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GEOPHYSICAL ABSTRACTS 99

OCTOBER–DECEMBER 1939

COMPILED BY

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GEOPHYSICAL ABSTRACTS 99, OCTOBER-DECEMBER 1939

Compiled by W. AYVAZOGLOU

1. GRAVITATIONAL METHODS

5162. Chang-Hung-Chi, Mesures de gravité dans l'ouest du Yunnan chinois [Measurements of gravity in the western part of the Chinese Yunnan]: Acad. sci. Paris Comptes rendus, vol. 208, No. 25, pp. 1972–1975, 1939.

Values of gravity determined at new stations in the mountainous western part of the Province of Yunnan are shown in a table. Measurements were made with the Holweck-Lejay pendulum 510.—*W. A.*

5163. Haalck, Hans, Der statische (barometrische) Schweremesser für Messungen auf festem Lande und auf See [Statical (barometric) gravity meter for measurements on land and sea], parts 2 and 3: Beitr. angew. Geophysik, vol. 7, No. 4, pp. 392–447, Leipzig, 1939.

For part 1 see Geophys. Abstracts 95, No. 4578.

Part 2 deals with (1) the theory of sources of errors; (2) the amount of single sources of errors (influences of temperature variations, changes in pressure, effect of changes in volume, changes in scale-value, friction and capillary forces, magnitude of the directing force); and (3) the elimination of the influence of temperature. Two typical arrangements for compensating the influence of temperature are shown graphically.

In part 3 the necessary developments of a gravity meter for making measurements on moving ships are discussed, as follows: (1) General conditions for observations, (2) reading and damping arrangements in a sea apparatus, (3) mounting the statical gravity meter on board a ship, (4) effect of the oscillations at the place of mounting on the values of measurements, (5) method of observation and reduction of results obtained from measurements at sea, and (6) practical experimental measurements on the North Sea in the summer of 1938. The course of the "true" gravity between Hamburg and Bremen, as measured on board a moving ship, and deviations of gravity from the normal course between Hamburg and Bremen are shown in a series of diagrams.—*W. A.*

5164. Hammer, Sigmund, Terrain corrections for gravimeter stations: Geophysics, vol. 4, No. 3, pp. 184-193, Menasha, Wis., 1939.

In this paper the correction for the gravitational attraction of the topography on a gravity station is considered as consisting of two parts: (1) The restricted but conventional "Bouguer correction," which postu-

lates as a convenient approximation that the topography consists of an infinite horizontal plain, and (2) the "Terrain correction," which is a supplementary correction taking into account the gravitational effect of the undulations of the terrain about the plane through the gravity station. The paper illustrates the necessity of making terrain corrections if precise gravity surveys are desired in hilly country and presents terrain correction tables with which this quantity may be determined to a relative accuracy of one-tenth milligal. This accuracy is required to fully utilize the high instrumental precision of modern gravimeters.—*Author's abstract.*

5165. Korostarenko, M. K., Gravitational variometer with two beams disposed at an angle of 90° [in Russian]: Razvedka Nedr, vol. 9, No. 6, pp. 43–47, Moscow, 1939.

This new model, designed by the author, makes it possible to determine horizontal gradients of the force of gravity in a much shorter time (from 30 to 34 minutes) than is required by any of the other models used so far (from 1 hour to 2 hours 40 minutes).

A description of the variometer is given, and results of laboratory tests are summarized in three tables.—*W. A.*

5166. Lettau, Heinz, Lotschwankungen am Gebirgsrand zur Zeit der Schneeschmelze [Gravity oscillations at mountain edges during melting of snow]: Gerlands Beitr. Geophysik, vol. 54, No. 3, pp. 179-193, Leipzig, 1939.

A three-weekly series of horizontal double-pendulum observations were made at Berchtesgaden. It was found that (1) at melting of the snow in March a systematic inclination of the *N–S* component of 0.16″ per day occurred in the sense of heaping to the south. With new snowfalls this decreased to 0.1″ per day but had a maximum at melting of 0.2″ per day. Provided this movement does not extend to the inner part of the mountains, it is assumed that the adjoining High Goll (2,522 m.) had given way up to 50 percent in the sense of isostatic layering under the snow load; (2) the maximum 24-hour change of inclination occurs at the start. This could be caused by microfaulting limited by the transition from elastic to plastic deformation within the real layers of the rock; (3) the tidal movements of the gravity oscillations in the *N–S* component reaches 37 to 51 percent of the amount for rigid earth with the M_2 and S_2 waves.—*R. S. R., Sci. Abstracts, vol. 42, No. 499, 1939.*

5167. Mace, C., and Bullard, E. C., Gravity measurements in Cyprus: Royal Astron. Soc. Monthly Notices, Geophys. Suppl., vol. 4, No. 7, pp. 473–480, London, 1939.

Observations of latitude and longitude on the coast of Cyprus revealed large deflections of the vertical when the results were compared with the positions of the stations computed from the triangulation of the island. These deflections are illustrated in a figure. Measurements of gravity were made to obtain evidence on the distribution of the masses responsible for these deflections. Three tables accompanying the article show (1) the positions of the stations and the values of "g", (2) attraction of topography and compensation in units of 10^{-4} cm./sec.^{2}, and (3) mean height of zones in meters.—*W. A.*

5168. Marti, Pierre, and Anthoine, Georges, Sur la croisière gravimétrique du sous-marin "Espoir" dans la partie sud-ouest du bassin occidental de la Méditerranée en 1936 [On the gravimetrical cruise of the sub-

marine *Espoir* in the southwestern part of the occidental basin of the Mediterranean Sea in 1936]: Acad. sci. Paris Comptes rendus, vol. 209, No. 7, pp. 374–376, 1939.

Measurements of intensity of gravity at sea, made in 1933–34 in the northwestern part of the occidental basin of the Mediterranean Sea (see Geophys. Abstracts 83, No. 3053), were continued in 1936 in the meridional part of this basin in the zone to the south of the Balearic Islands. Apparatus of the Vening-Meinesz type was used. Measurements were made at 46 stations at sea, about 80 km. apart, and also at 10 ports, with Toulon as the station of reference. Calculation of the results is not yet complete. The observations are compared with theoretical values of gravity, calculated by using the international formula in a function of the latitude of the place of observation. Figures showing the deviation of observed values from those calculated theoretically are given in a map. The results indicate that the western part of the occidental basin of the Mediterranean Sea can be divided into three distinct zones of gravity anomalies: (1) To the north of the Balearic Islands the gravity is greater than normal along the west side and smaller than normal along the east side; (2) in the central part of the basin the gravity is greater than normal; and (3) in the southern part of the basin the gravity is smaller than normal far at sea off the African coast but is greater than normal near the coast.—*W. A.*

5169. Mihal, N., A few words on the reduction of gravity, Acad. sci. U. R. S. S. Comptes rendus (Doklady), vol. 23, No. 2, pp. 145–146, Moscow, 1939.

