shows the wave period near the front increases as the cube root of travel distance. A solution for the period increase in terms only of the properties of the transmitting medium is formulated. Such a formula may offer a means for determining the thickness of the upper layer if the velocities of the shear waves and rigidities of the layers are known.—*V. S.*

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11533. Murphy, L. M. Mass analysis of microseismic readings and barometric lows [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus no. 9 bis, p. 14, 1949.

A comprehensive essentially graphical analysis of 30,000 microseismic amplitudes and 2,000 barometric lows for the winters of 1942–45 may be used to show the effect of land and water paths on amplitudes, the ability to detect lows as they approach and pass stations, the ability to differentiate between simultaneous storms at widely scattered stations, the absorption of energy by geologic barriers, and the suitability of various types of seismographs for microseism recording.—*M. C. R.*

11534. Novelly, W. O. Seismic exploration with surface shots: World Petroleum vol. 20, no. 3, pp. 56–59, 1949.

The Poulter method of surface shooting is described. For a complete description of the method *see* Geophysical Abstract no. 11539.

11535. Oulianoff, Nicolas. Les séismes et les noyaux de roches basiques dans les massifs centraux alpins [Earthquakes and the cores of basic rocks in the central Alpine massifs]: Acad. Sci. Paris Comptes Rendus, vol. 226, no. 26, pp. 2168–2170, 1948.

The average difference between the arrival times of the P_g, and P^* phases of the Swiss earthquake of January 25, 1946, at the Neuchâtel, Basel, Zürich, and Chur stations did not increase with distance. This can be explained by variations in the depth of the intermediate layer. The thickness of the granitic layer was calculated along the four directions of propagation, assuming an average velocity of 7.5 km./sec. in the intermediate layer and depth of focus of 10 km., first for a horizontal boundary between the granitic and the intermediate layers, and second, on Salonen's assumption, for a thickness of 40 km. of sial under the Alps and 25 km. under the foreland and of a granitic-intermediate boundary parallel to the sial-sima boundary. The first calculation gave for the four directions thicknesses of 9, 28, 31.5, and 39.5 kilometers respectively, and the second calculation gave 16.5 and 2; 37 and 22.5; 38.5 and 23.5; and 37 and 27 kilometers for the epicentral region and the region near the station respectively. Basic rocks are apparently closest to the surface in the direction toward Neuchâtel and are closer to the surface in the directions toward Basel and Zürich than toward Chur. It is concluded that there are powerful cores of basic rocks of the intermediate layer in the subsurface granitic chains connecting the massifs of the Aar and Black Forest and of Mont Blanc and Vosges, especially close the the surface in the latter chain, but that near Chur, Alpine fracturing and piling up of gigantic granitic sections has forced the basic rocks downward.—*V. S.*

11536. Petrashen', G. The two-dimensional Lamb problem in the case of an infinite elastic plane-parallel layer [in Russian]: Akad. Nauk SSSR Doklady, vol. 64, no. 6, pp. 783–786, 1949.

Waves produced by a concentrated force of short duration in an infinite plane-parallel elastic layer of a thickness h are discussed. The boundary conditions are as follows: The upper plane of the layer ($z=h$)

remains free of stress; along the lower plane a stress is acting which is determined only by the coordinates x and z. At some point in the layer a concentrated impulse produces an elastic strain in the medium. As a result elastic waves are generated and propogate through the elastic medium of the layer. These waves can be described by a double Fourier integral. Developing the function under the integral sign into a convergent series, the author proves that the surface deformation is of an oscillatory type, analogous to Rayleigh waves. The length of the resulting wave decreases logarithmically with the coordinate x, and absorption in the elastic medium is very small.—*S. T. V.*

11537. Poisson, Charles. Accidents tectoniques et tremblements de terre à Madagascar [Tectonic phenomena and earthquakes in Madagascar]: Madagascar Bull. géol., no. 1, pp. 68–74, 1949.

Neither volcanic nor deep focus earthquakes have ever been observed on Madagascar. Since the establishment of a seismological observatory on the island in 1927 some 267 local seismic shocks have been registered by the Mainka seismographs, but only twelve reached intensity VI on the international seismic scale. Almost all epicenters were either at the base of the main gneissic ridge of the island or in the Comoro Islands. The southern part of the coast of the Mozambique Channel is especially free of seismic disturbances, whereas in the northern portion numerous earthquakes have occurred. Among these was the earthquake of October 23, 1938 observed by many seismic stations of the world, some very remote, but not noticeable at the Madagascar Observatory. Statistical data are presented on seismic shocks observed at different places on the island, and a map is given showing the principal seismic centers.—*S. T. V.*

11538. Polli, Silvio. Su di un microbarografo modificato [Modifications of a microbarograph]: Annali Geofis., vol. 2, no. 1, pp. 103–112, 1949.

The microbarograph designed by P. G. Alfani for study of the relation between minute variations of atmospheric pressure and microseismic phenomena has been modified. Originally the sensitive member was a vessel filled with air covered with a rubber membrane and deflections of the membrane, caused by variations in atmospheric pressure, were measured by a system of mechanical levels. In the modified instrument deflection of the elastic membrane causes displacement of liquid filling a capillary tube and produces a magnified deflection of the pointer of the recording apparatus. The new instrument registers pressure variations of 0.001 millimeter mercury.

Comparison of microseismic disturbances with the barometric microvariations were always made on days of complete calm in Trieste. With a cyclone south of Iceland, oscillations in atmospheric pressure up to 0.03 mm. Hg with period seven seconds were observed. Parallel microseismic disturbances had an amplitude of 1.5 microns and period of 7 seconds. Two cyclones west of Ireland were also studied and comparison of the observations showed a perfect parallelism between the atmospheric micro-oscillations and the microseismic waves as to period, amplitude, wave form and the duration of the disturbances.—*S. T. V.*

11539. Poulter, T. C. and Swift, L. M. New method of geophysical exploration with applications to engineering and mining problems, 16 pp., 5 figs., First Pan-American Engineering Congress, Rio de Janeiro, 1949.

By detonating a pattern of charges on stakes in the air above the surface of the ground, increased efficiency has been obtained in converting the energy of the explosion into seismic energy which has directional properties and which contains a minimum amount of random frequency and random phase relations. Advantage is taken of the relatively good transmission characteristics of the weathered layer for low amplitudes. Energy leaves the individual explosions as a shock wave in which the decrease of energy is proportional to the distance. Transfer of energy when such a wave strikes the ground is high but because it is distributed over a large area, the amplitude is low. The seismic wave so initiated is directed almost vertically downward.

Both flat discharges of 10 to 12 inches diameter and thickness of 3/8 to 1 inch and cylindrical charges ranging from 1/3 pound to 20 pounds mounted in a vertical position with the cap in middle or top end have been effectively used. The arrangement of charges in the pattern is a function of the area being surveyed and varies from a few charges arranged in a straight line to a hexagonal or star-shaped pattern of 7 to 13 charges. The charges are mounted on adjustable steel stakes. A seismometer placed on the ground beneath one of the charges will provide a satisfactory time break. Experience indicates the quantity of explosives required per shot is about the same as that required for shot hole work though in any given area more or less may be required depending on the efficiency of shot holes and transmission characteristics of the subsurface formations in the area. Elimination of the shot hole and its attendant drilling problems will in some cases reduce operating costs by more than 50 percent and provide flexibility in selection and surveying of shot points.

Experimental tests in Texas and Oklahoma have shown that in comparison with records of normal shots record disturbances caused by direct transmission of random energy through surface layers are eliminated or greatly reduced, the general energy level is more uniform throughout the length of the record, early secondary refractions and very early reflections are brought out more clearly, in a given area the quality and character of the records are more uniform from one location to another, duplication between successive shots at the same location is perfect aside from such effects as wind disturbances, an absence of some apparent reflections, and the low energy level early in the record sometimes permits the very first phases to be observed.—*M. C. R.*

11540. Riznichenko, Iu. V. On the propagation of seismic waves in discrete and heterogeneous media [in Russian]: Akad. Nauk SSSR Izv., Ser. Geog. i Geofiz., vol. 13, no. 2, pp. 115–123, 1949.

Model experiments were conducted to study the propagation of elastic waves in discrete and heterogeneous media. A grill of rubber threads loaded with weights at the intersections was used to simulate a discrete medium, the weights were varied in magnitude to produce inhomogeneities, and disturbances at one intersection, generated by shocks at another, were recorded by a photoelement, amplifier, and oscillograph.

The conditions of equivalence between discrete and continuous media

were considered and a basis was gained for using experimental evidence in deducing formulas of the velocity of propagation of longitudinal, low frequency waves, for both a discrete linear medium, consisting of a chain of masses separated by elastic intervals, and a continuous, structurally heterogeneous medium, made up of a succession of alternating, plane, parallel layers of two kinds.

For the heterogeneous medium mathematical conditions were determined under which the velocity of longitudinal low-frequency waves is very small, smaller in the whole medium than in its components. The use of formulas is illustrated by the calculation of velocities of 16 m./sec., 1.9 km./sec., 1.47 km./sec., and 30 m./sec. in such actual media as dry quartz sand, wet sand, drilling mud, and porous snow, respectively, ordinary formulas of average velocity being shown not to hold for them. It is concluded that the discrete character and heterogeneity of real media may be factors in seismic observations, together with their imperfect elasticity.—*V. S.*

11541. Scholte, J. G. On the relation between sea waves and microseisms [abstract]: Union Géod. et Géophys. Internat., Assoc. Séismol. Comptes Rendus no. 9 bis, pp. 21–23, 1949.

An explanation of the origin of microseisms was indicated by Lee who remarked that gravity waves at the surface of the ocean give rise to elastic waves of small amplitude which do not diminish with depth and which generate a small movement at the bottom of the ocean. The movement of waves in the ocean is calculated in order to determine if this movement is large enough to be observed at distances of thousands of kilometers. It seems possible to bring the calculations into accordance with observations by an appropriate choice of constants.—*M. C. R.*

11542. Simon, Béla. A magyar medence földrengesi térképe [The seismological map of the Hungarian basin]: Földtani közlöny, vol. 69, no. 10–12, pp. 199–201, 1939.

A map has been constructed, based primarily on the data contained in the catalog compiled by A. Saly covering earthquakes in the years 1894–1907 and 1929–36, showing epicenters of earthquakes, their intensity according to Sieberg-Mercalli scale, and the outline of areas affected by different earthquakes. Places particularly subject to earthquakes are specially shown, as they are to be avoided in erection of important structures or those especially sensitive to seismic shocks.—*S. T. V.*

11543. Sondhi, V. P. The Makrān earthquake, 28th November 1945: Indian Minerals, vol. 1, no. 3, pp. 147–154, 1947.

The earthquake was accompanied by a great seismic sea wave; the appearance of four new islands along the coast, one of them bearing a crest of frozen or fossil earth waves set up in the clay layer of the sea floor by the passage of the earth tremors; and a great fire near Hinglāj caused by the ignition of a large volume of gas which erupted with great force. Soundings along the coast showed no changes in level of the sea floor and profiles of the islands are like isolated blisters rising 50 to 100 feet above a more or less even sea floor. The islands may have been formed by the force of gas pushing up the clay sea floor before

escape into air. Their alinement suggests that they are extensions of anticlinal axes which have been the scene of gas and mud eruptions on land. If the islands emerged because of the pressure of gas released by the earthquake and if the points of emergence indicate crests of hidden anticlines, then areas where the line of islands crosses the isthmuses of Ormāra and Gwādar should be suitable for petroleum exploration.—*M. C. R.*

11544. Stenzel, H. Das Schallfeld eines strahlers in einer Mediumschicht mit schallweicher and schallharter Begrenzung [The acoustic field of an emitter placed in a layer bounded by an absorbing and a reflecting plane]: Annalen der Physik, vol. 43, pp. 1–31, 1943.

General formulas for the mechanical (acoustic) field produced by an emitter placed in a layer bounded by a reflecting and an absorbing plane are deduced following the method used by R. Weirich in his study on propagation of electromagnetic waves. The field in the vicinity of the radiating source is investigated for different thicknesses of the middle layer. Using the method of images, the author calculates the reflected and the radiated energies at the boundaries. The resulting field is also represented graphically for different values of physical constants of the media involved. The practical importance of this study lies in its possible use in underwater signalling, echo logging, and the analysis of seismic phenomena connected with eruptions of submarine volcanoes.—*S. T. V.*

11545. Sterrett, Elton. Airborne equipment speeds seismograph surveys: World Oil, vol. 128, no. 7, pp. 95–98, 1948.

Successful use of air-transported instruments in magnetic and gravitational exploration has led to the development of special light-weight equipment and pontoon-float-mounted helicopters for seismic surveying. Personnel and equipment have been set on the ground and moved to new locations from the air in the marshlands of Louisiana, Texas, and South America. An operation is conducted with 3 helicopters, each having a pay-load lifting capacity of 400 pounds, and is completed in a fraction of the time required for work with marsh buggies or boats. It is reported that under normal conditions the shooting of a spread can be completed in 30 minutes.—*V. S.*

11546. Stoneley, Robert. The seismological implications of aelotropy in continental structure: Monthly Notices Royal Astron. Soc. Geophys. Supp., vol. 5, no. 8, pp. 343–353, 1949.

In a transversely isotropic medium, the velocity of elastic waves depends upon direction. This affects the angle of emergence and in discussion of near earthquakes would alter estimates of the thicknesses of the surface layers made on the assumption of isotropy. The distinction into compressional and distortional waves does not hold. Explosions would generate both P and S waves and an apparent difference in the instant of generation of P and S might arise. SH waves travel with a different velocity from that of SV and the law of variation of velocity with direction is different. Rayleigh type waves can be propagated over the surface of a transversely isotropic body in which the axis of circular symmetry is normal to the free surface, supposed plane. The

diminution of amplitude with depth differs from that in an isotropic body so that the amplitudes of the surface waves generated by a source at a given depth will differ from those in an isotropic medium. Love waves may be propagated in a transversely isotropic medium just as in an isotropic medium.—*M. C. R.*

11547. Takahashi, Ryutaro, and Hirano, Kintaro. Seismic vibrations of soft ground [in Japanese, with English summary]: Tokyo Imp. Univ. Earthquake Research Inst. Bull., vol. 19, no. 3, pp. 534–543, 1941.

A comparison is made between seismic vibrations of the ground without any alluvial layer and one covered with a deep and weak surface layer. Using the velocities of seismic waves in the surface layer and in its base bed, and their respective densities, a formula is derived relating these quantities with the thickness of surface layer and the impedance ratio for wave propagation in these media. These formulas make it possible to deduce from seismograms of shocks spreading through soft ground the seismograms that would have been obtained if the ground were not covered with a soft surface layer. Seismograms of the earthquake of March 8, 1941, taken at points situated directly on the rock and on a soft surface layer are compared. The seismograms obtained at points on the rock surface closely resemble each other, whereas that obtained on the soft alluvial layers differs completely. Both the theory and direct observations show that the seismic vibrations at the surface are modified by resonance oscillations of the soft upper layer. Several graphs and three seismograms are included in the text.—*S. T. V.*

11548. Tucker, M. J. and Collins, G. The frequency analysis of seismograph records [abstract]: Union Géod. et. Géophys, Internat., Assoc. Séismol. Comptes Rendus No. 9 bis, p. 16, 1949.

