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

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

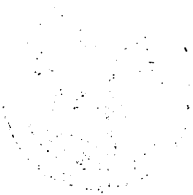


**UNITED STATES DEPARTMENT OF THE INTERIOR**

**J. A. Krug, *Secretary***

**GEOLOGICAL SURVEY**

**W. E. Wrather, *Director***



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

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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.

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## O. GENERAL GEOPHYSICAL SUBJECTS

11202. Armstrong, L. C., and Davidson, D. M. The practical view in geophysical exploration for metallic ore bodies: *Geophysics*, vol. 13, no. 4, pp. 550-555, 1948.

This is the full text of the paper. For abstract published in advance, see *Geophysical Abstracts* 136, no. 10738.

11203. Bermudez, A. J. Informe del Director General [Report of the General Manager]: *Petroleos Mexicanos*, no. 67, pp. 1-22, 1949.

During 1948 some thirty parties of geologists and geophysicists explored for oil in the states of Tamaulipas, Veracruz, Tabasco, Campeche, and Chiapas, and prospecting was started in the Yucatan Peninsula. Thirty-four geologic structures favorable for oil accumulation were located.—S. T. V.

11204. Brückshaw, J. M. Geophysics and economic geology: *Inst. Min. Metallurgy Bull.*, no. 508, pp. 1-20, 1949.

The basic factors and limitations involved in the application of geophysics to exploration for ores are discussed with special reference to magnetic, gravitational, and electrical methods. Several representative magnetic, gravitational, and electrical surveys are described briefly, and the difficulties inherent in each method are discussed.—V. S.

11205. Eckhardt, E. A. Geophysical activity in the oil industry in the United States in 1947: *Geophysics*, vol. 13, no. 4, pp. 529-534, 1948.

The cost of geophysical exploration for additional oil reserves within continental boundaries of the United States in 1947 was \$105,000,000, exclusive of expenditures on research and development. About \$90,000,000 was spent on seismic work and the rest on other methods of geophysical exploration, chiefly gravitational surveys. The number of seismological field parties more than doubled during the period 1941-47 to nearly 450 crews in 1947. About three-quarters of the seismic work done in 1947 centered in the states of Texas, Louisiana, and Oklahoma, which also yielded five-sixths of all the new pool reserves discovered in that year. Gravity operations were carried on by fifty-odd parties during 1938-42, increasing to a maximum of 170 parties in 1945, and decreasing to 120 parties in 1947. Texas and Louisiana accounted for more than half of the gravity work done in 1947, and the Rocky Mountain states for about a quarter of the work.—V. S.

11206. Eckhardt, E. A. World geophysical activity in 1948: *Oil and Gas Jour.*, vol. 47, no. 46, pp. 100-101, 148-149, 1949.

An outline is given of world geophysical exploration in 1948, which established a record high in search for petroleum and ore deposits. Seismograph operations in the United States increased 17.4 percent, with

Texas accounting for 43.6 percent of the activity, Louisiana 17.9 percent, Oklahoma 11.1 percent, and the Rocky Mountain states 8.1 percent. Almost 80 percent of seismograph work in the world was done in the United States, 5.76 percent in Canada, 3.99 percent in Venezuela, 2.22 percent in Mexico, and smaller fractions in other countries. Gravitometer operations in the United States increased in the last three quarters of 1948. Texas accounted for 36.5 percent, Louisiana 26.2 percent, and the Rocky Mountain states 20.5 percent. The United States did 67.9 percent of the gravity work of the world, Canada 5.9 percent, South America 12.0 percent, and the Eastern Hemisphere 11.5 percent. Magnetometer operations in the United States, when expressed in terms of crew-months, were limited in scope, but more area was mapped with airborne magnetometers during 1948 than with all seismographs the world over and at a cost of less than 2 percent. Magnetic work on the ground decreased. The total expenditures of the United States oil industry for its domestic geophysical operations in 1948 was approximately \$125,000,000 including \$105,000,000 for seismograph operations. At a price of \$2.00 per barrel of crude oil the cost of the purely geophysical work in explorations estimated to be about 1 percent of the value of the product.—V. S.

11207. Heiland, C. A. How can geophysics be of better service to the mining industry? *Geophysics*, vol. 13, no. 4, pp. 535-539, 1948.

This is the full text of the paper. For abstract published in advance, see *Geophys. Abstracts* 136, no. 10742.

11208. Kolubakin, D. Die Entwicklung des Chilenischen Bergbaues im Jahre 1948 [Development of the mining industry of Chile during the year 1948]: *Bergbau-Bohrtechn. und Erdöl Zeitung*, vol. 65, no. 4, pp. 7-8, 1949.

The article contains information on Chile's mineral production during 1948, with special attention to the development of the petroleum industry. Geophysical exploration was initiated in 1943, and in 1945 the first oil well, in Cerro Manartiales oil field, started production. On the basis of geophysical exploration the oil reserves of this field are estimated as not less than 30 million barrels. The field has 13 wells, 8 now producing, 4 with strong gas flow, and 2 dry holes. Geophysical exploration for oil has also been started in the San Sebastian region some 90 kilometers southeast of the first oil field.—S. T. V.

11209. Morgan, Frank. Physics in the oil industry: *Physics Today*, vol. 2, no. 6, pp. 6-13, 1949.

This article describes the application of physics in the oil industry, including geophysical exploration. Seismic, gravitational, and magnetic methods, and electrical and radioactive well logging are described.—S. T. V.

11210. Nodiia, M. Z. The state of geophysical investigations in the Georgian S. S. R. at the time of the 31st annual celebration of the great October socialist revolution [in Russian]: *Akad. Nauk SSSR Izv., Ser. Geog. i Geofiz.*, vol. 13, no. 2, pp. 97-107, 1949.

A brief account is given of the development of geophysical institutions in Georgia and of the geophysical investigations they have con-

ducted. During 1917-33 the work consisted of meteorological and magnetic observations and research. A magnetic survey of the trans-Caucasian region was made in 1930-34. After the establishment of a Geophysical Institute in 1933 activities expanded and included geophysical exploration. Magnetic work led to the development of a method for absolute measurements with the Schmidt vertical and horizontal balances and of a simplified method for the determination of the vertical magnetic gradient. Seismic exploration was aided by studies of the interpretation of seismograms involving a vertical boundary between two layers, and of the application of the seismic method in areas of complex relief. Investigations were also made of the use of heavy explosive charges. The gravity work consisted of exploration for oil and coal, pendulum surveying, and research in the use of gravity data for the calculation of the deviation of the vertical and the deviation of the geoid from the spheroid. Electrical methods were applied to exploration for pyrite, copper, cobalt, barium, oil, and other deposits. Telluric currents were studied.—V. S.

11211. Noth, Rudolf. Neue Explorationen in Polen [Recent explorations in Poland]: *Bergbau, Bohrtechn. und Erdöl Zeitung*, vol. 65, no. 4, pp. 8-11, 1949.

Exploration for oil and gas in Polish territory is now centered in the government's Bureau for Liquid Fuels which includes sections of geology, geophysics, and drilling techniques. Exploration has been extended from the old oil-bearing regions in the Carpathian Mountains, into the Carpathian foreland and several areas in central and northern Poland. The region of Kłodawa between Warsaw and Posen [Poznań] has been explored geophysically and several salt domes have been discovered. The hilly region around Stopnica in central Poland is now being explored. Traces of oil have been found in several places. The most important result of prospecting to date has been the discovery of natural gas in the Carpathian foreland and near Szalowa-Bieśnik.—S. T. V.

11212. Oil and Gas Journal. Puerto Rican geophysical survey shows favorable possibilities: Vol. 47, no. 9, p. 37, 1948.

The northern and southern coastal plains of Puerto Rico have been surveyed geophysically since 1947. Operations were conducted on a 70-mile line between Toa Alta (near San Juan) and Aguada on the western tip of the island, and also on a 40-mile line between Salinas and Guayanilla on the south shore, including tidelands and a 7-mile offshore area. In both areas seismic surveys delineated structural anomalies considered promising, especially an anticlinal nose in Tertiary sediments in the south where seismograms have been of very good quality. The seismograms recorded in marine operations in Puerto Rico are reported to be among the best obtained from similar work anywhere.—V. S.

11213. Pirson, S. J. Geophysical exploration for ground water supplies: *The Compass*, vol. 25, no. 4, pp. 250-266, 1948.

Geophysical methods for the detection of water supplies are discussed. Direct methods consist of measuring electrical conductivity or capillary suction. Electrical resistivity methods, based on the fact that ground

conductivity is a direct function of the amount of the water present, are best adapted to reservoir-rock conditions. Formulas are given for computing rock resistivity below and above the water table. The operation of the Wenner-Gish-Rooney expanding four-electrode system, and of the fixed electrode system with constant probing depth, used for resistivity mapping by continuous profiling, is explained and illustrated by curves characteristic of different geologic conditions. The capillary suction method is applicable to the determination of the depth to the water table in granular rocks, where ground water is under gravity and capillary control. The capillary pressure of such rocks depends upon their height above the water table, so that its measurement at the surface can be used to determine depth to the water table. The desaturation apparatus employed for testing soil samples is described, and a formula is given for capillary pressure as a function of depth to the water table. The indirect methods used to discover structural conditions favorable to the accumulation of ground water include gravitational, magnetic, and seismic-refraction techniques.—V. S.

11214. Pirson, S. J. Investigating the possibilities of new mineral deposits in Pennsylvania: *The Compass*, vol. 25, no. 4, pp. 249-250, 1948.

A brief report is given on the geophysical work of Pennsylvania State College. This includes aeromagnetic surveys of Clearfield County and half of Centre County, Pennsylvania, made in conjunction with ground magnetic and gravity surveys in the area, and a study of electrical logs of oil wells to determine quantitative relationships between resistivity and spontaneous-polarization data and formation thickness, porosity, permeability, connate water, and oil saturation, as indicative of oil potentialities. Some geochemical prospecting is also done.—V. S.

11215. Rummerfield, B. F. Oil exploration in Mexico speeded as nation seeks to expand production [in Spanish and English]: *Petroleo Interamericano* vol. 6, no. 8, pp. 34-41, 1948.

A broad program of geological and geophysical exploration for oil is reported inaugurated in Mexico. In 1948 there were 13 geological, 14 seismic, 4 gravitational, and 1 electrical crews in the field, and 6 additional geophysical crews were expected to be in operation by the end of the year. Working conditions, equipment required, and the geology of potential oil zones are outlined.—V. S.

11216. Schnaebelé, René. Monographie géologique du champ pétrolifère de Pechelbronn [Geologic monograph on the oil field of Pechelbronn]: *Service Carte Geol. Alsace Lorraine Mem.*, no. 7, 254 pp., 39 figs., 11 maps, 1948.

This geologic study of the oil field of Pechelbronn in lower Alsace includes a history of geophysical exploration by electrical, magnetic, electrical logging, and geothermal methods during 1927-38. The electrical surveys and logging by the Société de Prospection Electrique, *Procédés Schlumberger*, have been successful in delineating major faults. The magnetic surveys by E. Rothé, and B. and V. Perebaskine were less successful. More than 500 geothermal measurements studied by

J. Haas and C. Hoffmann showed no relation between the geothermal gradient and the presence of oil. The remarkably low values of the gradient appeared, however, to be related to the sedimentary and tectonic features of the area, as indicated by a map of isotherms for a depth of 400 meters.—*V. S.*

11217. Texas Oil Journal. Geophysical and core drilling activity: Vol. 16, no. 2, p. 21, 1949.

Geophysical parties engaged in petroleum exploration in the United States in 1949 numbered 556, including 421 seismic parties, and 81 gravimetric, 9 magnetic, and 45 core-drilling parties. The greatest exploratory activity was in Texas with 192 different crews operating.—*S. T. V.*

11218. Wyckoff, R. D. Geophysical exploration: Oil and Gas Jour., vol. 47, no. 28, pp. 342–352, 1948.

The uses of the principal geophysical methods in current oil exploration programs are reviewed, and advances in instrumentation, field techniques, and equipment such as the airborne magnetometer, marine seismic surveys, and underwater surveying by remote control gravimeters are noted.—*V. S.*

### 1. GRAVITATIONAL METHODS

11219. Baeschlin, C. F. Lehrbuch der Geodäsie [Textbook of Geodesy], 892 pp. Zürich, Orell Fussli Verlag, 1948.

This treatise on mathematical geodesy is largely devoted to the terrestrial ellipsoid, isostasy, and the theory of the gravity potential. The gravity field of the earth and of an ellipsoid of revolution, the measurement of gravity, the reduction of observed values of gravity to the geoid, the determination of the dimensions of the geoid and of the deflections of the vertical from gravity observations, and the measurement of gravity gradients are discussed. In connection with the measurement of the force and the gradient of gravity, consideration is given to the Vening Meinesz apparatus and the hypothetical pendulum, the Holweck-Lejay elastic pendulum, and the Eötvös torsion balance.—*V. S.*

11220. Boaga, Giovanni. Collegamento gravimetrico Padova-Pisa [Gravimetric tying of the Padova and Pisa stations]: Annali Geofis., vol. 2, no. 1, pp. 13–18, 1949.

Comparative determinations of absolute gravity were made in the summer of 1947 at the gravimetric stations of Padova and Pisa, Italy, using four Mioni pendulums suspended in a special vacuum chamber, and kept at constant temperature. Using an absolute value of  $g$  in Padova (the national reference station) of 980.658 gal as base,  $g$  in Pisa was found to be  $980.539 \pm 0.003$  gal. In connection with this and previous gravity measurements the author calls attention to the negative gravity anomalies observed at points north of the Livorno-Siena-Arezzo profile.—*S. T. V.*

11221. Boaga, Giovanni. Sul collegamento di due reti geodetiche contigue appartenenti a stati limitrofi [Establishment of ties between two contiguous geodetic networks of bordering states]; Riv. del Catasto e dei Serv. Tecnici Erariali, vol. 3, no. 2, pp. 101-112, 1948.

A problem of tying together adjacent geodetic networks developed as a consequence of independent geodetic and gravitational surveys in Italy, France, and Switzerland. The problem can be formulated mathematically as the determination of the corrections to be applied to coordinates of vertices of a triangulation network where the reference ellipsoid of the network is replaced by another, or where the length of the base and the orientation of the network are changed. The paper contains extended calculations and gives as the final result corrections to be applied to the coordinates of five geodetic stations in the border region. The final changes in geographic coordinates are very small, indicating precise geodetic work.—S. T. V.

11222. Boaga, Giovanni. Trattato di geodesia e topografia con elementi di fotogrammetria [Treatise on geodesy and topography with the elements of photogrammetry], vol. 1, 688 pp., vol. 2, 524 pp., Padova, Cedam, Casa Editrice Dott. A. Milani, 1948.

This is a comprehensive treatise covering both the theoretical and experimental work of modern topography and geodesy with numerous examples and practical applications. Volume 1 covers geodesy, including the elements of theoretical geodesy, the theory of probability and determination of errors, instruments and methods, and the elements of cartography and astronomic geodesy. Volume 2 on Topography includes discussions on planimetry, altimetry, tachymetry and topographic applications, and the elements of photogrammetry, stereophotogrammetry, and aerophotogrammetry.—M. C. R.

11223. Cizancourt, Henri de. Anomalies de la pesanteur et tectonique profonde des Pyrénées [The gravity anomalies and deep tectonics of the Pyrenees]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 1, pp. 76-78, 1948.

The existence of a gravity minimum with a Bouguer anomaly of about 120 mgals. in the central part of the Pyrenees has long been known, but recent work in French territory has disclosed an approximately rectilinear positive anomaly of 60 to 90 mgals. extending from Labourd to the Garonne along the north Pyrenees. The interpretation of these two anomalies calls for the existence of a deep structure involving the asthenosphere for a thickness of the order of 100 km. The negative anomaly corresponds to a large, approximately symmetrical syncline bounded by displacements which coincide in the central part of the Pyrenees with the southern limit of the axial zone and the northern limit of the north Pyrenees zone. This anomaly decreases progressively toward the west and is interrupted to the east in the Mediterranean by a zone of positive anomalies. The positive anomaly may be interpreted as resulting from a cylindrical mass of 7-km. radius with axis at a depth of 12 to 18 km. and a density difference of 0.5, or as from a prismatic mass inscribed within the cylinder. As this anomaly is independent of surface geology, the elevated value of the disturbing mass suggests a batholith. In the structural evolution of the Pyrenees the existence of a depression

on the north front of the Pyrenees combined with the presence of one of the faults limiting the basement syncline weakened the crust and facilitated the rise and intrusion of deep rocks. A correspondence is noted between the Pyrenees and the Alps, where the asthenosphere is also involved for a thickness of 100 to 120 km. and basic intrusions along deep faults are marked by a positive zone at Ivrea.—V. S.

11224. Eckhardt, E. A. Diurnal variations in the acceleration of gravity. *Am. Geophys. Union Trans.*, vol. 30, no. 2, pp. 183-184, 1949.

To study the tidal or diurnal variations of gravity, simultaneous observations were made during an extended week end in 1939 by twelve Gulf gravimeter parties scattered over a latitude range of about  $47^{\circ}$  and a longitude range of over  $127^{\circ}$ . Observations were made at half-hour intervals using the standard Gulf Torsion spring gravimeter. At the southernmost station at Santa Bárbara, Venezuela, the observed double amplitude of tidal variation was 0.25 mgals. against a computed value of 0.22 mgals. At the northernmost station in Varde, Denmark, the observed double amplitude was 0.094 mgals. against a computed value of 0.076 mgals. All data showed a progressive decrease of amplitude with latitude toward the north. Of 128 records, 100 gave observed values greater than computed, 18 nearly equal, and only 10 gave observed values less than computed. These measurements establish the fact that measurable tidal variations of gravity are, as expected, larger than those computed for a rigid earth. The author suggests the possibility that the earth yields to tidal forces as would an ice field composed of blocks of various sizes. Thus, while the whole field responds to the tides in a general way, there may be appreciable departures from the general mean in individual blocks which are more rigid with respect to the tidal forces than the mass as a whole.—M. C. R.

11225. Frowe, E. W. Offshore exploration with gravity meter and magnetometer. *Petroleum Engineer*, vol. 21, no. 4, pp. B92-95, 1949.

Advances in gravitational methods of offshore exploration are outlined, and advantages and limitations of the airborne magnetometer in marine work are noted. The latest advance is the use of a remote-control gravimeter lowered to the bottom and registering readings at the surface aboard ship. The instrument is enclosed in a small, water-tight case, weighs 500 pounds, can be used in shallow or deep waters. Its use has increased considerably the speed of operations. The airborne magnetometer gives accurate results free from local effects, makes it possible to extend exploration to inaccessible areas, and greatly accelerates work. It is economically sound for large surveys, but overcostly for small-scale operations.—V. S.

11226. Gassmann, Fritz and Prosen, Dragutin. Zur Interpretation des Schwere-defizites in den Schweizer Alpen [Interpretation of the gravity deficiency in the Swiss Alps]: *Eclogae geol. Helvetiae*, vol. 41, pp. 135-140, 1948.

The distribution of density below sea level in a cross section through the Swiss Alps from  $48^{\circ}44' \text{ N.}$ ,  $8^{\circ}31' \text{ E.}$  to  $45^{\circ}48' \text{ N.}$ ,  $9^{\circ}57' \text{ E.}$  was analyzed, using the Bouguer gravity map of Switzerland. It was assumed that the distribution of mass is two-dimensional and that a uniform

density of 2.72 exists above the discontinuity. Two possible densities of 3.0 and 3.3 below the discontinuity and two possible depths of 10 and 20 km. of the discontinuity beyond the Alps were assumed, and the results plotted in four profiles. If the discontinuity is identical with that recently determined seismically by Wanner, its position is between those calculated for densities of 3.0 and 3.3 below a 20-km. discontinuity. By interpolation, the density of the material below the discontinuity is 3.2 and it is therefore concluded that it is *sima*. The maximum depth of the discontinuity beneath the Alps is 37 km.—V. S.

11227. Gavrilov, L. The gravitational field produced by an infinite number of circular cylinders [in Russian]: *Akad. Nauk SSSR Izv., Ser. Geog. i Geofiz.*, vol. 13, no. 1, pp. 89-91, 1949.

A mathematical analysis is given of the gravitational anomaly produced on the plane of observation by the mass of an infinite number of circular cylinders situated below it with axes parallel to this plane and disposed linearly parallel to one another, at an equal depth and spaced at equal intervals. Formulas of the derivatives of the gravity potential are deduced for intervals of length  $\pi$  and of any length, with the use of Bessel functions and the theory of functions of the complex variable. It is found that a certain number of cylinders accounts practically for the entire magnitude of the anomaly. The error resulting from ignoring all the other cylinders in calculating the anomaly can be determined from the formulas given.—V. S.

11228. Innes, M. J. S. Gravity anomalies in northwestern Canada: *Canadian Jour. Research, sect. A*, vol. 26, no. 3, pp. 199-203, 1948.

The values of gravity obtained at 23 gravimetric stations established by the Dominion Observatory between 1921 and 1946 in northwestern Canada in the area between latitudes 55° and 70° and between Hudson Bay and Athabaska, Slave, and Mackenzie Rivers are compared with theoretical values computed from the International Gravity Formula. Free air, Bouguer, and isostatic reductions for a depth of compensation of 113.7 km. were computed. Isostatic anomalies are unimportant and may be attributed at some of the stations to the presence of large masses differing in density from the adopted mean density of 2.67. Slight negative isostatic anomalies at stations in the pre-Cambrian may be due to lack of isostatic adjustment following the removal of glacial loads. Tables of data and a map of the region surveyed are included.—S. T. V.

11229. Kolbin, M. F. New data on the geomorphology, tectonics, and gravity anomalies of dome-like elevations on the right bank of the Volga below Stalingrad [in Russian]: *Mosk. Obsch. Ispyt. Prirody Bull., Otd. Geol.*, vol. 23, no. 6, pp. 83-91, 1948.

Gravitational, morphologic and tectonic data have been examined to determine whether the abrupt bend in the course of the Volga below Stalingrad is caused by growing salt domes similar to those in the Emba region. Gravitational surveys made since 1934 have established the existence of four negative and five positive anomalies. These arcs are characterized alike by an uplift or displacement of the lower strata, a thinning of the upper strata, changes in facies, and an eastward bulge

in the high bank. Most positive anomalies are also related to topographic highs. The geology associated with the anomalies is similar irrespective of their sign. This is interpreted to indicate that salt domes, which usually cause negative anomalies, here cause positive anomalies also and constitute the masses deflecting the course of the river by their growth. Drilling on one positive anomaly where salt was found at a depth of 1,100 meters supports this interpretation. Thus viewed, all abrupt turns in the high bank of this part of the Volga accompanied by dislocations in deep strata may be caused by salt domes and become significant in exploration for petroleum and potassium deposits associated with them.—V. S.

11230. Rice, D. A. Gravimetric deflections by the method of condensation: *Am. Geophys. Union Trans.*, vol. 30, no. 3, pp. 323–327, 1949.

Investigation of the relationship between gravity anomalies and deflection of the vertical, long in progress at the U. S. Coast and Geodetic Survey, is being expedited by cooperation with the U. S. Army Map Service. Gravity data have been made available from many sources, a large part being centered in a nearly continuous area of 700,000 sq. mi. in south-central United States. 15,000 stations in Texas and Oklahoma at an average 3-mile spacing provide a sufficiently extensive gravity net for preliminary tests of the gravimetric method. The method of condensation is used in the current project to reduce observed gravity to the geoid which includes all attracting matter. Processing and plotting of anomalies have progressed to a point where the gravimetric method may be tested by comparison with astronomic and geodetic data. Results are presented here for the astro-geodetic stations of Roby and Polk in north Texas. As suspected previously and as demonstrated by the current investigations, the more distant zones cannot be ignored if accurate absolute deflections are to be obtained. Before means were developed for making accurate and extensive gravity surveys, it was possible to determine independent deflections of the vertical only by assigning certain densities to the visible topography and by making assumptions as to density distribution throughout the earth's crust. Past experience and examples given here indicate these assumptions can often result in errors as great as, or greater than, the deflections themselves. It is now possible to make use of observations of the intensity of gravity, from closely spaced points near a station to more and more widely spaced points as the distance increases, to obtain the more accurate deflections.—M. C. R.

11231. Scheffer, Viktor. A hegyes vidékeken végzett graviméteres mérések magassági korrekcióról [Elevation corrections for gravity meter surveys in mountainous regions] [in Hungarian and English]: *Földtani Közöny*, vol. 77, no. 1–12, pp. 12–26, 1948.

Due to uncertainty of density values to be applied, the Bouguer correction with constant density does not give reliable results in mountainous regions. The density increases from the plain towards the crest of the mountains where older and denser rocks may be exposed. The elevation correction also increases with the altitude of the station. Density depth and density surface diagrams are constructed for each geological

formation in the area and then a resultant diagram, the "mean average density diagram," is constructed according to the relative amounts of the different geological formations present at different elevations. Another purely empirical method for the determination of the "mean average density diagram" was elaborated by the author in 1944, in a gravitational survey of the northeastern Carpathian Mountains. The procedure is derived from the method suggested by L. L. Nettleton. The use of the diagram for the Bouguer reduction diminishes the uncertainty of the results of gravimeter surveys in mountainous regions. The article contains a detailed description of the proposed methods as applied to an example taken from an actual survey, with appended geologic and topographic maps of the region.—S. T. V.

11232. Skeels, D. C., and Watson, R. J. Derivation of magnetic and gravitational quantities by surface integration: *Geophysics*, vol. 14, no. 2, pp. 133-150, 1949.

This is the full text of the paper. For abstract published in advance, see *Geophys. Abstracts* 136, no. 10758.

11233. Staněk, Václav. Geofyzikální mapování gravimetrické a některé moderní přístroje pro ně [Geophysical gravimetric mapping and some modern instruments used for the purpose]: 46 pp., Prague, Česka Akad. Véd a umění, 1947.

This booklet presents a short résumé of the methods of study of the gravitational field and gives a description and a critical analysis of the Lejay-Holweck, Thyssen, Haalck, and Graf (Askania) gravimeters.—S. T. V.