The generally accepted interpretation of H. Faye's anomaly is examined and is shown to lead to incorrect, illusive conceptions. The way in which Faye's anomaly should be interpreted is discussed mathematically.—*W. A.*

5170. Mott-Smith, L. M. and F. W., Advancements in the use of the gravimeter in oil exploration: Petroleum Engineer, vol. 10, No. 10, pp. 85–97, Dallas, Tex., 1939.

Statements concerning developments in the construction of gravimeters, difficulties to be overcome in these developments, and the increase in the application of gravimeters in geophysical prospecting are outlined (60 gravimeter crews were operating in the United States on June 1, 1939). Transportation, mounting, surveying, and the process of computation are discussed. An example of a gravity survey of an area in the vicinity of Houston, Tex., is examined. The survey, made in 9 days, includes 169 stations in an area of about 100 square miles. A map, contoured at intervals of 0.2 milligal, is shown. In conclusion, the following comparison between a torsion-balance survey and a gravimeter survey is made: "Under average road conditions, it is possible to average by gravimeter at least 20 new stations per day. Thus, about 20 square miles per day can be covered, or about 500 square miles per month. The comparable torsion-balance crew obtains 8 stations per day. To obtain satisfactory accuracy for reconnaissance work the stations must be placed about one-quarter of a mile apart. Lines of stations are usually run in such a manner that there are about four stations per square mile. Thus an area of two square miles per day is surveyed, or about 50 square miles per month. The gravimeter is, therefore, 10 times as rapid as the torsion balance. Its

greater speed makes its cost per square mile of survey considerably less."—*W. A.*

5171. Nagata, Takesi, Torsion-balance survey of Mount Mihara, part 1: Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 17, No. 1, pp. 93–106, 1939.

This paper reports the results of a torsion-balance survey of Mount Mihara and the correlation between the gravity values and their derivatives. The relation between the variation in gravity field and volcanic activity was studied. Second derivatives of the gravity potential were observed at 18 stations near Mount Mihara, and the gravity value g was measured at 3 stations on Oosima Island. The Askania torsion balance 120 was used. Twenty-three tables and a map of graphical representation of Eötvös quantities illustrate the results.—*W. A.*

5172. Owen, David, Note on the bar pendulum: Physical Soc. London Proc., vol. 51, No. 285, pp. 456–458, 1939.

The time of oscillation of a bar pendulum is shown to be practically unaffected by the use of a carriage supporting the knife edge and sliding along the bar; the accuracy of the usual laboratory exercise on the bar pendulum is considerably increased. With a stop watch showing tenths of a second, the value of g can be determined quickly to within a few parts in 10,000.—*Author's abstract.*

5173. Skeeters, W. W., Gravity-meter prospecting for oil: Mines Mag., vol. 29, No. 6, pp. 304–309, 346, Denver, Colo., 1939.

Evolution of the gravity meter, its application, field operation, and accuracy are described.

The growing popularity of the gravity meter is proved by the rapid expansion in the gravity-meter business in the past few years. This popularity and an accompanying marked decrease in seismic and torsion-balance prospecting are shown by the following comparison between the various crews operating along the Gulf coast, and in Oklahoma, New Mexico, and Mississippi:

Apparatus	Number of crews in September 1937	Number of crews in September 1938
Torsion balance	30	15
Gravity meter	18	24
Seismograph	142	119

The change is explained by the growing demand in the oil industry for new reserves for which the gravity meter is a valuable reconnaissance instrument.

A comparison of the three main reconnaissance instruments—the magnetometer, torsion balance, and gravity meter—explains the increase in popularity of the gravity meter.—*W. A.*

5174. Tsuboi, Chuji, Deformations of the earth's crust: Gerlands Beitr. Geophysik, Supplementband 4, pp. 106–168, Leipzig, 1939.

Tiltmeters and methods of measuring changes of level are described. Actual amounts of change in level, in depths of the sea, and in the horizontal distance between pairs of points resulting from or accompanying volcanic eruptions, earthquakes, and secular movements are then given, with mathematical details of the necessary calculations. The examples are mostly taken from events in Japan, but with several from elsewhere. Over 250 references are given.—*C. A. S., Sci. Abstracts, vol. 42, No. 496, 1939.*

5175. von Thyssen-Bornemisza, Stephan, and Lubiger, F., Über eine gravimetrisch und theoretisch bestimmte Schwereanomalie [On a gravity anomaly determined gravimetrically and theoretically]: Beitr. angew. Geophysik, vol. 7, No. 4, pp. 366–391, Leipzig, 1939.

In order to examine the difference between a theoretically calculated and a measured gravity anomaly the gravity effect of a small valley, about 20 m. deep and 115 m. wide, was measured on a stone bridge crowning this valley. A Thyssen gravimeter was used. Theoretical calculations were made by three entirely different methods: (1) The cross section of the valley was divided into three lateral horizontal prisms; the gravity effect of the middle section of these prisms could be calculated by using Helmert's fundamental formulas; (2) K. Jung's "Two-dimensional" solution was applied and a special diagram was constructed; the gravity effect could be calculated by multiplying the number of fields of the diagram with the so-called "counting value" of each field; (3) finally, a method was employed in which Schleusener's reduction tables were used; these tables give directly the desired gravity effect for a certain density, height, and circular section.

Satisfactory results, in good agreement with the gravimeter measurements, were obtained from all the three theoretical solutions. The average difference between the measured data and the results calculated according to Helmert and Jung was 0.03 milligal, and calculated according to Schleusener, 0.07 milligal. The mean difference between the gravity values determined according to Helmert and Jung was even only 0.006 milligal. Thus, perfect accordance was obtained notwithstanding the fact that Helmert's and Jung's methods are very different. This serves as a proof that the theoretical methods give accurate results and that modern gravimeter measurements are precise and exact.—*Authors' abstract.*

2. MAGNETIC METHODS

5176. Coulomb, Jean, and Dugast, Georges, Sur l'intervalle de temps entre les éruptions solaires et les magnétiques [Time interval between solar eruptions and magnetic storms]: Acad. sci. Paris Comptes rendus, vol. 208, No. 20, pp. 1557–1559, May 15, 1939.

The results of previous measurements by Hale and Maurain show intervals of 24–30 and 40 hours, respectively. In this case the magnetic observations at Tamanrasset over the period 5/1/34 to 8/31/38 were used. For 23 cases of sudden magnetic storms, when during the preceding 4 days calm or nearly calm conditions prevailed, an interval of 24–30 hours was found. Eliminating sunrise and sunset observations, the agreement with Hale was even closer. For 29 storms having a less sudden commencement, the same time interval could be perceived.—*R. S. R., Sci. Abstracts, vol. 42, No. 499, 1939.*

5177. Farnham, F. C., A reference datum for magnetometer surveys: Am. Inst. Min. Met. Eng., Tech. Pub., No. 1077, 16 pp., 1939.