Kew Galitzin seismograph records used in a study of the relation of waves and microseisms were subjected to a frequency analysis. Records were enlarged twice photographically and a further 12½ times and at the same time converted to a black and white profile for frequency analysis by an automatic curve-follower.—*M. C. R.*

11549. Wells, R. J. Well velocity shooting in California: Geophysics, vol. 14, no. 3, pp. 346–356, 1949.

Sources of error in well velocity shooting lie in geophone and charge depth measurements, increased time due to hole shattering, subweathering velocity corrections, borehole drift, picking the first break in low energy impulses, assuming straight paths for computational purposes, casing breaks, and cable-borne impulses. The last has the greatest magnitude. Several examples are shown and analyses are made indicating the probable path of energy travel from shot to cable and down the cable to the geophone. Cable impulses can be almost entirely eliminated by shot holes offset 2,000 feet from the well.—*M. C. R.*

11550. Yoshiyama, Ryoichi. The hypocentral region of earthquakes: Seismol. Soc. America Bull., vol. 39, no. 3, pp. 187–188, 1949.

The hypocentral region is the space enclosed by a spherical surface around the hypocenter on which it is assumed a stress change acts. The mean value of the radius of this region is determined by the product of

the velocity of P at the focus and the difference in the origin times of P and the time when the S–P interval is zero. This is contrasted to Gutenberg and Richter's thesis that the apparent origin time of S is attributed to the progress of faulting.—*M. C. R.*

4. ELECTRICAL METHODS

11551. Abelès, Florin. Deux théorémes relatifs á la propagation des ondes sinusoidales dans les milieux stratifiés quelconques [Two theorems relating to the propagation of sinusoidal waves in stratified media of any kind]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 18, pp. 899–900, 1948.

An application of matrix mathematics shows that a superposition of n identical stratified media has no effect on a sinusoidal electromagnetic wave traversing them, or at most the effect of a phase shift of 180° in the fields, when the condition is satisfied that $a+d=2\cos(k\pi/n)$, where a and d are elements of the square matrix used to characterize the media, so selected that they constitute functions of the coordinate z only, and $k=1,2,\ldots,n-1$.—*V. S.* (For a more generalized treatment *see* Geophysical Abstracts 136, no. 10864.)

11552. Enslin, J. F. Lateral effects on electrical resistivity depth probe curves: Geol. Soc. South Africa Trans., vol. 51, pp. 249–270, 1949.

The electrical resistivity method is used extensively by the Geophysical Section of the Geological Survey of South Africa for the selection of bore hole sites in prospecting for water, in the investigation of foundation problems, and for location of mineral deposits. The Wenner configuration of electrodes has been used most, but for some problems the Lee partitioning is employed. In interpreting the depth-probe curves the empirical method has been found to be the only efficient method. In the application of the resistivity method very often the lateral change in resistivity is much greater than the change with depth. For the Wenner configuration of electrodes, the equipotential bowl theory is very useful. The detailed analysis shows that the empirical rule concerning the depth of investigation should be modified so that any change in the slope of a probe curve can be attributed to a change with resistivity, either at depth or laterally. Several examples taken from practical surveys, illustrated by graphs and charts, are discussed in detail.—*S. T. V.*

11553. Longuet-Higgins, M. S. The electrical and magnetic effects of tidal streams: Monthly Notices Royal Astron. Soc. Geophys. Supp. vol. 5, no. 8, pp. 285–307, 1949.

The movement of sea water in tidal streams relative to the earth's magnetic field induces electromotive forces of a few millivolts per kilometer which should from theory be at right angles to the water velocity and magnetic field and in northern magnetic latitudes directed from right to left as one faces downstream. Recent measurements of the potential difference between two pairs of electrodes on the sea bottom off Plymouth show that the potential gradient is at right angles to the streams in that part of the English Channel. Observations on cross-Channel telephone cables indicate a considerable flow of electric current takes place which can be accounted for by assuming the mean conduc-

tivity of the sea bed is of the order of 6×10^{-5} (ohms-cm.)$^{-1}$. Tidally generated earth-currents spread into land on either side of the channel and have been measured near Lulworth. As expected, the gradient in land is the reverse of that in water, a northerly gradient accompanying a westerly stream, and the falling off in potential gradient with distance from the coast is in about the expected ratio. The magnetic field associated with tidal earth currents is probably quite small at the earth's surface but may be appreciable at points below the earth's surface which are enclosed by circuits of current. The tidal earth-current density of the order of 10^{-8} amp./cm.^{2} in the English Channel would produce a horizontal field of about 10γ at a depth of 50 fathoms.

Mathematical discussion of the problem shows the horizontal gradient in the water is almost independent of vertical variations in water velocity but is affected critically by the depth of the channel and the conductivity of the channel bed, and that the induced electric currents can be expected to extend to depths comparable to the width of the channel.—*M. C. R.*

11554. Stommel, Henry. The theory of the electric field induced in deep ocean currents: Jour. Marine Research, vol. 7, no. 3, pp. 386–392, 1948.

Because ocean water is an electric conductor and is everywhere under the influence of the earth's magnetic field, it is to be expected that, by the law of electric induction, wherever the water is in motion electric currents and potentials will be generated in it. The theory of such phenomena in the deep ocean are discussed and solutions of the problem are presented which demonstrate the important physical aspects of electric fields associated with ocean currents.—*S. T. V.*

11555. Vallet, J. M. Étude des courants électriques naturels liés au carbonifère de la région de Salins-Chandoline-Bramois près de Sion, Valais [Study of natural electric currents associated with Carboniferous rocks in the region of Salins-Chandoline-Bramois near Sion in the Valais]: Soc. phys. et histoire nat. Genève, Archives des Sci., vol. 2, fasc. 1, pp. 22–56, 1949.

Spontaneous electrical potentials associated with Carboniferous rocks were studied in the region south of Sion, Switzerland, in an area characterized by an alternation of hard sandstones and argillaceous, graphitic, and other schists containing anthracite veins. More than 2,000 stations were occupied along profiles perpendicular to stratification, and equipotential contours were plotted at 100-millivolt intervals from measurements considered accurate within ±2 millivolts. It is found that spontaneous electric currents arise in graphitic schists and anthracite. However, they are not produced by graphite proper, nor by disseminated pyrite, but by oxidizing carbon contained in these schists either in an elementary but amorphous state or in combination with other elements. The graphitic schists and anthracite veins produce negative potential values, whereas sandstone and the other schists register positive values. The map shows alternating, elongated, weakly positive and strongly negative anomalies, sometimes alined on the same axis. Tentative conclusions are drawn from this distribution about the details of the local stratification, schistosity, and structure.—*V. S.*

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11556. Ventocilla, J. F. La exploración del subsuelo por el metodo eléctrico, para localizer los depósitos de grava [Prospecting for gravel deposits by the electrical method]: Soc. ing. del Peru Inf. y mem., vol. 50, no. 7, pp. 271–281, 1949.

The principles underlying the electrical resistivity method are discussed and several applications of this method in underground exploration are described. The importance of this rapid and economical method for prospecting for gravel deposits, which by themselves do not represent a great value, is emphasized. Such deposits are usually buried under an overburden of clay at shallow depth which makes their exploitation very economical. Instances are listed where this method would not give satisfactory results, as when the upper layer of the ground is very dry and thus has a very high electrical resistivity.—*S. T. V.*

11557. Whetton, J. T., and Myers, J. O. Earth resistivity measurements, tracing of galena-fluorspar veins at shallow depths: Mine & Quarry Eng., vol. 15, no. 2, pp. 37–44, 1949.

An electrical resistivity survey was conducted at the Eyam Mine in Derbyshire, England, to detect additional galena-fluorspar veins. In the area investigated Carboniferous limestone lies near the surface, and the veins reach to its top below the soil or boulder-clay cover, at depths rarely exceeding 20 to 30 feet. The relief is even, and the slope of the ground runs approximately along the strike of the two known veins crossing the area, making it possible to set up nearly level traverses at right angles to the trend of mineralization. The four-electrode method was applied, about 20 traverse lines were run mostly parallel with one another, observations were taken 2 feet apart in step-traverse fashion, and the fixed electrode interval ranged from 20 to 60 feet with different traverses. To obtain type curves as an aid to interpretation, test measurements were made over known veins in the Pateley Bridge area, Yorkshire, where the overburden is thin. The resistivity profiles of the Eyam survey showed veins as low segments of various shapes between pronounced maxima. They indicated the existence of nine veins, four of them extending through half of the traverses. The lack of uniformity in the resistivity values for veins is attributed to pronounced variations in their thicknesses observed in underground exposures, where they are found to change rapidly from a thin string of calcite to a broad pocket of ore.—*V. S.*

5. RADIOACTIVE METHODS

11558. Beharrell, J. Absorption of alpha rays in thick sources: Am. Geophys. Union Trans., vol. 30, no. 3, pp. 333–336, 1949.

In order to determine the radioactivity of rocks accurately by counting the α particles emitted from a powdered sample, it is essential that the absorption factor of the rock be evaluated. Various methods of determining the absorption factor are discussed and it is suggested that the Bragg-Kleeman rule gives results which are about 10 percent too low for the common rock-forming minerals. For minerals containing heavier elements the Bragg-Kleeman rule gives a better approximation. With these facts in mind, an average absorption factor of 1.69×10^{-3} gm./cm.^{3} for common igneous rocks is suggested. —*M. C. R.*

11559. Broser, I., and Kallmann, Hartmut. Measurements of α-particle energies with the crystal fluorescence counter: Nature, vol. 163, no. 4131, pp. 20–21, 1949.

A new type of counter has been developed for measurements of low alpha-particle intensities. It makes possible determinations of the radioactive energy of single particles but does not require high amplification, as is necessary with ionization chambers. Counting is made of the impulses of light quanta generated by the alpha radiations in a fluorescent substance which need not be enclosed in a vacuum tube. Large single fluorescent crystals of cadmium sulfide, prepared according to a method of R. Frerichs, are used for the fluorescent substance because, being highly transparent, they do not scatter light, they have an energy yield comparable to that of the best zinc sulfide, and, with special treatment, they produce brilliant red fluorescence when subjected to alpha radiations.

The experiments to test the properties of these crystals are described. They show that the intensity of the light is proportional to the alpha-particle energy absorbed in the crystal and that about 80 percent of all radiation impulses have the same intensity. The best crystals require 7.7 electron volts to produce one light quantum. Other substances must be used for counters of beta and of gamma radiations.—*V. S.*

11560. Burtt, B. P. Absolute beta counting: Nucleonics, vol. 5, no. 2, pp. 28–43, 1949.

The counting rate of a beta emitter relative to the disintegration rate depends on the geometry (percent of solid angle about the source subtended by the sensitive volume of the counter), absorption of the radiations by the air and window of the counter, and the scattering from the source support and assembly. If proper corrections are made for absorption and scattering, the geometry of an end-window GM tube is independent of the maximum beta energy between 0.3 and 2.3 m. e. v. An expression for the counting rate may be written as the product of the corrected efficiency (geometry), the disintegration rate and a number of factors expressing the effects of resolving time losses, absorption, and scattering, each of which must be evaluated to determine the disintegration rate of a beta emitter. This paper discusses the procedure for determining the corrected efficiency of an end-window Geiger counter using radium E from discarded radon tubes, the determination of the effects of absorption and scattering on the counting rates of Co^{60}, I^{31}, RaE, and P^{32}, a study of the various factors that affect backscattering and a listing of the backscattering corrections for many common sample mountings, the quantitative effects of lateral and vertical displacements of the source of beta counting rates, the preparation of RaE sources of known disintegration rate, and the detailed procedure for the determination of the absolute disintegration rate of beta emitters using a RaE standard.—*M. C. R.*

11561. Cassen, B., Reed, C. W., Curtis, L., and Baurmash, L. Low-rate alpha scintillation counter: Nucleonics, vol. 5, no. 4, pp. 55–59, 1949.

An alpha scintillation counter has been developed especially for very low rate counting problems such as those encountered in some health physics and dust study applications. The complete unit consists of a

photomultiplier tube and sample holder in a light-tight enclosure, a power supply, a low frequency amplifier for the output of the photomultipler, a two-stage binary counter, a mechanical counter that records each four actual counts, and stabilizing circuits. Specifications were for a maximum counting rate of not over 100 per minute. The sample is either evaporated or impacted, or held by adhesive in the bottom of a flat stainless steel dish which is inserted in the sample holder and held against the tube. The scintillating screen is a piece of transparent Scotch tape with its sticky surface dipped into Patterson type B Zn, CdS phosphor powder and taped on the surface of the glass envelope of the photomultipler tube. The counting characteristics and the geometry of the system were determined using 2 U_3O_8 standards, one showing a geometry of 64.8 percent theoretical half-geometry, the other 68.9 percent. A background count of between two and three counts per hour is normal. The method can be applied to any material which can be prepared as a sufficiently fine powder. The absolute activity is determinable by weighing the sample, once the geometry efficiency is known from the standards.—*M. C. R.*

11562. Coppens, René. Sur l'activité des inclusions radioactives contenues dans les roches éruptives [On the activity of radioactive inclusions contained in eruptive rocks]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 2, pp. 176–178, 1949.

The general formula for the number N of α rays emitted per square centimeter per second in a radioactive body is $N=3.10\ C_U dK\ (33-8.3p) + 10^3 C_{Th} dK\ (28.7-6p)$, C_U and C_{Th} being the uranium and thorium concentrations, d the density of the material examined, p the minimum length of the rays observed on the plate in centimeters of air, and K the ratio between their length in the body and in air $K=[0.85\times 10^{-4}/d\Sigma(c/SA)]$ where S=absorption, a concentration, and A, atomic weight. If $K'=[0.85/\Sigma(c\ S/A)]$, and p with the instruments used is 3μ or 6 mm. of air, then $N=8.4\ C_U K'+2.5\ C_{Th} K'$ which becomes $N=14.6\ K' C_U$ if C_{Th} is taken equal to 2.5 C_U, the generally observed ratio in eruptive rocks. K' varies with the nature of the material, being about 14 for granite and gradually increasing with uranium and thorium content to about 31 for uranium oxide and thorite. On this basis the inclusions in pulverized samples of granitic sand and mica schist from the Morbihan district of France showed concentrations of the order of 10 percent uranium and 20 to 25 percent thorium.—*V. S.*

11563. Coppens, René. Sur la répartition des minéraux radioactifs dans un granite [On the distribution of radioactive minerals in a granite]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 14, pp. 1218–1220, 1949.

The distribution of radioactivity in a granite from Brittany was studied by the photographic method, using a polished and a pulverized sample. The ratio, C_{Th}/C_U, of the concentrations of thorium and uranium was found from the ratio of the number of β rays from 31 to 38μ long to the number greater than 38μ to be approximately 2.8. On this basis, the general activity of the granite from the average number of α rays per square centimeter per second corresponds to uranium and thorium concentrations of 10^{-5} each. On the photograph of the polished specimen α rays could be distinguished emanating from strongly radio-

active inclusions of the order of a few tens of microns in size, and concentrations of α rays covering surfaces with dimensions of almost a millimeter. Optical examination showed the latter to be associated with yellowish-brown crystals. Lengths of α rays here indicated a high C_{Th}/C_U ratio, the crystals containing little or no uranium. The thorium concentration is approximately 1 percent. The volume of these inclusions was estimated to be 1/30,000 the volume of the granite.—*M. C. R.*

11564. Coppens, René. Sur une inclusion radioactive à forte teneur en uranium et thorium contenue dans un granite [On a radioactive inclusion with a strong content of uranium and thorium in a granite]; Acad. Sci. Paris Comptes Rendus, vol. 229, no. 13, pp. 617–619, 1949.