11234. White, P. H. N. Gravity data obtained in Great Britain by the Anglo-American Oil Company: *Geol. Soc. London Quart. Jour.* vol. 104, pt. 3, pp. 339-364, 1949.

Gravimeter surveys were made by the Anglo-American Oil Company in 1939-1940 and 1945-1946, concentrated for the most part in the basin areas of Great Britain and concerned primarily with the search for potential oil reservoirs. An area of 9,134 square miles was surveyed in detail and 11,466 square miles was surveyed regionally. The total number of stations occupied was 4,303, with 0.38 to 0.44 stations per square mile in detailed areas. All stations were located with great accuracy. A Carter null-setting gravimeter was used and all gravity measurements were tied to established pendulum stations of the British gravimetric network. The accuracy of a reading is estimated as  $\pm 0.35$  milligal. Interpretation of the gravimetric data resulted in delineation of the subsurface configuration of the Carlisle basin and the indication of folding beneath Carlisle; discovery of the western boundary faults of the Cheshire basin depicting the true shape of the basin as a rift structure bounded by parallel normal faults; indication of the eastern continuation of the Wharfe anticline, a major subsurface structure in south Yorkshire; and the discovery of the Gringley structure in the Midlands. In addition the surveys confirmed gravitationally many structural features already known from geological evidence. A composite isogam [isogal] and structure map of northern and central England, residual isogam [isogal] maps of Lancashire and Cheshire and the eastern

Midlands, an isogam [isogal] map of southern England, and a section from Kingsclere to the Isle of Wight showing gravity and geologic data are included.—*S. T. V.*

11235. Woollard, G. P. Gravity anomalies and the nature of the earth's crust: *Am. Geophys. Union Trans.*, vol. 30, no. 2, pp. 189–201, 1949.

Gravity anomaly data from several regions in North America, southern Asia, Europe, and the Pacific and Atlantic Oceans are reviewed. These anomalies seem to offer a reliable method of studying crustal structure in any one area but comparisons between continental and oceanic areas on the basis of gravity data alone cannot be made at the present time. On the whole, the crust appears to be in isostatic equilibrium with most of the major topographic irregularities compensated. Where lack of compensation is indicated, changes in the depth of compensation will bring results more into line. Local marked departures from isostatic equilibrium are associated with mountain ranges, sedimentary basins, island arcs, rift valleys, and grabens. These may be due in part to the local geology but the major portion of the anomaly appears to be related to deep-seated crustal effects. Smaller anomalies within continental shields and oceanic basins may be related to intra-crustal changes in lithology. The crust is rigid enough to sustain superimposed local loads such as volcanic mountains and delta deposits without appreciable isostatic yield but not the broader loading by ice caps.—*M. C. R.*

## 2. MAGNETIC METHODS

11236. Affleck, James. Aeromagnetometer profile flown from Venezuela to Texas: *World Oil*, vol. 128, no. 3, pp. 223–228, 1948.

During a flight from Maracaibo, Venezuela, to Kingston, Jamaica, and thence to Brownsville, Texas, almost exclusively over water, magnetic records were made with Gulf Research and Development Company's aeromagnetometer equipment. A large part of the flight was at an elevation of 8,000 or more feet above sea level, and position and flight elevation were not always certain. The precision of the magnetic readings is estimated as about  $\pm 2$  gammas. Several of the magnetic profiles are reproduced. They show strong magnetic anomalies near the Colombia coast, reaching a maximum value of 170 gammas about 480 miles from Maracaibo, and also important anomalies in the Kingston area. Although interpretations from profiles of this nature cannot be precise, these results can be correlated closely with known geology, and a possible fault and deep are postulated south of Jamaica.—*S. T. V.*

11237. Chapman, Sydney. The supposed fundamental geomagnetic field: *Annales Geophys.*, vol. 4, no. 2, pp. 109–123, 1948.

The geomagnetic field in the interior of the earth according to Blackett's hypothesis in which the flow of mass associated with the rotation of a symmetrical body is accompanied by a magnetic field, is calculated as if the flow of mass were a negative electric current of proportional intensity. Assuming the earth possesses spherical symmetry and rotates as if it were rigid, general formulas are obtained for vertical and hori-

zontal components of magnetic intensity for any interior point. The formulas are applied numerically to three distributions of density in the earth, one uniform and two with density decreasing outwards but by different laws. The variations of horizontal and vertical intensity are shown graphically for these density distributions and for the core hypothesis. The radial gradient of the vertical intensity is the same at the surface for the fundamental field, no matter what the assumed density distribution, and the core hypothesis and hence measurements of the variation of vertical intensity with depth below the surface offer no distinction between the two theories. For the horizontal intensity the two theories furnish gradients of opposite signs. In this respect the observations of Hales and Gough in South Africa support the fundamental hypothesis. It is also shown that the contribution of the atmosphere to the fundamental field is completely negligible.—*V. S.*

11238. Crout, P. D. An extension of Lagrange's equations to electromagnetic field problems: *Jour. Applied Physics*, vol. 19, no. 11, pp. 1007-1019, 1948.

The basic theory extending Lagrange's equations in mechanics to apply to electromagnetic field problems such as those encountered in ultra high frequency work and other branches of engineering is presented. Assuming that the electric field can at each instant be approximated by a linear combination of chosen "current modes" in which the coefficients are taken as functions of time and generalized coordinates, it is proved that Lagrange's equations are satisfied if the roles of the kinetic and potential energies are taken by the magnetic and electric energies respectively. In certain cases the generalized coordinates used with Lagrange equations may be considered as charges which have flowed around the various meshes of a lumped network whose Kirchhoff voltage equations are identified with the Lagrange equations, the network hence being equivalent to the given system to the degree of approximation permitted by the choice and number of generalized coordinates. The Lagrangian procedure thus gives equivalent networks. A duality is shown to exist between electric and magnetic quantities, thus, if the magnetic field is sufficiently approximated by a linear combination of "flux modes," Lagrange's equations are satisfied if the roles of kinetic and potential energies are taken by electric and magnetic energies, respectively. It is also shown that Lagrange's equations are valid if the chosen current or flux modes change with time in any specified manner, a fact which may be useful in problems involving moving coordinate systems and in propagation problems.—*M. C. R.*

11239. Deegan, C. J. Economics of aerial magnetics: *Oil and Gas Jour.*, vol. 47, no. 12, pp. 67-71, 77, 1948.

Factors affecting and means of reducing the cost of aeromagnetic surveys are discussed, and it is concluded that possible reductions in the cost of aeromagnetic surveying make it feasible under favorable conditions to survey an area as small as 20 to 25 miles. Costs related to the use of the aircraft can be lowered by reducing the time during which the plane is not productively employed. One way to do so is to save on the periodic moving of the operational base either by covering a large area from each base or by completing small areas on schedule and moving the base be-

tween jobs. Costs of surveying necessary for fixing the ground positions are high only in unmapped regions where the Shoran method must be used. If ground maps or aerial photographs are available, small areas may be surveyed economically. Costs of the establishment of a control grid of check points, and of tying to it survey lines for correcting magnetic readings for diurnal variation and instrumental drift can be lowered by using slower planes for smaller areas. The smallest suitable plane is likely to be of a type similar to the U. S. Army AT-11 two-engine trainer.—*V. S.*

11240. Ellison, M. A. Solar flares and their terrestrial effects: *Nature*, vol. 163, no. 4150, pp. 749–753, 1949.

A solar flare may be described as a sudden, short-lived increase in monochromatic radiation occurring in a limited region of the chromosphere in the vicinity of an active sunspot group. The geophysical effects of flares are of various characters and can be derived from two different causes. Flares show intensive wave radiations, mostly ultraviolet, and certain corpuscular emissions which reach the earth. Wave radiations are accompanied by simultaneous geomagnetic disturbances, but corpuscular emissions are characterized by delayed effects which depend on the travel time from sun to earth of the particles concerned. An impressive amount of evidence showing synchronous occurrence of solar flares and geomagnetic "crochets" has been assembled. Short-wave radio channels are interrupted simultaneously with the appearance of flares. On the other hand, corpuscular emissions produce geomagnetic storms about 26 hours after the central meridian passage of the sunspot. Astrophysicists have not yet given a comprehensive explanation of the cause of these phenomena. It is very probable that the flare problem is not restricted to the sun, but also concerns stars of certain type which show flare activity like the sun but on a scale  $10^{11}$  times as great.—*S. T. V.*

11241. Fanslau, Gerhard. Über eine neue magnetische Verticalfadenwaage [On a new vertical magnetic suspension-balance]: *Zeitschr. Meteorol.*, vol. 2, no. 7–8, pp. 216–225, 1948.

The construction, theory, and operation of a new vertical magnetic balance built on the suspension principle are described. Instead of the knife-edge magnet resting on agate-supports, common in vertical balances, a doubly lamellated magnet of moment 900 G cm.<sup>3</sup> and 6 cm. in length is suspended slightly eccentrically on a small nonmagnetic ribbon. Among the advantages gained by such design are the following: the alinement of the magnet in the horizontal plane can be made from the outside by means of the torsion-head screw of the ribbon; the torsion of the ribbon can be used as a standard of measure; and the deflecting magnets, frequently needed in knife-edge models, can be eliminated because the effective couples of the forces of  $Z$ ,  $H$ , and gravity are compensated by the torsion moment. The theoretical analysis shows that in the case of exact horizontal alinement of the magnetic axis the effective component of  $H$  vanishes in every position of the magnet relative to the magnetic meridian. The instrument is reported to withstand mechanical shocks and to be suitable for field surveys.—*M. C. R.*

11242. Frowe, Eugene. Exploration in the Gulf of Mexico with the air-borne magnetometer [abstract]: *Oil and Gas Jour.*, vol. 47, no. 32, p. 104, 1948.

Experimental flights with the air-borne magnetometer have been made over numerous structures in the Gulf Coast area to determine the correlation between magnetic profile and known geology. The results of these flights are given to show the extent of the correlation and to compare the magnetic anomalies of offshore structures with those of inland structures. The magnetic effects of derricks and well casings are discussed.

Frowe, E. W. Offshore exploration with gravity meter and magnetometer. *See Geophys. Abstract 11225.*

11243. Grabovskii, M. A. Modification of the magnetic properties of magnetite under the influence of mechanical stresses [in Russian]: *Akad. Nauk Izv. SSSR, Ser. Geog. i Geofiz.*, vol. 13, no. 2, pp. 143-150, 1949.

To test the hypothesis that the magnetization of magnetite changes when rocks containing magnetite are subjected to deformation in place, laboratory determinations were made of the effect of uniform deformation on the magnetic properties of magnetite samples from the Gora Vysokaya deposit, Nizhniy Tagil district U. S. S. R. The experimental procedure consisted in placing a sample  $10 \times 10 \times 100$  mm. between the poles of an electromagnet, compressing it by bringing the poles together gradually, and simultaneously measuring the induced magnetization, the compressing force, and the inducing field of the magnet, both before, during, and after application of pressure. The results indicated that the magnetization decreases with an increase of compressing force, as much as 15 to 20 percent for the samples studied. The decrease of residual magnetization was 25 to 30 percent. The effects of distension on magnetization were also studied but the samples were ruptured before results were obtained.—V. S.

11244. Grenet, Gaston. Enregistrement des variations rapides du champ magnétique terrestre au moyen d'appareils à aimant mobile [Recording rapid variations of the geomagnetic field by apparatus with a mobile magnet]: *Acad. Sci. Paris Comptes Rendus*, vol. 228, no. 13, p. 1148, 1949.

Use of new metal alloys in modern magnets has made possible construction of magnetometers with moments of inertia of the order of 100 gr./cm.<sup>2</sup> and periods of only 1 or 2 seconds. These can be used to record rapid variations of the geomagnetic field by being made to activate a galvanometer through a suitable electromagnetic device. The simplest form of such a device is a solenoid placed around the mobile magnet, because geomagnetic induction in the coil is negligible in comparison with induction caused by the rotation of the magnet. The sensitivity of a model constructed at the observatory of Tamanrasset for recording rapid variations of the horizontal component exceeded 1 mm./10<sup>-6</sup> gauss for periods of 2 to 10 seconds.—V. S.

11245. Heinie, Hans. Astronomical observations on Hopen: *Norsk Polarinstitut Skrifter*, no. 90, 33 pp., 1948.

An expedition of the Norwegian Svalbard-og Ishavsundersøkelser (Institute for study of Spitzbergen and Arctic Ocean) in the summer of

1947 determined the geographic coordinates of Hopen in the Arctic Ocean as  $76^{\circ}30'5''$  north latitude,  $25^{\circ}4'4.5''$  east longitude and the magnetic declination of the island as  $4^{\circ}23.7'E$ .—S. T. V.

11246. Kalashnikov, A. G. Method for determining the magnetic susceptibility of rocks in natural conditions [in Russian]: Akad. Nauk SSSR Doklady, vol. 63, no. 6, pp. 657–660, 1948.

Inasmuch as laboratory determinations of the magnetic susceptibility of rocks must be made on small samples, a method has been developed for measuring the susceptibility of rocks in natural conditions where they occur in large masses. The instrument consists of 4 flat, concentrically wound coils mounted in pairs, each pair being composed of a small coil inside a large coil. A current passed in opposite directions in the outer coils induces in the inner coils opposite magnetic fluxes so balanced that the difference between them, measured by a fluxmeter, approximates zero. A formula is deduced to show that, if the first pair of coils does not touch the rock and the second pair, used for measurements, is placed on the rocks' surface, the susceptibility of the rock will be  $2\pi$  times the difference between the two fluxes divided by the value of the flux in the measuring coil. In the two instruments constructed and tested experimentally the measuring pairs of coils had, respectively, outer diameters of 180 and 500 mm., a current of 1 ampere in the outer coils, and fluxes of  $2.02 \times 10^6$  and  $5.07 \times 10^6$  maxwells in the inner coils. Measurements of the magnetic susceptibility of a mixture of sand and magnetic powder, known theoretically to be  $570 \times 10^{-6}$  c. g. s. gave the values of  $554 \times 10^{-6}$  and  $545 \times 10^{-6}$  c. g. s. respectively, within the limits of the probable error of determinations.—V. S.

11247. Kastrop, J. E. Gulf's air-borne magnetometer in Florida: World Oil, vol. 128, no. 4, pp. 138–142, 1948.

As gravitational and seismic exploration for oil in Florida proved to be unsuccessful, a magnetic survey was undertaken with the Gulf air-borne magnetometer in 1948. The survey has progressed northward from the tip of the peninsula and is expected to cover a total of 40,000 square miles. The operational techniques are outlined briefly, and the causes of failure of the gravity and seismic work are reviewed. The gravitational method met with difficulties in Florida because the sedimentary section is thin compared with sediments in salt dome basins and lacks strong density contrast. Seismic exploration was handicapped by heterogeneous surface sands dispersing waves and by high velocity limestone strata diverting energy horizontally or back to the surface.—V. S.

11248. Klein, F. O. Preliminary magnetic chart for 1947: Am. Geophys. Union Trans., vol. 30, no. 2, pp. 221–222, 1949.

A preliminary chart is given of magnetic declination in the North American Arctic region in 1947, compiled from approximately 600 declination values computed from observations recorded on aerial missions of the 72nd Reconnaissance Squadron Photographic. The values were determined by comparing true headings on an astro-compass with magnetic headings simultaneously registered on a Fluxgate gyro-stabilized compass. The average accuracy of the true headings was of the order

of  $\pm 1^\circ$ , and that of the magnetic values is unknown but probably less. No discussion is given of the geographical distribution of the magnetic observations, but the chart was sectorized into many areas, for each of which mean declination values were determined.—V. S.

11249. Koulomzine, T. Temperature compensation of old type Askania magnetometers: *Min. Eng.*, vol. 1, no. 5, pp. 133-136, 1949.

The theory of the vertical Askania magnetometer is reviewed, a formula for the temperature coefficient of the instrument is derived and a method is given for reducing this coefficient to a value close to zero. The general formula, obtained for a symmetrical magnet system, shows that with small deflection angles the temperature coefficient  $T$  depends on the vertical component,  $Z$ , of the geomagnetic field, the temperature coefficient,  $u$ , of the magnetic moment, and the temperature coefficient,  $p$ , of the distance between the magnetic system's center of rotation and the projection of its center of gravity on its axis:  $T = Z(p - u)$ . Accordingly, when  $p = u$ , the instrument is compensated for temperature. It is shown that with Askania magnetometers of the old type, the necessary values can be nearly equated by means of an asymmetrical attachment of one magnet blade to the spacer block. The fact that the block in these models is made of aluminum, which has a coefficient of expansion different from that of the cobalt steel constituting the two magnet blades, a loosening of the south screw of one blade (in the northern hemisphere) makes possible an automatic readjustment of the relations between the relative positions of the points determining  $p$ , when the temperature changes, and brings its value closer to that of  $u$ . The formula, derived for such an asymmetrical attachment, is independent of the vertical component of the geomagnetic field and a function only of the mass of the magnet blade and of the magnetic moment of the entire system and gives the magnetometer a temperature coefficient close to zero. The loosened screw can be tightened against a small tubular paper washer inserted into the hole of the blade and pressing against the aluminum block.—V. S.

11250. Lincoln, J. V., and Shapley, A. H. Correlation of coronal and geomagnetic observations: *Am. Geophys. Union Trans.*, vol. 29, no. 6, pp. 849-854, 1948.

Analysis of coronal and geomagnetic observations from August 1942 to July 1944 indicated a systematic correlation between the intensity of the green line of the coronal spectrum and geomagnetic disturbances. (See *Geophys. Abstracts* 128, no. 8999). Coronagraphic data from Climax Observatory supplemented by observations from Pic-du-Midi and Wendelstein observatories for 1944-46 have been analyzed in an extension of this investigation. The coronal-geomagnetic correlation has become weaker since the minimum epoch of the sunspot cycle in 1944 and the apparent time relationship has shifted. Data for 1944 show the general characteristics of the relationship found in the previous investigation, a pronounced increase in magnetic activity two to three days after the bright coronal region was centered on the east limb and a minor increase eight days after east limb passage. Data from 1945 were inconclusive. In 1946 a more consistent coronal-magnetic correla-

tion was obtained with magnetic activity greatest, on the average, four to five days after east limb passage of the selected coronal regions, also high at  $-1$  and  $0$  days, and with secondary maxima at  $8$  and  $12$  days.—*M. C. R.*

11251. Madill, R. G. Declination results at Canadian stations north of latitude  $60^{\circ}$  N, 1938-47: Dominion Observatory Ottawa Pub., vol. 11, no. 9, pp. 343-352, 1949.

Between 1938 and 1947 declination observations were made at 350 points in northern Canada between  $60^{\circ}$  and  $80^{\circ}$  north latitude and  $62.7^{\circ}$  and  $138.5^{\circ}$  west longitude. Mean values of declination and relevant data for each station are presented in tabular form. In certain areas where daily variation and disturbance phenomena are not yet fully understood, these values are subject to further corrections, but they are of immediate importance in the construction of magnetic maps and in advancing knowledge of the distribution of magnetic meridians in northern Canada. Reference is made in the text to the types of instruments employed, among them the electrical-induction magnetometer constructed by the observatory. In this model the detecting element is mounted on the telescope tube of a theodolite in such a way that its use for astronomical observations is not impaired, and absolute measurements of declination, inclination, and intensity can be made rapidly and precisely. With this instrument, first employed in the area of the north magnetic pole, magnetic elements could be measured in localities where standard-type magnetometer was useless.—*V. S.*

11252. Madill, R. G. The general character of the earth's magnetic field in western Canada: Canadian Min. Met. Bull., vol. 41, no. 440, pp. 662-663, 1948.

A brief outline is given of magnetic investigations since 1725 in western Canada, and the general distribution and secular changes of the local geomagnetic field are described.—*V. S.*

11253. Nagata, Takeshi, Harada, Yosimichi, and Okada, A. Measurement of natural residual magnetization of sedimentary rocks by means of a new type magnetometer: Tokyo Univ. Geophys. Inst., Geophys. Notes 13, 7 pp., 1947.

To overcome difficulties in measuring the magnetization of weakly magnetic sedimentary samples exposed to intense accidental magnetic influences, the authors have designed a new apparatus, simple in construction, but as unaffected by such disturbances as the more complex magnetometer of the electro-magnetic-induction type previously constructed by A. G. McNish and T. Nagata. Instead of the suspension of the magnet, the test sample itself is suspended in the new apparatus on a phosphor-bronze fibre in the center of a set of rotatable circular solenoids, and the horizontal component of the geomagnetic field is compensated with the aid of a large Helmholtz coil. With such an arrangement the direction of magnetization in the sample can be determined by a measurement of the deflection angle of the suspended system. The underlying mathematical equations are given, and the construction of the apparatus is described.—*V. S.*

11254. Reed, D. E. and Garpner, E. U. Prospecting with the surface magnetometer: *Oil and Gas Jour.*, vol. 48, no. 1, pp. 106-109, 1949.

The geologic features causing magnetic anomalies are discussed, and failures of magnetic prospecting in its early days are attributed to faulty interpretation of data. In general, sedimentary rocks have weak magnetization, and igneous and metamorphic rock have stronger magnetic properties, with magnetization increasing from acidic to basic types. A magnetic anomaly can be the result of a structural elevation or depression of the basement, a lateral variation in magnetization of basement rocks, or a combination of both factors. Anomalies due to structural features of the basement have a limited extent and magnitude, becoming more extended and weaker as depth to the basement increases. Strong and widely extended anomalies originate chiefly in large lateral variations in the magnetic properties of basement rocks which tend partly to mask the effect from any basement structures that may be also present. The main problem of interpretation is to separate local structural anomalies from regional effects and to embody them in residual magnetic maps.—V. S.

- Skeels, D. C., and Watson, R. J. Derivation of magnetic and gravitational quantities by surface integration. *See Geophys. Abstract 11232.*

11255. Thellier, Émile, and Thellier, Odette. Sur une différence essentielle entre les orages magnétiques à début brusque et à début progressif, en ce qui concerne la récurrence de 27 jours [Significant difference between magnetic disturbances with abrupt and gradual beginnings with reference to the 27-day periodicity]: *Acad. Sci. Paris Comptes Rendus*, vol. 227, no. 20, pp. 1044-1046, 1948.

A statistical study was made of 688 magnetic disturbances recorded during the years 1884-1947. Of these 150 were too weak to be analyzed; of the remaining disturbances, 210 began suddenly and 328 had a gradual development. The first type does not show any periodicity, being caused by corpuscular radiation from chromospheric eruptions of the sun. The second type, on the contrary, shows a periodicity of 27 days. They are caused by continuous radiations from the solar surface.—S. T. V.

11256. World Oil. Aerial surveying speeds Mozambique exploration: *Vol. 128*, no. 12, pp. 200-202, 1949.

An aeromagnetic survey is being made with the Gulf magnetometer over the 42,000-square-mile concession of the Mozambique Gulf Oil Co. in Portuguese East Africa. Ground orientation to guide magnetometer flights was provided by preliminary aerial photography that furnished flight maps on a scale of 1:45,000. Position fixing of magnetic data by means of these maps is controlled by the local geodetic triangulation net. During the dry season from mid-July to November, 1948, 21,000 square miles of aerial photography and 16,000 square miles of magnetic survey were completed.—V. S.

11257. Zachos, K. Geophysikalische—magnetische, elektrische und Suszeptibilitäts-Untersuchungen bei Lam, Bayr. Wald [Geophysical investigations in Lam, Bavarian Forest, by magnetic, electric, and susceptibility measurements]: Beitr. angew. Geophysik, vol. 11, no. 1, pp. 1-35, 1944.

A magnetic anomaly associated with a gravel bed has been known in Lam, in the Bayrischer Wald since the Middle Ages. Magnetic and electrical surveys were made to determine the source of the disturbance. In spite of complicated tectonic conditions well-defined contours were obtained from magnetic measurements made by Askania field magnetometers. The instruments were provided with temperature compensation from  $-3^{\circ}$  C. up to  $22^{\circ}$  C. The vertical intensity anomalies ranging from  $-1500\gamma$  to  $3000\gamma$ , necessitated use of an additional magnetic field produced by auxiliary magnets. Scale values of the magnetometers used for the measurements of the vertical and horizontal vectors of the magnetic field were  $32\gamma$  and  $9.7\gamma$ , respectively. Special instruments were designed for measuring the magnetic susceptibility of the ground samples. Electrical surveys confirmed results obtained from magnetic measurements, and the findings of the whole survey were verified by a mineralogical examination of several trenches dug at the most important points. Procedures employed in different parts of the explored region are described in detail and the results obtained are presented in many graphs. It is suggested that considerable masses of pyrite and magnetite are buried in Unterschmelz and Mariahilf, near Lam.—S. T. V.

### 3. SEISMIC METHODS

11258. Agocs, W. B. Sea bottom slope determination from water sound arrivals: Geophysics, vol. 14, no. 2, pp. 123-132, 1949.

The author has extended his previous work on a method of determining the time break and shot-to-detector distance for a horizontal sea bottom to the general problem of a sloping sea bottom. Equations are set up relating the depth of the shot below the surface of the sea, shot-detector difference, and the direction and magnitude of the sea bottom slope to ratios of differences in the arrival times of certain waves. Either the ratio of the difference in time of arrival of the direct water wave  $W$  and the first reflection from the surface of the sea  $E_1$  to the difference in time of the second  $E_2$  and first reflection  $[(E_1 - W)/(E_2 - E_1)]$  or the ratio of the difference in time of arrival of second and first reflections to the difference in time of arrival of the third  $E_3$  and second reflection from the surface of the sea  $[(E_2 - E_1)/(E_3 - E_2)]$  may be used. Because solution of the equations would be difficult and laborious, graphic solutions and successive approximations have been used. Families of curves for different values of slope angles up to the limiting case of  $30^{\circ}$  to facilitate calculations are given. The method may be modified slightly for use in sonic sounding from the sea surface, using multiple echoes for slope and depth determinations.—M. C. R.