This paper describes a reference datum for magnetometer surveys, which, it is believed, will eliminate most of the difficulty arising from lack of uniformity in the reference datum used for such surveys. Table 1 gives the latitude-correction factors and table 2 the longitude-correction factors.—*W. A.*

5178. Graf, Anton, Ein neues Registrierverfahren für die Aufzeichnung der magnetischen Elemente [A new method of registration for indicating magnetic elements]: Beitr. angew. Geophysik, vol. 7, No. 4, pp. 357–365, Leipzig, 1939.

A photoelectric recording system is described that the author developed for the well-known magnetic Askania field balance of Adolf Schmidt. The new design can be used also for any other recording system equipped with mirrors, such as magnetic torsion-fiber instruments, torsion balances, and mirror galvanometers. The author discusses the advantages of the method, such as direct reading, long-distance reading, instantaneous value determination, variable speed of the paper, and possibility of high magnification. Finally, he shows new possibilities of using the field balance. The followng principle with regard to application seems to be established: If, owing to difficulties in transportation, the greatest reduction in weight is necessary, the photographic method may be more advantageous; however, the advantages of the electrical arrangement become especially valuable when the geophysical crew is located at one place for several months.—*Author's abstract, translated by W. A.*

5179. Jones, W. M., Magnetic effects associated with cinnabar deposits, Ngawha, North Auckland: New Zealand Jour. Sci. Technology, vol. 20, No. 5b, pp. 272b–276b, Wellington, 1939.

Results are described of a survey of vertical magnetic intensity in the vicinity of the Ngawha cinnabar deposits. An area of magnetic disturbance was found immediately adjacent to the cinnabar-bearing areas, and boring in the lake beds showed the presence of basaltic rock reaching to within 30 feet of the surface. The implications of this in regard to the origin of the deposits are discussed.—*Author's abstract.*

5180. Jones, W. M., Magnetic observations in the Onekaka-Parapara district, with some remarks on the geology of the iron-ore deposits: New Zealand Jour. Sci. Technology, vol. 21, No. 1b, pp. 16b–30b, Wellington, 1939.

Results are described of some magnetic observations on the Onekaka-Parapara iron-ore deposits and over the surrounding country between Takaka and Bainham. The magnetic properties of the ores were not found to be such as to enable them to be traced directly by magnetic survey, but considerable variations of vertical intensity were found in several of the tunnels recently driven into the ore bodies, and elsewhere on the surface close to them, while several major areal anomalies were also detected in the surrounding district. The causes of these magnetic effects, and their possible relations to the origin and structure of the ore bodies, are discussed.—*Author's abstract.*

5181. Kutscher, Fritz, Magnetische Versuchsmessungen auf silikatische Eisenerze in Thüringen [Magnetic experimental measurements for silicate

iron ores in Thuringia]: Beitr. angew. Geophysik, vol. 7, No. 4, pp. 350–356, Leipzig, 1939.

Experimental measurements made with the variometer on chamosite and thuringite ores in Thuringia prove that the ores have either very weak or almost no magnetic properties. The magnetic behavior probably depends on the magnetite admixtures that occur incidentally in the ores. Caution is advisable in explaining indications that may appear eventually. The amplitudes of disturbances rarely exceed 20 gammas.—*Author's abstract, translated by W. A.*

5182. Lauterbach, Robert, Geomagnetische Untersuchungen in Nordwest Sachsen und Nordost Thüringen [Geomagnetic investigations in northwestern Saxony and northeastern Thuringia]: Geophys. Inst. Univ. Leipzig, Veröff., ser. 2, vol. 9, No. 5, pp. 325–368, 1938.

The first part of this article deals with the geophysical investigations of the region. A description is given of (1) the instrument, (2) the care of the instrument, (3) the outline and execution of measurements, (4) the reduction of measurements, and (5) the results of measurements.

The second, or geological, part discusses (1) geologic conditions of the region under investigation, (2) comments on the general magnetic map, (3) anomalies of Delitzsch, Leipzig, Pegau, and Lauchstedt, (4) the effect produced by sediments, and (5) the comparison with gravity measurements.

Final values of disturbances are shown on a map.—*W. A.*

5183. Molin, Kurt, A general earth-magnetic investigation of Sweden, part 2, Inclination: Sveriges Geol. Undersökning, ser. Ca, No. 29, 119 pp., 4 pls., Stockholm, 1939.

This part of a general earth-magnetic investigation of Sweden, made during the period 1928–34 by the Geological Survey of Sweden, deals in details with inclination. (For part 1, Declination, see Geophys. Abstracts 89, No. 3685.)

Contents: (1) Summary of the geological determinations; (2) Inclination determinations in Sweden before 1928; (3) Density of distribution of inclination points; (4) Field work and instrumental equipment; (5) Determination of the inclination; (6) Comparisons of the dip circles and needle corrections; (7) Reduction of the inclination observed to the middle of the year; (8) Accuracy of the field measurements; (9) Reduction to epoch; (10) The inclination at the Upsala Magnet-house; (11) The inclination at the Abisco Absolute-house; (12) The registration station at Näs, Jämtland (scale values of the H-variometer and Z-variometer, scale values of the records of temperature, temperature coefficients of the H-variometer and Z-variometer, baseline values, and determinations of the values of H and Z for the middle of the year); (13) Hourly mean values of the horizontal intensity and the vertical intensity at Näs for the summer months of 1929 and 1930; (14) The inclination at the field stations at Näs, Jämtland; (15) Computation of terrestrial value for the inclination at the epoch of 1933, 5; (16) Computation of the anomalies; (17) The main inclination table; (18) Remarks and comparisons; (19) Remeasurements at older observation places; (20) The inclination and anomaly maps.

Plates: (1) Inclination map for the epoch of July 1, 1933; (2) Inclination anomaly map with lines of equal anomaly; (3) Map containing the

values of the anomaly of inclination; and (4) Anomaly of inclination of Skåne.—*W. A.*

5184. Nagaoka, Hantaro, and Ikebe, Tsuneto, Induction magnetograph for recording sudden changes of terrestrial magnetic field: Inst. Phys. Chem. Research, Sci. papers, vol. 36, No. 915, pp. 183–197, Tokyo, 1939.