A polished sample of granite from the Angers region, France, was found to contain an inclusion emitting an inordinately large number of α rays and undoubtedly containing uranium. An average of 185 α rays per sq. cm. per sec. was found on plates exposed for 30 min., 95 min., 2 hr. 30 min., and 4 hr. Though measurements of the lengths of trajectories indicated that the rays travelled more than 7 cm. in the air, an exclusive presence of thorium was ruled out because the number of the recorded trajectories exceeded 80 per sq. cm. per sec., the maximum for thorium in equilibrium with its derivatives. Calculation by the formula $(8.4\ C_U + 2.5\ C_{Th})\ k' = N$, with $k' = 32$ for uranium oxide and thorium, (*see* Geophys. Abstract no. 11562) would give a uranium concentration of $\lessapprox 70$ percent if no thorium were present. If thorium is present, C_U diminishes as C_{Th} increases. If the uranium and thorium are present as oxides, the maximum metal content is $\lessapprox 85$ percent and $C_U \lessapprox 63$ percent, $C_{Th} \lessapprox 22$ percent.—*M. C. R.*

11565. Coppens, René. Sur une nouvelle espèce d'inclusion radioactive contenue dans les roches éruptives [On a new kind of radioactive inclusion contained in eruptive rocks]: Acad. Sci. Paris Comptes Rendus, vol. 228, no. 25, pp. 1938–1940, 1949.

A small number of inclusions measuring a few hundredths of a square millimeter showed strong radioactivity when observed on photographs of samples of isolated heavy constituents of granite and an alluvial sand from the Morbihan district, France. The ratio of thorium to uranium concentration determined from the count of the ratio of the number of β rays of lengths 5.8 to 7 cm. to those greater than 7 cm. in air indicated little or no uranium. With a photographic exposure of only 3 hr. 20 min., the thorium concentration was shown to be about 76 percent, corresponding to pure thorite SiO_2, ThO_2.—*V. S.*

11566. Cotton, Aimé, Cotton, Eugène, and Tauzin, Pierre. Remarques à propos d'une Note de MM. Felix Ehrenhaft and H. Herzog [Remarks on a note by Felix Ehrenhaft and H. Herzog]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 17, pp. 794–797, 1948.

The increased radiation within a magnetic field observed by Ehrenhaft and Herzog (*see* Abstract 11568) may have been caused by the action of the magnetic field on charged particles, producing a bending of paths so that the rays are concentrated in a small area. It is calculated that with a field of 11,000 gauss and a radium E source, the radius of this area would be between 0 and 4.5 mm, depending on the energies of the β rays

In the experiment described, the number of electrons reaching the plate would be 3.4 times as many with the magnetic field acting as without. This calculation is for an experiment in vacuum, but as air has only slight absorption for β rays, the effect should be nearly the same.—*M. C. R.*

11567. Curtiss, L. F. Radioactive standards and methods of testing instruments used in the measurement of radioactivity: Inst. Radio Eng. Proc., vol. 37, no. 8, pp. 913–922, 1949.

The National Bureau of Standards program for standardization of radioisotopes is summarized. Methods of ascertaining characteristics of commercial instruments for radioactivity measurements are outlined, with emphasis on those used at the Bureau of Standards. The following tests required for Geiger-Müller counters used in quantitative measurements are described: determination of background counting rate; determination of plateaus; effects of changes of temperature on counters; dead-time measurements; measurement of pulse size; photosensitivity. Tests of scalers, rate meters, and health survey meters are also described. —*M. C. R.*

11568. Ehrenhaft, Felix, and Herzog, R. De l'influence sur le rayonnement d'un champ magnétique homogène et longitudinal [Concerning the influence exerted on radiations by a homogeneous and longitudinal magnetic field]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 13, pp. 626–627, 1948.

An experimental investigation of the effects of a homogeneous, longitudinal magnetic field on radioactive radiations was made, based on the response of photographic plates to β rays by darkening inversely proportional in intensity to the thickness of the absorbing medium between the plate and the source. RaE, an intervening aluminum shield, and a photographic plate were placed for 24 hours between the poles of a homogeneous magnetic field transversely to its lines of force, then placed outside the magnetic field for the same length of time. Without the field, no darkening of the photographic plate in response to the radiations was observed even with an intervening shield as thin as 1.8 mm. Within the field, however, the plate darkened notwithstanding a shield 3 mm. thick, whether the source of radiations was placed at the north or at the south pole. These results may indicate that a homogeneous, longitudinal magnetic field either diminishes the absorbing property of aluminum or augments the energy of radioactive radiations. The latter explanation is considered more probable.—*V. S.*

11569. Ehrenhaft, Felix and Herzog, R. F. K. De l'influence d'un champ magnétique homogène et longitudinal sur le rayonnement émis par une préparation radioactive (On the influence of a homogeneous and longitudinal magnetic field on the radiation emitted by a radioactive preparation): Acad. Sci. Paris Comptes Rendus, vol. 228, no. 7, pp. 550–551, 1949.

Focussing of β rays in a magnetic field as suggested by Cotton, Cotton, and Tauzin could not have been important in producing the effect of increased radiation in the author's previous experiment because the diameter of the preparation exceeded the distance to the photographic plate. Moreover, Cotton and his associates calculated that the inten-

sity would be multiplied by a factor of the order of 3.4 and according to measurements of absorption by Da Tchang Tcheng and Jeng Tsong, the initial intensity of β rays should be 100 times greater to obtain through 3 mm. Al radiation equal to that through 1.8 mm. The experiment was repeated using a constant thickness of 2 mm. of Al, and exposure time within the field of 24 hours and without the field of 134.7. Taking into account the diminution of radioactivity during the experiment, the ratio of the amounts of radiation during the two exposures was 1/3.4. Even under these conditions, the plate was clearly exposed within the field, and there was only a barely discernible darkening without the field (*see* also Geophysical Abstracts nos. 11566 and 11568.)—*M. C. R.*

11570. Festa, G. Sul funzionamento dei contatori di Geiger-Müller [The functioning of Geiger-Müller counters]: Annali Geofis., vol. 2, no. 1, pp. 74–91, 1949.

The theory of the Geiger-Müller counter is briefly stated, the analysis being focused on the discussion of the discharge mechanism and on the influence of the filling gas, especially of the polyatomic gases. Characteristics of the counter, such as its threshold, plateau, and other features are explained. The best gas composition is that indicated by Trost, giving high efficiency and short dead time. Attention is given to the latest improvements in the design of the counter and to related studies published after 1940. The author notes that the best general purpose Geiger-Müller counter quite often is not the best suited for certain specific experimental conditions.—*S. T. V.*

11571. Graves, J. D., and Dyson, J. P. A scintillation counter for laboratory counting of alpha-particles: Rev. Sci. Instruments, vol. 20, no. 8, pp. 560–565, 1949.

A simple, reliable, wide range alpha-counter has been developed which is suitable for routine counting in radiochemical laboratory analysis. This instrument operates in conjunction with a photomultiplier tube and a commercial Geiger tube power supply and is provided with an amplifier and scaler. The counting efficiency is 100 percent for practically all alpha particles; resolving time is limited by the electronic circuits; operation of the counter is unaffected by variations in temperature, humidity, or pressure; and the background is below 10 counts per hour. The chief drawbacks of the instrument are the small field of view for high sensitivity and the fact that only small samples can be investigated.—*S. T. V.*

11572. Guimarães, M. A., and Sampaio, P. A. A circuit for the study of the operation of the Geiger-Müller counter: Rev. Sci. Instruments, vol. 20, no. 7, pp. 485–488, 1949.

A vacuum tube circuit has been designed to measure the effective dead time of a Geiger-Müller counter and the probability of occurrence of spurious discharges within a given interval of time after an initial discharge. The pulse from the Geiger-Müller counter goes to a trigger circuit amplifier which feeds simultaneously a multi-vibrator circuit and one of the grids of an anticoincidence twin tube, the other grid being fed by the output pulse from the vibrator. The arrangement is such that one of the plates of the anticoincidence tube is not sensitive if the two

grids receive simultaneous pulses. Experimental results indicate the small increase in counting rate normally observed as the voltage increases in the plateau region can be attributed to spurious discharges.—*M. C. R.*

11573. Hagen, Werner. Das Geiger-Müller Zählrohr und seine Anwendung in Bergbau [The Geiger-Müller counter and its use in mining industry]: Gluckauf, vol. 85, no. 5–6, pp. 93–94, 1949.

The principle of the Geiger-Müller counter and its operation are described, and the radioactivity of rocks and minerals is summarized.—*S. T. V.*

11574. Hammer, F. E., and Hoecker, F. E. A new method of measuring the stopping power of several materials for alpha particles: Rev. Sci. Instruments, vol. 20, no. 6, pp. 394–398, 1949.

The air-equivalent of absorbing materials was measured by balancing the counting rates of two detectors in air with and without an absorbing film inserted between one of the detectors and its source. Measurements thus made of the air-equivalent and relative stopping powers of films of mica (1.46 ± 0.014), aluminum (1.50 ± 0.039) and polystyrene (1.06 ± 0.003) agree well with previously determined values.—*M. C. R.*

11575. Jeffreys, Harold. Lead isotopes and the age of the earth: Nature, vol. 162, no. 4125, pp. 822–823, 1948.

A. Holmes has calculated the age of the earth as 3,350,000,000 years, using the variation with time in the ratio of the abundance of lead isotopes in 25 ore samples of different age (*see* Geophysical Abstracts 132, no. 9849). As this estimate is considerably larger than those of other investigators, the premises, the data, and the statistical method used are examined and alternative calculations are made. Except one, the solutions obtained do not approach anywhere near that given by Holmes. The nature of the discrepancies indicates that the source of the divergence between the age estimates is a disturbance affecting the values of isotope Pb^{207} but not the values of isotope Pb^{206}, both among those used by Holmes.

Whatever the explanation of this disturbance may be—a variation in the isotopic constitution of the primitive lead, or experimental errors in the estimates of Pb^{204}, no reliance can be placed on age estimates that depend on the abundance of isotope Pb^{207}. The present analysis suggests that L. Ahrens' estimate of 2,100,000,000 years is not much less than the age of the crust.—*V. S.*

11576. Jordan, W. H., and Bell, P. R. Scintillation counters: Nucleonics, vol. 5, no. 4, pp. 30–41, 1949.

A review of the present stage of development is given, inspired by the papers at the June 1949 conference on scintillation counters at Oak Ridge. Research on many types of phosphors and developments in the design of photomultiplier tubes are described. Development of a scintillation spectrometer which can be used for measurement of beta and gamma ray energies is described. A bibliography of 32 references is included.—*S. T. V.*

11577. Knoerr, A. W. Geiger-Müller counters applied to mining: Eng. Mining Jour., vol. 148, no. 7, pp. 92–95, 123, 1947.

The principle of the Geiger-Müller counter is explained and several types of counters and their use in geophysical prospecting are described. The article includes a table of radioactive contents of typical rocks.—*S. T. V.*

11578. Novitzky, Alejandro, and Boiero, Jorge. Detectores de minerales radioactivos [Detectors of radioactive minerals]: Industria minera, vol. 7, no. 93, pp. 46–47, 1949.

The article gives a brief description of the Geiger-Müller counter and presents examples of its use in geophysical prospecting. The possibility of its utilization in chemical analysis in different manufacturing processes is also emphasized.—*S. T. V.*

11579. Poole, J. H. J., and Bremner, J. W. Investigation of the distribution of the radioactive elements in rocks by the photographic method: Nature, vol. 163, no. 4134, pp. 130–131, 1949.

A modification of the photographic method was used in which the rock slides were not covered with glass so that the nuclear plates exposed to them could be affected by alpha rays. To hold a slide and a plate in the same respective positions during the various phases of the procedure, a special brass frame with three contacts was used so that it was possible to make an accurate comparison of the developed plate with the original slide under a microscope to correlate alpha tracks with sources of rays.

A Kuru granite from north of Tammerfors [Tampere], Finland, showed 45 concentrations of alpha tracks within an area of 8 sq. cm., of which 33 appeared to be due to yellow crystals usually associated with biotite, possibly melanite or perovskite. It was estimated that one crystal, shown on a photomicrograph, contained about 0.3 percent of uranium by weight to emit the particles observed, if its density was about 4 gr./cc.—*V. S.*

11580. Savage, W. S. The search for uranium: The Earth Science Digest, vol. 3, no. 11, pp. 3–7, 1949.

Uranium minerals and their occurrences and methods of prospecting for them are described.—*S. T. V.*

11581. Strøm, K. M. A concentration of uranium in black muds: Nature, vol. 162, no. 4128, p. 922, 1948.

As the Cambrian black shales of the Oslo area, Norway, are known to contain 25 to 180 grams of uranium per ton, the concentration of uranium in the black muds formed under anaerobic conditions in the land-locked fjords of the Norwegian coast was investigated. Analyses of uranium content in mud samples from 10 localities were made by the ether extraction method which gives values independent of radium content. The results suggest a definite connection between drainage from granite areas and uranium concentration. The relationship was most conspicuous with the highest uranium value, 60 grams per ton, obtained in Topdalsfjord [Tovdalsfjord] into which empties a large river draining extensive granite areas.—*V. S.*

11582. Urry, W. D. Significance of radioactivity in geophysics—thermal history of the earth: Am. Geophys. Union Trans., vol. 30, no. 21, pp. 171–180, 1949.

Effects of the exponential decay of the sources of radioactive heat within the earth on the earth's thermal history are such that the upper crust of the earth was heating in its early history and subsequent cooling has been more nearly linear than had been supposed. In the deeper parts of the crust and below, the thermal history has been complex with simultaneous heating at one depth and cooling at another. Temperatures in the past beneath a Pacific-type ocean have not varied in the same manner. Recent determination of the radioactivity of ultrabasic rocks and iron meteorites indicate that a monomineralic olivine mantle and an iron core will have remained essentially at the initial temperature. The earth may have had an earlier existence as an undifferentiated body formed by the coalescence of particles. Its rebirth as a molten, differentiated, and later frozen body is possible if the total radioactive content of the earth was distributed uniformly and if its dust-cloud origin dates back about seven billion years. A parental planet from which might have come the asteroids and meteorites may have disrupted because of stresses accumulated by internal heating.—*M. C. R.*

6. GEOTHERMAL METHODS

11583. Bankovskii, V. A. Geothermal conditions in the coal mine Shcheglovka 100 [in Russian]: Ugol', no. 4 (277), pp. 18–22, 1949.

Temperature measurements were made in 1947–48 in bore holes drilled in the area of the proposed extension of the mine Shcheglovka 100 in the Donbass. A summary of temperature measurements at depths ranging from 250 to 1,000 meters shows that individual differences in temperature readings in various mines become noticeable only below 450 meters. This is attributed to the dissimilarity in geology, especially to variations in the dip of covering formations. The highest temperature found at a depth of 1,000 meters was 37° C.—*S. T. V.*

11584. Devienne, Marcel. Influence de l'humidité sur la conduction thermique des corps granuleux [Influence of humidity on the thermal conduction of granulated bodies]: Acad. Sci. Paris Comptes Rendus, vol. 226, no. 19, pp. 1512–1513, 1948.