11259. Bastings, L. Measurement of explosion shock on a concrete pier: *New Zealand Jour. Sci. Technology*, sec. B, vol. 29, no. 3, pp. 127-132, 1947, [1948]

On July 13, 1944, a group of underwater mines reported to contain a total charge of about 8,000 lbs. of high explosive was exploded at the entrance to Wellington Harbour. A record was made at a distance of 275 yards by two horizontal Jaggar-type pendulums mounted on the floor of a chamber in the pier supporting a navigation light. The initial disturbance had a period of 0.28 second and an amplitude of between 0.2 and 0.25 inch. The maximum acceleration was calculated to be between 25 and 31 percent of the acceleration of gravity.—*M. C. R.*

11260. Benioff, Hugo. Earthquakes and rock creep [abstract]: *Geol. Soc. America Bull.*, vol. 59, no. 12, pt. 2, p. 1391, 1948.

An investigation based on the Gutenberg-Richter magnitudes of a number of earthquakes and aftershocks indicates that the occurrence of aftershocks can be explained in terms of an elastic afterworking or creep in rocks. Aftershocks of the Long Beach earthquake show the creep was purely compressional in nature for the first 0.14 day and thereafter was purely shear. The study has been extended to include a number of earthquake sequences including the Hindu Kush and Tonga deep-focus groups, each of which forms an elastic, plastic, or combination elastic-plastic creep series. The evidence suggests that the rock masses in which these sequences have their origin behave as single mechanical units, and that these large masses accumulate elastic strain for time intervals up to 30 years or more. California earthquakes having epicenters west of the Sierras form an elastic creep series, termed the San Andreas sequence, which began approximately August 22, 1914, and continues to date.—*M. C. R.*

11261. Blumberg, R. K. A new displacement seismograph: *Earthquake Notes*, vol. 20, no. 1, pp. 7-8, 1948.

Horizontal and vertical components of a remote-recording, ink-writing seismograph with uniform frequency response over a wide range of frequencies and adjustable natural frequency have been constructed. The instrument is of the capacitance type. The transducer is flat from zero cycles per second to a frequency of several thousand cycles per second. The pen amplifier and pen are flat from zero cycles per second to about ten cycles per second. When first tested, the instrument had a static magnification of about three quarters of a million.—*M. C. R.*

11262. Byerly, Perry. The University of California seismographic stations: *Earthquake Notes*, vol. 20, no. 3, pp. 24-25, 1949.

Three of the nine stations of the University of California seismographic network, Arcata (on the campus of Humboldt State College), Reno (on the University of Nevada campus), and Fresno (on the campus of Fresno State College), are equipped with three-component Sprengnether instruments of two seconds free period and a magnification near 5000. At Mount Hamilton (Lick Observatory) and at Palo Alto (Stanford University) stations, Benioff vertical seismographs have been added to earlier equipment. The station at Mineral is similarly equipped.

A Benioff vertical ink-recording seismograph has been added to the equipment at the Berkeley station on the University of California campus. The Ferndale station has Bosch-Omori horizontal pendulums. The San Francisco station has two Wood-Andersons and a three-component Sprengnether with long period horizontals and short period vertical.—S. T. V.

11263. Caloi, Pietro, and Peronaci, Francesco. Il terremoto del Turkestan del 2 novembre 1946 [The Turkestan earthquake of November 2, 1946]: *Annali Geofis.*, vol. 1, no. 2, pp. 246–252, 1948.

The epicenter of the violent earthquake of November 2, 1946, in Turkestan was determined by the stereographic projection method, using 16 European stations, as  $41^{\circ}52.35' \pm 5.2'$  north latitude,  $71^{\circ}42.29' \pm 2.9'$  east longitude. The origin time was  $18^{\text{h}}28^{\text{m}}40.25^{\text{s}} \pm 2.3^{\text{s}}$  G. c. t. and the depth,  $73 \pm 23$  kilometers.—S. T. V.

11264. Carder, D. S. Travel times in the Lake Mead region, Arizona and Nevada [abstract]: *Earthquake Notes*, vol. 20, no. 1, p. 8, 1948.

Using data from the explosion of 4,000 pounds of TNT near Boulder City, Nevada, the velocity of *P* waves below 3 kilometers was found to be 6.38 km./sec. and the corresponding *S* wave velocity 3.75 km./sec. At depths less than 3 km. the *P* wave velocity is about 3 km./sec.—M. C. R.

11265. Carome, E. F., and Nash, H. C. A selective relay amplifier for recording WWV time signals: *Am. Geophys. Union Trans.*, vol. 30, no. 3, pp. 328–329, 1949.

The authors have developed a selective relay amplifier for recording WWV time signals, which consist of a continuous 440-cycle audio note interrupted for one minute before the hour and each five minutes thereafter carried on frequencies of 2.5, 5, 10, 15, 20, 25, and 30 megacycles. The design of the amplifier is an adaptation of the circuit of C. D. Hanchett, which employs a twin-*T* resistance-capacitance bridge and greatly reduces the amplitude of all frequencies except that of 440 cycles to which it is tuned. The instrument assures a maximum freedom from spurious time signals due to background noises and static, provides both automatic and manual control, and makes it possible to obtain the signal whenever desired. A schematic circuit diagram is included.—V. S.

11266. Chakrabarty, S. K. and Richter, C. F. The Walker Pass earthquake and structure of the southern Sierra Nevada: *Seismol. Soc. America Bull.*, vol. 39, no. 2, pp. 93–107, 1949.

The principal earthquake in the Walker Pass region on March 15, 1946, is located at  $35^{\circ}43.5'N$ ,  $118^{\circ}03.3'W$ , at a depth of 22 km., with origin time at  $13^{\text{h}}49^{\text{m}}35.9^{\text{s}}$  G. c. t. Epicenters of aftershocks scatter about this with some indication of a NNE trend. Times of the *P* phases correspond to a crustal structure with layers of 21.7 km., 9.7 km., and 10.7 km. thickness. The velocities of 5.56, 6.04, 6.94, and 8.06 km./sec. for *P* and 3.26, 3.65, 4.10, and 4.44 km./sec. for *S* agree with those previously determined for southern California.—M. C. R.

11267. Clayton, Neal. Correlation of seismic events with geological horizons: *World Oil*, vol. 129, no. 1, pp. 66-70, 1949.

The author reviews critically the correlation of seismic events with geologic horizons and recommends more attention to well surveys as the most accurate method of determining the velocity distribution in an area. In correlating seismic records with geologic data it should be recognized that differences in sedimentation or lithology may often have more to do with the recording of reflections or refractions than sudden changes in density or elasticity to which the form of the record is commonly ascribed. To aid interpretation, seismograms may be correlated with electric logs by using as criteria the general absence of persistent events in thick shale beds, existence of unconformities in the section, configuration of isopachs, and differences in the reflection properties of limestones and sands. Examples are discussed of such correlation in areas of Texas and Oklahoma with illustration by seismic and logging records.—V. S.

11268. Coulomb, Jean. Remarques sur la comparaison des microséismes en deux stations rapprochées [Remarks on the comparison of microseisms at two near stations]: *Annales de Geophys.*, vol. 4, no. 2, pp.163-164, 1948.

In studying the problem of distances over which microseism trains could be identified the author considers it essential to know what is being measured in comparing the records of stations and inquires into the nature of microseismic trains. With G. E. R. Deacon, the author believes that microseisms are produced by variations of pressure on the sea floor under stationary waves generated by sea movement at the center of a cyclone, and that the form of a train depends on the dispersion of the microseisms constituting it. Examination of the corresponding formula for microseismic trains shows that analogous trains are generated at consecutive moments in irregular sequence and follow each other with the same group velocity. From this it is concluded that the elements which can be used for identifying a microseismic train are its height, its breadth, the dispersion of its constituent waves, and the time elapsing between it and the next train. Using the element of dispersion a formula is deduced for the interval between tripartite stations. Its application to numerical calculations gives 10 km. as the maximum workable interval over which wave trains can be successfully identified.—V. S.

11269. Dix, C. H. Use of large computing machines in seismology [abstract]: *Geol. Soc. America Bull.*, vol. 59, no. 12, pt. 2, p. 1392, 1948.

Use of large-scale electronic digital computers such as the Eniac, Univac, and Edvac may make it possible to approach the solution of many complicated seismological problems, such as pulse propagation, the process of the release of energy by a slip along a fault and the generation of secondary types of waves at discontinuities. The process is one of replacing partial differential equations by approximating partial difference equations and solving these latter by direct integration. Thus fundamental physical relations remain close at all times and extraneous (nonphysical) solutions are avoided.—V. S.

11270. Finch, R. H. Volcanic tremor (Part I): *Seismol. Soc. America Bull.*, vol. 39, no. 2, pp. 73-78, 1949.

Soon after seismographs were installed at the Hawaiian Volcano Observatory in 1912, it was noticed that small tremors were being recorded almost continuously. After seismograph drums with higher speed were installed in 1918 two types of tremor were distinguished, one with a fairly uniform period and amplitude and the other with a greater range of period and amplitude, called "harmonic tremor" and "spasmodic tremor," respectively, by Jaggard. The period of the harmonic tremor is around 0.5 second. A tremor with period of about 0.1 second was recorded occasionally when lava was present in Halemaumau. Illustrations of records show typical tremor under different conditions. The origin of the tremor seems to be in the somewhat rhythmic hammering action of surging lava on strata of appreciable size forming the walls of feeding conduits or adjacent rifts.—*M. C. R.*

11271. Gane, P. H., Logie, H. J., and Stephen, J. H. Triggered telerecording seismic equipment: *Seismol. Soc. America Bull.*, vol. 39, no. 2, pp. 117-143, 1949.

Electronic equipment designed for research on the Witwatersrand earth tremors enables six seismograms originating at different sites up to 17 km. away to be recorded side by side on a common time scale. Seismograms are transmitted by radio from distant seismometers to the laboratory where they are recorded side by side on one photographic strip. High-speed recording is made feasible by automatic triggering of the usually stationary recorder by a critical seismic amplitude. While signals are stored for six seconds on a magnetic tape delay unit so no part of the record is missed. Automatic magnification control, compressing the larger amplitudes, is applied at the transmitting end. Photographs and wiring diagrams illustrate the equipment and sample records obtained with the equipment are shown.—*M. C. R.*

11272. Gutenberg, Beno. Unexplained phases in seismograms: *Seismol. Soc. America Bull.*, vol. 39, no. 2, pp. 79, 1949.

Huancayo seismograms of more than 100 deep-focus earthquakes originating at epicentral distances between  $1^{\circ}$  and  $30^{\circ}$  were studied in an investigation of unexplained phases. Three groups of waves following *P* by about 5, 10, and 20 seconds may be waves transformed from longitudinal to transverse at depths of approximately 40, 80, and 150 km., respectively. Other phases may be waves reflected at a depth of between 900 and 1,000 km. The possibility of a sudden small decrease in velocity near 900 km., below which the increase of velocity with depth is slower than above, is suggested. Other observed unexplained phases have not been investigated in detail.—*M. C. R.*

11273. Handley, E. J. Seismograph surveying in central Alberta: *World Oil*, vol. 128, no. 2, pp. 213-216, 1948.

The discovery of the Leduc oil field in Alberta in 1947, which promises to yield 250 million barrels, has attracted attention to the oil potentialities of western Canada. As a result, the number of seismic parties in Alberta increased from a few summer crews in 1947 to 35 all-year crews

in 1948, and gravity exploration was also expanded. The conditions of seismic work in the rigorous local winters, the adaptation of equipment, and the problems of interpretation are outlined briefly. It is found that, with properly designed instruments and trained personnel, exploration in sub-zero weather and snow is not more difficult in Canada than in other regions and has certain advantages, as many of the promising areas are swamplike. Because of special expenses the maintenance of a seismograph crew in winter is \$20,000 per month, but the cost per profile can be kept below \$100.—V. S.

11274. Heermann, O. Application of seismic reflection methods to salt dome structures [abstract]: Internat. Geol. Cong., Great Britain, 18th Sess., Titles and abstracts of papers, p. 26, 1948.

Analysis of regional seismic reflection surveys has markedly improved the interpretation of the structure of salt intrusions in the Permian salt basin in northwestern Germany, particularly in the northern salt dome area where the thickness of Cretaceous and Tertiary sediments increases. Reflection data obtained on basins between salt domes indicated the pre-Cretaceous and pre-Senonian stages of the evolution of the salt domes and their position within the Saxonian folding, and showed that the later movement of salt structures, their recent alignment, and the shape of shallow salt plugs are partly independent of basement salt structures. Anticlinal and synclinal types of salt structures are discussed. It is found that tensional and compressional salt intrusions alternate in the history of individual salt structures.—V. S.

11275. Hodgson, E. A. The rock burst problem: Canadian Min. Met. Bull., vol. 41, no. 440, pp. 664-666, 1948.

Rock bursts in mines have been investigated in Canada to develop a method of prediction and as a means of studying the structure of the earth. The research on prediction, including studies of rock-burst cycles, measurements of the vibration frequencies induced by blasts and bursts, design and operation of strain gages, analysis of variations in rock temperature, recording of microseisms, and investigations of rock stresses and their release mechanism has furnished much information but as yet no method of prediction has been found.

Rock bursts have also been used in seismic studies to determine both the number and thickness of the upper layers of the earth's crust to a depth of 30 miles and the wave velocities in these layers. Seismograms of small earthquakes in different parts of the world show a varying number of crustal layers with generally uniform velocities, but seismograms of quarry blasts in New England and of rock bursts in Canada have indicated greater velocities in these regions. To determine whether this conflicting evidence on velocities was due to local geology, or to the type of energy release, or to a greater precision in locating and timing the shocks, a series of seismograph stations has been operated since 1947 between Kirkland Lake and Ottawa, Canada, to record rock bursts occurring in the local mining camp.—V. S.

11276. Hodgson, J. H. The use of rock bursts in the study of crustal structure [abstract]: Am. Geophys. Union Trans., vol. 30, no. 2, pp. 186-187, 1949.

A series of rock bursts occurring since 1939 in the gold mines at Kirkland Lake, Canada, offers a source of energy for the seismic investigation

of crustal structure. A seismograph has been installed at Kirkland Lake to time the occurrence of the bursts, and a refraction profile will be built up along a traverse towards Ottawa, by setting up a series of seismograph stations and changing their locations as bursts are recorded.—*M. C. R.*

11277. Jones, W. M. New Zealand microseisms associated with the storm of 14th–16th February, 1947: *New Zealand Jour. Sci. Technology*, sec. B., vol. 29, no. 3, pp. 142–152, 1947 [1948].

Measurements were made of average trace amplitudes and of the periods of dominant wave trains of microseisms associated with the storm of February 14–16, 1947, as recorded by several New Zealand seismograph stations. Maximum amplitudes were recorded at Auckland, Wellington, and Christchurch when the storm center was at sea some 440 km. east of Wellington. The dominant periods were between 4 and 7 seconds, except at New Plymouth where they were 2 to 4 seconds, and tended to be greatest at time of maximum amplitudes. At Wellington, the microseismic activity could be correlated with the strength of southerly wind, with the intensity of the pressure low at the cyclone center, or with the pressure variation.—*M. C. R.*

11278. Kharin, D. A. Fifty years of the seismological network of the U. S. S. R. [in Russian]: *Akad. Nauk SSSR Vestnik*, no. 10, pp. 100–101, 1948.

Seismological observations were initiated in Russia in 1898, when the Russian Academy of Sciences appointed a special commission to work out a program of seismological study of Russia, and by 1907 seventeen seismic stations were in operation. B. B. Galitzin, a member of the Commission, designed a new type of seismometer with galvanometric registration. This instrument was generally accepted and installed in Russian stations, the number of which increased until the second World War, when a great number of Russian seismic stations were destroyed by the Germans. After the war almost all of these stations were restored and equipped with better instruments, registering distant as well as near earthquakes. Records of the Russian seismological observatories are published in the "Monthly Preliminary Bulletin" and the quarterly "Bulletin."—*S. T. V.*

11279. Lahn, E. Seismological investigations in Turkey: *Seismol. Soc. America Bull.*, vol. 29, no. 2, pp. 67–71, 1949.

Systematic geological and seismological investigations have been conducted only since the proclamation of the Turkish Republic in 1923. Geologically, Anatolia consists of a number of interior tablelands surrounded by mountain ranges, the northern and southern Anatolian ranges belonging to the two main branches of the Alpine orogenic system of Eurasia. Seismological investigations have defined several zones in which disastrous shocks have occurred continually since antiquity and in which severe damage is reported in all the towns, and a number of secondary zones in which shocks are frequent but serious damage rarely occurs. In the first category are: the northern Anatolian zone extending from the Marmara basin to the Araxes [Aras] valley which has had the greatest number of disastrous shocks in recent years; the Aegean-Marmara zone in western Anatolia, which has been the most active of all Turkish structures; and the Hatay-Marash [Antakya-Maraş] zone of southeast Ana-

tolia, active in past centuries though no serious damage has occurred in the last hundred years.—*M. C. R.*

11280. Lunts, Ia. L. Propagation of spherical waves in an elasto-plastic medium (in Russian): *Prikladnaia Matemat. i Mekhan.*, vol. 13, no. 1, pp. 55-78, 1949

Spherical waves are generated if pressure uniformly distributed over the boundary surface of a spherical cavity becomes greater than the limit of elasticity of the medium containing the cavity. In studying the problem the author follows the scheme suggested by Prandtl. The differential equation controlling the process is derived and solution given in a finite form. Analysis of the solution shows that two spherical waves are generated in space, corresponding to elastic and plastic deformations of the material. Initial and boundary conditions prescribe that the deformation and its time derivative be zero at the time when the pressure on the cavity begins to exceed the limit of the elasticity of the medium. It is also assumed that after the instantaneous impulse, the pressure decreases monotonically.—*S. T. V.*

11281. Lynch, J. J. An investigation of two-second microseisms at Fordham University: *Earthquake Notes*, vol. 20, no. 2, p. 15, 1948.

Records of two-second micorseisms have been studied at Fordham University since July 1947. Leet's suggestion that they are associated with passage of a cold front has been confirmed over a period of a year, though it has been impossible to determine whether or not they are generated only when the cold front reaches the ocean. Two-second microseisms are part of a band spectrum, each storm containing periods ranging from 1.5 to 2.5 seconds. In many storms, two groups of different periods have met head on. A tripartite station has been set up on the Fordham campus to continue the investigation.—*M. C. R.*

11282. Lynch, J. J. Progress of investigation of two-second microseisms at the tripartite station at Fordham University: *Earthquake Notes*, vol. 20, no. 3, p. 24, 1949.

Three horizontal two-second period Sprengnether instruments in concrete vaults at the apices of an isosceles triangle of sides 1200, 1200, and 1,000 feet are connected by twisted shielded cables to three high sensitivity galvanometers (0.0039 microamp. per mm.), which record on a triple drum driven at a speed of 300 mm./min. in the main vault of the Fordham station. The most serious difficulty encountered has come in spite of twisting and shielding of cables, from ground currents which seem to vary with the conductivity of the ground. The difficulty has been solved temporarily by running an overhead line to one of the seismometers.—*S. T. V.*

11283. Macelwane, J. B., Robertson, Florence, Heinrich, R. R., and Blum, V. J. The variability of vibrations from quarry blasts, 64 pp., St. Louis Univ. Inst. of Technology, 1948.

During the years 1938-48 the authors studied vibrations in the ground generated by blasts in the Fort Bellefontaine and Prospect Hill quarries, St. Louis, Missouri. The vertical component of ground motion was

observed, using a Taylor-Macelwane mechanical seismograph with natural frequency of three cycles per second, near-critical damping, and adjustable magnification. Records were made at different distances from the quarries of blasts ranging in size from 200 to 1300 lbs. Records of similar blasts were sometimes alike but more often different. A detailed study of this variability, using displacement and deduced acceleration as criteria, shows a wide scatter of data. The report includes several seismograms and numerous graphs of displacements and accelerations plotted against the amount of explosives and distances.—*S. T. V.*

11284. The Military Engineer. Seismological organization in the Americas: Vol. 41, no. 279, p. 50, 1949.

At the Fourth Consultation of the Pan American Institute of Geography and History, held at Buenos Aires in October 1948, a resolution was passed endorsing the formation of a Committee on Seismology to promote and coordinate the seismological work in the American hemisphere, make seismological studies, help in standardizing seismological instruments and methods of seismic recording. One of the most important practical aspects will be the study of engineering seismology, particularly in countries of the Cordilleran belt in South and Central America.—*S. T. V.*

11285. Murphy, L. M. A survey of microseismic activity: Earthquake Notes, vol. 20, no. 3, pp. 21–23, 1949.

A survey of ground motion associated with different period microseisms, now available as a byproduct of studies of microseismic amplitudes and meteorological phenomena, may be of value in considering sites for new observatories or the installation of sensitive equipment. The average microseismic background measured in microns, determined by averaging sets of low and high scalings from several month's records during the summer and winter seasons, is given for all U. S. stations operating Benioff instruments. Minimum summer and winter background for 42 stations which cooperated in the 1947 worldwide survey of microseisms is also listed. Geological foundations under the stations are given, but no attempt has been made to establish the influence of the foundation on the microseismic background.—*M. C. R.*

11286. Nile, S. W. Montana earthquake of November 23, 1947 [abstract]: Geol. Soc. America Bull., vol. 59, no. 12, pt. 2, pp. 1394–1395, 1948.

Instrumental data place the epicenter of the earthquake of November 23, 1947, near the divide between the upper Ruby River valley and the Red Rock River valley, Montana. Available field information agrees with such determination. The quake was felt throughout most of Montana, in bordering counties of Idaho, and in northern Wyoming. Rock slides occurred on both east and west flanks of the epicentral region, and new water and mud springs were created.—*V. S.*

11287. Nordquist, J. M., and Geldart, L. P. Coincidences in calendar dates of earthquakes [abstract]: *Geol. Soc. America Bull.*, vol. 59, no. 12, pt. 2, p. 1395, 1948.

A statistical investigation of the relative frequency of the occurrence of pairs of earthquakes on or near the same date in different years at nearly the same geographical location, by comparison with Poisson's exponential function, indicates that earthquakes are distributed at random geographically and throughout the year.—*M. C. R.*

11288. Palmer, R. L. Techniques and problems in marine seismic exploration: *Oil and Gas Jour.*, vol. 47, no. 8, pp. 160-168, 218-222, 1948.

Commercial seismic exploration in off-shore waters of the United States began in the Gulf of Mexico in 1944. At first ordinary land equipment and techniques were employed, but the difficulties of reflection shooting in some areas brought about the introduction of 24-channel seismographs and other adaptations which increased the accuracy and speed of work. Developments in procedures, including use of electronic equipment, small Navy craft, location-marking buoys, suspended charges, and floating, suspended, sledge-mounted, and cable-enclosed detectors are described.

Among the reflection shooting techniques, attention is given to five methods suited to different problems. For reconnaissance, a 60-percent subsurface control can be achieved by recording for each detector spread detonations from six shot points placed around it, if the spreads cover 20 percent of the exploration line. For detailed shooting the control can be 100 percent if the detector spread is set at intervals half its length along the exploration line, and if the shot point is placed in its center each time.—*V. S.*

11289. Peronaci, Francesco. Limite della sensibilit  umana alle accelerazioni sismiche (Limits of human sensibility to seismic accelerations): *Istit. Nazionale di Geofisica Pub. no. 85*, 11 pp., Rome, 1943.

Because determination of the intensity of an earthquake often depends on a subjective estimate by the inhabitants of the shaken area, the authors investigated the perceptibility to different persons of horizontal and vertical impulses of sinusoidal wave form produced by an oscillating table on which the subjects were placed. In accordance with the observed frequencies of earthquake waves, periods of the vibrations ranged from 0.2 to 3 seconds. The experiments show that the sensibility of the human body to mechanical vibrations varies with the frequency and attains a maximum at a period of about 0.4 second, both for vertical and horizontal vibrations. The minimum acceleration perceptible at this frequency ranges from 0.4 to 0.7 gal for horizontal vibrations, and from 0.8 to 1.0 gal for vertical vibrations. These accelerations correspond to the lowest grades on intensity scales.—*S. T. V.*

11290. Perrine, C. D. Periods in earthquake activity: *Seismol. Soc. America Bull.*, vol. 39, no. 2, pp. 109-115, 1949.

The author believes he has found extensive evidence of the dominating influence of lunar gravitation as the controlling factor in seismic activity.

An exploratory investigation, based on data in Milne's Catalogue of Destructive Earthquakes, confirms the extension of the 186-year period back to "A. D. 0," and also the presence of a 93-year period. In addition, a periodic increase of seismic activity to a sharp maximum followed by a sudden, often nearly complete cessation of activity is indicated. Double, very marked maxima with increasing separations in about double the 186-year period are suggested. The large number of lunar and lunar-solar periods present in seismic activity establish lunar gravitation as the underlying cause.—*M. C. R.*

11291. Petrashen', G. Lamb problem for the case of an elastic semispace [in Russian]: Akad. Nauk USSR Doklady, vol. 64, no. 5, pp. 649–52, 1949.

This paper presents a new mathematical method for investigating dynamic processes in elastic media which can be applied to problems ordinarily treated by complex variables, and treats the Lamb problem for a semispace in detail. The method can be applied to a similar problem for a plane-parallel layer, or to the study of dynamic processes in an elastic sphere disturbed by a concentrated impulse of short duration. Initial and boundary conditions are as follows: at zero time a concentrated force is applied to the boundary plane of the semispace. This force is independent of the  $Y$  coordinate, which is normal to the plane of the displacement. Two differential wave equations are derived and their solution given in the form of Fourier integrals. With different assumptions about the coefficients of these equations the solutions can be interpreted as representing a system of longitudinal and transverse seismic waves, or as a system of Rayleigh waves spreading over the boundary plane.—*S. T. V.*

11292. Poisson, Charles. La géologie profonde de Madagascar d'après les tremblements de terre locaux [Deep geology of Madagascar from local earthquakes]: Acad. Malgache Memoires, pp. 133–136, 1948.