A magnetograph for measuring the time rate dH/dt of the terrestrial magnetic field H, with a special shape for collecting the lines of force into a permalloy core enclosed in a cylindrical coil, is described. A record of the complicated magnetic disturbance caused by an electric tram is given. Comparison of the apparatus for simultaneous observations of dZ/dt with induction loop of $8.25\times10^4 m^2$ at the Kakioka Magnetic Observatory, showing the reliability of the apparatus, is given by graphs. The effect of earthquake shocks is discussed particularly with the instruments in mind. A sketch of the volcanological study with the apparatus, and various uses of ionospheric investigations, are suggested; and absorption of rapidly changing fluctuations in the ionosphere is considered probable. The difficulty of finding a proper site for installing the apparatus is explained.—*Authors' abstract.*

5185. Stagg, J. M., and Paton, J., Aurora and geomagnetic disturbance: Nature, vol. 143, No. 3631, p. 941, London, 1939.

The authors consider that near the zone of maximum auroral frequency the electric-current systems responsible for surface geomagnetic disturbance and those manifested as auroral arcs may be more closely associated spatially than hitherto supposed.—*Editorial abstract.*

3. SEISMIC METHODS

5186. Benioff, Hugo, and Gutenberg, Beno. Observations with electromagnetic microbarographs: Nature, vol. 144, No. 3645, p. 478, London, 1939.

Results obtained with electromagnetic microbarographs designed by Benioff are described. They respond to the range of frequencies five cycles per second to two cycles per minute and are capable of recording the natural movements of the atmosphere. Wave movements, produced by earthquakes, surf, or artificial sources, and also air currents, can be detected.—*Editorial abstract.*

5187. Birch, Francis, The variation of seismic velocities within a simplified earth model, in accordance with the theory of finite strain: Seismol. Soc. America Bull., vol. 29, No. 3, pp. 463–479, Berkeley, Calif., 1939.

Murnaghan's theory of finite strain has been applied in an approximate form to a study of the density and velocity variations in a simplified model of the earth outside the core, the model consisting of two homogeneous layers, each at a uniform temperature. Following Jeffreys, the layers are separated by a first-order discontinuity at a depth of 474 km. Above 474 km. the variations of the velocities in this model are shown to be practically the same as Jeffreys' "observed" values. The main features of the velocity-depth curves are represented with fair precision down to the core. This is of course no longer true if the velocities are supposed to vary continuously through the 474 km. level. Whichever supposition be held, if the rate of change of velocity immediately below 474 km. is to be reproduced closely, a gradual change of composition must be introduced. The variation of density upon the two-layer supposition is very close

to that derived by Jeffreys and by Bullen by numerical integration of the "observed" velocities, on the supposition of adiabatic compression of homogeneous layers. The validity of their method is shown to depend upon the existence of a small temperature gradient, or of compensating factors which cannot be evaluated. It is suggested that a more rigorous solution of the equations of motion derived from the theory of finite strain might prove of value in interpreting the oscillatory character of seismic records, as well as the direction of the ground motion associated with various wave types.—*Author's abstract.*

5188. Byerly, Perry, Near earthquakes in central California: Seismol. Soc. America Bull., vol. 29, No. 3, pp. 427–462, Berkeley, Calif., 1939.

Least-squares adjustments of observations of waves of the P groups at central and southern California stations are used to obtain the speeds of various waves. Only observations made to tenths of a second are used. It is assumed that the waves have a common velocity for all earthquakes. But the time intercepts of the traveltime curves are allowed to be different for different shocks. The speed of $\overline{P}$ is found to be 5.61 km./sec.$\pm$0.05. The speed for $\overline{S}$ (founded on fewer data) is 3.26 km./sec.$\pm$0.09. There are slight differences in the epicenters located by the use of $\overline{P}$ and $\overline{S}$, which may or may not be significant. It is suggested that $\overline{P}$ and $\overline{S}$ may be released from different foci.

The speed of P_n, the wave in the top of the mantle, is 8.02 km./sec. $\pm$0.05. Intermediate P waves of speeds 6.72 km./sec.$\pm$0.02 and 7.24 km./sec.$\pm$0.04 are observed. Only the former has a time intercept which allows a consistent computation of structure when considered a layer wave. For the Berkeley earthquake of March 8, 1937, the accurate determination of depth of focus was possible. This enabled a determination of layering of the earth's crust. The result was about 9 km. of granite over 23 km. of a medium of speed 6.72 km./sec. Underneath these two layers is the mantle of speed 8.02 km./sec. The data from other shocks centering south of Berkeley would not fit this structure, but an assumption of the thickening of the granite southerly brought all into agreement.

The earthquakes discussed show a lag of P_n as it passes under the Sierra Nevada. This has been observed before. A reconsideration of the P_n data of the Nevada earthquake of December 20, 1932, together with the data mentioned above, leads to the conclusion that the root of the mountain mass projects into the mantle beneath the surface layers by an amount between 6 and 41 km.—*Author's summary.*

5189. Caloi, Pietro, Traveltimes near earthquakes: Ricerca Scientifica, vol. 10, pp. 388–397, Rome, May 1939.

The traveltimes of earthquake waves near the origin are tabulated for earthquakes of northwest Italy.—*W. A.*

5190. Corkan, R. H., The analysis of tilt records at Bidston: Royal Astron. Soc. Monthly Notices, Geophys. Suppl., vol. 4, No. 7, pp. 481–497, London, 1939.

The recording mechanism of a Milne-Shaw seismograph was modified so as to be suitable for tilt registration, and the clock was replaced by a synchronous electric motor. The observations for 12 months (1935–36) were harmonically analyzed and the load tilt separated from the body tilt. This separation determines and is independent of the phase lag of the load tilt and thus eliminates the secondary effects of

the oceanic tides. Comparison between the observed and the theoretical semidiurnal body tilt gave a value for the yielding of the earth midway between the determinations by Michelson and Gale and by Schweydar. The response of the quarterdiurnal load tilt to the loading tide agrees with the response of the semidiurnal load tilt. The 1933 diurnal-tilt constants implied a body tilt not following the equilibrium law. Examination of these constants indicates that several years' observations are required before forming definite conclusions concerning the diurnal tilt. There is no evidence of appreciable permanent tilting of the ground at Bidston, but the existence is shown of large oscillations of tilt which appear to be partly related to oscillations of atmospheric pressure.—*R. S. R., Sci. Abstracts, vol. 42, No. 499, 1939.*

5191. Doherty, J. W., Seismic exploration for oil: Miner, vol. 12, No. 8, pp. 40–43, Vancouver, British Columbia, 1939.

The theory of accumulation of oil and the principles of the refraction and reflection methods of seismic prospecting for oil are briefly discussed. The average cost of a seismograph party for reflection shooting is estimated as follows: To explore a tract of about 40,000 acres would take a seismograph crew about a month, at an average of 1,500 acres a day. The month's work would cost from $7,500 to $10,000, depending upon the contract, the location of the area, the amount of dynamite necessary, and the difficulty of drilling shot holes.—*W. A.*

5192. Eller, W. H., A new recording tiltmeter: Seismol. Soc. America Bull., vol. 29, No. 3, pp. 481–484, Berkeley, Calif., 1939.