The influence of water condensed on particles on the coefficient of thermal conduction of granulated bodies was studied by immersing a metal cylinder containing glass balls 3.3 mm. in diameter in cold water of constant temperature and measuring the thermal change at the center of the cylinder as a function of time. The air in the cylinder was at first kept dry; then known masses of water were introduced, and the cylinder was connected with a container of water vapor held under different pressures. The coefficient was 0.000418 cal. cm.$^{-1}$ sec.$^{-1}$(° C)$^{-1}$ for dry air at 0° C. and for air of the same temperature, not saturated by vapor, but it increased at a gradually declining rate as water began to condense on the balls. With a condensation of 0.618 mgr. per litre the increase of the coefficient was 7 percent; with 0.300 gr. per litre, 38 percent; with 2.780 gr. per litre, 55 percent; and with water filling the cylinder completely, 372 percent. Theoretical consideration points

to the importance of the presence of water concentration at the points of contact between balls.—*V. S.*

11585. Rózycki, S. Z. Uwagi o rozmieszczeniu stopnia geotermicznego w Polsce i krajach sąsiednich [Note concerning the distribution of the geothermal gradient in Poland and neighboring countries]: Warszawske Towarzystro Naukowe Sprawozdańia for the year 1947, pp. 115–122, 1948.

Temperature measurements in boreholes at some twenty places in Poland and neighboring countries show great variations of geothermal gradient, by far exceeding the limits of probable errors of individual determinations. Some of the deviations from the value of the geothermal gradient characteristic for Central Europe can be explained by local geological influences, such as proximity of salt deposits near Inowrocław. Others are indicative for the geological structure of northeastern part of Poland, where in the borehole near Pisz, on the lake region Pojezierze Mazurskie, the reciprocal geothermal gradient was determined as 96 meters. Summing up the characteristics of the thermal zones of the upper lithosphere in Poland in connection with the geological structure, it is possible to distinguish a cold area (reciprocal geothermal gradient 40–100 meters) in northeast Poland, lying on the edge of the old shield with crystalline substratum; a normally warm area (reciprocal geothermal gradient 30–35 meters) in the zone of Hercynian and Kimmerian folding; rather cooled areas in the Carpathian Mountains (reciprocal geothermal gradient 40–50 meters); a warm zone (reciprocal geothermal gradient 15–25 meters) beyond the Carpathian Mountains. A map of Poland at a scale of 1 : 7,000,000 is appended.—*S. T. V.*

7. GEOCHEMICAL METHODS

11586. Hawkes, H. E. and Lakin, H. W. Vestigial zinc in surface residuum associated with primary zinc ore in east Tennessee: Econ. Geology, vol. 44, no. 4, pp. 286–295, 1949.

Analyses of samples of residual clay at the Friends Station zinc deposit, Tennessee, indicate a normal content of 0.03 percent Zn which may be the effect of widely disseminated sphalerite in the parent limestone. Areas in the residuum containing 0.05 percent Zn and more were found in association with and apparently genetically related to a primary zinc deposit in the bedrock. The rapid test for zinc used in this survey (*see* Geophysical Abstract no. 11588) gives promise of becoming a useful tool in zinc exploration.—*M. C. R.*

11587. Keller, W. D. Higher alumina content of oak leaves and twigs growing over clay pits: Econ. Geology, vol. 44, no. 5, pp. 451–54, 1949.

The ash from samples of oak leaves and twigs was spectrographically quantitatively analyzed, and found to be richer in alumina where the trees grew over clay deposits rich in alumina. The leaves and twigs were partly dried in paper sacks and ashed in an electric muffle at red heat in a platinum dish. The ash samples were excited directly in a carbon arc of a Hilger spectrograph, and estimates of relative compositions were made by comparison of line densities on the photographic plate. It is probable that the method followed by the author can be used as an indicator of the Al content of substratum clay.—*S. T. V.*

11588. Lakin, H. W., Stevens, R. E., and Almond, Hy. Field method for the determination of zinc in soils: Econ. Geology, vol. 44, no. 4, pp. 296–306, 1949.

A method for the field estimation of total zinc in soils has been developed and tentatively adopted by the Geochemical Prospecting Unit of the U. S. Geological Survey. A small sample of soil is fused with potassium bisulfate, the fused mass dissolved in water, buffered at pH 4 to 5.5 with acetate buffer, and sodium thiosulfate added to prevent reaction of copper, mercury, silver, gold, lead, bismuth and cadmium with dithizone. Measured increments of the sample solution are added to a carbon-tetrachloride-dithizone solution, with vigorous shaking after each addition, until a standard color is obtained in the organic phase. Forty to sixty determinations per day can be made by one man. Comparisons of data from the field method with accurate laboratory analyses indicate the field method is sufficiently reliable for use in geochemical prospecting if an adequate number of soil samples are analyzed, but single determinations should never be used to draw a conclusion.—*M. C. R.*

8. DRILL-HOLE METHODS

11589. Bush, R. E., and Myers, J. P. A composite radioactivity log of the east Texas basin: Tomorrow's tools today, vol. 15, no. 3, pp. 12–16, 34, 1949.

In the east Texas district each geological formation exhibits certain characteristics which make it easily recognizable on the radioactivity well log, and the log may therefore be used to advantage in establishing correlative markers and determining possible productive formations. Several examples of radioactive behavior of typical geological formations in east Texas and the interpretation of the corresponding logs are given.—*S. T. V.*

11590. Campbell, J. L. P., and Winter, A. B. Production evaluation from radioactivity logs: Tomorrow's tools today, vol. 15, no. 2, pp. 4–8, 1949.

Important information for use in appraising and evaluating drilled property can frequently be obtained from the radioactivity logs regardless of the physical condition of the well. The radioactivity log is especially useful in places where salt contamination affects the mud in the well, making it impossible to obtain good electrical logs. West Texas and New Mexico areas are examples of such conditions. The article contains several radioactivity logs and their interpretations for the curves obtained in sand formations, in limestone and dolomite.—*S. T. V.*

11591. Colorado School of Mines Quarterly. Sources of subsurface information: Vol. 44, no. 3, pp. 820–826, 1949.

Information concerning the collections of well logs and of samples of geophysical exploration available in this country is given. One of the most complete collections is the Well Sample Library of the Colorado School of Mines in Golden, Colorado, containing more than 220,000 samples from 1,439 wells. A number of typical electric logs are also available for study. Similar sources of information on petroleum geology include the Well-sample Library of the University of Texas,

Austin, Texas, containing samples from over 25,000 oil, gas, and water wells from every section of Texas; Well-sample Library of the Arkansas Geological Society, Little Rock, Arkansas; Kansas Well-Log and Sample Bureau in Wichita, Kansas; Petroleum Information, Inc., of Denver, Colorado; and the New Mexico Bureau of Mines and Mineral Resources, Socorro, New Mexico.—*S. T. V.*

11592. Doll, H. G. Induction logging and application to logging of wells drilled with oil base mud: Colorado School of Mines Quart., vol. 44, no. 3, pp. 340–345, 1949.

A new method of electric logging, known as "induction logging" has been introduced for resistivity measurements in holes where a direct contact between the electrodes and the drilling mud is not possible. An alternating magnetic field is generated in the formations surrounding the hole by alternating current sent through a coil, referred to as the transmitter. This magnetic field creates circular eddy currents in the formations and, as a secondary effect, on electromotive force in a special coil, called the receiver, mounted at a selected distance above the transmitter. The intensity of this electromotive force is proportional to the circular eddy currents and consequently to the electric conductivity of the formation opposite the transmitter. Because of the anisotropy of formations traversed by the hole the induced currents do not cross the boundary from one region to the other, and correlation charts are easy to construct.

A description of the instruments used in this method of well logging and a comparative table containing a self-potential curve, a resistivity curve obtained by usual technique, and a resistivity curve determined by induction logging are given.—*S. T. V.*

11593. Grant, R. G. Radioactivity well logging in Mississippi: Tomorrow's tools today, vol. 14, no. 3, pp. 4–9, 1948.

Radioactivity well logging and its uses and advantages are discussed. Several examples of complete radioactivity logs obtained in Mississippi illustrate the techniques of this method of well exploration.—*S. T. V.*

11594. Greider, Bob. Lithologic logging: Colorado School of Mines Quart., vol. 44, no. 3, pp. 296–302, 1949.

The lithologic (sample) log is indispensable in exploration because important lithologic characteristics of sediments, such as grain size and shape, crystallinity, color, and accessory minerals, are not determinable from electric or radioactive profiles, and unconformities are difficult to evaluate from electric log data without stratigraphic details. The lithologic log is normally used in conjunction with the self-potential and resistivity logs and must be carefully correlated with them. The author gives detailed instructions on the process of collecting rotary samples and cable-tool samples and their preparation and analysis, describes the necessary equipment for their examination, and gives examples of percentage description and interpretive description.—*S. T. V.*

11595. Henley, Jack. Correlation between neutron curves and drilling time logs: Tomorrow's tools today, vol. 15, no. 1, pp. 30–31, 1949.

Correlation of the neutron curve with the drilling time log quite often gives an operator information about the exact location of formation tops

which is very reliable in limestone areas. Several examples are given showing how it is possible, by comparing the two well logs, to get precise information on the geological characteristics of subsurface formations.—*S. T. V.*

11596. Langton, Arthur. Well logging by drilling mud and cuttings analysis: Colorado School of Mines Quart., vol. 44, no. 3, pp. 369–378, 1949.

Modern methods of mud analysis make possible the detecting of the most minute quantities of oil and gas contained in a porous formation penetrated by the bit and the exact placing of these "shows" at the proper depth. In the application of this method continuous tests are made on the mud and cuttings returning to the surface. The gas content in the mud and in the cuttings is determined by a hot wire gas detector, cuttings being first ground. The presence of oil is detected by a physical examination of the mud under ultraviolet light. Simultaneously density, temperature, and viscosity of the mud are measured and recorded. Sand and lime contents in the cuttings are also determined. A description of the equipment used in this logging is given.—*S. T. V.*

11597. Mercier, V. J. Radioactive and electrical logging: World Oil, vol. 122, no. 7, pp. 128–132, 1949.

Electrical and the radioactivity logs are correlated with information obtained in core analysis, drill stem tests, and production results of a well, and advantages and disadvantages of the two systems are pointed out. On the whole the radioactivity logs seem to be more advantageous for by this method it is possible to obtain a satisfactory log under practically any borehole conditions. Of particular significance in limestone areas is the clear delineation of highly radiocative shales on radioactivity logs and the ability of the neutron log to indicate zones of porosity.—*S. T. V.*

11598. Mercier, V. J. Radioactivity well logging: Colorado School of Mines Quart., vol. 44, no. 3, pp. 345–359, 1949.

Radioactivity logging and its advantages are described. Several practical examples of radioactivity well logging and comparative charts of this and other methods are given. The author believes radioactivity logging is the most economical survey available.—*S. T. V.*

11599. Patnode, H. W. Relation of drilling-mud resistivity to mud-filtrate resistivity [abstract]: Oil and Gas Jour., vol. 47, no. 24, p. 93, 1948.

The resistivities of a series of slurries composed of fine-grained particles of high resistance have a definite relation to the resistivity of the suspending fluid. A slurry made with a clay, such as Aquagel, may have a higher or a lower resistivity than the mud filtrate, depending on the effective relative resistances of the suspended clay and the fluid it displaces. A drilling mud filtrate usually has a resistivity appreciably lower than the resistivity of the mud, though it may be the same or greater. The ratio of mud-filtrate resistivity to mud resistivity has been found experimentally to range from 1.5 to 0.66. In view of their differences, both mud resistivity and mud-filtrate resistivity must be determined at specified temperature when electric logs are run in order to make accurate calculations from these logs possible.—*V. S.*

11600. Saye, Ed, 3d. Radioactivity well log interpretation in the East Lindsay Field of Oklahoma: Tomorrow's tools today, vol. 15, no. 2, pp. 17–24, 1949.

Accurate determination of geophysical properties becomes increasingly important with the increasing depth of wells. Coring gives important information on sub-surface structure, but is very expensive and time consuming. Combining coring with radioactivity logging reduces the cost substantially. Cores are cut from the first well or two drilled in the new field, and then a radioactivity well log is run in these wells. By comparing the data of the coring with the neutron curve, the effective pays can be picked out readily. Later the radioactivity logs are run in any subsequent well drilled in the field and without additional coring it is possible to make an accurate correlation of stratigraphy and locate possible producing zones. The article gives examples of the data obtained from coring and of the information obtainable from electrical log, the neutron and the gamma ray curves, and shows how different geological formations can be properly correlated.—*S. T. V.*

11601. Stratton, E. F., and Ford, R. D. Electric logging: Colorado School of Mines Quart., vol. 44, no. 3, pp. 302–349, 1949.

The authors discuss self-potential logs obtained in formations bearing fresh and salt water, the influence of the porosity and permeability of the formation, the effect of the drilling mud, of bed thickness, of variation in hydrostatic pressure and give typical logs for various cases. A special section is devoted to definition of different terms used in practice. The interpretation of logs is discussed in detail and examples are given of numerous logs obtained in practical exploration. Fifteen additional charts, inserted by the editors, illustrate certain lithologic and electrical characteristics of different bore holes.—*S. T. V.*

11602. Tixier, M. P. Electric log analysis in the Rocky Mountains: Petroleum Engineer, vol. 21, no. 7, pp. B34–52, 1949.

Good approximation of the water saturation and porosity of the reservoir rocks in the Rocky Mountains may be made from data derived from resistivity and *SP* logs. The method is based first on the determination of an empirical relationship between water saturation in uncontaminated formations and in invaded zones, and, second, on results from field experiments regarding the relationship between *SP* deflections and the resistivities of mud and formation water. Several examples of the application of the method are given. (*See also* Geophysical Abstract 11603.)—*S. T. V.*

11603. Tixier, M. P. Evaluation of permeability from electric-log resistivity gradients: Oil and Gas Jour., vol. 48, no. 6, pp. 113–122, 1949.

In wells traversing reservoir rock saturated with water at the bottom and with oil at the top, electrical resistivity increases from bottom to top and is a linear function of depth in the transition zone in formations of low permeability. These observations are expressed in a formula for the resistivity gradient and are combined with known formulas for relation between electrical resistivity and water saturation, water saturation and capillary pressure, and capillary pressure and permeability to deduce an equation relating resistivity and permeability. The

equation depends on the densities of formation water and oil in a well and makes it possible to determine the permeability from electric logs in many cases.

Three charts of master curves are plotted from the equation to represent the relation between resistivity gradient and permeability, each chart being drawn for a different density of formation water and containing curves for different computed oil densities. The resistivity gradient is computed from the log by means of the formula, the densities of local formation water and oil estimated, and the permeability corresponding to the gradient found on the suitable chart and curve. The average values determined by this method for the Rangely sandstone of Colorado, the Layton sandstone of Oklahoma, the Cisco sand of northern Texas, and the Tensleep sand of Wyoming are 2.2, 34, 420, and 425 millidarcies, respectively, compared with laboratory average values of 2.72, 27, about 450, and 450 millidarcies.—*V. S.*

11604. Alvarez, Manuel. Porosidad y permeabilidad en la relacion con la inyeccion de gas en un campo pertrolero [Porosity and permeability in relation to gas injection in an oil field]: Petroleos Mexicanos, no. 72, pp. 100–111, 1949.

The flow of a mixture of liquids and gas through an underground formation is a more complicated phenomenon that that of a homogeneous fluid. Experiments and observations have shown that the permeability of a porous medium for gas is almost zero as long as the medium is saturated with liquid. When the liquid content is 90 percent of saturation the permeability for the gas begins to increase and reaches 30 percent of the permeability of the dry medium when the liquid content is 45 percent of the saturation. It reaches 90 percent when the liquid content drops to 20 percent of saturation. Further decrease of the amount of liquid does not change the permeability for the gas. In accordance with these data the moment of gas injection into an oil deposit must be determined. This makes necessary the measurement of the pressure and of the ratio gas-liquid in the deposit. These observations refer primarily to sandstone, but are also applicable to limestone and dolomite.—*S. T. V.*

9. UNCLASSIFIED GEOPHYSICAL SUBJECTS

11605. Andreev, B. A. The calculation of the spatial distribution of potential fields and its utilization in exploration geophysics, part 2 [in Russian]: Akad. Nauk SSSR Izv., Ser. Geog. i Geofiz., vol. 13, no. 3, pp. 256–267, 1949.