Some 250 seismic shocks have been observed and partly recorded at the seismological observatory at Ambohidempona, near Tananarive, which is equipped with a Mainka seismograph with a maximum magnification of 140. Most of these earthquakes must be classified as insignificant. Analysis of the seismograms obtained at this station, as well as of the records from other seismological observatories, using the Joliat and Jeffreys tables, suggests that the thickness of the granitic layer beneath the island is 10 to 15 kilometers, with the latter figure more probable, and the thickness of the underlying basaltic layer some 20 kilometers. The Mohorovičić discontinuity is about 35 kilometers deep.—*S. T. V.*

11293. Rey, Jean. Un nouveau mode d'amplification pour seismographs [A new method of amplification for seismographs]: École Française d'ingénieurs Beyrouth Publ. techniques et scientifiques, no. 3, 27 pp., 1943.

Mechanical magnification of the displacements of a seismograph necessitates the use of large pendular masses, as for example, the seismographs of Göttingen or Strasbourg Observatories which have masses of 17 to 20 tons. The author suggests a pneumatic method of magnification which makes possible the use of much smaller pendular masses. The essential element consists of a piston, rigidly attached to the vibrat-

ing mass and moving with small clearance in a cylinder. This cylinder has a second, much smaller opening covered with a small piston attached to a recording system. The displacement of the small piston and consequently of the recording pen are much greater than that of the first piston. A seismograph of the proposed design was constructed and tested on a shaking table. Its performance was found to be in close agreement with that calculated. The magnification of the new seismograph varies with the frequency of the arriving waves.—S. T. V.

11294. Reich, H., Schulze, G. A., and Fortsch, O. Das geophysikalische Ergebniss der Sprengung von Haslach in südlichen Schwarzwald [Geophysical findings resulting from the Haslach explosion in the southern Black Forest]: Geol. Rundschau, vol. 36, pp. 85-96, 1948.

Analysis of the seismograms of explosions of 73 and 11 tons of explosives in Haslach on April 28 and 29, 1948, registered at numerous stations along the profile from Haslach to the outskirts of the Alps and at several points of the Rhine Valley, showed three layers of the crust: the upper, a granite layer in which the velocity of longitudinal waves is 5.9-6.0 km./sec.; the second, a gabbro layer in which the velocity is 6.55 km./sec.; and the third, a peridotite layer, with 8.2 km./sec. The average thickness of the upper layer is about 21 kilometers, the depth to the second discontinuity is 31 kilometers. From comparison of these results with geological and gravitational data, it is concluded that the gabbro and peridotite layers are rising near Mannheim on the Rhine, that the peridotite layer is sinking in the upper Danube region, and that the gabbro layer is rising in the Alpine foreland.—S. T. V.

11295. Richter, C. F., and Nordquist, J. M. Aftershocks of the Manix earthquake [abstract]: Geol. Soc. America Bull., vol. 59, no. 12, pt. 2, p. 1395, 1948.

Epicenters of the aftershocks of the Manix earthquake of April 10, 1947, in the central Mojave Desert, are distributed along a belt extending east of south from that of the main shocks. Such a line is transverse to the Manix fault on which small strike-slip displacements were found. Decreasing depth is indicated for the more southerly shocks.—M. C. R.

11296. Ricker, N. H. Attenuations and amplitudes of seismic waves: Am. Geophys. Union Trans., vol. 30, no. 2, pp. 184-186, 1949.

The author has previously shown theoretically that the disturbance created by the detonation of a small explosive charge in a homogeneous and isotropic earth assumes a certain characteristic form, shaped by the earth's absorption spectrum for elastic waves, which he calls a seismic wavelet. When observed at great distances from the explosion, the wavelets assume a symmetrical form. At distances not too close to the explosion, according to theory, the center of the wavelet travels with the classical velocity of sound in the medium, its breadth is proportional to the square root of the propagation time of its center, and its amplitude is inversely proportional to a power of the travel time of its center,  $4/2$  for displacement-type,  $5/2$  for velocity-type, and  $6/2$  for acceleration type. In observations close to the explosion, asymmetry should develop in the wavelet form because of the presence of high frequency

components not yet filtered out by the earth's absorption. Departures from the laws of propagation should occur very close to the explosion because there is likely to be plastic flow, entailing a much larger coefficient of viscosity and greater absorption.—*M. C. R.*

11297. Rothé, J. P., Peterschmitt, Elie, and Stahl, Pierre. Les ondes séismiques des explosions d'Haslach (Forêt Noir) [Seismic waves from the explosion at Haslach in the Black Forest]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 5, pp. 354–356, 1948.

The seismic effect of the explosions of April 28 and 29, 1948, destroying the Haslach subterranean installations ( $48^{\circ} 16' \text{ N}$ ,  $8^{\circ} 07' \text{ E}$ ), was recorded by portable seismographs along the Strasbourg-Kempton profile and by the Strasbourg, Messtetten [Messstettin], Stuttgart, Basel, Zürich, Neuchâtel, and Chur observatories. The velocity of longitudinal waves in the vicinity of Haslach was 5,630 m./sec., at stations more than 80 kilometers from Haslach 6,410 m./sec., and at distances of 140–190 kilometers 8,130 m./sec. Transverse waves were not clearly recorded; only the  $S_1$  wave with velocity of 3,300 m./sec. was observed. The depth of discontinuity between the granitic and basaltic layers was found to be  $16 \pm 0.5$  km. and the depth of the Mohorovičić discontinuity in southern Germany 30–32 kilometers.—*S. T. V.*

11298. Schulze, G. A. Seismische Ergebnisse der Helgoland-Sprengung [Seismological findings from the Helgoland explosion]: Die Naturwissenschaften, vol. 34, no. 9, p. 288, 1947.

A special meeting of the Royal Society was devoted to reports by the representatives of Denmark, Netherlands, Belgium, France, and Germany on seismological observations made in different countries during the Helgoland explosion on April 18, 1948. Seismic waves were observed up to 1,000 kilometers distance. The  $P_n$  phase previously observed only during natural earthquakes has been positively identified for the first time. Its velocity was 8.1 km./sec. In northwestern Germany the depth of the  $P_n$  layer was 27 km.  $\pm$  3 km. Another discontinuity was found at a depth of 11 kilometers, below which the longitudinal velocity was 6.4 km./sec.—*S. T. V.*

11299. Sneddon, Richard. Offshore California gets geophysical survey: Petroleum Engineer, vol. 20, no. 1, pp. 242–248, 1948.

The procedures, equipment, and geologic problems of exploration for oil by the seismic reflection method off the California coast in 1948 are outlined. In contrast to the Gulf of Mexico, the continental shelf is quite narrow, depths of 600 feet being not uncommon within a 5-mile limit. The structural features sought are sharply folded anticlines with dips of  $30^{\circ}$  to  $60^{\circ}$  and associated faults and pinch-outs, rather than the salt domes, low angle reversals, and small dip closures of the Gulf region. The survey fleet consisted of a survey boat marking the explored area of ocean bottom with surface lines of buoys; a recording boat carrying the seismograph equipment and laying out, together with the tail boat, a geophone cable along these lines; a jetting boat placing deeply submerged charges; a shooting boat setting near-surface charges and detonating all shots; and a liaison boat for miscellaneous services. The geophone cable was usually paid out in spreads of 11 single or triple

seismometers spaced 100 feet apart and floated on the surface or at a depth of several feet. As many as 120 shots were fired in a day. The records are reported to have been generally good.—V. S.

11300. Stechschulte, V. C. and Birkenhauer, H. F. An instrumental study of the Ohio earthquakes of March 1937 [abstract]: *Earthquake Notes*, vol. 20, no. 1, p. 4, 1948.

From a study of the seismograms of the destructive earthquakes near Anna on March 2 and March 9, 1937, longitudinal velocities of 8.25, 7.7, 7.15, and 6.3 km./sec. and transverse velocities of 4.6, 4.4, and 3.73 km./sec. were determined. The depth of focus was 25 km.—M. C. R.

11301. Teufel, V. W. Offshores eismic exploration in Gulf: *Petroleum Engineer*, vol. 21, no. 4, pp. B7-10, 1949.

The equipment and techniques of offshore seismic exploration in the Gulf of Mexico are outlined. The fleet used consists of six boats, three of them for shoran surveying, two for seismic work, and one for liaison. The shoran unit lays out seismic steel-reinforced cable lines utilizing boat-occupied base stations for triangulation and balloon buoys for marking shot points. The shooting boat, firing charges in the water, is in radio-telephone contact with the recording boat carrying the seismograph equipment mounted on rubber shock cords. A double registration system records twelve straight and twelve composite traces, and a water-noise filter eliminates undesirable, water-transmitted, high-frequency energy. The quality of the records obtained is considered to be generally better than that secured upon adjacent land because of the diminishing thickness of the weathered layer under the water.—V. S.

11302. Treskov, A. A. Determination of the thickness of the earth's crust by means of waves reflected from its base [in Russian]: *Akad. Nauk SSSR Doklady*, vol. 61, no. 2, pp. 271-274, 1948.

The author's previous mathematical demonstration that  $pP$  and  $sS$  phases can be used to determine the thickness of the earth's crust in the area of wave reflection is extended to cover such determination from  $PP$  and  $SS$  phases. For calculation a simple formula is deduced:  $H = 33(T/T_0)$ , where  $H$  is crustal thickness,  $T$  is the retardation of waves reflected from the earth's surface relative to those reflected from the base of the crust, and  $T_0$  is such retardation at a point where the crust is 33 km. thick, as adopted in the Jeffreys-Bullen 1940 tables. The values of  $T_0$  can be computed from the tables, and the values of  $T$  are obtained from the seismograms investigated. The formula makes it possible to determine the thickness of the crust at various points by means of the seismograms of any near or distant station. Its application by the author to the records of the Pulkovo and the Sverdlovsk observatories, U. S. S. R., has given a thickness of approximately 31 km. in the Apennine Peninsula, 39 km. in equatorial Africa, 58 km. in the Zulu Sea, 60 km. in the Banda Sea, and 48 km. in central Asia.—V. S.

11303. Vecchia, Orlando. La sismica di refrazione aiuta a risolvere i problemi geologici nel progetto delle dighe per serbatoi artificiali [Seismic refraction methods are useful in solving geological problems met in selecting dam

sites for artificial storage reservoirs]: *Riv. geomineria*, vol. 9, no. 2, pp. 89-100, 1948.

To determine the suitability of the location for the erection of large water storage reservoirs, seismic refraction surveys were made in different mountainous regions of Italy, covering a wide range of conditions, such as igneous, metamorphic, calcareous, or dolomitic foundations overlain by alluvial, glacial, or lacustrine deposits, in some cases of great thickness. Geological conditions presented many difficulties, but the results obtained were always valuable and revealed much information on the geology of the sites. In several cases exploratory drill holes confirmed the accuracy of the seismic exploration and the correctness of its interpretation.—*S. T. V.*

11304. Veldkamp, J. De ontplofing op Helgoland en de structuur van de aardkorst in nw-Europa [The explosion of Helgoland and the structure of the earth's crust in northwestern Europe]: *Nederlandsch Aardrijksk. Genootschap Amsterdam Tijdschr.*, 2nd ser., vol. 66, no. 2, pp. 150-161, 1949.

The velocity of seismic waves from the explosion of about 7,000 tons of ammunition at Helgoland on April 18, 1947, recorded at distances between 50 and 1,000 kilometers, was 8.15 km./sec. The crustal structure of northwestern Europe was found to be 16 km. of granite overlying 14 km. of basalt. The energy transformed into seismic waves was less than one thousandth of the energy liberated by the explosion.—*S. T. V.*

11305. Wilson, James T. The primary waves of the Michigan earthquake of August 9, 1947 [abstract]: *Earthquake Notes*, vol. 20, no. 1, p. 4, 1948.

A field epicenter was located at 42°00' N., 85°10' W. First arrivals between 120 and 1,200 kilometers define a straight line travel time curve with velocity of about 8.0 km./sec. A velocity of 6.6 km./sec. may be indicated by observations at near stations.—*M. C. R.*

#### 4. ELECTRICAL METHODS

11306. Barret, W. M. Exploring the earth with radio waves: *World Petroleum*, vol. 20, no. 4, pp. 52-53, 1949.

Difficulties previously encountered in the use of radio waves in geophysical exploration were overcome when it was discovered that underground strata absorb radio frequencies selectively and that waves of properly chosen frequencies may be transmitted with special equipment to considerable depths without loss of energy by reflection at the surface. In the system devised by the author and his associates, waves of proper frequency are fed into a new type of radiating apparatus, directed by it along the earth's surface, gradually refracted into the ground along numerous parallel ray paths, propagated downward toward a reflecting formation, such as a mineral deposit, partly refracted farther down, and partly reflected back to the surface to join by further refraction the surface waves and reach the receiver. The cumulative effect of the energy transmitted along the many ray paths and returned from a particular reflecting horizon is reported to produce a greatly amplified response in the receiver. (For description of test, see *Geophysical Abstract* 11314). —*V. S.*

11307. Castany, G. Application des méthodes de prospection électriques à un problème particulier en Tunisie—les seuils hydrauliques [Application of methods of electrical prospecting to a special problem in Tunisia—the hydraulic sills], [abstract]: Internat. Geol. Cong., Great Britain, 18th Sess., Titles and abstracts of papers, p. 25, 1948.

Fractures which for the most part appear on the surface as inconspicuous ridges have long been known in Tunisia as remarkable water sources. The faults are covered by more recent overburden and cannot be detected by studies of surface geology. The Office of Public Works of the Regency Government obtained noteworthy results applying the resistivity method to the structures of Hadjeb El Aïoun, Gafsa, and Sbeitla. As the fracture zones form contacts between different lithological units, the lines of rupture appear clearly in the series of transverse resistivity profiles. The profiles also show the outlines of faults and beds and the folding of the substratum. The results have been checked and amplified by deep electrical soundings and have been confirmed by subsequent drilling.—V. S.

11308. Evjen, H. M. Theory and practice of low-frequency electromagnetic exploration: Geophysics, vol. 13, no. 4, pp. 584-594, 1948.

This is the full text of the paper. For abstract published in advance, see Geophys. Abstracts 136, no. 10870.

11309. Haycock, O. C., Madsen, E. C., and Hurst, S. R. Propagation of electromagnetic waves in earth: Geophysics, vol. 14, no. 2, pp. 162-171, 1949.

Successful use of radar for locating objects has led to consideration of the possibility of its use for determining discontinuities within the earth. Literature on the propagation characteristics of electromagnetic waves in the earth is reviewed and certain experiments are described in which the velocity, attenuation, and wave length of electromagnetic waves in earthy materials were measured for various frequencies using a buried transmission line, buried dipole antennas, and transmission through overburden of a mine tunnel. Indications are that frequencies from 300 to 1,000 kc. are most practical for through-the-earth propagation. The problem is one of getting sufficient energy into the ground and beamed so the direction of a reflected wave could be accurately determined. Application of ordinary radar techniques for the location of underground discontinuities is doubtful at 300 to 1,000 kc. because of the short distances involved. A possible method using a frequency modulated transmitter which would enable determination of the phase shift between transmitted and reflected waves shows promise but has not been fully investigated.—M. C. R.

11310. Magnée, Ivan de. Delimitation géoélectrique du premier pipe de kimberlite découvert dans les champs diamantifères du Kasai, Congo belge [Geoelectrical delineation of the first kimberlite deposit discovered in the diamond fields of Kasai, Belgian Congo]. [abstract]: Internat. Geol. Cong., Great Britain, 18th Sess., Titles and abstracts of papers, p. 27, 1948.

In 1946 the Belgian Center of Geophysical Prospecting Studies organized electrical exploration in the Bakwanga diamond district of

eastern Kasai. The local horizontal pre-Cambrian limestones are covered here with a heavy sandy alluvial and eluvial overburden. Intersecting resistivity profiles revealed an oval zone of 15 hectares registering values lower than those of the limestone. This anomaly was interpreted as indicating an extension of a deposit of yellow-ground kimberlite, and its general orientation indicated that kimberlite should be the source of local diamonds. Borings on the circumference of the anomaly confirmed the identification and the delineation of the deposit.—V. S.

11311. Palmer, L. S. and Hough, J. M. Some earth resistance measurements in Holderness [abstract]: Internat. Geol. Cong., Great Britain, 18th Sess. Titles and abstracts of papers, pp. 28–29, 1948.

Earth-resistance measurements were made at 13 stations on a north-south traverse across the Holderness Plain in northern England to determine the contours of the underlying chalk or the total depth of the glacial overburden. For each station graphs were plotted of the apparent specific resistance [resistivity] against a function of the depth; and from the points of inflection and of maximum slope of the graphs, the depths of the topsoil of a high resistance layer of sand or gravel, and the total thickness of the overburden were calculated. Approximate formulas based on a mathematical analysis of experimental curves were used instead of the empirical Gish-Rooney law. Available borehole data generally confirmed the results and supported the method of interpretation and underlying calculations. There were no indications of any marked erosion channel in the chalk along the traverse investigated. A layer of gravel or sand at 60 feet below the present surface probably indicates an interglacial period in the last ice age.—V. S.

11312. Thyssen, Stephan von. Über das Temperaturfeld stationärer elektrischer Ströme im Untergrund [On the thermal field of stationary electric currents in the subsurface]: Beitr. angew. Geophysik, vol. 11, no. 1, pp. 103–118, 1944.

Electrical currents circulating in the ground generate thermal fields around bodies of high electrical conductivity. Temperatures rise in accordance with Joule's law until a thermal equilibrium is reached under which the total amount of electrically produced heat is dissipated by thermal conductivity. The author analyzed this problem for steady currents and proposes a method for the determination of thermal conductivity of underground formations based on the relation  $\lambda = E^2/S2t$  where  $\lambda$  is the specific thermal resistance of the soil,  $S$  the specific electric resistance [resistivity], and  $t$  is the measured temperature rise produced by the presence at a certain point in the ground of a potential excess  $E$ . The effect of ground-water circulation on heat convection is also analyzed. The thermal field pattern is computed for a spherical body and a circular plate embedded in homogeneous ground. The calculations show that bodies of small dimensions reach a thermal equilibrium in a few seconds, whereas bodies of the same material but of great dimensions reach their final temperature only in several years. The possibility of using the suggested method in investigation of boreholes is emphasized.—S. T. V.

11313. Witte, Leendert de. A new method of interpretation of self-potential field data: *Geophysics*, vol. 13, no. 4, pp. 600-608, 1948.

A new efficient method is given for the interpretation of self-potential field data based on Petrovski's theory, assuming the ore body to be a polarized sphere. Three points are used, all of which are well defined by the equipotential pattern: the negative center, the positive maximum, and the so-called "mid-value" point (point located between positive and negative centers where the potential equals one-half of the sum of the minimum and maximum). Inaccuracies resulting from distortions by topography are thus kept to a minimum. Curves are given which permit determination of the location, depth, and dip of the ore body. The dip can be determined accurately between  $5^\circ$  and  $85^\circ$ . The method cannot be used for vertical polarization. The depth and location can be found with relative accuracy for dip angles greater than  $10^\circ$ . The main advantage of this new method is the ease of interpretation and the greater accuracy for high-dip angles. It is stressed that for accurate interpretation the positive maximum is as important as the negative center, and should therefore be carefully sought during the field work and mapped to its full extent.—*M. C. R.*

11314. World Petroleum. Salt mine test proves earth penetration by radio waves: Vol. 20, no. 3, pp. 62-63, 1949.

In an experiment made by W. M. Barret in the Kleer mine shaft at Grand Saline, Texas, in December 1948 to test the penetration depth of radio waves in the ground, a small radio-transmitter was set up on the surface, and signals were successfully picked up with a receiver in the shaft after they had travelled through about 700 feet of sediments, 25 feet of cap rock, 400 feet of salt, and 100 feet of air. The special radio-transmitting equipment used has been designed to prevent the considerable loss of energy at the air-earth interface caused by reflection, to which the shallow penetration of radio waves in former experiments was ascribed. The new system is operated with a new type of transmitting and receiving apparatus which reduces reflection and compensates for the absorption of the waves in the earth by an increase of the effective ray-path section. The penetrating depth of this equipment is considered to be much greater than that demonstrated in the test.—*V. S.*

Zachos, K. Geophysical investigations in Lam, Bavarian Forest, by magnetic, electric, and susceptibility measurements. *See Geophys. Abstracts* 11257.

##### 5. RADIOACTIVE METHODS

11315. Aliverti, Giuseppina, and Lovera, G. Sulla esalazione del radon dal suolo [On the emission of radon from the soil]: *Annali Geofis.*, vol. 2, no. 1, pp. 137-141, 1944.

The amount of radioactive gas emitted by the soil depends on the radioactive content of the soil, meteorological conditions, and on the state of the soil. Theoretical and experimental determinations of the rate of escape of radon are reviewed and results tabulated. Calculations based on recent experiments in a small vertical hole at Pavia (*see Geophysical Abstracts* 136, no. 10879) indicate diffusion of about nine atoms of radon per second per square centimeter of surface, much larger than

other experimental determinations. Since radon diffusion in earth must be much smaller than in air, calculations are made using the average of three recent experimental determinations, and it is concluded that if this substitution is valid for Pavia, the diffusion of radon in earth at Pavia is about eight times smaller than in air.—*M. C. R.*

11316. Aliverti, Giuseppina, and Lovera, G. Su la influenza di alcuni elementi meteorologici du la diffusione del radon nell, aria tellurica [Influence of certain meteorological factors on the diffusion of radon into soil air]: *Annali Geofis.*, vol. 2, no. 1, pp. 92–102, 1949.

Differential equations are derived for the diffusion of radon from the ground into the air under constant and under varying pressure and temperature. From the solutions of these equations a set of values was computed for selected meteorological conditions. These values, presented in tables and in graphs were verified by measuring the radon content of the soil air at different depths in cylindrical holes drilled into the ground and provided with impermeable walls. These observations, made at different temperatures and under different atmospheric pressures, are in good agreement with the calculated values.—*S. T. V.*

11317. Coltman, J. W. The scintillation counter: *Inst. Radio Eng. Proc.*, vol. 37, no. 6, pp. 671–682, 1949.

Present knowledge of the characteristics and the details of operation of the scintillation counter is reviewed. Flashes of light released when high-energy alpha particles strike a fluorescent screen constituted one of the earliest means of detecting nuclear particles. When used with an extremely sensitive device, the photomultiplier tube, a detector is produced which has a field of application similar to that of the Geiger-Müller counter, is rugged, stable and convenient for field use, and appears to have an indefinitely long life. The photomultiplier detector differs from conventional detectors chiefly in that the primary detecting area may be quite small but the absorption is relatively high and less sensitive to general background radiation.—*S. T. V.*

11318. Davidson, C. F. A prospector's handbook to radioactive mineral deposits, 28 pp., Department of Scientific and Industrial Research, London, 1949.

This handbook, directed primarily toward prospectors and field geologists in colonial territories but applicable to field work in general, enumerates and describes the most important minerals containing uranium or thorium and describes methods of testing ores for radioactivity.—*S. T. V.*

11319. Enns, T. Radiation survey meter: *Franklin Inst. Jour.*, vol. 246, no. 2, pp. 181–182, 1948.

A simple portable instrument with a wide range of sensitivity has been constructed for radiation surveys. The apparatus consists of an aluminum ionization chamber and an electrometer circuit using a Victoreen VX41 electrometer tube. The approximate sensitivities of the instrument to gamma radiation are as follows: one microampere = 0.720 roentgen per hour with a  $10^{10}$  grid resistor; one microampere = 0.144 roentgen per hour with a  $5 \times 10^{11}$  grid resistor; and one microampere per second = 0.108 roentgen per hour with rate-of-drift setting. The maxi-

imum range of the instrument is 14.4 roentgens per hour; the minimum practical range is one microampere per minute or 0.0018 roentgen per hour. The circuit diagram is given.—V. S.

11320. Feldman, K., and Wright, G. M. Diamond drill hole Geiger-Müller counters: Canadian Jour. Research, vol. 27, Sect. F., no. 2, pp. 23-27, 1949.

An instrument has been developed at the National Research Laboratory in Ottawa for detecting gamma rays in diamond-drill holes of a diameter not less than 1.25 inches to depths of 1,000 feet. It consists of battery-operated electronic circuits connected to a Geiger-Müller tube at the lower end of a cable. Each count from the Geiger-Müller tube, attenuated by the cable, is amplified to actuate a trigger circuit. The square pulse thus generated is modulated by a neon oscillator and this modulated pulse is amplified by a power amplifier to give a note in the loudspeaker and to actuate a rate meter which has a maximum full range sensitivity of about 2,000 counts per minute. The tube used is of the self-quenching type, operated at 1,000 volts. A wiring diagram and a detailed description of different elements of the instrument are given.—S. T. V.

11321. Hée, Arlette. Recherches sur la radioactivité d'un granite des Vosges par la methode photographique [Investigation of the radioactivity of a granite from Vosges by the photographic method]: Acad. Sci. Paris Comptes Rendus, vol. 227, no. 5, pp. 356-358, 1948.

The radioactivity of a granite sample from Tholy (Vosges Department) was investigated by the photographic method in an attempt to localize precisely the active substance. The sample chosen was particularly useful because the biotites were crammed with zircons and pleochroic haloes which, according to Joly's theory, are assumed to bear a close relationship to the thorium and uranium in the rock. A thin section of the granite was tightly pressed against a photographic plate and exposed for three weeks. The biotites produced white and dark striae corresponding to cleavage planes, quartz and feldspar produced black surfaces, zircons, black spots, and the haloes, white spots. Activity was associated chiefly with the zircons. The existence of a white region surrounding an active zircon was in accord with Joly's idea that the haloes are due to ionization by alpha rays.—S. T. V.

11322. Hess, V. F. Analysis of the gamma rays from granite and the ionization balance of the atmosphere: Norsk geol. tidsskr., vol. 27, no. 1-2, pp. 1-13, 1948.