Earth tilt may be determined from measurements on seismograph records, or by use of special tilt-measuring instruments such as the Ishimoto horizontal-pendulum recording-type tiltmeter, the Wingate-Jagger vertical-pendulum clinoscope, and the Merritt interferometer tiltmeter.

The instrument described in this paper is a recording tiltmeter of the horizontal-pendulum type, very rugged in construction and, as used at present, needing attention but once a week to change the record and wind the clock. It resembles a seismograph in many ways but differs primarily in the method of coupling between the pendulum boom and the magnifying arm and in the method of recording. A photograph of the tiltmeter, diagrams of magnetic coupling between the pendulum and the magnifying lever, and a diagram of the tiltmeter record are given.—*W. A.*

5193. Gutenberg, Beno, and Richter, C. F., Depth and geographical distribution of deep-focus earthquakes (2d paper): Geol. Soc. America Bull., vol. 50, No. 10, pp. 1511–1528, Washington, D. C., 1939.

This paper is in continuation of a previous publication (see Geophys. Abstracts 93, No. 4314). The writers distinguish: (1) Shallow shocks, at depths not exceeding about 50 km.; (2) intermediate shocks, at depths from about 50 to 300 km.; (3) deep shocks. Separate maps are drawn for intermediate and for deep shocks, and new or revised determinations are presented and discussed. Previous conclusions as to mechanism and origin remain unmodified.—*Authors' abstract.*

5194. Hagiwara, Takahiro, and Omote, Syunitiro, Land creep at Mount Tyausu-yama (Determination of slip plane by seismic prospecting): Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 17, No. 1, pp. 118–137, 1939.

As creeping, superficial soil has many cracks and is otherwise greatly disturbed, the propagating velocity of a seismic wave traveling through it is naturally expected to be small compared with that of a wave traveling through the underlying rock, even if the creeping soil and the underlying rock were originally of the same kind. With this difference considered, the refraction method of seismic prospecting was thought to be most suitable for determining the depth of the slip plane. The seismograph used was a vertical-component instrument designed by Hagiwara, a description of which is given. The results of the seismic survey along five lines traversing the creep zone are shown in a series of time-distance curves for these lines, as are the seismograms and a geologic map of Mount Tyausu-yama.—*W. A.*

5195. Iida, Kumizi, Determining Young's modulus and the solid-viscosity coefficients of rocks by the vibration method: Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 17, No. 1, pp. 79–91, 1939.

A certain dynamic method and an apparatus for determining Young's modulus of rocks are described in detail. Experiments were made with several metal cylinders (brass, aluminum, steel) and with several kinds of rocks (marble, granite, sandstone, pumice). Specimens of various lengths were used. The Young's modulus and the solid-viscosity coefficients of marble and granite were of the order of 10^{11} and 10^{6} in C. G. S. units, respectively; whereas for sandstone and pumice these values were of the order of 10^{9} and 10^{6}, C. G. S. units, respectively.—*W. A.*

5196. Iida, Kumizi, Forced shearing vibrations of a structure, part 1: Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 17, No. 1, pp. 49–57, 1939.

The forced shearing vibration of a structure was mathematically investigated. The relations between the damping factor, height, and modulus of rigidity of a structure and the stress at its foot were obtained. It was ascertained that the damping term, the modulus of rigidity, and the height of the structure under the short period of the forced vibration were great in proportion as the stress at the foot was small. The dynamical treatment shows that if suitable deformation were allowed much of the stress could be avoided. To minimize earthquake damage, the important points to be considered are the relations between the period of vibration of the earthquake, and the height, elasticity, and pliability of the structure. Continuation of the investigation with the aid of models is planned.—*W. A.*

5197. Iida, Kumizi, Elastic and viscous properties of a certain kind of rock: Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 17, No. 1, pp. 59–79, 1939.

The writer describes the experimental results in connection with certain physical properties of pumice, such as elasticity and viscosity, as exhibited by static and dynamic measurements. He investigated the relations between their properties and the water content and found that the wave velocities propagated in the specimen and the solid-viscosity coefficients diminish with the increase of water content. Young's modulus and the modulus of rigidity obtained by static measurement diminish somewhat rapidly with the increase in water content. Young's modulus, obtained dynamically, increased with the increase in water content, and the modulus of rigidity remained almost unchanged

despite the variation in water content. The results show the characteristics of sponge-like materials such as pumice.—*W. A.*

5198. Ishimoto, Mishio, Observations sur les secousses d'une petite amplitude [Observations on shocks of small amplitudes]: Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 15, No. 3, pp. 697–705, 1937.

The slight variations of 0.3-sec. period observed at Tokyo during the daytime were of artificial origin, such as the movements of vehicles. The length of period depends on the nature of the surface soil. The writer observed no increase in amplitude before an earthquake. He describes a specially sensitive seismograph that has a pendulum period of oscillations 0.25 to 1.25 sec., constructed according to the Wood-Anderson type and suitable for observing vibrations.—*W. A.*

5199. Jeffreys, Harold, Times of *P*, *S*, and *SKS*, and the velocities of *P* and *S*: Royal Astron. Soc. Monthly Notices, Geophys. Suppl., vol. 4, No. 7, pp. 498–533, London, 1939.

A former study of Japanese deep-focus earthquakes provided a set of corrections to the tables of *Sd*, *Sr*, and *SKS*, whose uncertainties were checked or estimated by the comparison of different earthquakes, and some data concerning the loop of the *P* curve. The distribution of weight with regard to distance was, however, very uneven for *Sr*, and the data for *SKS* extend only to 100° with any appreciable weight, on account of the positions of the bulk of the stations. It was therefore necessary to include the information provided by the normal and southern earthquakes already used. The method of treatment in the construction of the new tables is fully explained. The main tables give the first arrivals of *P* and *S*. Where the first arrival for one tabulated depth is *Pd* and that for the next deeper one is *Pr*, interpolation between them will sometimes give errors of a second. This can be avoided by using the following supplementary table, which gives *Pd* where later than *Pr*, *Pr* where later than *Pd*, and the upper branch. Possible sources of error are discussed.—*R. S. R., Sci. Abstracts, vol. 42, No. 499, 1939.*

5200. Jeffreys, Harold, The times of *PcP* and *ScS*: Royal Astron. Soc. Monthly Notices, Geophys. Suppl., vol. 4, No. 7, pp. 537–547, London, 1939.