The calculation of the spatial distribution of potential fields, previously examined for the upper half space, is analyzed for the lower half space containing the sources of potential. Among the methods of extensions of the potential function from the upper into the lower half, the use of Taylor series, applied by H. Evjen and S. Pirson to gravity anomalies, is considered of little value because all components of the field change very rapidly near the sources. On the other hand, the use of Neuman's and similar equations, derived from the Poisson formula, is deemed impractical because of their complexity.

It is pointed out that solutions can be sought for the same equations in the form of infinite series, instead of in the above finite form, and two methods of successive approximations are applied to an integral equation for the two-dimensional problems, derived from the Poisson formula. One, involving the use of finite differences for calculating values of the potential function at points on a vertical line passing through the upper half space, gives expressions analogous to those of D. S. Hughes for the three-dimensional problem and allows a relatively simple determination of the function as the boundary value of a finite sum for $n \to \infty$. However, rapidly increasing cumulative errors make the calculation of the 4th or 5th finite difference inaccurate and invalidate the method for practical application.

In the other method, series of successive approximations are employed to derive from the initial equation a formula of a relationship of recurrence, the members of which are expressed not as finite differences but as integrals of the Poisson type computable by the author's technique without the accumulation of errors. This formula yields by further transformations a solution of the initial equation provided the successive approximations are uniformly convergent. A further analysis of a gravitational or magnetic anomaly, produced by an infinitely thin and infinitely long linear body, leads to the final conclusion that the process of successive approximations for any derivative of the gravitational and magnetic potential converges uniformly and gives the value of the derivative at any point of the lower half space satisfying the condition that the minimum depth of the source of potential be greater than the depth of the point, which in turn must be greater than zero.—*V. S.*
(For part 1 of paper *see* Geophysical Abstracts 131, no. 9629.)

11606. Bacher, Konrad. Über die Bestimmung der elastischen Konstanten von Gesteinen mit Ultraschall [Determination of the elastic constants of rocks by supersonics]: Erdöl u. Kohle, vol. 2, no. 4, pp. 125–127, 1949.

A method is described of accurately determining the velocity of propagation of seismic waves from measurements made on small samples of rock such as well logging cores. The rock sample, shaped as a small plane-parallel plate, is exposed to sound waves of variable frequency ranging from 1,000 to 20,000 kilohertz and the amount of sonic energy passing through the plate at different angles of incidence is measured. It is possible to determine the velocities of both transverse and longitudinal waves with an accuracy estimated as ± 2 percent. Tables give the density, longitudinal and transverse velocities, Poisson's ratio, and shear and Young's moduli of 15 rocks and minerals studied by the author as well as comparisons with velocities given by other investigators. Longitudinal velocities in meters per second for the various rocks are as follows: basalt, 5,830 and 5,930; gypsum, 4,790; glass, 5,900; mica, 7,760; gneiss, 7,870; limestone, 5,210 and 6,130; marble, 6,150; charcoal, 3,700; schist, 6,500 and 5,870; serpentine schist, 5,060; rock salt, 5,250. With the exception of basalt, velocities determined by the supersonic method lie near the upper limit of those determined seismically.—*S. T. V.*

11607. Correns, C. W., and Schumann, H. Zur Durchlässigkeitsbestimmung der Gesteine [Concerning the determination of the permeability of rock]: Erdöl u. Kohle, vol. 2, no. 10, pp. 439–442, 1949.

A new method of permeability determination, tested by the authors for accuracy in the laboratory of the University of Göttingen on several hundred samples, is described. A specimen of quadratic shape, two centimeters wide and one centimeter thick, is cut from the rock. This specimen is first kept in a Soxlet apparatus, filled with carbon tetrachloride for about twelve hours, after which it is boiled in the same liquid for six to ten hours, until the emitted CCl_4 becomes colorless and only slightly fluorescent. This corresponds to an oil content in the sample of less than 1.5×10^{-5} gr. oil per gram of rock. The sample is finally dried at 105° C, and placed in a special apparatus in a stream of air and the corresponding pressure drop across the plate is measured, as well as the amount of the passing air, its temperature and pressure. On the basis of D'Arcy's law, with corresponding corrections for turbulent flow, tables are computed which make possible the determination of the porosity of the sample. The apparatus can be also used to determine the porosity of such aggregates as oil bearing sand. A detailed description of the procedure is given in the article.—*S. T. V.*

11608. Deegan, C. J. How should you use geophysics?: Oil and Gas Jour., vol. 48, no. 18, p. 125, 1949.

The author points out that in exploration under competitive conditions it is usually impractical to defer decisions on land leases for purposes of exploitation until seismic data are obtained and that there is justification for placing greater reliance on magnetic and gravitational reconnaissance and regional geologic knowledge in making leasing arrangements.—*V. S.*

11609. Minaw, Faris. Triode valve oscillation hysteresis with a view to radiogeophysical prospection: Inst. d'Égypte Bull., Tom. 30, pp. 101–115, 1949.

Under certain conditions, a triode valve oscillator shows a hysteresis behavior. As the capacity of the anode oscillatory circuit condenser is increased gradually, the triode oscillator jumps, at a point, from a state of oscillation to a state of non-oscillation. As the capacity is decreased gradually, the system jumps from a state of non-oscillation to a state of oscillation but at a point which is not identical with the first mentioned. By stabilizing the oscillator and fixing the working conditions, the one for increasing capacity may be used as a reference point with respect to which small capacities or capacity changes can be measured by substitution. For geophysical applications, a dipole antenna is connected to the anode oscillatory circuit. This provides the possibility of developing a method that may be used to indicate the presence or absence of nearly located underground water in desert or arid regions, and to indicate the approach of an airship to water, or in damp regions to ground, or to a mountain when visual methods fail. A circuit diagram is given and factors controlling the values of anode circuit capacity at which the sudden changes of capacity occur are discussed.—*M. C. R.*

11610. Robb, G. L. Geologic techniques in civil engineering: Colorado School of Mines Quart., vol. 44, no. 3, pp. 780–819, 1949.

The article contains an extensive discussion of different geological and geophysical methods of exploration of sites for engineering structures. In many engineering geology problems certain types of information, such as the depth to firm bedrock or the extent of a buried gravel deposit, can be obtained by geophysical methods at less cost and more quickly than by drilling or other means. Geophysical exploration in connection with engineering problems pertains to near-surface conditions which normally are eliminated from geophysical exploration as conducted in the petroleum industry. The most widely used methods of geophysical exploration in the engineering field are the seismic refraction and the electrical resistivity techniques. Less frequently used are the magnetic and gravimetric methods. Several practical examples of the application of geologic techniques to engineering, such as in the construction of the Davis Dam, Keyhole Dam, Malhear Siphon, Palisade Dam, and the analysis of the Columbia River landslides are described.—*S. T. V.*

11611. Schneider, W. C., and Burton, C. J. Determination of the elastic constants of solids by ultrasonic methods: Jour. Appl. Physics, vol. 20, no. 1, pp. 45–58, 1949.

The application of ultrasonic methods to the determination of the elastic constants of solids is considered in some detail. A rotating plate technique has been devised which makes use of the variation of intensity of the transmitted energy with the angle between the incident beam and a sample plate. A plane parallel sheet of material is used for a sample and is rotated about a vertical axis perpendicular to a horizontal sound beam. The generator (a piezo electric crystal) sample, and detector (also a piezo electric crystal) are immersed in liquid. The velocities of dilatation and transverse waves in the sample may be determined from the critical angles at which total reflection occurs, and from these data Poisson's ratio and the mechanical moduli may be derived. The method was developed chiefly for use with plastics but has been successfully applied to the measurement of the elastic constants of several metals.—*M. C. R.*

11612. Sestoft, Ingolf. A geophysical theory of the ice ages [abstract]: Union Géod. et Géophys. Internat. Assoc. de Séismol. Comptes Rendus no. 9 bis, pp. 5–9, 1949.

Increased moisture and circulation of the air necessary for planetary glaciation may be attributed to the disengagement from the interior of the earth of heat accumulated by radioactive processes during long geological periods. The great escape of heat must take place through the basaltic floor of the Pacific. When the accumulation of heat approaches its climax, the melting point of the magma will be reached below the continents and at a comparatively small depth under the bottom of the Pacific Ocean, the result being not only the sinking of the continents but also a considerable heating and increased evaporation of the waters of the Pacific. As the continents are later squeezed to extreme heights when the basalt hardens, the precipitation will be in the form of snow, and glaciation will follow.—*M. C. R.*

10. RELATED GEOLOGICAL SUBJECTS

11613. Agostinelli, Cataldo. Sulla variazione della velocità angolare terrestre durante una lunazione [On the variation of angular velocity of the earth during a lunar month]: Istit. Lombardo Rend., vol. 79, no. 2, pp. 527–547, 1944.

The variation of the angular velocity of the rotation of the earth with a period of one lunar month is caused by the changes in the distribution of the rotating masses in relation to the earth's axis as a result of tidal phenomena. The theoretical analysis of the problem takes into account the viscosity of water. The angular velocity is computed for two extreme cases of mass distribution from the equations of celestial mechanics. The results show that the variation of the angular velocity is between 0.036 and 0.096 seconds of arc per day.—*S. T. V.*

11614. Brodie, G. H. Origin of shallow structures in west central Texas: World Oil, vol. 129, no. 6, pp. 61–66, 1949.

As basement movements in west central Texas appear to have been small, particularly since Ellenberger time, it is possible that the local shallow structures in the overlying strata are formed by sedimentation rather than by tectonic processes. Draping of sediments over reef masses of such great thickness and rugged relief, comprising peaks and valleys, may produce sufficiently large structures to effect substantial closure and oil accumulation. The Wimberly pool and Noodle Townsite pool in Jones County are examples of such fields. Isolated thick sand bodies may also produce the same effect. The possibility of such origin of shallow structures would justify wider oil exploration.—*V. S.*

11615. Deegan, C. J. Gulf coast oil—Why are these fields where they are? Oil and Gas Jour., vol. 48, no. 2, pp. 190–192, 326–330, 1949.

The distribution of oil fields in parallel belts on the Gulf coast of Texas and Louisiana is explained by the gradual recession of the coast line through the geologic periods because of accumulation of eroded soil along the shores. As not all the 900 local fields are equally productive, the largest 24 of them accounting for 67 percent of all the oil produced up to January 1, 1949, and for 35 percent of the proven reserves of the entire area, the problem of profitable extension of exploitation offshore is the finding of the richest fields, so as to offset increased cost of marine drilling and operation. According to sedimentological studies such fields appear to be located on land mainly in the areas of the Colorado-Brazos delta and the Rio Grande delta and to be producing predominantly from the Marginulina-Frio and only secondarily from the Wilcox-Yegua, other formations being less significant. Further sedimentological work on the coast is of aid in narrowing principal promising offshore areas.—*V. S.*

11616. Frost, A. Some thoughts on the functions of geology and geologists: Geol. Soc. South Africa Proc., vol. 51, pp. XXV–XXVII, 1949.

This is a presidential address delivered to the Society in which the main function of geologists is defined as the finding for mankind of such

materials as can be obtained from the earth's crust and supplying information concerning its structure and content. It is suggested that geophysical data should be collected in the early stages of an investigation so that they would be available to the geologist trying to interpret the geology of the area. Geophysical data should be fitted to the possible structural interpretations and if none of them fits, other interpretations should be devised to conform to the data. It is important that geophysicists be aided and encouraged into new, better and more reliable methods of obtaining the data required to help solve the increasingly difficult geological problems.—*S. T. V.*

11617. Gunn, Ross. Isostasy—Extended: Jour. Geology, vol. 57, no. 3, pp. 263–279, 1949.

In recent years, as methods for correcting for elevation, density, and topography have become more accurate, it has become increasingly clear that many regions of the earth cannot be in isostatic adjustment. Large gravity anomalies have been interpreted as indicating gross departures from normal density in the vicinity of the observing stations and it has frequently been suggested that they imply an unstable geological structure, even where no diastrophic activity is in progress. Such discrepancies in the interpretation of gravity anomalies can be eliminated by including an aspect of crustal stability specifically ignored by the earlier investigators of isostasy. The author presents the basic principles for the equilibrium of a lithosphere supported by a weak underlying magma but endowed with a substantial elastic strength. Under such conditions localized geological loads are spread over a considerable area and this results in the establishment of an extended isostatic equilibrium, called by the author isobaric equilibrium. The basic mechanism and methods for determining the deformation of the lithosphere under various kinds of loading are outlined. The hypothesis suggested by the author makes possible the forecasting of the magnitude and distribution of gravity anomalies from structural data and, conversely, the deduction of the structural details from gravity anomalies. Gravity anomalies do not, in general, imply an unstable geological condition, but indicate that part of the stabilizing system of forces arises from the strength of the lithosphere.—*S. T. V.*

11618. Guzman, E. J. Pemex reports full details of exploration, drilling, and development activities in northeastern Mexico: Oil and Gas Jour., vol. 47, no. 46, pp. 165–180, 1949.

An account is given of geological, geophysical, and drilling exploration conducted by Petroleos Mexicanos (Pemex) in the Tertiary basin of northeastern Mexico. The area is stratigraphically and structurally part of the Gulf Coast of Texas, Louisiana, and Mexico. Attention is centered on the geologic aspects of exploratory drilling in the most active area of Reynosa [Reinosa], adjacent to the Rio Grande and extending from Camargo to the Gulf Coast. The structures drilled near the United States border are described, seismological maps and cross sections are presented, and tentative correlations with wells on the American side are given.—*V. S.*

11619. Hieronymus, Hellmuth. Eine Zweipolschollenhypothese für die Erde [Hypothesis of two polar continents of the earth]: Geofis. Pura e Appl., vol. 14, no. 3–4, pp. 194–196, 1949.

Development of Wegener's theory of continental drift, which assumes a single original continent formed on one side of the earth, leads to logical contradictions: the continental masses move partly against the centrifugal force of the earth's rotation, and the separation of the continents takes place at a geological age when the earth's crust had already become solidified, which is improbable. A modification is proposed in which two original continents, one at each pole of the earth, are assumed. These broke into several parts after an initial shock, moved toward the equator and became separated from one another. This assumption of two original polar continents removes the difficulties of Wegener's theory and is in agreement with other geological theories.—*S. T. V.*

11620. Hume, W. F. Terrestrial theories. A digest of various views as to the origin and development of the earth and their bearing on the geology of Egypt. 682 pp. Cairo, Government Press, 1948.

The contents cover the nature of the universe, nature and origin of the solar system, theories of the origin of the earth, nature of the earth's internal structure, isostasy, radioactivity and convection currents, nature of the pre-Cambrian, and considerations regarding the presence or absence of life in the pre-Cambrian. Nearly half the book is devoted to a chronological review of theories of the origin and subsequent history of continents and oceans.—*M. C. R.*

11621. Kosiba, Aleksander. Zagadnienie poziomych ruchów kontynentów w swietle niektorych wyników badawczych [Wegener's theory of continental drift in the light of new researches]: Czasopismo geograficzne, vol. 18, no. 1–4, App. 80–97, 1947.