The author discusses the discrepancy between the experimentally determined ionization produced by gamma rays from a Quincy granite and that computed from its uranium, thorium, and potassium content. (See Geophys. Abstracts 134, no. 10351.) The average ionization obtained from repeated determinations with very precise instruments was almost 6 ion pairs per cc./sec. compared to a computed value of 2 ion pairs. Back-scattering of cosmic rays, as a possible source of the observed surplus ionization, is rejected since the total ionization produced by cosmic rays amounts to only 2 ion pairs at sea level. The author, after eliminating several other explanations as improbable,

suggests that granite emits its own penetrating radiation of unknown origin.—S. T. V.

11323. Hornkohl, Herbert. Prospección de minerales radioactivos [Prospecting for radioactive minerals]: Bol. Minero, no. 585, pp. 28–29, 1949.

The article gives basic information on radioactive minerals and on prospecting taking into account special conditions in Chile.—S. T. V.

11324. Kallmann, Hartmut. Quantitative measurements with scintillation counters: Phys. Review, vol. 75, no. 4, pp. 623–626, 1949.

The efficiency of a number of fluorescent materials used in scintillation counters was measured by observing the capacity to transform the absorbed energy into light, and the practical yield of light. Zinc sulfide, which has a high capacity for transformation of absorbed energy into light, was found to have a relatively low practical yield because it is opaque to its own radiation. Organic substances, such as naphthalene and phenanthrene, are much better materials in this respect and ought to be used in radioactive measurements by the scintillation method.—S. T. V.

11325. Lind, D. A. Design and performance of a multicellular Geiger counter for gamma radiation: Rev. Sci. Instruments, vol. 20, no. 4, pp. 233–235, 1949.

A Geiger counter has been designed and constructed to the following specifications: high sensitivity to gamma radiations in the energy range 0.025 to 1.0 m. e. v., acceptance of an approximately parallel beam about 2 inches square, very low background, recovery time not limited to extremely short values. The instrument consists of nine individual pill-box shaped counters, each 3 inches in diameter, mounted inside a single 8-inch long envelope. The anode has the shape of a four-pronged spider centered in the box. The counter has a flat plateau at about 150 volts and an intrinsic sensitivity of 25 percent. Its lifetime is better than  $10^7$  counts. It has a sensitivity for gamma radiation comparable to a good scintillation detector, the construction is simple, and the performance comparable with Geiger counters of more conventional geometry.—M. C. R.

11326. Schweitzer, G. K. The measurement of radioactivity in solution: Tennessee Acad. Sci. Jour., vol. 24, no. 2, pp. 123–125, 1949.

Solution measurements have been found to be very satisfactory for the determination of high-energy radioactive isotopes, giving off particles with an energy of not less than 0.8 m. e. v. Many radioisotopes of interest in tracer experiments fall into this class. In the measurements of radioactivity particular attention must be paid to the preparation of the sample—the same volume of solution, the same counting tube and circuit, the same container, and the same geometry must be used in measurement of all liquid samples to be compared. A detailed description of the apparatus used and instructions to be followed in their handling are given. Open-solution counting with an end-window tube of the Geiger-Müller counter will detect minimum particle energy of 0.75 m. e. v. The enclosed-solution method, though not as sensitive,

is the safest as the danger of counter tube contamination is minimized.—*S. T. V.*

11327. Stevenson, J. S. Prospecting for uranium: *Western Miner*, vol. 22, no. 3, pp. 42-45, 1949.

The mineralogy, types of deposits, and characteristics of outcrops, helpful as guides in prospecting for uranium, are discussed with particular reference to conditions in British Columbia.—*V. S.*

11328. Stothart, R. A. Tracing wildcat trends with radon emanations: *World Oil*, vol. 127, no. 10, pp. 78-79, 1948.

Radon emanation surveys, which had been used effectively as a check method for determining fault trends and productivity limits (*see* Geophysical Abstracts 112, no. 6818, and 119, no. 7722), now offer a means for determining desirable areas for wildcatting when known production in an area affords a correlation base. In the upper Gulf Coast, for example, wells are relatively closely spaced over large areas and there are sufficient producing wells to establish radon-time relations for the area. Radial surveys may be run and the variations in radon emanations when correlated with another set from within 10 miles may be used to delimit shoreline conditions too low in relief to be accurately outlined by other geophysical methods. A series of such intersecting traverses may develop trends which when interpreted in the light of past experience may indicate areas best suited to exploration with the drill. It is noted that radon emanation surveys were apparently discredited when tests made in the areas of the 1945-46 atomic bomb explosions and resurveys of previously surveyed regions showed discrepancies. These were later determined to be only surface effects, and a method of making measurements in test holes was devised to overcome the difficulty.—*M. C. R.*

11329. U. S. Atomic Energy Commission and U. S. Geological Survey. Prospecting for uranium, 123 pp., U. S. Govt. Printing Office, Washington, D. C., 1949.

This booklet gives information on uranium- and thorium-bearing minerals, the geological conditions indicating their occurrence, and the methods of testing these minerals in the field and in the laboratory. It contains also extensive data on the laws and regulations concerning prospecting, mining, and selling these minerals. A short bibliography on prospecting for uranium minerals is included.—*S. T. V.*

11330. Urry, W. D. Radioactivity of ocean sediments, 6, Concentrations of the radio-elements in marine sediments of the southern hemisphere: *Am. Jour. Sci.*, vol. 247, no. 4, pp. 257-275, 1949.

Seventy determinations of the radium content in ocean sediments, are reported for a number of depths in each of six cores secured from the southern hemisphere by the U. S. Navy Antarctic Expedition of 1946-7. With the exception of one inshore deposit, the maximum radium content was found at some distance below the surface of the ocean bottom. The curves of radium content as a function of depth were found similar qualitatively to curves previously obtained from North Atlantic and Caribbean cores. The maximum radium content was  $29.67 \times 10^{-12}$  g./g.

at a depth of 25.8 cm. in a core of alternating red clay and globigerina ooze from 8°56'S, 92°5'W. A core of red clay from 32°21'S, 105°55'W shows maximum radium content of  $13.19 \times 10^{-2}$  g./g. at a depth of 6.0 to 6.5 cm. Three cores from the Ross Sea gave dissimilar curves of radium content with maxima of 5.6, 4.26, and  $3.03 \times 10^{-12}$  g./g. at depths of 15.0–16.0, 49.8–51.0, and 25.0–26.1 cm., respectively. A core from the New Zealand plateau showed almost uniform radium content for a length of 176 cm., suggesting that this method of determining time from the mode of variation of radium content is applicable only to deep sea sediments.—*M. C. R.*

## 6. GEOTHERMAL METHODS

11331. Benfield A. E. The effect of uplift and denudation on underground temperatures: *Jour. Appl. Physics*, vol. 20, no. 1, pp. 66-70, 1949.

Disturbances of underground temperatures caused by uplift and denudation have been calculated for simple ideal conditions assuming an elevated plane tableland with an infinitely deep root and horizontal extent large in comparison to its height above the surroundings. The calculated temperatures in °C. at depths of 0 to 5 km. below the exposed surface for an assumed equilibrium value of 20°C./km. (in one example, 10°C./km.) and diffusivity of 0.0130 cm.<sup>2</sup>/sec., after 0.3, 1, 3, and  $10 \times 10^6$  years for speeds of denudation of 1, 3, and  $10 \times 10^{-9}$  cm./sec. are given in tables. It is shown that uplift and denudation increase the heat flow above its equilibrium value, but that no very large increase is likely unless the equilibrium heat flow is small and the speed of denudation is large.—*M. C. R.*

11332. Birch, Francis. Flow of heat in the Front Range [abstract]: *Geol. Soc. America Bull.*, vol. 59, no. 12, pt. 2, p. 1312, 1948.

About 70 measurements of temperature obtained at tunnel level (about 8,300 feet above sea level) during the construction of the Alva B. Adams (Continental Divide) Tunnel under Rocky Mountain National Park have been reduced to find the flow of heat in this region. Corrections have been applied for the topography on several different hypotheses with regard to the physiographic history. The corrected gradient lies between 24.8° C./km. on the assumption that the present topography has persisted indefinitely, and 20.3° C./km., on the assumption that the surface features have been derived from an old-age surface by uniform uplift and erosion during the last million years. An uncertainty of about  $\pm 1^\circ$  C./km. results from lack of reliable data concerning the surface temperatures. Thermal conductivity is to be measured for more than 100 samples of tunnel rock, chiefly granites, gneisses, and schists. The mean value of conductivity for the first 60 samples is 0.0079 in cal./cm. sec. degree, at the mean temperature of about 10° C. Combined with the correction gradients, this mean conductivity gives values of heat flow between 2.0 and 1.6, in units of  $10^{-6}$  cal./cm.<sup>2</sup>/sec., depending upon the assumption as to time of development. These values are significantly higher than the best determinations in lower regions and may be regarded as supporting the hypothesis of crustal thickening in mountain formation.—*M. C. R.*

11333. Kennedy, W. Q. On the significance of thermal structure in the Scottish-Highlands: *Geol. Mag.*, vol. 85, no. 4, pp. 229-234, 1948.

A thermal map of the Scottish Highlands has been constructed on the basis of metamorphic data gathered by G. Barrow, C. Tilley, G. Elles, and other investigators. Isothermal surfaces were identified with the metamorphic zones of the Barrow-Tilley system of advancing metamorphism, established by the succession of index minerals: chlorite→biotite→garnet→kyanite→sillimanite. This system provides a relative temperature scale allowing the graphic portrayal of the manner in which the temperature-pressure conditions varied in response to known metamorphic advances. In the mapping, the northern Highland block was shown as if restored to its original position by a correction for its 65-mile lateral displacement along the Great Glen fault, so as to show the true relationship of metamorphic zones.

The map shows the thermal structure of the Highlands to be an anticline of thermal surfaces which essentially parallels the main Caledonian folding. Its development is related by the author to the disintegration of a mountain root in the basement, leading to some upward migration of the remelted granitic material and consequent injection, migmatitization, and zonal metamorphism at higher levels.—V. S.

11334. Lovering, T. S. Geothermal gradients, recent climatic changes, and rate of sulfide oxidation in the San Manuel district, Arizona: *Econ. Geol.*, vol. 43, no. 1, pp. 1-20, 1948.

Thermal gradients were measured in eleven churn drill holes to determine whether oxidizing sulfides undisturbed by mining operations gave off measurable amounts of heat. Measurements were made to maximum depths of 710 to 1,000 feet and temperatures were estimated to tenths of a degree F. with an error of probably not more than one-tenth of a degree. Nearly all the gradients have two inflection points and many have three. Conductivities of the different wall rocks differ by such small amounts that the effect on the gradient was inconspicuous with the instruments used. Inflections above the 500-foot depth agree with the assumption that the average surface temperature increased when the arid cycle began about 1880. Inflections near depths of 800 feet may be due to a possible warmer climate accompanying the drought at the close of the 16th century. Other inflections show a close relation to the upper limits of the sulfides, especially when they are above water level, the inflection in each case consonant with a heat source in the sulfides. The gradient due to oxidation is from 0.4° to 0.6° F. per 100 feet and the heat liberated under each square centimeter of surface by oxidizing pyrite is approximately 28 calories per year. At this rate about 40,000 years would be required for complete oxidation of the pyrite.—M. C. R.

11335. Sukharev, G. M. Thermal conditions in the Tertiary strata of the trans-Terek plain as an indication of oil and gas potentialities (in Russian): *Neftegaz Khoziaistvo*, vol. 26, no. 10, pp. 45-47, 1948.

Thermal measurements made before 1935 in the artesian wells of the plain north of the Caucasus Mountains and west of the Caspian Sea revealed geothermal gradients as high as 1° C./12 m. Additional data were obtained by the author from a test hole drilled in 1947-48 to Tertiary strata at a depth of 3,096 meters. Analyses showed a decrease of the

geothermal gradient with depth to values approximating the normal  $1^{\circ}\text{C./33 m.}$  in the Tertiary strata and also an increase in mineral content of the waters associated with the lower strata. The correlation between low mineral content of the water and high geothermal gradient in the upper layers is attributed to circulation of ground waters in the strata, whereas the normal geothermal gradient indicates stagnant fluids, a condition favorable for preservation of gas and oil deposits. Accordingly, in the region under consideration the normal gradients may indicate the presence of such accumulations.—*V. S.*

## 7. GEOCHEMICAL METHODS

11336. Starr, C. C. Leaf samples as an aid to prospecting for zinc: *Western Miner*, vol. 22, no. 1, p. 43, 1949.

To test the usefulness of geochemical methods of prospecting, samples of alder leaves and of ground water from the vicinity of a known zinc vein in the vicinity of Silverton, British Columbia, were analyzed. Results of the analysis of ten 100-gram samples of air-dried leaves burned to ash show a variation of zinc content ranging from 139 to 1,111 parts per million, which appears consistent with the known course of the vein. Analysis of eleven one-litre samples of water gave inconclusive results.—*V. S.*

11337. Warren, H. V. and Delavault, R. E. Biogeochemical investigations in British Columbia: *Geophysics*, vol. 13, no. 4, pp. 609–624, 1948.

Possibilities of developing field methods to detect biogeochemical anomalies have been explored in British Columbia. (For results of some of these investigations see *Geophys. Abstracts* 131, no. 9627 and 138, no. 11338). The authors conclude that each plant and plant organ tends to possess a normal Cu and Zn content and to exhibit a normal Cu to Zn ratio which may be modified by significant variations in the geology or geography of an area and by the presence of Cu or Zn mineralization. If the normal can be determined under appropriate conditions, anomalies of value in the search for ore may be detected and plotted, but much more work must be done before normals can be indicated for different areas. Biogeochemical methods may also indicate elements such as B, Mn, or Mg associated with or forming haloes around ore bodies. Young twigs provide the most satisfactory samples. The most satisfactory field analytical method for Cu and Zn is the dithizone "neutral-mixed-color-end-point" method.—*M. C. R.*

11338. Warren, H. V., and Delavault, R. E. Further studies in biogeochemistry: *Geol. Soc. America Bull.*, vol. 60, no. 3, pp. 531–559, 1949.

This paper outlines some of the analytical techniques employed for a re-examination of the problem of biogeochemical prospecting such as: electrodeposition and microtitration, dithizone extraction, and dithizone titration with "mixed color end point," for copper and hydrogen sulfide precipitation and microtitration, and dithizone methods similar to those for copper but with a different pH for zinc. The dithizone method seems best for both copper and zinc analyses. Numerous samples from the Britannia and Sullivan mines, British Columbia.

were collected and analyzed to provide data on what metal content might be expected in trees adjacent to and removed from buried bodies of ore. Twigs are probably more satisfactory than leaves, needles, or fruit as indicators of variations in the metal content of soils and rocks. Twigs are easier to collect, to sample, and to ash. Satisfactory results have been obtained from 1-gram and 2-gram samples. If the evidence is substantiated, it may be possible to carry on biogeochemical prospecting in winter. In some areas the zinc-copper ratios may be more significant in biogeochemical prospecting than the absolute amounts of zinc and copper present in the trees and lesser plants, particularly when these amounts are low. Results show the normal copper-zinc ratio is in the range of .10 to .15; a copper-zinc ratio greater than .15 in igneous or metamorphic areas suggests the presence of abnormal amounts of copper while in areas of zinc concentration the zinc-copper ratio will rise from 10 to about 100, or 500 at places devoid of copper.—V. S.

### 8. DRILL-HOLE METHODS

11339. Deegan, C. J. New well-logging device being tried by Humble engineers: *Oil and Gas Jour.*, vol. 47, no. 11, p. 62, 1948.

Experiments have been conducted on a new method of well logging based on the fact that when nickel is subjected to a magnetic field the molecules shrink and give off energy in the form of sound waves and that, conversely, when nickel is subjected to sound waves the magnetic field is affected. The instrument consists of an 8-foot nickel tube containing two coils insulated magnetically from each other inside a 15-foot cylinder which can be lowered into a well. A magnetic field generated in the upper coil by electric current causes the nickel to send out sound waves which are then reflected in varying amounts by the wall rock. These reflected waves cause variations in the magnetic field in the lower coil which are translated into electric current and recorded in the conventional manner. Preliminary tests indicate that formation boundaries can be located within four feet and that it is possible to differentiate not only among shale, sandstone, and limestone but also to detect variations within a shale formation.—V. S.

11340. Fearon, R. E. Gamma-ray logging: *Nucleonics*, vol. 4, no. 4, pp. 67-75, 1949.

Gamma-ray well logging is the measurement and derivation of information from the intensity of gamma rays naturally emitted into a well bore by any given succession of strata. The means of obtaining such measurements, the significance which may be attributed to them, and the manner in which they serve to augment the total value of the well log are discussed.

For simplification it is assumed that sections of a long narrow borehole may be taken as equivalent to completely enclosed cavities in uniform strata, and attention is limited to radiations for which the mass absorption coefficient may be regarded as constant for elements common in sedimentary rocks. The detector of radiation is assumed to be an ionization chamber. Geiger counters have been used successfully but the treatment is more complex. A relatively thin-walled but pressure-filled ionization chamber in a cavity in the rock strata experiences a

liberation of radiant energy in its gas content which is the same as the energy emitted by a quantity of surrounding rock having the same weight as the contained gas. Thus it is possible to compute the relative radioactive concentration in grams of radioelement per gram of rock necessary to produce a given ionization current in the thin-walled chamber. Such data are presented for radium, thorium, and potassium.

For thin-walled chambers the sample may be defined, as a practical expedient, as extending from the wall of the borehole into the rock by an amount equal to the reciprocal of the absorption coefficient in the rock for the radiations from the element being measured and having a length equal to that of the ionization chamber plus the well diameter. For a thick-walled ionization chamber there is a "collimating" effect which causes it to prefer rays entering perpendicularly to its walls. For the cylindrical ionization chamber used in well logging this amounts to a preference for rays entering in the equatorial plane. For a detector thickly lined with strongly absorbing material, the end effect is less and the sample measured is more nearly the length of the chamber. The thin-walled chamber can better admit rays from nearby strata in directions not parallel to the equatorial plane, but rock appreciably distant from the borehole wall can efficiently emit into it only radiation parallel to the equatorial plane because of the effect of the intervening rock which acts as a cylindrical shield around the detector. The thin-walled detector thus gives greater weight to rocks closely neighboring the hole. Cased boreholes have the effect of a thick-walled detector except when the steel pipe is held in place by Portland cement which may produce errors because of its radioactive content.

The proper speed of logging varies in accordance with the general level of radioactivity, and the permitted speed is a function of the accuracy required. For present day operations satisfactory results are obtained from speeds of 1,000 ft./hr. in unfavorable cases to 4,800 ft./hr. in favorable cases.—*M. C. R.*

11341. Fearon, R. E. Neutron well logging: *Nucleonics*, vol. 4, no. 6, pp. 30-42, 1949.

Neutron logging is a method of logging a borehole by scanning the exposed strata successively with a detector of ionizing radiation and a source of neutrons, fixed with respect to one another but moving as a unit in the borehole. The logging curve derived is a report of the intensity of the secondary ionizing radiation, plotted against depth. The circumstances are so chosen that the gamma rays contributed by the radioelements inherent to the strata represent only a negligible part of the intensity observed. The apparatus employed has a neutron source surrounded by a gamma-ray shield to emphasize the relative influence of the neutrons emitted by the source, and means of measuring ionizing radiation and of eliminating or minimizing spurious effects. Because of space limitations, a capsuled neutron source, such as one involving the reaction of alpha rays on beryllium, is employed.

The problems of secular equilibrium and space distribution of radiations involved in neutron logging are discussed. The intensity of gamma rays present in a cavity in rock at a distance from a point source of neutrons depends on the following: the intensity of gamma rays absorbed by inert matter in the cavity; the source strength, constant and

characteristic of the substance in the source capsule; a factor which is due to the neutron spectrum of the source, which increases as the energy of the most energetic populous group of neutrons present in the source flux becomes larger; a "chemical factor" corresponding to the average effectiveness with which elements present in the rock convert the neutron flux into a gamma-ray flux, which is not subject to large variations but is larger for dry rocks than wet ones; the value to which the full absorption coefficient for the neutron flux converges as more and more rock is penetrated by the radiation, a determinative quantity which is critically influenced by the hydrogen content of the rocks; and the distance through rock to the cavity from the source of neutrons. Effects which are due to influence of hydrogen cooperate to decrease the intensity of radiation with increasing hydrogen concentration. The neutron curve is thus a convenient method of studying variations of hydrogen content in the strata, the relationship in some cases being sufficiently exact to permit a quantitative calibration in a given well in terms of percent of petroleum-filled or water-filled pore spaces.

Neutron- and gamma-ray curves used in combination augment each other. The gamma-ray curve identifies fine shaly sediments by high radioactivity, but the remaining rocks as broad minima. The neutron curve represents porous fluid-filled zones as local minima in the broad maxima which otherwise correspond with these rocks, but cannot differentiate between a thin shale zone and a porous zone by itself.—*M. C. R.*

11342. Guyod, Hubert. Portable recording equipment for electric logs: *Petroleum Engineer*, vol. 21, no. 3, pp. B66-68, 1949.

Recently developed portable equipment can be used for logging boreholes down to depths of 4,000 feet, recording in one operation both potential and resistivity curves. Alternating-current voltage is impressed through a double system of electrical circuits between the logging electrode and the ground from a 110-volt, 60-cycle power source. As the electrode is lowered, a potentiometer on one circuit records changes in electrical potential between it and the ground. As the electrode is withdrawn to the surface, the potentiometer, switched into the other electric circuit, records resistivity changes alongside the previously recorded potential changes. The potentiometer is made to correct and scale down to required range the values of registered potential and resistivity by means of its rectifier, selector switch, scale selector, and other control components.—*V. S.*

11343. Hills, J. M. Sampling and examination of well cuttings: *Am. Assoc. Petroleum Geologists Bull.*, vol. 33, no. 1, pp. 73-91, 1949.

Samples of well cuttings provide one of the chief sources of information on the subsurface formations in the Mid-Continent and Permian basin areas of the United States. These can be taken from both cable-tool and rotary holes so that it is possible to obtain samples representative of the formations penetrated. Descriptions and plotted logs which give a picture of the rocks penetrated can be prepared from microscopic examination of these samples. These logs can be correlated to picture

the regional stratigraphy and index beds can be selected for use in structural contouring. From the detailed sample description of sections of pay sands, estimates may be made of oil and gas recovery and reservoir studies and well-remedial work undertaken.—*V. S.*

11344. Mercier, V. J. Modern methods speed Hugoton completions: *World Oil*, vol. 127, no. 7, pp. 167-169, 1948.

Radioactivity logs were among the methods recently used to speed completions at the Hugoton gas field of Kansas and Oklahoma, largest known natural gas reserve in the world. The gas occurs here throughout 250 feet of Permian dolomites and limestones, commonly divided into five zones. In the past, the general practice was to put casing just above the upper zone, a Herrington [Herington limestone] dolomite, often setting cement too high or too low. For the completion work a reliable electrical log could not be obtained without costly replacing or reconditioning of the mud because the formation above the Herrington is Wellington salt which contaminates the drilling fluids. The gamma-ray log was found well suited for use with the local limestone and dolomite beds, the radioactive constituents of which give a good lithologic differentiation of sections. The neutron-log was shown by core data, perforations, and test to indicate reliably the porous zones containing gas, and its characteristic shift upon entering or leaving casing helped to locate the position of the cement.—*V. S.*

11345. Mygdal, K. A. Assemblage log—an aid to management: *Petroleum Engineer*, vol. 19, no. 8, pp. 242-247, 1948.

The assemblage log is a new form of compilation record composed of data from progress reports on electrical, radioactive, caliper, drilling time, geological sample, and drilling mud logs. These and other records are transferred to a single 6-inch wide strip of tracing paper by superposition and tracing from the original curves. The most satisfactory vertical scale for these logs is 1 inch to 100 feet, and for well-profile work 1 inch to 200 feet.—*V. S.*

11346. Renfroe, C. A. Petroleum exploration in eastern Arkansas, with selected well logs: *Arkansas Geol. Survey Bull.* 14, 159 pp., 1949.

The oil and gas possibilities in eastern Arkansas have been evaluated on the basis of evidence accumulated from wells drilled in the area. Fifty-eight selected well logs from twenty counties are tabulated, and a generalized columnar section compiled for eastern Arkansas. It is concluded that oil and gas prospects in the Tertiary rocks are not good, that a possibility of commercial production from the Cretaceous Natchitoch formation exists, and that the Cretaceous basal sand is a possible source if it should be found on a structure or pinched out up the regional dip. If intrusive igneous bodies similar to the nepheline syenite plugs near Little Rock exist in the deeper portions of the Mississippi embayment, oil traps may be formed in the flanking sands or by the arching of overlying sediments. The oil and gas prospects of the Paleozoic rocks are not known.—*M. C. R.*

11347. Schlumberger, M., and Mathieu, J. L. Applications of Schlumberger method to the investigation of coal seams encountered in boreholes. [abstract]: Internat. Geol. Cong., Great Britain, 18th Sess., Titles and abstracts of papers, p. 29, 1948.

Three Schlumberger methods, electrical logging, side-wall coring, and dipmeter surveys, have been successfully employed for the investigation of coal seams.—V. S.

11348. Speer, J. H. Color reproduction of well logs: World Oil, vol. 128, no. 12, pp. 68, 72, 1949.

Duplication of strip logs, combining electrical logs, driller's log, casing record, drilling time, results of microscopic examination of cuttings, and other data, is now possible by color photography, using a special camera which reproduces full details in as many as 20 colors.—V. S.

11349. Tapper, Wilfred. Portable well logging unit: World Oil, vol. 127, no. 10, pp. 80-82, 1948.

A portable electrical well-logging unit has been developed for use in shallower holes, such as core holes, seismograph shot-holes, and water wells, where the conventional electrolog is uneconomical. It consists of a logging instrument, recording tray, and measuring system, weighing together 100 pounds, and of a self-powered winch with a maximum of 3,000 feet of cable, weighing 1,000 pounds. The unit can record a self-potential curve, a single-point impedance curve, and a caliper curve on separate trips, two degrees of sensitivity being provided for the first, five for the second, and two for third type of log. The logs are traced directly on a paper chart by a stylus, on a depth scale of one inch per 50 feet of hole. Illustrations of the curves are given. It is reported that the portable unit is operated simply and quickly and that it has been successfully used on a large scale in Kansas, Oklahoma, and Texas. Information on the geology of an area can be considerably increased by the logging of shallow holes where these are numerous.—V. S.