The observed times of *PcP* and *ScS*, given by Gutenberg and Richter, lead to an estimate of $0.5480\ R \pm 0.0004\ R$ for the radius of the core, or 3473 ± 2.5 km. The estimate is consistent with the observations made by Scrase and Stechschulte and has a slightly smaller uncertainty. It has been used to calculate times of *PcP*, *ScS*, *PcS*, and the various allowances for focal depth.—*Author's abstract.*

5201. Jeffreys, Harold, The times of the core waves: Royal Astron. Soc. Monthly Notices, Geophys. Suppl., vol. 4, No. 7, pp. 548–561, London, 1939.

The times of *PcP* and *ScS* are compared with *PKP* and *SKS* to give times in the core, which agree satisfactorily over a range of 29°. It is found, by an extension of Airy's theory of diffraction near a caustic, that appreciable amplitudes for a diffracted *PKP* could not exist more than about 3° from the cusp at 142° for periods of 1 sec., or 14° for periods of 10 sec. The opinion of Lehmann, Gutenberg, and Richter that *PKP* between 110° and 142° is refracted at an inner core is therefore substantiated. Some progress is made with the formation of the *PKP* table on this hypothesis.—*Author's abstract.*

5202. Kislow, A., Measurements of mean seismic velocities in Torton, in the Carpathian foreland [in Polish]: Kosmos, vol. 64, No. 1, pp. 61–73, Lwow, 1939.

Investigations were based on material collected by the geologic branch of the "Pionier Co." from 1934 to 1937. The purpose of the measurements was to determine variations in the velocities of seismic waves with depth, as well as to determine the dependence of these values on the angle of reflection of the seismic waves.

The writer describes a method for determining directly the mean-velocity measurements by lowering the seismograph into a borehole to a certain depth and producing the detonation on the surface of the ground. The results of such direct measurements and the theoretical problems connected with the investigations are described and are illustrated in tables and diagrams.—*W. A.*

5203. Leet, L. D., Ground vibrations near dynamite blasts: Seismol. Soc. America, Bull., vol. 29, No. 3, pp. 487–496, Berkeley, Calif., 1939.

Vibrations produced by explosions that were used to shatter and remove rock have been previously recorded instrumentally at different distances, and measurements of their speeds of travel have formed the basis of studies of local earthquakes. These studies of maximum ground amplitudes near large blasts have been reported in connection with a program for investigating characteristics of ground vibrations produced by quarry blasts, with special reference to their effects on structures. (See U. S. Bureau of Mines: Tech. Papers 518, 556; Reports of Investigations 3319, 3353, 3431.)

The present report describes the nature of the wave motions involved. A description of the three-component seismograph used has been included. A new type of surface wave has been observed, as well as migration of the center of energy through a group of Rayleigh waves. The discussion on the elastic waves produced by blasting is summarized as follows: "In general, then, the concentrated energy at the source is actually divided among the principal wave types, which are there added together. Within very short distances, however, these wave types begin to separate because of their different velocities. There are thus two factors working to reduce the maximum shaking to which the ground is subjected. One is the natural decay of each wave with distance, as internal friction exhausts its original energy. The other, which is usually the dominating effect at short distances, is the stringing out of the wave types, each carrying its portion of the initial energy, until there is no longer any concentration where two or more types join forces to produce additive amplitudes." Diagrams show the records of a series of quarry blasts.—*W. A.*

5204. Lynch, W. A., A note on the recording of the long-period traffic disturbances at Fordham: Seismol. Soc. American Bull., vol. 29, No. 3, pp. 505–508, Berkeley, Calif., 1939.

Traffic disturbances recorded on the Benioff seismograph at Fordham have been discussed in a previous paper (see Geophys. Abstracts 95, No. 4641). An explanation is now offered of the mechanism by which the long-period disturbance is recorded. The long-period galvanometer is affected directly and records as a long-period seismometer of the torsion type; at the same time, the galvanometer is energized

by the transducer of the Benioff, and the resultant displacement of the light spot on the drum is a combination of the two effects. The results of the investigations are represented by seismograms.—*W. A.*

5205. Marr, J. D., Seismic-reflection method comes of age: Mines Mag., vol. 29, No. 6, pp. 288–289, 346, 348, Denver, Colo., 1939.

After briefly classifying geophysical-exploration methods, the writer analyzes the seismic-reflection method through its periods of development: Infancy, adolescence, and maturity. The period of infancy he considers to cover the years from its conception in 1927 until about 1934–35; the period of adolescence, from 1934–35 to 1938–39. Recent results, evident improvements in instruments, and conditions and conceptions relating to the seismic-reflection method, make it appear that the method is passing from adolescence into maturity. The maturing of the reflection method, the writer believes, will make it possible to do accurate reconnaissance subsurface mapping rapidly and economically.—*W. A.*

5206. Peters, J. H., Low-magnification attachment for Milne-Shaw seismograph: Seismol. Soc. America Bull., vol. 29, No. 2, pp. 341–343, Berkeley, Calif., 1939.

As the Milne-Shaw horizontal-component seismograph at this station (Honolulu) is easily thrown out of action by a shock of moderate intensity, the attachment was devised to come into operation on the occurrence of such a shock. Its essential points are that the recording mirrors are fixed directly to the boom of the seismograph and auxiliary recorders provided. The drum is driven by a storage battery, so as not to be affected by a possible breakdown in the public supply [of electricity]. The arrangement is figured.—*C. A. S., Sci. Abstracts, vol. 42, No. 499, 1939.*

5207. Pratley, H. H., Reflection-seismograph work in California: Mines Mag., vol. 29, No. 6, pp. 281–282, 339, 341–342, Denver, Colo., 1939.

This paper calls attention to the increase of reflection-seismograph work in California from an average of 4 crews in 1932 to 31 crews in 1938, owing to many important discoveries, especially in the San Joaquin Valley. The following factors, which are particularly applicable in seismograph surveys in California, are discussed: (1) Shot-point spacing and depth of control, (2) percentage of subsurface control used in mapping, and (3) velocities used in computations. Two diagrams show (1) a synthetical contour map, in which a horizontal velocity gradient of 120 feet per mile is applied to a uniform velocity function; and (2) a synthetic hypothetical example, in which a horizontal velocity gradient of 50 feet per mile is applied to a uniform velocity function.

The author is interested to study the possibilities that these two examples provoke, together with the application of a horizontal velocity gradient to the many square miles of low-dip areas in parts of the San Joaquin Valley.—*W. A.*

5208. Saita, Tokitaro, Experiments in the vibration and destruction of a wooden dwelling house [in Japanese]: Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 17, No. 1, pp. 152–167, 1939.

The author describes briefly experiments made in connection with the vibration and destruction of a wooden dwelling house. From

observations of small vibrations due to slight earthquake shocks, the author points out that the vibration periods of wooden houses are proportional to their amplitudes. From this experiment with artificial violent shakings, he concludes that the vibration period of a wooden dwelling house is nearly proportional to its amplitude.—*Author's English abstract.*

5209. Sezawa, Katsutada, and Kanai, Kiyoshi, Damping of periodic visco-elastic waves with increase of focal distance, part 2: Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 17, No. 1, pp. 9–26, 1939.