Recent geodetic and astronomical measurements do not show any distinct tendency toward an adequate variation of longitude, especially with regard to Greenland, to confirm the Wegener theory of the horizontal movement of continents. Many sources of possible error in previous geodetic determinations are also pointed out but it is concluded that the theory should not be completely rejected. Because of the fundamental importance of the problem a joint international investigation is proposed to make use of the more accurate methods and instruments of present day science.—*S. T. V.*

11622. Marmer, H. A. Sea level changes along the coasts of the United States in recent years. Am. Geophys. Union Trans. vol. 30, no. 2, pp. 201–204, 1949.

Systematic tide observations by the U. S. Coast and Geodetic Survey along the coasts of the United States for the past 20 years or more indicate greater relative subsidence of the Atlantic coast between Boston and Mayport since 1930. The rate is about 0.02 foot per year. Greater relative subsidence since 1930 is also indicated along the Gulf and Pacific coasts, the rate being only two-thirds of a hundredth of a foot per year in the last case. In contrast, sea level at Ketchikan, Alaska rose from

1919 to 1935, remained stationary to 1940 and has since been falling. These varying rates suggest differential movements of the continental block. Results of systematic tide observations throughout the world may differentiate between effects of a general rise of sea level and crustal movements.—*M. C. R.*

11623. Menzel, D. H. Our sun, 326 pp., Philadelphia, Blakiston Co., 1949.

This is a treatise on the dominant member of our planetary system with brief discussion of different methods of studying it. Astronomical theories and astrophysical phenomena are expounded in plain language without use of mathematics.—*S. T. V.*

11624. Pettersson, Hans. The geochronology of the deep ocean bed: Tellus, vol. 1, no. 1, pp. 1–5, 1949.

It is difficult to date the strata of the deep ocean bed by the method of lead or/and helium ratio to uranium or/and thorium, used for continental rocks, because of the slowness of disintegration of the two parent elements, their small content in ocean sediments, and the unsuitable structure of their deposits. Accordingly, the author examines other methods of studying cores, in part analyses of the more short-lived elements of the uranium series.

The findings of Piggott and Urry that radium content decreases with depth below the sedimentary surface, and consequently with time, may provide a method of determining the rate of sedimentation within the latter half of the Quaternary when radium is ionium-supported, so that its disintegration rate is accelerated. The author's research on manganese concretion nodules, in which radium is separated from ionium, may also aid age determinations in some cases, as the mean rate of their radial growth with time has been established from the decrease of radium content toward their center. The work of Thorarinsson in Iceland and of Neeb in the Sunda Seas suggests the possible use of volcanic ash layers in geochronological studies. Other approaches considered promising are foraminiferal and pollen analyses.—*V. S.*

11625. Saltykov, N. I. Foundations of buildings most suitable to the region of the Bol'shezemel'skaya Tundra [in Russian]: Inst. Merzlotovedeniia Trudy, vol. 4, pp. 125–204, 1944.

Selection of sites and of the type of foundations for structures to be erected on a permanently frozen ground is discussed. The climatic features of a region which determine the behavior of a foundation are analyzed, the most important being the thickness of the snow layer, intensity and direction of the winds, duration of the winter, temperature during the summer months, and the thickness of the active layer of the ground. Clay ground should be avoided if possible, because it freezes and thaws with very irregular variations in volume, causing foundation settlement. The amount of the settlement is also determined by the diffusion of heat into the frozen ground. Thermal isolation of the building from the ground is often necessary. The author also recommends the erection of buildings on basements well ventilated in winter. The load on the carrying area of the ground should not exeed 7.5 pounds per square inch.—*S. T. V.*

11626. Vershinin, P. V., Deriagin, B. V., and Kirilenko, N. V. Concerning the ground water that does not freeze [in Russian]: Akad. Nauk SSSR Izo. Ser. Geog. i Geofiz., vol. 13, no. 2, pp. 108–114, 1949.

The properties of the ground, important in construction work, hydrotechnics, and electrical exploration, depend in part on the state of the water present in it. An investigation was made of the relation of the volume of non-freezing water and electrical conductivity to the temperature, porosity, water saturation, and particle size of the ground by calorimetric and electrical resistivity methods. The curves for water saturation of 10.79, 19.37, 27.08, and 57.2 percent, plotted against decimal logarithms of electrical resistivity and temperatures declining from +16° to −20° C. showed that at the lower temperatures the resistivity increases with saturation notwithstanding the corresponding augmentation of non-freezing water. This effect is attributed to the interstitial ice, formed in greater amount with water saturation, which presses to disjoin adjacent ground particles and thus increases resistivity at the points of their contact. On the other hand, the considerably more uniform resistivity found with increasing temperature for the least water-saturated ground is considered to indicate that the immediate water coatings of ground particles do not freeze even at −20° C. and thus must have a freezing temperature different from 0° C. It is concluded from these and related results that two basic causes operate simultaneously to prevent complete freezing: the difference in the freezing temperature of water under ordinary conditions and of water in thin layers on the surface of ground particles, and the expansion of ground volume in freezing due to formation of ice, for which small interstitial spaces leave no room.—*V. S.*

11627. Ver Wiebe, W. A. Oil fields in North America. 251 pp. Ann Arbor, Edward Brothers Inc., 1949.

This revised edition of Ver Wiebe's book contains descriptions of the geologic setting, stratigraphy, structure, and production of oil and gas fields of continental North America. Classification is on the basis of structural units which in turn are subdivided on a geographic basis. An introductory chapter discusses the origin, migration, and accumulation of petroleum and natural gas.—*M. C. R.*

11628. Wegmann, C. E. Geological tests of the hypothesis of continental drift in the Arctic regions: Meddelelser om Grønland Bd. 144, no. 7, 1948.

The development of the drift hypothesis is briefly outlined. Attention is called to the "De Geers Line" from Vesteraalen in Norway along the continental slope off Bear Island and Spitsbergen to Greenland and along the continental margin north and west of the Arctic archipelago to the mouth of Amundsen Sound. If the American-Greenlandic block moved along this line toward the European block, the highlands of Peary and Grant Land would come into position outside Spitsbergen and the Barents Sea, corresponding to Scandic land which supplied the material for the Mesozoic and Tertiary sediments on Spitsbergen. Geologic investigations to test this hypothesis would include geochemical and petrographic studies of the clastic sediments of the Spitsbergen synclinorium and geologic-petrographic and geochemical investigations in Grant Land and Peary Land.—*M. C. R.*

11629. Wilson, M. E., chairman. Structural geology of Canadian ore deposits, a symposium, 948 pp., Montreal, Canadian Inst. Min. Metallurgy, 1948.

Current information on the structural traits that have controlled the formation of ore in Canadian mining areas is assembled in this volume. Papers contributed by 123 Government, university, and mining geologists, mining engineers, and company consultants, cover the general features of the Cordilleran, pre-Cambrian Shield, and Appalachian provinces and districts and the local characteristics of particular deposits. The material presented shows that in every case ore deposition has been closely associated with some structure and that exploration for new deposits and for extensions of old fields must be guided by an understanding of structural form. The text is illustrated by sketch maps, geologic sections, and photographs, and is supplied with a comprehensive index.—*V. S.*

11630. Workman, L. E., and Bell, A. H. Deep oil possibilities in Illinois: World Oil, vol. 128, no. 8, pp. 128–134, 1948.

Oil possibilities in the St. Peter and deeper formations in Illinois are examined on the basis of evidence from 16 dry holes drilled during the last 4 years in the western part of the State from Madison to Hancock Counties and in the central to northern part from Douglas to Lee Counties. A comparison of structure contour maps of the top of the St. Peter formation, and of the surface of the pre-Cambrian basement indicates that the thickness of Paleozoic sediments between these horizons may vary from 2,000 to more than 4,000 feet. Two geologic sections are shown through the northern and the central part of the State, giving lateral variations in the thickness and lithology of formations. This drilling evidence offers no favorable prospects of oil at deep levels in the northern one-third of Illinois. Farther to the south there appears to be a general decrease of oil productivity down from the Mississippian system, so that such accumulations as may exist in the pre-St. Peter Ordovician and in the Cambrian formations on known structures are likely to be small. However, it may be possible to locate by geophysical methods some structures below old unconformities that are not reflected in known key horizons.—*V. S.*

11. TECHNICAL AIDS TO EXPLORATION

11631. Church, Earl. Theory of photogrammetry. Syracuse University, Dept. Photogrammetry, Bull. no. 19, 1948.

This short text covering both terrestrial and aerial photogrammetry is designed for use in a one 3-semester-hour graduate course.—*M. C. R.*

11632. Deegan, C. J. Raydist, a method of surveying by use of radio waves: Oil and Gas Jour., vol. 48, no. 9, pp. 69–71, 90–91, 1949.

In surveying by the Raydist method, use is made of 3 land radio-stations and of 2 intersecting sets of numbered hyperbola lines drawn on the map to indicate where the waves transmitted are in phase. The boat, or vehicle, the position of which is to be determined, carries 3 radio receivers and 2 phase meters, the latter being equipped with counters registering the same numbers as those of the hyperbolas on the map. When the boat leaves port, these 2 counters are set in an initial

position to check with the numbers of the 2 hyperbolas at the port's location on the map. As progress is made to destination, each phase meter automatically adds or substracts one number on its counter every time the boat reaches the next hyperbola line. Thus, at any point on the boat's course, its position may be determined by reading the meters' counters, looking for the corresponding numbered lines on the map, and finding their intersection, which is the location sought.—*V. S.*

11633. Derry, D. R. Geological mapping: Canadian Min. Met. Bull., vol. 41, no. 440, pp. 682–688, 1948.

A summary is presented of answers given by Canadian geologists to a questionnaire circulated by the Sub-Committee on Mapping, Field Methods, and Mining Geology, of the Geology Division, Canadian Institute of Mining and Metallurgy. The information constitutes the sub-committee's report for 1947–48 and consists of a section on field methods of geologic mapping and a section on standardization of map symbols. The field methods include those used in surface geology and in mining geology and pertain to aero-photography, ground techniques, and underground mapping. The problems of map standardization include the use of uniform scales, coloring, and symbols for contour lines, faults, shear zones, geologic boundaries, strikes, dips, and outcrops. Suggestions are given on the general improvement of geological maps.—*V. S.*

11634. Hagiwara, Takahiro. A new device for remote mechanical recording of slow movements: Tokyo Imp. Univ. Earthquake Research Inst. Bull., vol. 19, no. 3, pp. 523–526, 1941.

Remote recording of slow movements, such as daily or secular changes of the earth's magnetic field or the drift of the zero point of a gravimeter, is often necessary in geophysical studies. A method is proposed which depends on the time interval separating electrical signals and which is applicable to all measuring instruments which have a recording device with an optical lever. A light ray from a lamp with vertical filament strikes a mirror on the movable system of the instrument and is reflected to a vertical screen provided with a slit behind which a phototube is placed. If the image of the filament comes to the slit and illuminates the photo-tube an activating current is turned on and the lamp is rotated, repeating the motion of the mirror. A special electromagnet marks on recording paper a dot corresponding to the position of the deflected mirror. The record consists of dots marked every four minutes. Several pictures of the instrument and its parts and a wiring diagram of the electric circuit are included.—*S. T. V.*

11635. Iberall, A. S. A novel recording accelerometer: Rev. Sci. Instruments, vol. 20, no. 4, pp. 304–307, 1949.

The U. S. Bureau of Standards has developed a small recording accelerometer for testing personnel in flight. Requirements included a range of 12*g*, accuracy within 4 percent of full scale, a natural frequency of 10 c. p. s., a permanent record visible while recording, paper speed between 4 and 12 inches per minute, and, if electrically operated, operation from 28 volts d. c. The method of design may be followed in constructing other small or panel type slow speed recording instruments.—*M. C. R.*

11636. Kendall, D. N. Airborne survey techniques aid in ground exploration: Precambrian, vol. 12, no. 6, pp. 6–8, 1949.

Aerial aids to ground exploration include aerial photographs, aerial maps, aerial positioning, and aerial geophysical techniques. Aerial geophysical techniques either depend on aircraft for transportation, as in gravitational and seismic surveys with helicopter-transported instruments, or are carried out by means of measurements made from the air, as in magnetic and radioactive exploration. Considerable experimental work is being done on the recording of radioactivity from the air, and five methods are reported in existence, of which the scintillation method appears to be the most promising.—*V. S.*

11637. Leonov, M. Ia. Stability of quasiharmonic oscillations [in Russian]: Akad. Nauk SSSR Doklady, vol. 64, no. 5, pp. 645–648, 1949.

To attain the highest possible precision in the design of seismographs and other instruments containing vibrating systems, it is necessary to consider cases where the frictional resistance of the moving coil does not remain constant, but varies periodically. On the basis of mathematical analysis, the conditions of dynamical stability of such a vibrating system are established in the general form. An approximate formula is also derived which yields sufficiently accurate results for technical application.—*S. T. V.*

11638. McCaslin, L. S., Jr. Aluminum exploration equipment has advantages in Gulf Coast marshes. Oil and Gas Jour., vol. 47, no. 24, pp. 88–89, 1948.

Transportation difficulties and high humidity in the marshlands of the Gulf Coast have led to the use of aluminum for the construction of heavy geophysical equipment to reduce its weight and make it corrosion-resistant. Shooting-truck bodies, dynamite trailers, water-truck bodies, flat boats, pontoons, and shot-hole drills, as well as gravimeter station platforms, and boxes for geophysical instruments are being manufactured of aluminum.—*V. S.*

11639. Slusser, E. A. Radiolocation in oil prospecting: Electronics, vol. 22, no. 8, pp. 70–74, 1949.

Radar, ratran, shoran, lorac, and raydist systems and their use in geophysical surveying are described. The long-range lorac and raydist systems, both based on phase-measuring techniques, seem particularly useful for making overwater surveys.—*M. C. R.*

12. PATENTS

[The figure in parentheses indicates the classification of the entry; see table of contents]

11640. (2) Magnetometer. Jacob H. Rubenstein, Buffalo, N. Y.: U. S. patent 2,480,265, issued Aug. 30, 1949.

In a magnetometer, an inductor having a fixed core of high magnetic permeability, an elongated member of high magnetic permeability held in fixed relation at one end of said core for directing the varying flux from an external magnetic field into said core, said elongated member having a cross sectional area and length several times that of said fixed core and said proportions of said core and member being such that when said core is approaching saturation with flux the permeability of said

member is approaching its maximum permeability, a condenser in circuit with the winding of said inductor to provide an LC circuit, means resonating said LC circuit to maintain a recirculating current therein, means maintaining a high flux density in said core short of saturation when the maximum amount of said flux from said external field is directed into said core whereby a reduction in the amount of said flux from said external magnetic field so directed into said core causes a large increase in the permeability of said core, and means measuring changes in said recirculating current induced by changes in the permeability of said core. Claims allowed, 8.

11641. (2) Combination magnetometer and gradiometer. Otto H. Schmitt, Port Washington, N. Y., assignor to the United States of America as represented by the Secretary of the Navy: U. S. patent 2,485,847, issued Oct. 25, 1949.

In a magnetometer system in which signals proportional to the sum and difference of the magnetic fields at two spaced points is required, means for obtaining such signals comprising a pair of magnetometer elements located at each of the spaced points, each element including a magnetic core and a coil extending normally to the line joining said points, a drive transformer having a pair of equal secondary windings, one of said windings being connected in a series circuit with one of the magnetometer coils in each pair in the same polarity, the other winding in a series circuit with the other magnetometer coils, one of said coils being connected in reverse polarity, the junctions between said coils being grounded, a driver oscillator for energizing the primary in said transformer, and a pair of transformers having input windings fed from the midpoints of said transformer secondaries, and output windings for delivering signals proportional to the sum and difference of said magnetic fields respectively. Claims allowed, 2.