11350. Vincent, R. P., Leibrock, R. M., and Ziemer, C. W. Well flowmeter for logging producing ability of gas sands: Am. Inst. Min. Met. Eng. Trans., vol. 174, pp. 305-314, 1948.

The Stanolind flowmeter, employing a hot-wire anemometer connected in a Wheatstone-bridge circuit for measuring gas velocities in the well bore above each producing section, has proved useful in determining the relative productive ability of individual sand sections of gas wells. Results of tests conducted in the Hugoton gas field in western Kansas have indicated in two cases that all or the greater part of the total gas obtained was coming from only one section in wells where four supposedly productive sections had been perforated individually. These results contradict in many instances the indications provided by electric logs and by core analysis. The fact that these latter sources often give incorrect indications demonstrates the need of a method, such as is supplied by the well flowmeter, for accurately determining the amount of gas coming from each producing section.—V. S.

11351. Weber, Reinhold. Fortschritte bei den Messungen des Gasgehaltes der Spülung von Erdöl- und Steinkohlenborungen [Progress in measurements of gas content of the circulating mud of oil and coal drill holes]: *Erdöl und Kohle*, vol. 2, no. 5, pp. 175-178, 1949.

The practice in recent years has been to use automatic recorders of gas content of the mud. Three procedures may be used: Samples can be taken at intervals, for example, every 50 cm., of the drilling advance and heated, the liberated gas burnt under catalytic action of a platinum wire, and the amount of gas determined from the resulting temperature. This procedure gives very accurate results. The second procedure is automatic based on a continuous recording of the variation of the heat conductivity of the gas sample. Accurate results can be obtained as long as no other gases besides methane are present. The third is the use of the Orsat apparatus which has a range from 0 to 15 per cent of methane content. The analysis takes about 1½ minutes per sample. The Orsat apparatus may be connected to a signal system, starting the alarm if the methane content becomes too high. Every layer of coal, even a very thin one, produces an increase of gas content in the mud, thus making possible a correlation of horizons or an identification of the formation. Comparison of electrical well logging with gas well logging shows that they complement each other. Gas logging gives sharper indications in shorter time and permits a more precise location of horizons.—S. T. V.

11351. Wolf, Alexander. Use of electrical models in study of secondary recovery projects: *Oil and Gas Jour.*, vol. 46, no. 50, pp. 94, 96-98, 1948.

Because of the analogy between Darcy's law and Ohm's law an electrical model, in which electric current is used in place of the fluids actually flowing in the reservoir, may be used to study the behavior of secondary-recovery operations. The manner in which the injected fluid will spread through the reservoir, the portion of the reservoir which cannot be flooded under a given well arrangement, and, in some cases, the composition of the produced fluid after break through of the injected fluid may be predicted from model experiments, and a wide range of problems affecting production can be studied. Because so many variables can be taken into account, the electrical model is superior to a mechanical model, such as one made of porous material, where flow is largely controlled by surface tension because of the small dimensions used. At present the electrical model is used extensively in cycling operations but its potential applications are much wider.—V. S.

11353. Wyllie, M. R. J. A quantitative analysis of the electrochemical component of the S. P. curve [abstract]: *Oil and Gas Jour.*, vol. 47, no. 24, p. 96, 1948.

An investigation of the relationship between the electromotive force across a shale barrier and the concentrations of sodium chloride solutions on either side has shown that the action of such a barrier is analogous to that of a glass membrane separating two acid solutions of different hydrogen ion concentration. The shale behaves as a sodium electrode and is responsive to the activities of the sodium ions in the

two solutions in such a way that the potential can be calculated by means of the Nernst equation. This conclusion is confirmed by laboratory experiments. The quantitative evaluation of the shale cell potential has applications in the determination of connate-water content of oil sands from electrical logging data. Based on the self-potential and the resistivity curves, a method has been devised for calculating the amount of connate water in a bed characterized by intergranular porosity and containing both connate water and hydrocarbons.—*V. S.*

## 9. UNCLASSIFIED GEOPHYSICAL SUBJECTS

11354. Foster, W. R. Useful aspects of the fluorescence of accessory-mineral zircon: *Am. Mineralogist*, vol. 33, no. 11-12, pp. 724-735, 1948.

It is suggested that the fluorescence of zircon, when exposed to ultraviolet radiation, may be used for the inspection of commercial concentrates of zircon and for other minerals containing zircon as an impurity. It may also aid in prospecting for beach deposits of workable grade and in following the course of beneficiation of zircon-bearing sands. Contrasts of fluorescent behavior of zircon grains from igneous rocks of various geologic ages, and those from igneous as compared to sedimentary sources, may prove useful in the solution of petrological problems.—*M. C. R.*

11355. Goguel, Jean. Constitution géologique des dépressions périalpines de la Saône et du Rhône, d'après la prospection géophysique [Geologic constitution of the pre-Alpine depressions of the Saone and Rhone Rivers from geophysical prospecting], abstract: *Internat. Geol. Cong., Great Britain, 18th Sess., Titles and abstracts of papers*, p. 26, 1948.

Simultaneous gravimetric, telluric, and electrical surveys of the pre-Alpine plains of France, have made it possible to delineate faults and to locate troughs of subsidence involving a great thickness of Oligocene. Gravity anomalies indicate the configuration of the coal basin of the Bas-Dauphine district and the orientation of the Permo-Carboniferous synclines under the foothills of the Jura Mountains. Other anomalies suggest very deep intrusives not indicated on the surface. The position of the Tertiary basins shows that they formed centers of resistance which the folds of the Jura and of the sub-Alpine ridges avoided, as if their sediments lacked plasticity.—*V. S.*

11356. Gries, J. P. Exploration in the Dakota basin: *World Oil*, vol. 128, no. 2, pp. 121-126, 1948.

Exploration in the Dakota basin, considered by the author to be the most neglected potential oil-producing region of its size in the United States is reported, and the oil possibilities of 5 areas are discussed in relation to local geology. Much geophysical work has been done by oil companies, and magnetometer mapping of South Dakota has been initiated by the Geological Survey of that State. In general the geophysical records were good, but interpretation was difficult because of insufficient knowledge of the subsurface geology. Electrical logs were run in at least 18 holes, some water analyses were made, and sample cuttings were collected in 35 wells. It is suggested that this material could be profitably re-studied in the light of the experience recently acquired in making

and interpreting seismograph records in the northern Rocky Mountain region.—V. S.

11357. Hess, H. H. Report of the chairman of the Special Committee on Geophysical and Geological Study of Ocean Basins, 1947-1948: *Am. Geophys. Union Trans.*, vol. 29, no. 6, pp. 913-914, 1948.

Attention is drawn to certain problems encountered in geophysical and geological studies of ocean basins in 1947-48, which require solution before further advances can be made. Seismic refraction work in the deep sea is essential to determine the nature of the first reflecting layer. Investigation of the shear directions of deep focus earthquakes offers promise for obtaining basic information on deep tectonic processes. Expanded gravity observations at sea in submarines are posing problems of effective methods for calculating data and applying corrections. Proposed further deep drilling at Bikini offers an opportunity to make geothermal measurements for determining the gradients and the rate of heat loss beneath the oceans.—V. S.

Kastrop, J. E. Gulf's airborne magnetometer in Florida. *See Geophys. Abstract 11247.*

11358. Leonard, J. H. A summary of extension courses suitable for field-crew training: *Geophysics*, vol. 14, no. 2, pp. 172-174, 1949.

All extension courses offered in the United States on subjects related to geophysics are summarized in 2 tables. In the first table the 25 colleges and universities giving such courses are listed, and in the second, subjects taught are listed according to the institutions teaching them.—V. S.

11359. Liustikh, E. N. Conditions of identity in the preparation of models of tectonic processes [in Russian]: *Akad. Nauk SSSR Doklady*, vol. 64, no. 5, pp. 661-664, 1949.

The advantages of experiments on models in investigations of physical processes have lead to the development of an extensive theory of models in the thermotechnical and aero-hydrodynamic fields. The chief difficulties in establishing such a theory in geophysics are not the adaptation of mathematical formulas but the simulation of specific local tectonic characteristics. The generalized criteria of identity, determining the scale of tectonic models, are expressed by equations relating length, time, density, stress, force, acceleration of gravity, and viscosity, on the basic assumption that folding depends primarily on viscous rather than on elastic properties. It is found, however, that these relationships cannot be satisfied by models in practice even when the mechanical properties of local rocks are known at least approximately. Various possible simplifications of the equations are then examined step by step in the light of the sources of possible error introduced by the assumptions involved. The case of tectonic conditions for which the mechanical properties of rocks are not known is also considered.—V. S.

11360. The Military Engineer. Fourth Pan-American consultation of Cartography: vol. 41, no. 280, pp. 127-129, 1949.

The Fourth Pan-American Consultation on Cartography, sponsored by the Pan-American Institute of Geography and History, was held in Buenos Aires, Argentina, October 15 to November 14, 1948. Reports on geodetic work indicated that a substantial amount of triangulation, leveling and base measurement work has been done in South American countries. One session was devoted to discussion of the use of electronic distance-measuring equipment in precise surveying. Cuba reported the formation of an Institute of Cartography which is to have a Section of Geophysics. Mexico announced the establishment of 17 gravity stations as control points for gravimetric surveys and of 125 magnetic stations, 10 being international repeat stations. Argentina reported establishment of 110 pendulum stations and gravity chains of 450 stations occupied by gravimeters. Comprehensive geomagnetic surveys also have been made. A series of resolutions concerning scientific standards and coordination of geophysical activity in different countries was adopted.—S. T. V.

11361. Moon, C. G. Suggestions for a course in elementary geophysics: The Compass, vol. 24, no. 2, pp. 81-86, 1947.

A one-year introductory course in geophysical prospecting for oil is outlined. The course is intended primarily for students majoring in geology, but is suitable for those majoring in physics.—V. S.

11362. Nikolaev, N. I. On the results of the conference on questions of the most recent movements and deformations of the earth's crust [in Russian]: Priroda, vol. 38, no. 2, pp. 76-78, 1949.

An account is given of the conference on the most recent movements and deformations of the earth's crust held in Moscow in 1948. Geophysical contributions included papers on methods for measuring current tectonic processes, results of instrumental measurements of slow crustal movements, and conclusions on tectonic deformations, derived from geophysical data. The new seismic map of the U. S. S. R. compiled by G. P. Gorshkov and his collaborators and the new tectonic map of the country prepared by N. I. Nikolaev have made it possible to compare zones of the most recent pronounced movements of the crust with regions of intense seismic activity. The significance of tectonic shifts in exploration for oil and gas, geodetic measurements, search for placer deposits, and other scientific and technological investigations was stressed.—V. S.

11363. Noakes, L. C. A method of determining the distribution of oil in a reservoir rock by means of ultra-violet light: Royal Soc. New South Wales Jour. and Proc. for 1947, vol. 81, no. 3, pp. 169-174, 1948.

The reservoir properties of the oil-bearing glauconitic sandstone at Lakes Entrance, Victoria, were investigated by examination of the fluorescent properties of drill cores in ultra-violet light. The examination consisted in determination of the distribution of oil in a cross section of the core, the approximate percentage of cross sectional area showing oil, and the vertical continuity of oil-bearing patches. The horizontal and vertical distribution of oil as established by this work agreed within

close limits with that determined from diamond drill cores in the same area.—S. T. V.

11364. Proudman, J. I. International Union of Geodesy and Geophysics: *Nature*, vol. 162, no. 4123, pp. 744-745, 1948.

The Eighth General Assembly of the International Union of Geodesy and Geophysics and meetings of its seven constituent Associations were held at Oslo August 19-28, 1948. The Association of Geodesy devoted attention to the rapid development of static gravimeters which have greatly facilitated gravimetric investigation both for geophysical prospecting and for geodetic purposes, and authorized setting up a Gravity Bureau. Deviations of the vertical, undulations of the geoid, and methods of differential geometry applied to geoidal determinations were also discussed. The Association of Seismology held special sessions devoted to recent research on the seismicity of the earth, results of the Helgoland, Burton-on-Trent, Haslach, and Soltan explosions, and seismic prospecting in France, Spain, and the United States. A special meeting was devoted to papers on microseisms. The influence of solar activity on terrestrial magnetism, airborne surveys, and the origin of the earth's magnetism were discussed in the Association of Terrestrial Magnetism and Electricity. In the Association of Volcanology papers were presented on the asymmetric shape of the earth's surface and its effect upon the volcanism of the earth, on volcanic activity in Japan, Kamchatka, the East Indian Archipelago, and the Mediterranean.—S. T. V.

11365. *Revue de la Société Haitienne d'histoire et de géographie. Travaux de l'Institut Géographique et Géologique de l'Université de Santo-Domingo* (The work of the Geographic and Geologic Institute of the University of Santo-Domingo): Vol. 20, no. 72, pp. 51-53, Port-au-Prince, 1948.

Topographic and geophysical investigations of the Dominican Republic formed a large part of the activity of the Institute during 1947. Extensive magnetic measurements were carried out. The division of seismology has been preparing a seismological history of the Dominican Republic and a map of epicenters of observed earthquakes. A detailed study of the violent earthquake which occurred August 4, 1946, is under preparation. The division of seismology is closely following the established program of seismological cooperation of the American Republics.—S. T. V.

11366. Suter, H. H. Relative role of some geological tools in oil exploration: *Am. Assoc. Petroleum Geologists Bull.*, vol. 32, no. 11, pp. 2127-2139, 1948.

Geophysical methods of oil exploration are seen as special methods of geologic mapping, that is, as geologic techniques or tools. The evolution of a geologic section by integration of geologic, seismo-geologic, and electro-geologic data is demonstrated by means of a generalized case. Claims of success of geophysical methods independent of geology are discussed. A plea is made for integrated symposia on regional geophysical geology and for more publication of data on geophysical failures in order to find out possible underlying causes and thus determine criteria for selecting the most logical mapping techniques in each case.—M. C. R.

## 10. RELATED GEOLOGICAL SUBJECTS

11367. Brooks, B. T. Role of active-surface catalysts in formation of petroleum: Am. Assoc. Petroleum Geologists Bull., vol. 32, no. 12, pp. 2269-2286, 1948.

Explanations of the composition of petroleum and the method of their formation must be consistent with the limiting physical conditions shown by a study of producing fields and geological conditions. Relatively low temperatures, usually not exceeding 140° F., are most significant among these conditions. The data on which D. C. Barton based his conclusions that heavy asphaltic naphthenic oils change with age and depth to lighter oils have been reexamined together with data on oils produced from newer fields and the trend of the changes confirmed. Considerable variations in composition were found, however, for oils of the same age and depth. The conditions bringing about such changes are considered to be primarily the catalytic effects of the minerals in the formations with which the crude oil has been in contact, together with the relatively low temperatures for varying geologic ages. Such conditions require considerable variation from a simple linear function of age and depth. Differences in temperature gradients or bottom-hole temperatures probably also account for some variations. The chemical complexity of petroleum is best explained by the catalytic effect of active-surface minerals which include most clays and sands containing clay, but are not limited to them.—V. S.

11368. Cailleux, André. Études de cryopédologie [Studies in frozen ground]: 68 pp., Collection Expéditions Polaires Françaises, Paris, 1948.

The author describes different phenomena connected with freezing ground and devotes considerable attention to the methods used in the study of these phenomena. The introductory chapter deals with the processes of heat flow through the ground, propagation of the temperature variation, forms of isothermal lines, results of freezing and thawing, and the effects of these phenomena on the structure of the soil, such as variation of volume, heaving, and soil creep. Much attention is devoted to description of different forms in frozen ground, such as hoar frost and discontinuous frozen soil, ice wedges, polygonal patterns, fossil ice, fibrous ice layers, and ice veins.—S. T. V.

11369. Emery, K. O., Tracey, J. I., and Ladd, H. S. Submarine geology and topography in the northern Marshalls: Am. Geophys. Union Trans., vol. 30, no. 1, pp. 55-58, 1949.

In connection with the atomic bomb tests at Bikini in 1946, studies were made in the northern Marshalls of the characteristics of atolls. The work has shown that many of the important features, both above and below sea level, are definitely related to the direction of the prevailing winds, waves, and currents. Beyond the windward (north and east) reefs of Bikini, the steep outer slope is broken in most places by a terrace at ten fathoms. The margin of the windward reef is a *Lithothamnion* ridge, cut by strong grooves or surge channels. Large islands are developed on these reefs. Lee reefs have nearly vertical outer slopes near the surface. The lagoons studied are 25 to 35 fathoms deep and are bordered by a ten-fathom terrace. Many flat-topped seamounts are present in

the area. The 14 seamounts that were well-surveyed rise from 2,500 fathoms to depths of between 470 and 850 fathoms.—V. S.

11370. Garrels, R. M., Dreyer, R. M., and Howland, A. L. Movement of dissolved materials through rocks [abstract]: *Geol. Soc. America Bull.*, vol. 59, no. 12, pt. 2, p. 1325, 1948.

One type of transfer of dissolved materials through rocks is that in which the rock is first saturated with solvent (water), and the movement of material through the rock takes place by diffusion of ions or molecules through the stationary solvent in the rock pores. The amount of material which moves through a unit cross section area of unit length is determined chiefly by the concentration gradient, the temperature, the diffusion coefficient of the solute, and the effective or connected pore area of the rock. Measurements were made of the amount of transfer of potassium chloride through several limestones. Neither the permeability nor the porosity (as determined by saturating the rock sample with water) was a good indicator of the amount of material expected to diffuse through the rock. Apparently the amount of material passing through the rock is independent of pore size but is a good measure of the area of pores forming continuous channels through the rock in the direction measured. The work indicated that below 100° C. transport by ionic or molecular diffusion through a fixed solvent is an effective geologic process only over distances of a few inches or at most a few feet.

11371. Liustikh, E. N. On the question of the mechanism of folding [in Russian]: *Akad. Nauk SSSR Doklady*, vol. 65, no. 6, pp. 895–898, 1949.

A critical analysis is made of the hypothesis that geosynclinal folding is the result of horizontal compression of the folded zone between rigid masses, caused by the contraction of the earth. It is shown mathematically that even the very thick blocks now assumed cannot produce sufficinal folding of the known synclinal zones. At the base of a zone, compression is accompanied by contraction and folding of layers, but at higher levels, because of the general upward movement of the material, each layer is subjected to two forces, horizontal pressure at its ends tending to bring about its folding, and upward pressure at its bottom tending to stretch it into an anticlinal arch preventing folding. The higher the layer the greater the upward pressure, until folding becomes impossible. It is concluded that if there were horizontal compression of zones by very thick blocks, only distended and torn layers would be produced near the surface. Actual near-surface folding could be created only by masses of a thickness smaller than the typical 20–30 kilometer geosyncline formed during one tectonic phase, which is the unit that is compressed at one time. It is now generally recognized, however, that compression by such thin masses could not explain the existing synclinal zones.—V. S.

11372. Lopez de Azcona, J. M., and Perez Masia, A. La densidad en el interior de la tierra [Density in the interior of the earth]: *Rev. Geoffs.*, vol. 7, no. 27, pp. 221–253, 1948.

The authors analyzed the formulas of G. E. Marsch, G. Boaga, H. Haaleck, and K. E. Bullen for variation of density with depth within the earth, using these criteria: the mean density must equal 5.52; the

value at the surface of the earth should equal 2.64 to 2.67; the geodetic findings on the shape of the earth must be satisfied; the principal moments of inertia calculated on the basis of the assumed variation of density must satisfy the equations of celestial mechanics controlling the phenomena of precession and the motion of the moon; the assumed relation must be in agreement with the data on the propagation of seismic waves. The hypothesis of a continuous variation of density was rejected because it cannot satisfy the above criteria. In accordance with Bullen's theory a discontinuity at a depth of 2,900 kilometers was assumed. The authors calculate the density at the center of the earth to be between 12.8 and 13.9.—*S. T. V.*

11373. MacDonald, D. F. Panama canal slides, 73 pp., 52 plates, Balboa Heights, Canal Zone, Department of operation and maintenance. Special engineering division, 1947.

This is a report on geological conditions and related factors which could contribute to the cause of slides in the Panama Canal Zone. Although the Canal Zone is in the Central American earthquake belt, records of earthquakes since 1621 show none of high intensity. The fault scarp where many earthquakes and consequent landslides occur is about 50 miles from important structures. Consequently the canal structures are not exposed to serious seismic danger. The author believes no flattening of the excavation slopes by way of earthquake insurance is necessary, but that it is necessary to minimize leakage of subsurface water. Several slides were caused by seepage of water along joints, which increased the weakness of the rocks until they finally failed. Heavy blasting which can open sealed cracks below the water table, thus contributing to the leaky conditions of the rocks, should be avoided near important excavations.—*S. T. V.*

11374. Marble, J. P. Annotated bibliography of articles relating to the measurement of geologic time (1946-47): Committee on the Measurement of Geologic Time, Rept. 1946-47, pp. 6-38, Washington, D. C., Nat. Research Council, June, 1948.

This bibliography contains references to all papers, books, and documents brought to the attention of the compiler between April 1, 1946, and April 1, 1947. Mention is made of only those portions of the material that deal with some phase of the general field of the committee's work. Entries are supplied with annotations or abstracts.—*V. S.*

11375. Schwartz, G. M. Some aspects of ore deposits important in geophysical work: Geophysics, vol. 13, no. 4, pp. 540-549, 1948.

This is the full text of the paper. For abstract published in advance, see Geophys. Abstracts 136, no. 10940.

11376. Sel'skii, V. A. Geological structure of the oil-bearing zone of the western provinces of the Ukraine [in Russian]: 84 pp., Moscow, Gostoptekhizdat, 1941.

This is a geological description of 22 oil fields investigated by Polish scientists between 1922 and 1940, based on many, mostly unpublished surveys, including gravitational, magnetic, electric, and seismic studies. The extent of exploration of various areas was very unequal and no cor-

relation between the results of different surveys was found. Gravitational measurements were started with two four-pendulum instruments and continued with torsion balances. A detailed gravimetric map of the area is given. Magnetic surveys were started in 1927 with four Schmidt balances and two La Cour magnetometers. The accuracy of the later measurements is not less than  $\pm 2\gamma$ . Numerous anomalies were discovered. Some exploration has been done by Schlumberger methods. The most extensive surveys have been made by seismic methods, both reflection and refraction, starting in 1930. Seismic explorations are handicapped by the complicated geological structures of this mountainous country and great variations of seismic velocity. In many of the explored regions later development work has confirmed the findings of the geophysical surveys. Oil has been found in formations belonging to three different geological ages.—S. T. V.

11377. Shishkin, N. S. The role of convective circulation in the formation of cell-shaped patterns of microrelief [in Russian]: *Akad. Nauk SSSR Izv., Ser. Geog. i Geofiz.*, vol. 12, no. 2, pp. 177–181, 1948.

Objections to the convection theory of A. Law and K. Gripp, which explains the formation of cell-shaped patterns of soil microrelief, such as mud spots on moraines and structured soils in Arctic and sub-Arctic regions, are examined critically and arguments refuting them are discussed. In particular, H. Stehe's contention that no convective circulation can occur in a soil containing less than 60 percent water is shown to be erroneous. The conclusion is that the convection theory can explain satisfactorily the structural regularity of all cell-shaped varieties of microrelief formed in very humid soils, including polygonal cracks of rectangular and hexagonal shape, and nodular microrelief.—V. S.

11378. Sullivan, C. J. Ore and granitization: *Econ. Geol.*, vol. 43, no. 6, pp. 471–498, 1948.

An attempt is made to explain the variation in composition of granitic rocks and associated ore deposits on the basis of the granitization hypothesis. Granitization may be regarded as the approximate reestablishment of the geochemical equilibrium attained when the earth first cooled but which was later upset by the large quantities of predominantly basic "volcanic" rocks brought into the sial by physical forces. This hypothesis supplies a possible explanation for the distribution of granitic rocks and ore deposits in geologic time. In the formation of a granitic rock, whether by crystallization from a melt or rearrangement of atoms by other processes, the elements are concentrated in inverse ratio to their incorporation by isomorphous substitutions in the common rock-forming minerals, thus to a large extent explaining the association of specific ores with specific types of granitic rocks. It is of economic importance to distinguish between synchronous and subsequent batholiths. If granitization is assumed to be a process of ultrametamorphism with alteration proceeding from sedimentary and volcanic rocks to metamorphic rocks and thence to banded granite and finally magmatic granite, the differences between synchronous and subsequent batholiths become intelligible, the synchronous batholiths being those which have not reached the liquid magmatic stage and the subsequent those which have reached a sufficiently liquid stage to have moved subsequent to their formation.

Synchronous granites show a close spatial relationship to contact metasomatism and ore deposition. In areas where synchronous batholiths occur these facts may be used to guide prospecting, particularly to localize ore search over nonoutcropping granite cupolas. Ore deposits of "volcanic" origin differ from those originating during a granitization cycle by their relative scarcity of lithophile ore elements, relatively high sulfur content, and lack of zonal arrangement.—*M. C. R.*

11379. Tainsh, H. R. An aid to the forecasting of underground structures [abstract]: Internat. Geol. Cong., Great Britain, 18th Sess., Titles and abstracts of papers, p. 35, 1948.

This short note concerns the search for oil pools associated with folded sedimentary rocks. Some structures have been drilled to depths of 12,000 feet or more, but many folds are yet untested, and in most oil provinces deeper prospects must be re-examined. Notwithstanding the extensive work done on the geometry of folding, little geologic guidance is available for this exploration because the relation between theoretical solutions and actual geologic sections remains largely unknown, particularly for extrapolation to great depth. However, geologists must draw tentative sections to aid in locating the many wells drilled each year. As the difficulties in predicting underground structures are admittedly great, it is suggested that much assistance could be given to oil exploration and to the general study of structural geology if a comprehensive collection could be made of measured sections at depth, showing competent and incompetent folding and faulting.—*V. S.*

11380. Texas Oil Journal. New oil frontier is seen for Panhandle's basin area after five-year exploration job: Vol. 15, no. 11, p. 31, 1949.