Continuing previous work (see Geophys. Abstracts 96, No. 4818), the writers demonstrate several cases of attenuation of visco-elastic waves with increase in focal distance; namely, two-dimensional transmission of Rayleigh and Love waves, transmission of similar waves on a spherical surface, and transmission of Love waves through a heterogeneous body. For Rayleigh waves in a visco-elastic body, the coefficient of damping of the waves is intermediate between those of distortional and dilational waves in the same body. The same condition applies to the damping coefficient of Rayleigh waves with time increase. The coefficients of damping for Love waves under the conditions investigated do not differ much from those for transverse waves. The writers point out that the attenuation coefficient of Love waves in a heterogeneous solid is larger than that of distortional waves transmitted on the surface of the same solid.—*W. A.*

5210. Sezawa, Katsutada, and Kanai, Kiyoshi, The range of possible existence of Stoneley waves and some related problems: Tokyo Imp. Univ., Earthquake Research Inst., Bull., vol. 17, No. 1, pp. 1–8, 1939.

Stoneley found that Rayleigh-type waves may be transmitted along the surface of separation of two solids. The writers discuss mathematically the conditions under which such waves can exist.—*W. A.*

5211. Shepard, E. R., The seismic method of exploration applied to construction projects: Military Engineer, vol. 31, No. 179, pp. 370–377, Washington, D. C., 1939.

The field of usefulness of the seismograph as applied to shallow-exploration problems is outlined, and some of the chief factors involved in such problems are discussed. After briefly reviewing the theory of seismic exploration (apparatus, determination of velocity in rock and slope of interface, relation of shooting distance to depth of exploration), the author examines the characteristics of velocity in different materials and tabulates the speed of propagation of seismic waves in different subsurface materials.

A few typical graphs prepared from actual operations in the field illustrate the application of the seismograph to a variety of formations and show the manner in which irregularities and anomalies are treated in analyzing the field data.—*W. A.*

5212. Stoneley, R., On the *L* phase of seismograms: Royal Astron. Soc. Monthly Notices, Geophys. Suppl., vol. 4, No. 7, pp. 562–568, London, 1939.

An analysis of the times of transit of the *L* phase given in the International Seismological Summary for 15 well-observed earthquakes gives a frequency distribution which is strongly double-humped. The maxima correspond to travel rates m of about 0.420 and 0.467 minutes per degree, and these refer to the onsets of the Love-wave and Rayleigh-

wave phases, which are here denoted by *LQ* and *LR*, respectively. Significant differences in the relative frequency of *LQ* and *LR* in different shocks are shown to occur for earthquakes in the same epicentral region, and these seem to indicate differences in the type of dislocation at the focus.

The apparent values of m are grouped at 10° intervals of epicentral distance Δ, and solutions by least squares made for m as a linear function of Δ. The *LQ* solution is $M=0.4180\pm0.0015+(\Delta-55°)(0.0403\pm0.0305)$, where $\pm$ indicates standard deviations. The solution for *LR* is $m=0.4686\pm0.0020+(\Delta-55°)(0.030\pm0.041)$. In both cases the $(\Delta-55°)$ term is not significant so that m may be regarded as constant. The weighted mean values are then $LQ=0.4195\pm0.0012$, corresponding to 4.426 ± 0.013 km./sec.; $LQ=0.4674\pm0.0011$, equivalent to 3.972 ± 0.009 km./sec. The ratio of these velocities is 0.90, in fairly good accordance with the predicted ratio 0.92.—*Author's abstract.*

5213. Swartzlow, C. R., A new seismograph station at Mineral, Calif.: Seismol. Soc. America Bull., vol. 29, No. 3, pp. 485–486, Berkeley, Calif., 1939.

The installation of a new Wood-Anderson seismograph at the park headquarters of Lassen Volcanic National Park at Mineral, Calif., is reported. Data pertaining to the station are given.—*W. A.*

5214. Treskov, A. A., A graphical method of treatment of seismograms of plutonic earthquakes: Acad. sci. U. R. S. S. Comptes rendus (doklady), vol. 23, No. 2, pp. 149–151, Moscow, 1939.

Tables of Gutenberg and Richter (see Geophys. Abstracts 88, No. 3573) contain traveltimes of all seismic waves as functions of the epicentral distance Δ and the depth of focus h, but the usual method of determining h and Δ is based not on the assemblage of phases stated but only on differences *pP–P*, *sS–S*, and *sP–P*, the complete utilization of the tables thus being limited. This raises the problem of devising a method of determining the depth of focus and the epicentral distance that should utilize all the phases and be directly demonstrative and thus facilitate the rational application of Gutenberg's tables and secure greater reliability and correctness of interpretation of phases recorded in seismograms. The author believes that this can be done by his graphical method. The principles of the method are as follows: A curve, based on Gutenberg and Richter's tables, is drawn in coordinates of h and Δ, which are based upon the difference *f–P* of the times of arrival of the waves of the given phase and of longitudinal waves. The coordinates of the points of the curve determine the total combinations of values of h and Δ, corresponding to the given difference *f–P*, in conformity with the tables of Gutenberg and Richter. If curves are constructed for all phases stated, then, with perfectly accurate definition of the times of phases and of ideal precision of tables of Gutenberg and Richter, all the curves drawn must intersect at a common point, of which the coordinates will yield the exact values of the epicentral distance Δ and of the depth of focus h. In practice, of course, the curves do not all intersect at one point; they intersect within a limited area and thus permit the determination of the depth of focus by the proposed graphical method with an accuracy of 10 to 20 km. The possible error of epicentral distance is of the order of 1°. A diagram illustrates an example of the graphical method.—*W. A.*

5215. Walter, E. J., The Arkansas earthquake of September 17, 1938: Seismol. Soc. America Bull., vol. 29, No. 3, pp. 497–503, Berkeley, Calif., 1939.

An isoseismal map was drawn on the basis of information obtained from a questionnaire that was sent out to determine the boundary of the area in which the Arkansas earthquake was felt and the points of highest intensity. The location of the epicenter, macroseismic data concerning the earthquake, and the geology of the region are described.—*W. A.*

5216. Waters, K. H., and Wen-Po, Weng, an investigation of the seismic-electric effect: Beitr. angew. Geophysik, vol. 7, No. 4, pp. 337–346, Leipzig, 1939.

Experiments have been carried out to determine whether (a) the seismic-electric effect is due to a real change of resistivity with compression, (b) the possible use of using the method described in preference to any other method of recording the arrival of a seismic wave, (c) the best electrode system to be used for further investigations of a quantitative nature.