11642. (2) Magnetic field strength indicator. Thaddeus Slonczewski, Glenwood Landing, N. Y., assignor to Bell Telephone Laboratories, Inc., New York, N. Y., a corporation of New York: U. S. patent 2,485,931, issued Oct. 25, 1949.

A system for indicating the field strength of magnetism comprising in combination three magnetometer cores of magnetic material having their principal magnetic axes mutually perpendicular, windings for each core, a source of alternating current connected to windings of each magnetometer whereby second harmonic voltages are produced therein of magnitudes proportional respectively to the product of the field strength and the direction cosine of the angle formed between the principal axis of each core and the direction of the magnetic field, an electric squaring means responsive to all three of said second harmonic voltages for producing a current varying as a function of the sum of their squares, and an indicating means responsive to said produced current whereby the indications are caused to vary as a function of the strength of the magnetic field. Claims allowed, 9.

11643. (2) Detection system. Thaddeus Slonczewski, Glenwood Landing, N. Y., assignor to Bell Telephone Laboratories, Inc., New York, N. Y., a corporation of New York: U. S. patent 2,488,341, issued Nov. 15, 1949.

A system for indicating changes in the strength of a magnetic field comprising in combination a detector magnetometer comprising a core of magnetic material having a principal magnetic axis, two orienting magnetometers each similar to said detector magnetometer, windings in each of said cores, means supporting said three magnetometers with their principal axes mutually perpendicular, a source of alternating current connected to windings of each magnetometer whereby even order harmonic voltages are generated therein of magnitudes proportional respectively to the product of the field strength and the cosine of the angle formed between the principal axis of each core and the direction of the field, an orienting means including electric motor means connected to windings on said two orienting magnetometers and responsive to selected even order harmonic voltages generated therein for maintaining the principal axis of said detector in substantial alignment with the direction of the field to be observed, an electric squaring means responsive to a selected even order harmonic voltage generated in each of the two orienting magnetometers for producing a compensating direct current varying as a function of the sum of their squares, circuits coupling the squaring means to the detector magnetometer circuit whereby the compensating direct current is caused to compensate the response of the detector magnetometer to any small angular misalignment with the field observed, a linear detector for deriving a direct current from a selected one of said even order harmonic voltages generated in said detector magnetometer and an indicating means responsive to the compensated direct current output of the linear detector. Claims allowed, 7.

11644. (2) Detection system. Edwin P. Felch, Jr., Chatham, N. J., and Francis G. Merrill, Yonkers, and Thaddeus Slonczewski, Glenwood Landing, N. Y., assignors to Bell Telephone Laboratories, Inc., New York, N. Y., a corporation of New York: U. S. patent 2,488,389, issued Nov. 15, 1949.

A system for indicating changes in the strength of a magnetic field comprising in combination a detector magnetometer comprising a core of magnetic material having a principal magnetic axis, two orienting magnetometers each similar to said detector magnetometer, windings on each of said cores, means supporting said three magnetometers with their principal axes mutually perpendicular, a source of alternating current connected to windings of each magnetometer whereby even order harmonic voltages are generated therein of magnitudes proportional respectively to the product of the field strength and the cosine of the angle formed between the principal axis of each core and the direction of the field, an orienting means including electric motor means connected to windings on said two orienting magnetometers and responsive to selected even order harmonic voltages generated therein for maintaining the principal axis of said detector in substantial alignment with the direction of the field to be observed, an electric squaring means responsive to a

selected even order harmonic voltage generated in each of the two orienting magnetometers for producing a compensating direct current varying as a function of the sum of their squares, circuits connecting the squaring means to the detector magnetometer whereby the compensating direct current is passed through the detector magnetometer to compensate its response to any small angular misalignment with the field observed, a linear detector for deriving a direct current from a selected one of said even order harmonic voltages generated in said detector magnetometer and an indicating means responsive to the output of the linear detector. Claims allowed, 7.

11645. (3) Safety device for setting off explosive charges. Russell G. Martin, Russellville, W. Va.: U. S. patent 2,481,231, issued Sept. 6, 1949.

A portable shot firer comprising an insulated box-like casing having top and bottom walls, a pair of vertically disposed dry battery cells arranged in inverted, side by side position in said casing and substantially filling the space between said top and bottom walls, a conductive spring on said bottom wall bridging the terminals on the lower ends of said cells, a spring retracted plunger contactor mounted on and operating through said top wall, said contactor being arranged to engage the upper terminal of one of said cells when depressed, a pair of laterally spaced lever contactors pivotally mounted on said top wall to swing inwardly toward each other from outward starting positions, a bridging block mounted on said top wall between said levers, spring means normally yieldably maintaining said levers in their outward starting positions in which said levers are out of contact with said bridging block, a conductive spring on the underside of said top wall engaging the upper terminal on the other of said pair of cells and connected to one of said lever contactors, a pair of jacks mounted on said top wall, and means severally connecting the remaining lever contactor and said plunger contactor with said jacks, whereby an electrical detonator connected to said jacks can be detonated only while said plunger contact is held in depressed position and both of said lever contactors are held inwardly against said bridging block. Claims allowed, 3.

11646. (3) Visual representation of complex waves. Lionel Schott, East Orange, N. J., assignor to Bell Telephone Laboratories, Inc., New York, N. Y., a corporation of New York: U. S. patent 2,481,247, issued Sept. 6, 1949.

In combination with a receiver of complex waves, a multiplicity of frequency selective means for separating the received waves into a corresponding multiplicity of component frequency bands, an oscilloscope including means for producing an energy ray and two deflectors adapted to deflect the ray in respective different directions, and means including a commutative connector between said selective means and said deflectors for deflecting said ray in a multiplicity of different directions in cyclically repeated succession and, in each said direction, to an extent dependent on the intensity of the waves in a respectively corresponding component band. Claims allowed, 9.

11647. (3) Teleseismic detecting, signaling, and recording. Roger L. Arringdale, Wakefield, Mass., assignor to Diamond Instrument Co., Wakefield, Mass., a corporation of Massachusetts: U. S. patent 2,482,233, issued Sept. 20, 1949.

A plural-component manually portable teleseismic detecting, signalling and recording system including a single supporting column and a plurality of seismometer elements for a like number of different components, said elements being operatively suspended from said column in angular relation thereto and to each other in the same horizontal plane, which passes through the column near the base thereof. Claims allowed, 6.

11648. (3) Apparatus for seismic prospecting. Alexander B. Hildebrandt, Tulsa, Okla., assignor to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,483,770, issued Oct. 4, 1949.

In a geophone apparatus adapted to first move freely in a bore hole and adapted subsequently to be clamped at a desired point in the hole, a releasable clamping means comprising a first lever pivoted to the geophone apparatus, spring means associated with said first lever exerting a bias to force an end of the lever against the wall of the bore hole, a projection secured to the said first lever, a second lever positioned to engage the projection of the first lever, spring means associated with said second lever exerting a bias on the lever to cause the lever to disengage the said projection, a rotatable bar adapted to contact said second lever to prevent disengagement in one position and to permit disengagement in a second position, a coil of wire mounted in said geophone apparatus and an armature slideably mounted in said coil and arranged to move from a first to a second position upon the flow of current through the said coil, said armature being adapted in the said first and second positions to control the rotation of the rotatable bar. Claims allowed, 2.

11649. (3) Pressure responsive transducer. Clifford Frondel, Cambridge, Mass., assignor to Cambridge Thermionic Corp., Cambridge, Mass., a corporation of Massachusetts: U. S. patent 2,486,146, issued Oct. 25, 1949.

A piezoelectric gauge for measuring pressure transients in a fluid comprising a plurality of piezoelectric elements connected in parallel, two relatively stiff electrical leads insulated from each other, a supporting member connecting the respective element sides of one electrical polarity to one of said leads, an inner core of wax-like material surrounding said elements and said supporting member, a thin layer of electrical conducting material covering said core and linking the respective element sides of the other polarity with the other of said leads, and an out projecting sheath of insulating material covering said conducting layer. Claims allowed, 7.

11650. (3) Geophone. Raymond G. Piety, Tuckahoe, N. Y., assignor to Phillips Petroleum Co., a corporation of Delaware: U. S. patent 2,487,029, issued Nov. 1, 1949.

In a geophone having a case, permanent magnets forming a magnetic field which field follows the vibratory movements of the ground mounted

in said case, said field being formed with an air gap, and an inertia member suspended therein comprising a coil in which the movement of the magnetic field in response to earth movements generates current, the improvement comprising a lightweight mounting for said coil, comprising a longitudinally slotted mica cylinder with one helical layer of said coil cemented to the inside of said cylinder and a second helical layer of said helical coil cemented to the outside of said cylinder, and springs mounting said cylinder at the top and bottom to said field structure. Claims allowed, 4.

11651. (3) Automatic volume control for seismograph systems. Charles H. Fay and Thorwald J. Tvedt, Houston, Tex., assignors to Shell Development Co., San Francisco, Calif., a corporation of Delaware: U. S. patent 2,489,126, issued Nov. 22, 1949.

An automatic volume control for seismic recording systems having detector means for producing electric signals, recorder means for recording said signals and amplifier means connected between said detector and said recorder means, said automatic volume control system comprising rectifier means energized by the output of said amplifier means, first triode means having a grid connected to the direct current output of said rectifier means, whereby the cathode to plate flow of said triode means is controlled by said direct current, a delay circuit comprising resistance means connected between the cathode of said triode means and the grids of said amplifier means, whereby the bias applied to said amplifiers is controlled by the cathode to plate flow of said triode means, a rapid recovery circuit comprising a first condenser connected in parallel with said delay circuit, a second condenser having one plate grounded and the other plate connected to a control point on the resistance means of the delay circuit, second triode means having its plate grounded, its cathode connected to said control point, and its grid connected to the cathode of said first triode means through said first condenser, and negative bias means connected between the grid of said second triode means and said control point, whereby said second triode means is maintained nonconductive during normal operation and is caused to permit flow therethrough upon a discharge of said first condenser following a rapid fall of the signal level and an attendant rapid rise of potential of the cathode of said first triode means, the flow through said second triode means providing a path for a rapid discharge of the second condenser and a rapid decrease of the negative bias applied to the amplifier grids. Claims allowed, 5.

11652. (4) Intensity, intensity ratio, and phase difference measuring system for geophysical prospecting. Bjarni S. Bjarnason, Toronto, Ontario, Canada, assignor to Hans T. F. Lundberg, Toronto, Ontario, Canada: U. S. patent 2,481,492, issued Sept. 13, 1949.

An instrument of the character described adapted to present a picked up potential in phase opposition to another potential comprising, a variable gain amplifier, a phase shifting network having its input electrically connected with the output of said amplifier, a second phase shifting network having its input electrically connected with the output of the first named network, at least one of said networks being provided with an adjustable phase control having an indicating dial, a potentiometer electrically connected across the output of said second network,

whereby the strength and phase of the current across the potentiometer may be regulated, an adjustable current control for said potentiometer provided with an indicating dial, a second amplifier having its input electrically connected with said potentiometer control, a plurality of potential pickups, and means for electrically connecting said pickups with said amplifiers. Claims allowed, 12.

11653. (4) Phase selective signal transmission system. Charles B. Aiken, Houston, Tex., assignor, by mesne assignments, to Schlumberger Well Surveying Corp., Houston, Tex., a corporation of Delaware: U. S. patent 2,483,718, issued Oct. 4, 1949.

A method of obtaining separate indications of at least one of two superimposed alternating current signals that are substantially in phase quadrature, comprising providing a standard periodically variable voltage having substantially the same phase as one of said signals but of substantially constant greater amplitude, combining said two signals and said standard voltage so that the amplitude of said combined signals and voltage varies in accordance with said one signal but is not substantially affected by said other signal of quadrature phase, and utilizing said combined signals and voltage to produce effects in accordance with said one signal. Claims allowed, 14.

11654. (5) Multigrid ionization chamber. Robert Earl Fearon, Tulsa, Okla., assignor to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,480,808, issued Aug. 30, 1949.

An ionization chamber for the detection of radioactive radiations that comprises a pair of electrodes insulated from each other and at least two grids between said electrodes and insulated from said electrodes and from each other. Claims allowed, 3.

11655. (5) Radiation exposure meter. Ernest O. Wollan and Louis A. Pardue, Oak Ridge, Tenn., and Norman Goldstein, Chicago, Ill., assignors to the United States of America as represented by the United States Atomic Energy Commission: U. S. patent 2,483,991, issued Oct. 4, 1949.

A radiation meter of the class described comprising a film holder, a film which is sensitive to X-ray and gamma radiation contained in said holder, and filter means arranged to filter the radiations reaching an area of said film, the absorption characteristics of said filter means and the energy response characteristics of said film being so correlated that the response of said film for equal exposures in roentgen units is substantially independent of the quantum energy of the radiation in the energy range which it is desired to meter. Claims allowed, 20.

11656. (5) Method of detecting mud films on exposed rock strata. Morris Muskat, O'Hara Township, Allegheny County, Pa., assignor to Gulf Research & Development Co., Pittsburgh, Pa., a corporation of Delaware: U. S. patent 2,484,422, issued Oct. 11, 1949.

The method of locating the level of mud film on the walls of a borehole which comprises adding to the drilling mud before drilling a tracer constituent in sufficient concentration to produce when bombarded with neutrons an identifiable gamma ray intensity higher than that of the formations to be penetrated, said tracer constituent comprising the

chemical element aluminum, bombarding a portion of the wall of the borehole with neutrons, simultaneously measuring at said portion the gamma ray intensity inside the borehole and measuring the depth of said portion of the borehole. Claims allowed, 4.

11657. (5) Method and apparatus for measuring hardness and intensity of penetrating radiation. Robert E. Fearon, Tulsa, Okla., assignor to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,484,493, issued Oct. 11, 1949.

A method of measuring the hardness of penetrating radiation that comprises subjecting an ionizable medium which is being circulated through at least two separate paths to a known intensity of the penetrating radiation, filtering from one path a considerable fraction of the radiation having hardness below a predetermined value, and measuring the difference between the ionization produced in each path at the origin of said measurement. Claims allowed, 14.

11658. (5) Measurement of wall thickness. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,486,845, issued Nov. 1, 1949.

The method of measuring the thickness of a wall or plate which comprises directing penetrative radiation into said wall from a radioactive source positioned on one side of the wall, measuring over a plurality of areas of equal size on the other side of the wall the intensity of the radiation transmitted through the wall to said areas by means of a radiation detector, while shielding from the transmitted radiation all of the exposed surface of the detector with the exception of a relatively small surface, determining the area having approximately the greatest intensity of radiation and then measuring the intensity of said area and the surrounding area with said exposed surface of detector unshielded. Claims allowed, 6.

11659. (5) Measurement of thickness. Alexander Wolf, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,486,902, issued Nov. 1, 1949.

A device for measuring the thickness of tube walls comprising an elongated detector of gamma radiation, a frame attached to and extending longitudinally away from said detector, said frame containing a contact plate intersecting the axis of said detector and extending toward said detector while being inclined at an acute angle to said axis, a source of said gamma radiation disposed near said intersection of said plate and said axis, a contact member disposed on a line projecting laterally from said plate at said intersection, said contact plate and contact number defining an arcuate space for accommodating tubes of various diameters at right angles to said axis with the outer surface of a tube in contact with said plate and said member whereby a beam of radiation from the source is transmitted tangentially through the tube wall to the detector and the arrangement being such that as tubes of increasing diameters are placed in the frame the center of the beam will be located progressively farther from the outer surface of the tubes while at the same time the average linear width of the beam through

the pipe increases, and means for indicating the intensity of said transmitted radiation. Claims allowed, 8.