Geophysical and geologic exploration during the past 5 years promises to open a new oil district in the northeastern Texas Panhandle. The area is the Texas part of the Anadarko basin of western Oklahoma, which covers Hemphill, Roberts, Ochiltree, and Lipscomb Counties and parts of Wheeler, Hutchinson, and Hansford Counties. Beginning in 1944, Roberts County in particular has been the center of widespread geophysical surveys and core drilling. No information on the results of drilling has been released, but it is understood that salt in the Permian beds and in the Panhandle lime [Ogallala formation] has complicated the interpretation of seismic records. The oil detected is apparently from Mississippian and Pennsylvanian formations.—*V. S.*

11381. Tsuya, Hiromichi. The Fukōzu fault, a remarkable earthquake fault formed during the Mikawa earthquake of January 13, 1945 [in Japanese, with an English summary]: Tokyo Univ. Earthquake Research Inst. Bull., vol. 24, pts. 1-4, pp. 59-75, 1946.

The Fukōzu fault formed during the Mikawa earthquake has been traced for slightly more than 9 km. from Kiriya and Miyahasama to Katanohara on the coast of Atsumi Bay [Atsumi-wan]. The fault makes a nearly right-angle bend in its middle portion from a east to a south-southeast course. The fault plane dips toward the south and west at a 50° to 70° angle. The northeast side has apparently been depressed as much as 2 meters but the horizontal displacements are considerably less (a maximum of 1 meter eastward shift of the south side of the north wing

and less than 50 cm. northward shift of the west side of the south wing). Structural damage was confined to the southwest side of the fault. Evidence along the coast indicates upheaval of the land on the west side of the fault. It is therefore inferred that at the time of the earthquake the Sagane-san block, bounded on its northern and eastern sides by the fault, was upthrust in a northeasterly direction. From geological evidence, it is inferred that formation of the fault represents renewed activity along old lines.—*M. C. R.*

## 11. TECHNICAL AIDS TO EXPLORATION

11382. Bazhaw, W. O. Geophotometric mapping: Photogram. Eng., vol. 15, no. 1, pp. 114–118, 1949.

Geophotometric mapping is used in gravity surveying to obtain topographic data for terrain corrections by means of photographs instead of readings with a transit. The instrument used is a 35 mm. "topographic camera" equipped with a telephoto lens and rigidly mounted on a standard transit head equipped with an azimuth compass. In the field the operator levels the camera, sights on the rod, and snaps the picture, making no other records. The lens has a field of 10°, permitting work in mountainous country. An auxiliary lens and prism system attached to the camera photograph simultaneously, on the same film, a portion of the azimuth compass side by side with the picture of the rod and landscape. Thus, each exposure records all the information that is needed to determine the distance, direction, and elevation difference between the instrument and the rod. In the film the fixed target-interval on the rod makes it possible to calibrate the vertical scale of the photograph in terms of elevation. All measurements are made in the office from the film negatives with a special reading apparatus projecting the image on a screen marked with reference lines. This method of topographic surveying is faster and more precise than work with the transit.—*V. S.*

11383. Boaga, Giovanni. Calcolo numerico [Numerical calculation], 472 pp., Milan, Fasani Publishers, 1949.

Simplified techniques of calculation and computational short cuts that may be useful in the interpretation of empirical data have been assembled in this reference volume. The contents cover graphic solutions of equations, analytical solutions of systems of equations, interpolation, integration of differential equations, and the expression of empirical data by analytical formulas.—*V. S.*

11384. De Blieux, C. W. Photogeology in Gulf Coast exploration: Am. Assoc. Petroleum Geologists Bull., vol. 33, no. 7, pp. 1251–1259, 1949.

With the application of geomorphology as a basic principle, suitable techniques of interpreting aerial photographs have been developed for the Gulf Coast region where topographic expression of subsurface structure is largely absent. Five aerial photographs are included to illustrate application of the methods.—*M. C. R.*

11385. Goddard, G. W. New developments for aerial reconnaissance: Photogram. Eng., vol. 15, no. 1, pp. 51-72, 1949.

Some advances in the apparatus and techniques used for aerophotographic reconnaissance by the U. S. Air Force are outlined. The speed of operations is now such that a non-stop trimetrogon photostrip was obtained across the United States in about 7 hours in 1948, providing a record over a distance of 2,700 miles from an altitude of 40,000 feet. The equipment includes a trimetrogon installation of six 9×9-inch cameras and seven additional large cameras with 48-inch f/6.3 lenses for covering an angle of view of about 140°. Research is being conducted on a new type of camera with a rotating optical system and a perfected film magazine, which will make a horizon-to-horizon sweep in a direction perpendicular to the line of flight and will provide the photographic record previously obtained with a set of cameras. Other advances, realized or projected, are discussed regarding cameras, lenses, gyroscopic mountings, moving-film magazines, scanning units, strip photography, night operations, dust bombs, shoran aerial triangulation, target models, and continuous-processing equipment.—V. S.

11386. Gockel, Heinrich. Gangstörungen zweier Pendeluhren durch Kopplung über einen mitschwingenden Pfeiler [Interaction between two pendular clocks caused by coupling due to sympathetic oscillations of the supporting column]: Die Naturwissenschaften, vol. 34, no. 2, p. 53, 1947.

Two astronomical clocks were suspended on a strong concrete column of 1.6×0.8 m. cross section and 1.8 m. height. To eliminate interference the planes of oscillations of the pendulums were made perpendicular to one another. In spite of this and the strength of the supporting column, a coupling of the clocks' pendulums was observed, caused by microscopic torsional vibration of the concrete column. This produced periodic variation of the amplitudes of the pendulums. The daily rate of each clock, when operating alone, was less than 7/1,000 seconds per day. It increased to 32/1,000 seconds per day when two clocks were operating simultaneously.—S. T. V.

11387. Mott, G. P. Aerial mapping for oil: World Petroleum, vol. 20, no. 3, pp. 66-70, 1949.

The techniques and instruments of photogeologic reconnaissance and photogrammetric mapping, used for regional surveys in oil exploration, are outlined.—V. S.

11388. Simmons, L. G. Natural tables for the computation of geodetic positions, Clarke spheroid of 1866, U. S. Coast and Geodetic Survey Spec. Pub. 241, 86 pp., 1949.

The trend in computational work in geodetic problems away from logarithms toward the use of natural functions and calculating machines has necessitated the development of new methods for computation of geographic positions in triangulation work. Natural functions used in these computations are listed in tables in this volume, the unique feature being the table listing length of meridian continuously from the equator to latitude 75° covering all regions in which geodetic work is likely to be done. The tables permit an accuracy of about one unit in the third

decimal place of seconds of arc for lines up to 200 miles in length. Derivation of the tables and sample computations are shown.—*S. T. V.*

11389. South African Science. Radar aids mapping: vol. 2, pp. 175-176, 1949.

Radar methods are now being used in surveying from the air with high accuracy. The time interval between transmission and return of signals sent from the aircraft to a ground station and reflected is accurately measured in millionths of a second and translated into distance from the ground station. Two such stations make it possible for the airplane to steer a highly accurate course in taking pictures or in making magnetic measurements. The radar signals can be used with accuracy at distances up to 200 miles from the transmitter.—*S. T. V.*

11390. Steinhoff, J. R. Automatic direction finder: *Electronics*, vol. 22, no. 2, pp. 97-99, 1949.

The loop assembly of this instrument consists of four coils, wound separately on a cylindrical form. The four coil voltages are sampled separately. The output of each circuit is proportional to the voltage generated in the corresponding antenna coil. The switching system consists of four triodes connected as individual oscillators. Each stage is inductively coupled to the preceding stage. The receiver is a three-band superheterodyne with an average sensitivity of about 1.5 mv. A signal just audible in the receiver earphone is sufficient to give a direction indication. A field strength of 5 mv. per meter is sufficient for an accuracy of one degree.—*S. T. V.*

Speer, J. H. Color reproduction of well logs. *See Geophys. Abstract* 11348.

11391. Stephenson, R. C., and Foote, R. M. Fotogeologia: una herramienta para el desarrollo minero [Photogeology—a new tool of the mining industry]: *Bol. minero*, no. 585, pp. 24-27, 1949.

Among the advantages of geological mapping by aerial photography are greater accuracy and a substantial reduction of expenses, particularly in inaccessible regions. Aerophotography gives the geologist a picture of the region which in many cases is equivalent to a geological map. The interpretation of a geological survey is much easier if the investigator is familiar with this method. Advantages are especially great in studying deposits of coal or clay. The method is most advantageous when used to supplement other methods of exploration.—*S. T. V.*

11392. Stern, E. B., Jr. Shoran radar, war's contribution to oil exploration: *Oil and Gas Jour.*, vol. 46, no. 37, pp. 70-72, 1948.

Geophysical uses of Shoran in marine and land exploration are outlined. The system has a maximum range of 250 miles to high-flying aircraft, but in surface work the range depends on the height of the antennas. The accuracy of position determination is within  $\pm 100$  feet.—*V. S.*

11393. Whittleston, W. G., and Ziman, J. M. A general purpose recording apparatus: New Zealand Jour. Sci. Technology, Sec. B, vol. 29, no. 6, pp. 308-317, 1948.

A small portable general purpose recording apparatus has been designed based on an A. C. bridge network combined with a balancing motor controlled by phase discriminating relays. A theoretical discussion on the use of inching mechanisms for anti-hunting purposes is included and the application of the inching principle to the recording apparatus described. Circuit diagrams and components list are included.—*M. C. R.*

11394. Whitmore, G. D. Advanced surveying and mapping, 620 pp., Scranton, Pa., International Textbook Co., 1949.

The book provides instruction material for a college course covering geodetic surveying, mapping, and aerial photogrammetry.—*S. T. V.*

## 12. PATENTS

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

11395. (2) Magnetic testing with artificial standard. Theodore Zuschlag, West Englewood, N. J., assignor to Magnetic Analysis Corp., Long Island, N. Y., a corporation of New York: U. S. patent 2,470,839, issued May 24, 1949.

In a system for testing magnetic materials, an energizing coil connected to be energized from an alternating current source, a pickup coil positioned symmetrically with respect to said energizing coil, means for placing a specimen of said material within the fields of both coils, a recording device including recording and reproducing means, means for connecting said pickup coil to said recording means, an indicating device, means for connecting said reproducing means to said indicating device, and means for connecting said pickup coil to said indicating device such that fluctuations from said reproducing device and said pickup coil are impressed on said indicating device simultaneously.

The method of testing elongated magnetic material which comprises the steps of recording on a record medium a representation of the magnetic characteristics of a standard specimen of material to be tested, electrically reproducing the recorded representation in the form of first electric fluctuations, generating second electric fluctuations representative of the magnetic characteristics of successive portions of the material under test, successively repeating the electrical reproduction of the record at such rate that said first and second fluctuations are in substantial synchronism, combining said fluctuations, and actuating an indicating device with the resultant of said combined fluctuations. Claims allowed, 10.

11396. (2) Magnetic field responsive device. Robert G. Rowe, Niagara Falls, N. Y.: U. S. patent 2,474,693, issued June 28, 1949.

In a magnetic field responsive device, a magnetostrictive element nodally supported for a preferred mode of substantially undamped vibration, coil means excited from a constant frequency source of

periodically varying voltage and magnetically linked with said element to magnetostrictively vibrate said element, detector means coupled to said element sensible to variances in the characteristics of magnetostrictive vibrations of said element and indicator means coupled to said detector means arranged to indicate variances in the characteristics of magnetostrictive vibrations of said element. Claims allowed, 17.

11397. (2) Magnetic detector. William E. Kahl, West New York, N. J., assignor to Bell Telephone Laboratories, Inc., New York, N. Y., a corporation of New York: U. S. patent 2,477,337, issued July 26, 1949.

In a magnetic detection system of the type employing a magnetometer comprising a core of magnetic material having windings thereon energized from a source of alternating current of fundamental frequency to generate even order harmonic voltages in the windings proportional in magnitude to the strength of the magnetic field to be measured, the detector circuit comprising a source of alternating current of fundamental frequency, a magnetometer having an exciting winding of known inductance and effective resistance at the fundamental frequency, a capacitor connected in series with said winding, the capacitance whereof being of magnitude tending to approximately tune the known inductance to resonance with currents of fundamental frequency, a resistor of resistance approximating said effective resistance connected in shunt to said series connected winding and capacitor, said winding, capacitor and resistor comprising a magnetometer network, and circuits connecting said network to the alternating current source. Claims allowed, 4.

11398. (2) Flexible electromagnetic wave guide. William Douglas Allen, Malvern, England: U. S. patent 2,479,288, issued Aug. 16, 1949.

An electromagnetic wave guide comprising an innermost hollow tube formed of conducting wire mesh, and a flexible sleeve surrounding and secured to said tube, the interior of said tube being devoid of all matter except air whereby the sole dielectric within the tube is an air core of high power factor. Claims allowed, 10.

11399. (2) Adjustable strength permanent magnet. Richard G. Jewell, Swampscott, Mass., assignor to General Electric Co., a corporation of New York: U. S. patent 2,479,363, issued Aug. 16, 1949.

A permanent magnet structure comprising a hollow cylindrical structure of permanent magnet material which has axial slots across its diameter at right angles to each other extending approximately two-thirds the length of the cylinder from one end to form four symmetrically arranged approximately triangular-shaped pole pieces joined by the unslotted part of the cylinder as a yoke said structure being permanently magnetized to produce a four-pole permanent magnet wherein the four pole pieces have alternate polarity and means comprising permanent magnet plug insert portions of said pole pieces rotatable about an axis at right angles to the flux axis of said pole pieces for adjusting the relative strength of said pole pieces after being magnetized. Claims allowed, 2.

11400. (2) Apparatus for magnetic measurements. Wilson M. Powell, Berkeley, Calif., assignor to the United States of America as represented by the United States Atomic Energy Commission: U. S. patent 2,479,699, issued Aug. 23, 1949.

A calibrating apparatus comprising a permanent bar magnet, a vertical tubular member surrounding and supporting said magnet, an arresting element radially disposed about said tubular member at a fixed distance from said magnet, a hollow core solenoid telescopically engaging said tubular member and adapted to move freely therealong until contact is made with said arresting element, means for retaining said solenoid in a first predetermined position with respect to said magnet, means for releasing said retaining means whereby said solenoid falls under the influence of gravity until stopped by said arresting means at a second predetermined position with respect to said magnet, and means connecting said solenoid to a flux meter to be calibrated. Claims allowed, 2.

11401. (3) Seismograph blaster time breaker circuit. Deslonde R. de Boisblanc and John E. Bondurant, Bartlesville, Okla., assignors to Phillips Petroleum Co., a corporation of Delaware: U. S. patent 2,470,846, issued May 24, 1949.

In apparatus for geophysical exploration, a circuit for recording the time break which comprises, in combination, a Wheatstone bridge circuit of the resistance type, one arm of said bridge including the heating element of an electrical blasting cap, and a resistor in series with said blasting cap, the ohmic value of said resistor being greater than the ohmic value of said blasting cap, a transformer having its primary winding connected across two opposite corners of the bridge, a generator connected across the other opposite corners of the bridge, means for actuating said generator to pass an electric current through said blasting cap for initiating an explosion in an attached charge which causes disintegration of said heating element, thereby opening said one arm of the bridge circuit, and a differentiating circuit for receiving and sharpening the pulse produced by the opening of said arm of the bridge circuit, said transformer transmitting the sharpened pulse to a recording mechanism to record the pulse. Claims allowed, 1.

11402. (3) Peak accelerometer. William H. Hoppmann, Valley Stream, N. Y.: U. S. patent 2,472,829, issued June 14, 1949.

In an instrument for determining shock acceleration to which a structure is subjected, a guide in the form of a cylinder, a weight of predetermined mass in the form of a piston movable in the cylinder, a base plate for the instrument closing one end of the cylinder, a screw-threaded attachment embodied in the plate coaxial with the cylinder, a like screw-threaded attachment embodied in the weight coaxial with the attachment of the base plate, a gage specimen of predetermined tensile strength and comprising screw threads at its opposite ends companion to the threads of the attachments.

A gage specimen for peak accelerometers comprising a plug of inelastic material with a predetermined tensile strength, a circumferential

notch in the plug positioned intermediate its ends, the cross-sectional area of the plug at the base of the notch being predetermined for rupture when subjected to a predetermined shock load, attaching means at opposite ends of the plug. Claims allowed, 3.

11403. (3) Device for transmitting and receiving compressional waves. Hugo Benioff, Pasadena, Calif., assignor, by mesne assignments, to Submarine Signal Co., Boston, Mass., a corporation of Delaware: U. S. patent 2,473,354, issued June 14, 1949.

A device for transmitting and receiving compressional wave energy comprising a casing having a radiating member at one side thereof with the external surface in acoustic relationship with a sound-propagating medium and the interior surface shielded therefrom, said member having passive vibrating elements aligned at right angles to said member, and active resonant vibratory elements mounted at both ends of said passive vibrators. Claims allowed, 6.

11404. (3) Means for the interchange of electrical and acoustical energy. Edwin E. Turner, Jr., West Roxbury, Mass., assignor, by mesne assignments, to Submarine Signal Co., Boston, Mass., a corporation of Delaware: U. S. patent 2,473,835, issued June 21, 1949.

Means for the interchange of electrical and acoustical energy comprising a hollow cylindrical element the outer surface of which serves to radiate and receive compressional wave energy, a plurality of crystals arranged alternately crosswise to each other forming crosses with the ends of the crystals bearing against the walls of the cylinder in positions substantially 90 degrees from each other, said crystals being piezoelectric elements with electrodes positioned on the surfaces of the crystals in planes normal to the axis of the cylinder. Claims allowed, 5.

11405. (3) Underwater transducer. Donald E. Ross, Ocean Beach, Calif., assignor to the United States of America as represented by the Secretary of the Navy: U. S. patent 2,473,971, issued June 21, 1949.

A transducer for propagating sound in fluid, said transducer comprising a housing having a recess open at one end, a metal frame closing said recess, said frame having an opening, nonmetallic material closing said opening thereby forming a sound transparent window, said non-metallic material having an acoustic impedance substantially equal to the fluid in which the sound is to be propagated from the transducer, means securing said frame to said housing to form a fluid-tight enclosure therefor whereby said transducer can be immersed in the fluid, a unitary motor assembly within the housing facing the window, said motor assembly including a back plate on the opposite side from the window and end support members secured to the back plate, and layers of a cork and rubber mixture having a low acoustic impedance lining said recess and completely surrounding said motor assembly except at the position facing said window, said layers being snugly fitted between the back plate and support members and the housing to form the sole support for said motor unit assembly to position and maintain the same fixed within the housing relative to said window. Claims allowed, 1.

11406. (3) Feedback automatic volume control circuit for seismic amplifiers. Clarence B. Scott, Tulsa, Okla., assignor to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,475,258, issued July 5, 1949.

An amplifying circuit for use in amplifying a varying electrical signal for recording, comprising a plurality of amplifier tubes, means for applying the varying signal to the grid of the first amplifier tube, means for taking off the amplified signal from the plate of the last amplifier tube, a feedback arrangement between the plate of the last amplifier tube and the cathode in the first amplifier tube, including a phase changing tube having its grid connected to the plate of the last amplifier tube and being of a character to produce a plate signal and a cathode signal  $180^\circ$  out of phase with each other, a pair of control tubes, one of which has its grid connected to the plate of said phase shifting tube and the other of which has its grid connected to the cathode of said phase shifting tube and both having their plates connected to opposite ends of the primary of a transformer, means for applying a rectified portion of the signal derived from the plate of the last amplifier tube in equal amounts and in phase to the grids of said control tubes, a central tap on said primary winding for applying plate voltage to said control tubes and means connecting the secondary of said transformer to the cathode of said first amplifier tube. Claims allowed, 1.

11407. (3). Seismometer case cover. Cecil S. Brownlow, Bartlesville, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware: U. S. patent 2,477,172, issued July 26, 1949.

A metal closure cap assembly including, in combination, a base having a pair of openings formed therein, a glass bead insulator sealing each of said openings, a conductor extending through each insulator and having a terminal portion at each end thereof, a housing protruding from the top of said base and having a transverse passage formed therein communicating with both of said openings, a plug for closing and sealing one end of said passage, a sealing member for closing and sealing the other end of said passage, said sealing member having a part thereof protruding into said passage, there being a longitudinal bore formed in said sealing member with an enlarged outer portion, a sheathed cable extending through the bore in said sealing member, a body of soft metal in the enlarged portion of said bore, means compressing said soft metal into sealing engagement with said sealing member and the sheath of said cable, said cable including a pair of conductors secured to the respective terminal portions of said glass bead insulators and a cord extending into said cylindrical passage and tied to the inwardly protruding part of said sealing member, and means sealing the inner end of said bore and securing said cord to said inwardly protruding part. Claims allowed, 5.

11408. (3). Seismic exploration with control of directional sensitivity. Alexander Wolf, Houston, Tex., assignor to Texaco Development Corp., New York, N. Y., a corporation of Delaware: U. S. patent 2,477,844, issued Aug. 2, 1949.

In a seismic exploration system for suppressing reflections from horizontal or gently dipping beds without materially reducing sensitivity to reflections from steeply dipping beds, a source of seismic waves, a

plurality of seismic wave detectors disposed along the earth's surface in series alignment with said source, an indicating device connected to each adjoining pair of detectors, an impedance in the connection between said device and each detector, and a pair of impedances connected across each indicating device, the center point between each of said pairs of impedances being grounded, the value of each impedance in said pairs being less than the value of each of said impedances connected between a detector and an indicating device so that each of said devices will indicate the difference between the outputs of the detectors to which it is connected. Claims allowed, 3.

11409. (3) Seismic detector. Alfred C. Winterhalter, Beaumont, Tex., assignor to Sun Oil Co., Philadelphia, Pa., a corporation of New Jersey: U. S. patent 2,478,517, issued Aug. 9, 1949.

In combination, a seismic detector having output terminals and constructed and arranged to have two stable positions of rest on an approximately horizontal surface, the detector being inverted in one of said positions as compared with the other, leads for the transmission of electrical signals from the detector, and a gravity responsive switch mechanically connected to the detector and electrically connected between said output terminals and said leads to reverse the connections between said terminals and leads when the position of the detector is reversed from one stable position to the other, so that signals transmitted from the detector through said leads will have predetermined correspondence with earth movements. Claims allowed, 5.

11410. (3) Method of and apparatus for geophysical exploration. Glen Peterson, Tulsa, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware: U. S. patent 2,479,772, issued August 23, 1949.

A radio geophone system comprising, in combination, a multi-channel receiver, a recorder for each channel, a geophone assigned to each channel, a transmitter modulated by the electrical current produced by each geophone, a receiver at each geophone location for transforming and converting received signals into control impulses, firing mechanism for detonating an explosive charge, a transmitter actuated by said firing mechanism for producing a radio wave when the explosive charge is fired, said radio wave being picked up by the geophone receivers, means for utilizing the resultant control impulses to excite the respective geophone transmitters to produce radio signals, means for simultaneously utilizing said control impulses to mechanically shock the respective geophones and produce second radio waves through modulation of the geophone transmitters, the resultant signals being radiated to said receiver and being recorded by said recorder units, the time delay between said signals in each channel being a measure of the time delay in the geophone assigned to said channel. Claims allowed, 19.

11411. (4) Apparatus for recording of rapidly varying processes. Ernst Jacobi, Oslo, Norway; vested in the Attorney General of the United States: U. S. patent 2,477,062, issued July 26, 1949.

In an apparatus for recording rapidly varying electrical potentials on a longitudinally moving recording strip, a recording pin, means for

moving said pin transverse to said strip, means for producing an auxiliary periodically varying electric potential, impulse means controlled by the sum of the electric potential to be recorded and the said auxiliary potential in such a manner that an impulse is given to the recording pin when the potential sum reaches a predetermined value, said impulse means comprising a thyatron tube having an input circuit and an output circuit, means for applying said potential sum to said input circuit, a direct current source connected to energize said output circuit, a resistor in series with said direct current source, a condenser in shunt with said resistor and direct current source and means in said output circuit for supplying energy of discharge of said tube to said pin. Claims allowed, 4.

11412. (5) Method and apparatus for detecting radiations. Robert Earl Fearon, Tulsa, Okla., assignor to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,472,153, issued June 7, 1949.

A method of detecting penetrating radiation that comprises circulating a confined ionizable medium in a closed system, subjecting the medium to the penetrating radiation to produce ionization thereof, separating the ions thus formed in accordance with their electrical mobility, collecting one group of the separated ions, and measuring the electrical current produced by the collection of the ions as a measure of the penetrating radiation that enters the ionizable medium. Claims allowed, 12.

11413. (5) Alpha particle counting. Casimer J. Borkowski, Oak Ridge, Tenn., assignor to the United States of America as represented by the United States Atomic Energy Commission: U. S. patent 2,472,365, issued June 7, 1949.

In an ionization chamber and amplifier system for alpha particle counting, in combination, an outer tube of wire mesh having arranged concentrically therein an electrode structure comprising a coaxial rod and tube having insulating material interposed therebetween, a connector grounding said wire mesh tube, a source of relatively high voltage impressed on said coaxial tube whereby a signal current will appear in said rod as a result of ionization of air within the wire mesh tube and a connector from said rod to the amplifier. Claims allowed, 4.

11414. (5) Radiation detector. William R. Baker, Berkeley, Calif., assignor to the United States of America as represented by the United States Atomic Energy Commission: U. S. patent 2,474,773, issued June 28, 1949.