11660. (5) Radiation detector. Donald G. C. Hare, Westport, Conn., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,486,944, issued Nov. 1, 1949.

A detector of gamma rays comprising a gas-filled chamber, a bundle of gamma ray counters in said chamber, said counters being arranged in closely adjacent, parallel relation and substantially coextensive in length, each of said counters comprising a metallic tubular member, a plurality of thin metallic plates disposed in parallel, separated relation substantially laterally within said member to form a cathode bank, each of said plates being provided with at least one hole and the holes in the plates being disposed in an alined series, and an anode wire disposed along the longitudinal axis of each series of holes, the plates and tubular members of the individual counters being connected together electrically to form the cathode of the detector. Claims allowed, 2.

11661. (5) Radiation detecting device. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,489,133, issued Nov. 22, 1949.

A radiation detecting device comprising a casing, a plurality of plates disposed in a bank in said casing in separated relation and connected together electrically to form a cathode member, said bank of plates being provided with a plurality of series of holes, the holes in each series being disposed in alinement, a wire comprising an anode disposed on the longitudinal axis of each series of holes, said anode wires being insulated from each other, a plurality of amplifiers, said cathode member and one of said wires being connected to the input of each of said amplifiers and recording means connected to receive the output of all said amplifiers. Claims allowed, 9.

11662. (8) Neutron method of porosity logging. William L. Russell, Tulsa, Okla., assignor to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,480,674, issued Aug. 30, 1949.

Method of exploration of geological formations comprising the step of measuring radiations in the neighborhood of said formations and caused by nuclear disintegration of elements therein contained, the step of impregnating said formations with a properly selected substance having a stable nucleus and adapted to modify said disintegration, the step of measuring radiations caused by nuclear disintegration as affected by the presence of said substance in said formations, and comparing the measurements obtained in said first and said third step. Claims allowed, 16.

11663. (8) Method of locating water and gaseous fluid stratas in well bores. Harlan John Eastman, Denver, Colo., assignor to Eastman Oil Well Survey Co., Denver, Colo., a corporation of Delaware: U. S. patent 2,480,720, issued Aug. 30, 1949.

The method of locating the point of entry of water and gaseous fluids into a well bore which includes, determining the temperature of the well fluid column which is formed by the flow of fluids into the well bore from

the formation and which normally stands in the well, then removing well fluids from the upper portion of said column to permit additional well fluids to enter said bore, and then determining the temperature of the well fluid column along the entire length of said column after the entry of said additional fluids to locate the different temperature zones created by the entry of water and gaseous fluids whereby the location of the point of the entry as indicated by said zones may be ascertained. Claims allowed, 12.

11664. (8) Method and apparatus for radioactivity well logging. Gerhard Herzog, Houston, Tex., assignor, by mesne assignments, to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,481,014, issued Sept. 6, 1949.

A method of logging a bore-hole which comprises moving through said hole a pair of vertically elongated radiation detectors of different lengths, one of said detectors being substantially as long as the vertical dimension of the thinnest stratum to be logged, recording the output of said one detector while the detectors are moving through the hole in the vicinity of a thin stratum, and recording the total output of both detectors while the detectors are moving through other portions of the hole. Claims allowed, 15.

11665. (8) Clinometer for well bores. Judson S. Swearingen, Southton, Tex., assignor, by mesne assignments, to Robinson Tool Co., Houston, Tex., a corporation of Missouri: U. S. patent 2,482,224, issued Sept. 20, 1949.

In a device of the class described, an elongated member having a bore therein, an inclination unit mounted in said bore, said unit comprising a housing, there being a passage for fluid between the member and housing, a piston within said housing, a stepped cup movable with said piston, a pendulum suspended in the housing for engagement with the stepped cup when the member is inclined, spring means normally urging the piston and cup toward the pendulum, a stem attached to the piston and extending outwardly through the housing, a valve member on said stem to move the stem outwardly when fluid is forced through the bore, and restricted areas in said bore to produce variable throttling of the fluid as the stem moves outwardly. Claims allowed, 4.

11666. (8) Method and apparatus for logging boreholes. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware. U. S. patent 2,483,139, issued Sept. 27, 1949.

The method of logging a borehole to determine the character and location of formations traversed by the hole which comprises passing through the hole a source of radiation from which neutrons and gamma rays are emitted, some of the neutrons being scattered and slowed down in the formations and returned to the hole along with natural gamma rays from the formations, gamma rays induced in the formations by neutron bombardment and gamma rays originating in the source and scattered in the formations, the number of the returned, slowed neutrons depending upon the character of the formations, impressing an electrical potential of the order of 1,000 volts on an ionizable medium of relatively low density and exposing said ionizable medium to secondary radiation produced by the neutrons intercepting said drill hole as well as to said

gamma rays intercepting the drill hole whereby electrical discharges are created in said ionizable medium, the size of the discharges depending upon the nature of the radiation intercepted and the number of the discharges being determined by the intensity of the intercepted radiation, and measuring only those discharges whose magnitude is sufficiently great to be indicative of the fact that they are created by slow neutrons. Claims allowed, 2.

11667. (8) Inclination indicating apparatus. Gordon Jackson, Long Beach, Calif., assignor, by direct and mesne assignments, to Eastman Oil Well Survey Co., Dallas, Tex., and Denver, Colo., a corporation of Delaware: U. S. patent 2,486,529, issued Nov. 1, 1949.

The combination with a drill stem, of an inclination indicating apparatus for indicating the inclination of a well bore through which the drill stem extends, said apparatus including, an inclination indicating instrument having means for indicating deviation from the vertical, means within said instrument for operating the indicating means, said instrument also having pressure actuated means for preventing actuation of said instrument, and means for exposing the pressure actuated means of said instrument to the pressure of the fluid which normally circulates through the drill stem, whereby said instrument cannot operate so long as fluid is circulating through the stem and is released to permit actuation of the operating means when said circulation is halted. Claims allowed, 8.

11668. (8) Measuring system for borehole radioactivity. Shelley Krasnow, Arlington County, Va., and Leon F. Curtiss, Montgomery County, Md., assignors, by mesne assignments, to said Krasnow: U. S. patent 2,487,058, issued Nov. 8, 1949.

A method of geophysical prospecting that comprises lowering a detector of radioactivity into a drill hole through the stem of the drill being used to drill the hole, and simultaneously continuously recording the radioactivity of formations surrounding the drill stem as an indication of their nature. Claims allowed, 3.

11669. (8) Well logging null recorder. Robert F. Davis, Falls Church, Va., assignor to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,488,491, issued Nov. 15, 1949.

In a geophysical exploration device, an instrument sensitive to phenomena characteristic of earth formations surrounding a bore hole and comprising a capsule to be lowered into a bore hole, said capsule containing an electrical element the impedance of which is sensitive to the presence of the phenomena to be measured, a circuit including said element and a source of constant electrical potential, said circuit having an output voltage varying in proportion to the magnitude of the phenomena to be measured, a comparator within said capsule connected to receive the voltage output of said circuit, a second source of constant electrical potential connected to said comparator, said comparator including a variable resistance for varying the current output of said second constant potential source in accordance with any difference in magnitude between the output voltage of said electrical circuit and a voltage developed in the comparator by the current supplied thereto by the second source of constant potential, and a recording device located at the sur-

face of the earth, connected to said second source of potential, and directly responsive to the magnitude of the current flowing from said second source of constant potential as controlled in accordance with the comparison of voltages by said comparator, for recording the magnitude of the phenomena to be measured. Claims allowed, 1.

11670. (11) Radio distance and direction indicator. Luis W. Alvarez, Santa Fe, N. Mex., assignor, by mesne assignments, to the United States of America as represented by the Secretary of War: U. S. patent 2,480,208, issued Aug. 30, 1949.

Apparatus for associations with an aircraft for indicating the disposition of reflecting objects on a portion of the surface of the earth which includes means for transmitting short pulses of radiant oscillatory energy in a narrow fan-like beam approximately in shape part of the surface of a cone having its vertex at the aircraft, means for receiving echoes of said pulses and measuring the time of their reception relative to the time of transmission of said pulses, means for varying the angle between the surface of said cone and its axis, and means for correlating the said angle with the time of reception of said echoes and with observed altitude of the aircraft adapted to present a maplike visual indication of the disposition of reflecting objects on a portion of the surface of the earth. Claims allowed, 27.

11671. (11) Pulse code operated electronic range indicator. Andrew B. Jacobsen, Somerville, Mass., assignor, by mesne assignments, to the United States of America as represented by the Secretary of War: U. S. patent 2,482,544, issued Sept. 20, 1949.

In a radio circuit, an artificial delay line, means for applying voltage pulses to said delay line, a plurality of multigrid vacuum tubes, means for connecting the grids of said multigrid vacuum tubes to said delay line so that when voltage pulses in a predetermined sequence pass down said delay line said grids will be simultaneously raised in potential, a first rectangular pulse generator, means for supplying to said first rectangular pulse generator trigger pulses spaced at predetermined time intervals, a second rectangular pulse generator, means for triggering said second rectangular pulse generator, means for applying the output of said second rectangular pulse generator to said first rectangular pulse generator to prevent triggering of said first generator during a predeterminable period of time, a third rectangular pulse generator, means for causing the output of said first rectangular pulse generator to trigger said third rectangular pulse generator, means for applying the output of said third rectangular pulse generator to at least one grid in each of said multigrid vacuum tubes, a fourth pulse generator of which at least a portion of the output is a substantially linear function with respect to time, means for causing the output of said third pulse generator to trigger said fourth pulse generator, means for inverting at least a portion of the output of said fourth pulse generator, means for applying the inverted voltage to at least one of said grids of one of said multigrid vacuum tubes, means for applying a further portion of the output of said fourth pulse generator to at least one grid of another of

said multigrid vacuum tubes, load means connected to each anode of said vacuum tubes, a differential amplifier, means for applying voltages developed across said load means to said differential amplifier, and means for feeding back the output of said differential amplifier to said fourth pulse generator whereby the time duration of the output of said fourth pulse generator is altered in accordance therewith. Claims allowed, 3.

11672. (11) Pulse radio echo distance indicator. Charles E. Dolberg, Philadelphia, Pa., assignor, by mesne assignments, to Philco Corp., Philadelphia, Pa., a corporation of Pennsylvania: U. S. patent 2,483,187, issued Sept. 27, 1949.

In a radio ranging system, a transmitter, a source of control pulses connected to said transmitter to effect transmission of pulse-modulated high-frequency signals, a receiver for receiving said pulse-modulated signals upon reflection thereof by some object, said receiver being prone to receive said pulse-modulated signals directly from the transmitter, said receiver including a frequency converter stage constructed and arranged to convert said pulse-modulated high-frequency signals to pulse-modulated intermediate-frequency signals, said frequency converter stage generating also spurious video frequency pulse signals in response to the said direct reception of pulse-modulated high-frequency signals, means for deriving pulses from said source, means for modifying the latter pulses so that they are coincident with and of the same magnitude as said spurious pulse signals but of opposite phase, and means for combining the modified pulses with said spurious pulse signals substantially to cancel out the latter. Claims allowed, 3.

11673. (11) Automatic radio direction finding system. Charles William Earp and Jeffrey Dennis Weston, London, England, assignors, by mesne assignments, to International Standard Electric Corp., New York, N. Y., a corporation of Delaware: U. S. patent 2,485,578, issued Oct. 25, 1949.

An electric wave modulating arrangement comprising a thermionic valve having a cathode, a control grid and an anode, means for applying a high frequency alternating voltage wave between the said cathode and earth, means for maintaining the said control grid substantially at earth potential for the high frequency waves, means for applying a low frequency modulating signal voltage between the said control grid and earth, and means for deriving modulated high frequency waves from the said anode.

An electrical navigational direction indicating arrangement for a moving vehicle comprising a system of aerials adapted to derive from electrical waves collected thereby a differential voltage and a reference voltage, an electronic switch means for intermittently operating said switch comprising a source of switching signals, a radio receiver, and a discriminator, means for applying alternately the sum and the difference of the said reference and differential voltages to the receiver comprising said switch, means for comparing the demodulated waves from the output of the receiver with the signals from the said switching source comprising said discriminator. Claims allowed, 17.

11674. (11) Radio distance measuring system. Edward L. Ginzton, Garden City, N. Y., assignor to The Sperry Corp., a corporation of Delaware: U. S. patent 2,485,583, issued Oct. 25, 1949.

In a radio system for determining the distance to an object having motion relative to said system, the combination comprising means for generating radio frequency energy, means for alternately and periodically radiating for a time period and receiving for an equal time period, means for varying the duration of said time period, means for mixing the frequencies of said generated and received energies to obtain a difference frequency wave depending upon said relative motion and a frequency meter responsive to an amplitude modulation due to said variation of said time period to indicate said distance measurement. Claims allowed, 8.

11675. (11) Distance measuring apparatus. Edward L. Ginzton, Garden City, N. Y., assignor to The Sperry Corp., a corporation of Delaware: U. S. patent 2,485,584, issued Oct. 25, 1949.

In a reflected pulse type radio system, wherein periodic pulses of electromagnetic energy are directed at a distant object and the corresponding reflected portions of said energy pulses are received back at the system, means for determining the distance to said object, comprising an electron tube, means for supplying a fixed bias for the control electrode of said tube, means comprising a connection independent of said fixed bias, means for initiating current flow through said tube upon the receipt of a negative transmitted pulse, means for terminating said current flow upon the receipt of a negative received pulse, a resistor-capacitor parallel circuit arrangement in series with said tube, and means for extracting the voltage built up across said circuit arrangement. Claims allowed, 3.

11676. (11) Map with area position indicator. John O. Elliott, San Francisco, Calif.: U. S. patent 2,487,318, issued Nov. 8, 1949.

A map compromising a plat divided into a plurality of rows and columns of unitary areas each showing the location of identifiable points therein, an index designating by row and column the location of the identifiable points within the several unitary areas, a light carrier having cells corresponding to the unitary cells of a column, means for moving the cells into matching relation with a selected column, a column selector operable to supply current to the lighting elements when positioned in matching relation with a selected column, a row selector operable to supply current to the lighting element of the carrier corresponding to a selected row, and independently operable means for controlling the supply of current through the selectors to a single selected cell lighting element. Claims allowed, 7.

11677. (11) Contour indicating device. Alda V. Bedford, Princeton, N. J., assignor to Radio Corp. of America, a corporation of Delaware: U. S. patent 2,487,511, issued Nov. 8, 1949.

A device for producing an electrical signal corresponding to the contour of an indicium comprising means for cyclically moving a point source of energy transversely across said indicium and progressively in a direction normal to said transverse direction, energy responsive means

for producing a signal voltage corresponding to the energy reflecting property of said indicium from point to point along the path of said point source, and means initiated concurrently with the start of the transverse movement of said point source and terminated by the first subsequent signal voltage for producing a control voltage whose amplitude is proportional to the distance between the starting point and the point at which said first subsequent signal voltage occurs. Claims allowed, 11.

11678. (11) Determination of the content of a mineral in ores and the like. Rasmus Christian Østraat Wiig, Svarstad, Norway: U. S. patent 2,489,066, issued Nov. 22, 1949.

In apparatus for determining the mineral content of ore, two spaced hollow coils connected to provide opposed magnetic fields, at least one of said coils having an open internal space for freely accommodating the material to be tested, a magnetic member bridging ends of the coils, a magnetic member bridging the other ends of the coils, a movable coil mounted between said members adapted to be influenced by lines of flux between said members, a pointer carried by said movable coil, and magnetic means for counteracting residual magnetism acting on said coil. Claims allowed, 2.

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