In a radiation detector the combination comprising a first chamber having a port formed therein, a cover for said port adapted to support radioactive material and to be sealed over said port, a second chamber disposed within said first chamber having a grid portion aligned with said port, a collector plate disposed within said second chamber and aligned with said grid and port, electrical means connected to said first and second chambers and said collector plate for maintaining said second chamber at a positive potential with respect to said first chamber and said collector plate at a positive potential with respect to said second chamber, and an amplifier disposed within said second chamber and connected between said second chamber and said collector plate for amplifying the charge collected by said collector plate. Claims allowed,

11415. (5) Geiger counter structure. Herbert Friedman, Arlington, Va.: U. S. patent 2,475,603, issued July 12, 1949.

Geiger-Müller counter for the measurement of weak radiation comprising a radiation shielding enclosure having an aperture therein, a counter tube within the enclosure comprising a thin flat radiation transmitting window mounted adjacent the aperture, a gas tight envelope sealed to the window, a linear anode conductor within and carried by the envelope and directed toward the window, and a cathode within the envelope consisting of a cylindrical helix of wire of circular section, coaxial with the anode, the helix pitch being small and operative to establish a uniform counting field strength along the anode, and an ionizable gas filling in the envelope. Claims allowed, 1.

11416. (5) Impulse counter. Megeuer Kalfaian, Asbury Park, N. J.: U. S. patent 2,476,303, issued July 19, 1949.

In an impulse counting system a scale-by-two impulse dividing arrangement comprising a directly cross-controlled combination of a first and second trigger circuits; each of said trigger circuits comprising a first and a second tube of the grid-controlled type so cross-coupled that while one tube is conducting it imposes a high direct-current negative voltage upon the control grid of its mate tube to render it substantially non-conductive, said first and second tubes of the said first and second trigger circuits in the said aforementioned arrangement having associate exciter tubes each of which having a first and a second control grid and connected in a manner such that in the said first trigger circuit an exciter tube bearing the numeral as a third tube initiates the conductance of the second tube by direct coupling and an exciter tube bearing the numeral as a fourth tube initiates the conductance of the first tube by direct coupling; and in the said second trigger circuit an exciter tube bearing the numeral as a fifth tube initiates the conductance of the second tube by direct coupling and an exciter tube bearing the numeral as a sixth tube initiates the conductance of the first tube by direct coupling, a source of signals randomly or evenly distributed in connection with the aforesaid arrangement and means therewith for applying said signals upon one of the control grids of the said fifth and sixth exciter tubes of the said second trigger circuit simultaneously in positive direction to drive said grids to near cathode potential from a normal high negative bias; and means for simultaneously applying said last mentioned signals upon one of the control grids of the said third and fourth exciter tubes of the said first trigger circuit simultaneously in negative direction to drive said grids to a high negative bias from a normal near cathode potential, the other control grid of the said third exciter tube of the said first trigger circuit having direct coupling with the first tube of the said second trigger circuit in a manner such that while said last mentioned first tube is conducting it imposes a high negative bias upon said grid of the said third exciter tube rendering it inoperative; and the other control grid of the said fourth exciter tube of the said first trigger circuit having direct coupling with the second tube of the said second trigger circuit in a manner such that while said last mentioned second tube is conducting it imposes a high negative bias upon said grid of the said fourth exciter tube rendering it inopera-

tive, the other control grid of the fifth exciter tube of the said second trigger circuit having direct coupling with the second tube of the said first trigger circuit in a manner such that while said last mentioned second tube is conducting it imposes a high negative bias upon said grid of the said fifth exciter tube rendering it inoperative; and the other control grid of the said sixth exciter tube of the said second trigger circuit having direct coupling with the first tube of the said first trigger circuit such that while said last mentioned first tube is conducting it imposes a high negative bias upon the said grid of the said sixth exciter tube rendering it inoperative, whereby by the said manner of direct cross-coupling of the said first and second trigger circuits a triggering performance is effected such that while the aforesaid incoming positive signal reverses the said second trigger circuit under the direct cross-coupled guidance of the said first trigger circuit the said first trigger circuit remains inactivated by the reception of the said last mentioned signal in negative direction until the said signal decreases substantially whereupon the said first trigger circuit reverses under the control of the said last reversed state of the said second trigger circuit, and the incoming signals alternate in an outgoing circuit or circuits for chain counting. Claims allowed, 2.

11417. (5) Radiation projector. Charles S. Piggot, Washington, D. C., and Jesse Edward MacAdams, Takoma Park, Md.: U. S. patent 2,477,648, issued Aug. 2, 1949.

A radiation projector of the type adapted selectively to position a radiant energy source either in a protected position or an exposed position comprising a shielding and housing mass having a chamber formed therein, said chamber being formed with an open portion and a closed wall portion, rotor means disposed in and having surfaces complementary to said chamber, said rotor means being formed with a pocket adapted to contain said source, and means for rotating said rotor means selectively to position said pocket in communication with said open portion or said wall portion. Claims allowed, 15.

11418. (5) Geiger-Müller counter. Jan Bleeksma, Mount Vernon, N. Y., assignor, by mesne assignments, to Philips Laboratories, Inc., Irvington on Hudson, N. Y., a corporation of Delaware. U. S. patent 2,479,201 issued Aug. 16, 1949.

A Geiger-Müller counter, comprising a central anode, a tubular envelope comprising a central metallic portion in the form of a cylindrical sleeve having tapered ends serving as a cathode, two cup-shaped glass end portion fused to the tapered ends of said central portion and extending from the ends of said central portion and surrounding with clearance the ends of said anode, a reentrant bottom part in one of said cup-shaped end portions, a metallic member fused to said reentrant bottom part and extending there-through for supporting said anode, a radiation permeable window enclosing the other of said glass end portions, and a filling in said envelope comprising a mixture of an ionizing medium and a quenching medium. Claims allowed, 2.

11419. (6) Device for measuring thermal conductivity. Charles B. Hood, Jr., Wesley Jones, and Herrick L. Johnston, Columbus, Ohio, assignors to

the United States of America, as represented by the United States Atomic Energy Commission: U. S. patent 2,475,138, issued July 5, 1949.

In a thermal conductivity cell, in combination, a first spherically shaped body, a second spherically shaped body having an opening sealed by a closure and surrounding said first body and spaced therefrom to provide a receptacle therebetween for a material to be tested, said spherically shaped bodies being substantially concentric, means for supplying heat to said first body, means for measuring the amount of heat supplied, means for maintaining said second body at a substantially fixed temperature, and means for measuring the surface temperature of said first body. Claims allowed, 10.

11420. (8) Core catcher. John S. Goodwin, Whittier, Calif., assignor to Globe Oil Tools Co., Los Nietos, Calif., a corporation of California: U. S. patent 2,471,616, issued May 31, 1949.

Core breaking and catching means including, a vertical external elongate ring having an inwardly directed annular shoulder flange at its lower end, a vertical internal ring of lesser height than the external ring arranged within the external ring and engaged with said shoulder flange, means connecting said rings, a plurality of seats comprising aligned notches formed in both rings, a plurality of like dogs, means pivotally mounting a dog in each seat, and resilient means engaging each dog and normally yieldingly holding it in position where it extends substantially radially of the rings and is inwardly directed from its point of pivotal mounting. Claims allowed, 6.

11421. (8) Apparatus for treating oil and gas bearing strata. Severn D. Sprong, Monroe, N. Y.; Katharine Sprong Osborn (Katharine W. Sprong), executrix of Severn D. Sprong, deceased, assignor, by direct and mesne assignments, to Thermactor Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,472,445, issued June 7, 1949.

Means for heating sub-surface strata for the release of oil and other petroliferous material contained therein, said means comprising: electro-magnetic heating means provided with a vertically extending central laminated core and a plurality of mutually vertically spaced sets of pole pieces, each set comprising a plurality of mutually horizontally spaced pole pieces and electrical windings surrounding said central core the lateral periphery of which is materially spaced from the lateral faces of said pole pieces whereby to provide passages through said heating element about said windings and between said pole pieces; in combination with a tubular member of electro-magnetic conducting material disposed about said heating element in operative juxtaposition with the lateral faces of its said plural pole pieces, said tubular member being provided with perforations; and means for suspending said heating element within a bore leading to the sub-surface strata in close adjacency to said tubular member and the strata to be treated. Claims allowed, 1.

11422. (8) Well analyzer. William A. Bruce, Tulsa, Okla., assignor to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,472,464, issued June 7, 1949.

A method for studying the behavior of a well producing a fluid from a subterranean formation, which comprises establishing an electrical

circuit having a source of power to represent formation pressure, resistances to represent total resistance to flow of fluid through the formation for a predetermined distance around the well, condensers to represent the fluid capacitance of the formation for said distance around the well, a condenser to represent fluid capacitance of the well itself, and current draw-off means to represent the production of fluid from the well, determining the variations of bottom hole pressure in the well with time when the well is shut in after flowing, adjusting the various elements of the electrical circuit to give a variation in voltage with time at the point in the electrical counterpart corresponding to the bottom of the bore hole corresponding to the variations of bottom hole pressure in the well with time when the well is shut in after flowing, and thereafter introducing into the electrical circuit electrical changes which correspond to projected changes in operation of the well, and measuring in the circuit the effect of such projected changes on the other factors involved in the production of fluid from the well. Claims allowed, 4.

11423. (8) Well logging. Lynn G. Howell, Silver Spring, Md., assignor to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,474,581, issued June 28, 1949.

A method for logging a borehole which comprises passing through the borehole simultaneously and at the same speed a plurality of spaced Geiger-Mueller detectors of radiations resulting from nuclear disintegrations thereby obtaining two separate electrical impulse counts responsive to radioactivity along the borehole, converting said counts into proportional varying electrical signals and recording separately said signals. Claims allowed, 2.

11424. (8) Radiological well logging. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,475,137, issued July 5, 1949.

A device adapted to be passed through a bore hole to determine the nature and location of formations traversed by said hole comprising an elongated housing, said housing enclosing a source of neutrons and gamma rays, a detector of high energy gamma rays, a detector of high and low energy gamma rays and a detector of neutrons, said first and second named detectors being disposed vertically at opposite sides of said source and said neutron detector being disposed horizontally opposite said source, means associated with said neutron detector for shielding said first and second named detectors from direct gamma radiation from said source, and means for simultaneously recording the outputs of said detectors. Claims allowed, 11.

11425. (8) Well surveying apparatus. Henri-Georges Doll, Houston, Tex., assignor to Schlumberger Well Surveying Corp., Houston, Tex., a corporation of Delaware: U. S. patent 2,475,353, issued July 5, 1949.

In bore hole investigating apparatus, the combination of a body adapted to be lowered into a bore hole containing a liquid, an eccentric mass rotably mounted in the body, power means for rotating said mass to produce periodic pressure fluctuations in said liquid at a relatively rapid rate above that to which a direct current meter is responsive, thereby generating variable alternating electrofiltration potentials in

the vicinity of permeable formations, a first electrode assembled to said body so as to be movable at substantially the same level therewith, a second electrode located at a position where it is not subject to the same instantaneous pressure as said first electrode, circuit means transmitting to the surface alternating potentials picked up by said electrodes and produced by said generated alternating electrofiltration potentials, and means for providing indications of said alternating potentials. Claims allowed, 3.

11426. (8) Well logging equipment. Henri-Georges Doll, Houston, Tex., assignor to Schlumberger Well Surveying Corp., Houston, Tex., a corporation of Delaware: U. S. patent 2,475,354, issued July 5, 1949.

Apparatus for locating permeable formations traversed by a bore hole containing a column of liquid, comprising a casing adapted to be lowered in said column of liquid and having an opening at one end thereof, an expansible member mounted over said opening and forming a closure therefor, and means in the casing for applying a reciprocating motion to said expansible member at a relatively rapid rate above that to which a direct current meter is appreciably responsive, thereby creating alternating electrofiltration potentials in the vicinity of permeable formations, a first electrode assembled to said casing so as to be movable at substantially the same level therewith, a second electrode located at a position where it is not subject to the same instantaneous fluctuating liquid pressure as said first electrode, circuit means transmitting to the surface alternating potentials picked up by said electrodes and produced by said created alternating electrofiltration potentials, and means for providing indications of said alternating potentials. Claims allowed, 5.

11427. (8) Method and apparatus for locating predetermined levels in boreholes. Henri-Georges Doll, Paris, France, assignor, by mesne assignments, to Schlumberger Well Surveying Corp., Houston, Tex., a corporation of Delaware: U. S. patent 2,476,136, issued July 12, 1949.

In a method for bringing an oil well into production, the steps of lowering into the bore hole at least one radioactive projectile together with gun mechanism for discharging said projectile into the earth surrounding the bore hole, simultaneously lowering an exploring electrode therewith in known relation to said gun mechanism, obtaining indications of spontaneous potentials occurring between said electrode and a point of reference, said potentials being characteristic of the formations surrounding the bore hole, causing said gun mechanism to discharge the projectile into the earth surrounding the bore hole and in known, arbitrarily selected relation to one of said formations, thereby establishing a detectable reference marker in the bore hole, withdrawing said gun mechanism, inserting a casing in the bore hole, lowering into the casing perforating apparatus together with a detector responsive to the radioactivity associated with said projectile, determining the location of said projectile reference marker by means of said detector, bringing said perforating apparatus to the level of said one formation by using said projectile reference marker as a point of reference, and causing said perforating apparatus to perforate the casing at said one formation. Claims allowed, 23.

11428. (8) Method of positioning apparatus in boreholes. Henri-Georges Doll, Houston, Tex., assignor to Schlumberger Well Surveying Corp., Houston, Tex., a corporation of Delaware: U. S. patent 2,476,137, issued July 12, 1949.

A method of placing a reference marker in known relation to a formation traversed by a bore hole, comprising the steps of lowering into the bore hole a well casing penetrating emanation producing projectile together with gun mechanism for firing said projectile, simultaneously lowering therewith geophysical exploring means in known relation to said gun mechanism, obtaining, by said exploring means, identifying indications of a characteristic of the formations surrounding the bore hole, causing said gun mechanism to discharge said projectile into the earth surrounding the bore hole and in known and arbitrarily selected relation to an identified one of said formations, withdrawing said gun mechanism from the hole, placing a casing in the hole, forming in the casing a galvanic cell which produces a localized, detectable potential distribution in the casing, lowering into the casing a detector for said projectile together with an exploring electrode, detecting said projectile and said localized potential distribution by means of said detector and said exploring electrode, respectively, and determining the spatial relation between said projectile and said localized potential distribution, thus establishing the latter as a reference marker for said one identified formation. Claims allowed, 10.

11429. (8) Apparatus for subaqueous geologic prospecting. Walter B. Lang, Roswell, N. Mex.: U. S. patent 2,476,309, issued July 19, 1949.

In a system of submarine drilling employing a drilling rig carried by a floating platform, a drill casing and a drill stem operable through the casing; the method which consists in (a) locating the floating platform in a position overlying the site at which it is desired to conduct the drilling; (b) anchoring the floating platform at said location to limit its lateral movement under tide, wind, wave and ground swell effects; (c) making up, in suspension, a string of casing adapted to reach the site from the floating platform and terminating in a drilling shoe at its lower end; (d) drilling in said string of casing and cementing the drilled in casing in place so as to secure a firm hold on the subterranean site; (e) supporting said casing to maintain it substantially erect above the site of operations; (f) connecting the so supported casing to said floating platform in a manner providing for vertical and gyral movement of the platform relative to the site; (g) lowering a drilling means through the casing into drilling relation with the site, and connecting said drilling means to the cable of the rig; and (h) drilling with said drilling means while compensating positively and continuously for tendency of the rig cable to become too slack or too short due to rising and falling motion of the platform relative to the site. Claims allowed, 9.

11430. (8) Recording apparatus for correlating measurements in accordance with depth. Serge A. Scherbatskoy, Tulsa, Okla., assignor to Well Surveys, Incorporated, Tulsa, Okla., a corporation of Delaware: U. S. patent 2,479,518, issued Aug. 16, 1949.

A system for producing a log of the formations penetrated by a drill hole that comprises means for producing adjacent the formations elec-

trical signals that are a function of the physical properties of the formations, means for simultaneously producing separate electrical signals that are related to the depth of the formations adjacent which the first recited electrical signals are produced, means for separately and independently recording the two sets of signals as they are produced in correlation with time, means for separately and simultaneously reproducing said signals in correlation with a time schedule equal to that employed in recording the signals, means utilizing one set of the reproduced signals to operate a recorder strip, means for simultaneously utilizing the second set of electrical signals for tracing a record on the recording strip which record will be a function of the speed at which the recorder strip is driven, whereby there results a log of the physical formations correlated with depth. Claims allowed, 1.

11431. (8) Geophysical prospecting method. Nelson P. Stevens, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,479,787, issued August 23, 1949.

A method of prospecting for petroliferous deposits in the earth which comprises collecting soil gas samples at each of a plurality of spaced boreholes in a prospect area below the soil breathing level and without contamination with atmospheric air, quantitatively determining the oxygen and carbon dioxide content of each sample, correlating and mapping values obtained from both of said determinations so that an area of increased petroliferous deposits is outlined by the points of anomalous variation in the values constituting a function of both the oxygen and carbon dioxide contents. Claims allowed, 2.

11432. (11) System for determining the position or path of an object in space. Paul W. Nosker, Yellow Springs, Ohio: U. S. Patent 2,470,787, issued May 24, 1949.

Means for continuously obtaining information sufficient to determine the instantaneous position of an airplane with respect to three ground points located at the vertices of a triangle, said means comprising a control station located at the first of said ground points, said control station comprising a local oscillator and means for radiating a first carrier wave modulated by the frequency of said local oscillator, means in said airplane for receiving and demodulating said first carrier wave and for modulating a second carrier wave with the signal resulting from demodulation of said first carrier wave, means in said airplane for radiating said modulated second carrier wave, means at said control station for receiving and demodulating said second carrier wave and for comparing the phase of the resulting signal with that of the local oscillator signal, means at the second of said ground points for receiving and demodulating said second carrier wave and for modulating a third carrier wave with the signal resulting from demodulation of said second carrier wave, means at said second ground point for radiating said modulated third carrier wave, means at the third ground point for receiving and demodulating said second carrier wave and for modulating a fourth carrier wave with the signal resulting from demodulation of said second carrier wave, means at said third ground point for radiating said modu-

lated fourth carrier wave, means at said control station for receiving and demodulating said third carrier wave and for comparing the phase of the resulting signal with that of the local oscillator signal, and means at said control station for receiving and demodulating said fourth carrier wave and for comparing the phase of the resulting signal with that of the local oscillator signal. Claims allowed, 2.

11433. (11) Radio range system. Harry Wilkie, Dayton, and Francis L. Moseley, Osborn, Ohio: U. S. patent 2,471,470, issued May 31, 1949.

An omni-directional radio range system, comprising a radiating system of equi-angularly spaced radiating units: a source of carrier frequency; means for modulating the carrier source to derive a plurality of dissimilar energy wave impulses; means for transmitting those respective impulses sequentially to the respective radiating units during successive equal time intervals thereby to establish a rotating radiation field with directional characteristics; means for receiving and segregating the wave impulses, rectifying them, and setting up in the same sequence, adjacent direct mutual magnetic fields equi-angularly spaced; and means for indicating the location of the resultant magnetic axis of the mutual field. Claims allowed, 5.

11434. (11) Electronic square wave signal generator. Lawrence H. Johnston, Rural, N. Mex., assignor, by mesne assignments, to the United States of America as represented by the Secretary of War: U. S. patent 2,473,432, issued June 14, 1949.

An electronic square wave signal generator comprising first and second gas tubes, each having at least an anode, a control grid and a cathode, a source of variable unidirectional voltage having its positive terminal connected to the anode of said first tube, loading means connected between the negative terminal of said source and the cathodes of both tubes, the anode of the second tube being connected to the positive terminal of a second source of voltage through a resistor, and to the negative terminal of said second source through a capacitor, a source of periodic pairs of pulses, means for supplying the first pulse of each of said pairs to the control grid of the first tube and the second pulse of each of said pairs to the control grid of the second tube, said first pulse rendering the first tube conductive, said second pulse rendering the second tube conductive, whereby said first tube is cut off, the duration of the application of the unidirectional voltage to the loading means being fixed by the interval between the pulses of each pair, and the periodicity of the application of the unidirectional voltage to the loading means being fixed by the frequency of said source, the amplitude of the square wave output developed across the loading means being variable in successive output pulses in response to variation in said unidirectional voltage. Claims allowed, 1.

11435. (11) Oscillographic recording apparatus. Richard M. Davis, Oklahoma City, Okla., assignor to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,474,303, issued June 28, 1949.

A recording apparatus consisting of a means for producing a beam of light oscillating in a fixed plane, an elongated reflector having a cross-section in the form of a triangle arranged in the direct path of said beam

of light with its apex in the plane of oscillation of said light beam, a focusing lens arranged on either side of said triangular reflector with its axis parallel with the axis of said triangular reflector and means for passing a sensitized strip through the focal point of each of said focusing lenses in a direction transverse to the direction of oscillation of the light beam passing through said lenses from said reflector, whereby duplicate records are obtained. Claims allowed, 1.

11436. (11) Underwater bottom hardness tester. Ralph F. Shropshire, Woods Hole, Mass., assignor, by mesne assignments, to Raytheon Manufacturing Co., a corporation of Delaware: U. S. patent 2,477,094, issued July 26, 1949.

A soil hardness measuring device for determining from a station on a vessel or the like in the water the hardness of an ocean bottom by impact comprising: a tester including a plunger support, a plunger movable in the support, an indicating scale fixed relative to the support, an indicator movable along the scale, and indicator moving means on the plunger; means for retrievably dropping the tester freely through the ocean from the station and means for orienting the tester to maintain the plunger perpendicular to the ocean bottom during plunger impact therewith. Claims allowed, 3.

11437. (11) Stereoscopic position indicating means. Richard H. Ranger, Newark, N. J.: U. S. patent 2,477,651, issued Aug. 2, 1949.

In a stereoscopic device, a right plate and a left plate spaced apart, identical map designs positioned on said plates, a plurality of equally spaced concentric circles on said right plate, a plurality of corresponding eccentrically spaced circles on said left plate, corresponding circles having the same radius and having centers progressively displaced from the center of said map as the radius is reduced, a symmetrical system of lines on said right plate connecting the outer circle with the center, elements of said line system terminating symmetrically and consecutively on equally spaced circles intermediate between the outer circle and the center, a system of lines on said left plate similar to those on the right plate and connecting corresponding displaced circles whereby the circle and line systems when viewed in stereoscopic fusion appear as a series of conical ridges and valleys on whose side walls appear a series of contour lines intermediate between the ground plane and the apices of ridges. Claims allowed, 2.

11438. (11) Directed beam high-frequency oscillator. Adolph H. Rosenthal, New York, N. Y., a corporation of New York: U. S. patent 2,479,084, issued Aug. 16, 1949.

An electronic device and system for producing electric oscillations, particularly of high and ultra-high frequency, said device including an elongated evacuated envelope, means for developing two electron streams in said envelope and close to opposite ends thereof, means for velocity modulating each stream so that groups of electrons recur in each progressing stream, electron optical means for directing said streams from opposite sides into a restricted space within said envelope so that said groups in each stream form in said space, a pair of energy abstracting electrodes spacedly arranged from one another so as to form a gap

between them substantially determining said restricted space, means at opposite sides of said space for producing a separating magnetic field each across the paths of the electron streams incoming and outgoing from said space so as to deflect the electrons of the outgoing stream from the path of the incoming stream, means for producing another magnetic field across the path of each incoming stream between said separating magnetic field and said velocity modulating means, the direction of said other field opposite that of said separating field so that the electrons of different velocities of the incoming stream are de-focused and deflected in one direction by said other field and re-focused and deflected in opposite direction by said separating field, and electrodes in the path of each deflected outgoing stream for collecting its electrons; said system including electrical means for driving said velocity modulating means at the same frequency and at such phase relation that said groups form alternately in said streams within said space. Claims allowed, 24.

11439. (11) Magnetic recorder head. Marvin Camras, Chicago, Ill., assignor to Armour Research Foundation of Illinois Inst. Technology, a corporation of Illinois: U. S. patent 2,479,308, issued Aug. 16, 1949.

A magnetic transducer head comprising a core of relatively high magnetic permeability and relatively low magnetic retentivity, said core having a gap therein extending inwardly from one edge to define a pair of confronting magnetic poles, and a single current-carrying conductor disposed in said gap itself between said confronting poles, said one edge of said core being arranged to have a magnetic record medium passed therealong across said gap, and an energizing circuit for said conductor forming a closed loop around the path of travel of said record medium. Claims allowed, 7.

11440. (11) Position indicating system. Joseph T. Webber, Galesburg, Mich., assignor to Editors and Engineers Ltd., Los Angeles, Calif., a corporation of California: U. S. patent 2,479,531, issued Aug. 16, 1949.

A position indicating system comprising a plurality of spaced radio transmitting stations, each station having a transmitter, the field of the transmitter of one station overlapping the field of the transmitter of an adjacent station, each transmitter adapted to transmit direction-significant signals, all of said transmitters adapted to transmit said signals on the same wave frequencies, and a pulser for each transmitter timed to interrupt transmission therefrom to transmit a succession of relatively brief, widely spaced pulses of direction-significant signals, each of said pulses including a plurality of transmitted waves, the pulser of each transmitter having a slightly different recurrence pulse rate from the recurrence pulse rate of the pulser of each of the other transmitters, whereby substantially all of the relatively brief pulses of each transmitter occur during the relatively long silent intervals between successive pulses of each of the other transmitters, the silent interval between two successive pulses of said succession of pulses from each transmitter being less than the interval of persistence of vision, whereby the traces of a true direction on the viewing screen of a cathode ray tube associated with a receiver tuned to receive said transmission appears steady and continuous. Claims allowed, 18.

11441. (11) Radio position determining system. Ludlow B. Hallman, Jr., Dayton, Ohio, assignor to the United States of America as represented by the Secretary of War: U. S. patent 2,479,567, issued Aug. 23, 1949.

In an aircraft course-determining device a plurality of spaced receiving antennas at opposite ends of a wing respectively, receiving means responsive to difference in frequency between waves received by said antennas for determining course, and means in the path of the course for radiating frequency modulated waves that have a portion wherein the change of frequency is linear. Claims allowed, 6.



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