It has been found that the seismic-electric effect is real and is, in fact, a true change of resistivity of the bulk of the ground as the compression wave passes through it. It seems very unlikely that a distortional wave will have any appreciable effect on the resistivity. It seems unlikely also that the seismic-electric effect will supersede at present the accepted methods of recording the ground motion as it has the disadvantages, (1) that the method is relatively insensitive, (2) that the potential variation is much more complicated than the corresponding changes of resistivity, and (3) that it is too much affected by weather conditions to be of much service in those countries which are susceptible to wet and thundery weather. The electrode system, however, worked quite satisfactorily and should prove quite suitable for use if further quantitative experiments are to be conducted on this subject.—*Authors' abstract.*

5217. Wen-Po, Weng, Sensitivity of the geophone: Nature, vol. 143, No. 3631, p. 941, London, 1939.

The geophone suggested by the author consists of a coil and a magnetized nickel rod with a weight. In combination with a four-stage resistance-coupled amplifier and an improved Shire oscillograph, the sensitivity of the instrument is of the same order as that of Jone's seismometer. The accompanying plate compares the record of these two types of seismometers.—*W. A.*

5218. White, M. P., and Byrne, R., Model studies of vibrations of structures during earthquakes: Seismol. Soc. America Bull., vol. 29, No. 2, pp. 327–332, Berkeley, Calif., 1939.

The theory is outlined of a model to study linear oscillators having 1° of freedom, with or without viscous damping, using only ground accelerations. For the same amplitude the model could, on this scheme, have smaller dimensions and smaller movements of the shaking table.—*W. A. R., Sci. Abstracts, vol. 42, No. 500, 1939.*

4. ELECTRICAL METHODS

5219. Bartley, M. W., Hematite deposits, Steeprock Lake: Canadian Min. Met. Bull., Trans., vol. 42, No. 327, pp. 359–370, Montreal, 1939.

The present paper is an attempt to give information on the structure and mode of occurrence of hematite deposits. An extensive mag-

netometric and electrical-conductivity survey of the middle arm of the lake from Elbow Point north to, and including the northern part of, the arm was conducted during December and January. From careful measurements and interpretations the southerly extent of the body would probably be 2,700 feet south of the north shore of the middle arm, a point 600 feet east of drill hole 13. Electrical measurements were made at intervals of 300 feet for 1,900 feet northward from this point and then 2,000 feet west to the west shore of the arm. Indications of dense hematite were found at each set-up over a distance of 3,500 feet, and then they stopped abruptly at a fault. The writer suggests the probability of similar material between the 300-foot intervals. A map shows the zone of concentration as indicated by a geophysical survey and by diamond drilling.—*W. A.*

5220. Bruckshaw, J. M., A new geophysical instrument: Mining Mag., vol. 60, No. 5, pp. 265–271, London, 1939.

In a previous paper (see Geophys. Abstracts 61, No. 1915) a description was given of the inductive method of geophysical prospecting, together with details of an improved equipment designed for use with such a method. At that time, the apparatus was not tested under field conditions. Small-scale experiments simulating such conditions were made only in the laboratory.

The present article deals with the field test made with this apparatus. The author describes (1) the apparatus, (2) the area surveyed, (3) the experimental results, and (4) the interpretation of the results. The area had been surveyed previously by other electrical methods, such as the equipotential-line method, the ratiometer method, and the spontaneous-polarization method; and a conductor had been located with all these methods. The location of the same conductor by the new improved instrument offered a satisfactory test of the capabilities of this instrument.—*W. A.*

5221. Electrical well logging, Houston Geological Society study group: Am. Assoc. Petroleum Geologists Bull., vol. 23, No. 9, pp. 1287–1313, Tulsa, Okla., 1939.

This report is a summary of the work done over a period of several months by the Houston Geological Society study group, which was interested in electrical well logging. Members of the group contributed different parts of the paper. The report is devoted particularly to the study of certain applications and interpretations of electrical curves showing peculiar characteristics due to abnormal conditions. It is divided into the following six main parts: (1) Self-potential diagram of electrical log; (2) Resistivity diagram of electrical log; (3) Application and correlation; (4) Interpretation of formation content; (5) Effect of salt beds on measurements; and (6) Future of electrical logging.—*W. A.*

5222. Fritsch, Volker, Beiträge zur Funkgeologie, VII. Einiges über die Ausbreitung elektromagnetischer Wellen in Bargwerkschächten und Stollen [Contributions to radiogeology, part 7. On the propagation of electromagnetic waves in mining shafts and galleries]: Beitr. angew. Geophysik, vol. 7, No. 4, pp. 449–461, Leipzig, 1939.

The author describes tests by which the propagation of medium and long waves in deep mining shafts and galleries may be investigated.

On the basis of results obtained from these tests, he examines the conditions of propagation in general and discusses briefly their scientific and practical importance.—*Author's abstract, translated by W. A.*

5223. Fritsch, Volker, Einiges über die Beziehungen der Funkgeoligie zur Blitzforschung [Relation of geological conditions of radio transmission to lightning researches]: Gerlands Beitr. Geophysik, vol. 54, No. 3, pp. 245–328, Leipzig, 1939.

It is shown that certain radio effects depend upon geological conditions and that this throws light on areas likely to be struck by lightning flashes. Information useful in this direction can be better obtained by the use of high-frequency currents in geophysical research than by the customary low-frequency methods.—*W. A. R., Sci. Abstracts, vol. 42, No. 500, 1939.*

5224. Petrowsky, A. A., and Akimov, A. T., Instruction for applying the direct-current electrical method of prospecting in regions of permanently frozen ground. Symposium of instructions and directions on the study of permanently frozen grounds and of eternal frost [in Russian]: Acad. sci. U. S. S. R., pp. 85–102, Moscow, 1938.

The authors describe the general principles of the direct-current electrical method and its varieties: (1) Electrical profiling, (2) electrical sounding, (3) measurement of the gradient, and (4) electrical logging. Diagrams illustrate the application of various methods in the field. The authors explain the construction of theoretical curves (master curves or pallets) that serve for working out and interpreting results; they discuss the difficulties of interpretation, errors, and means of correcting them; and they outline the equipment of a party assigned to an electrical survey in a region of permanently frozen ground.—*W. A.*

5225. Rosenzweig, I. E., New theory of apparent resistivity of horizontally stratified soils: Am. Inst. Min. Met. Eng., Tech. Pub., No. 1102, 23 pp., 17 figs., New York, 1939.

The problem considered in this paper is as follows: An arbitrary horizontally stratified area is given. The electrical properties of this area are characterized by a function $\rho\ (z)$, which shows the relation between resistivity ρ of the soil and the depth z. Generally, the apparent resistivity ρ will be computed by earth-resistivity measurements made by any given configuration of electrodes. General solutions of this problem are important for interpretation of field results of resistivity measurements concerning structural investigations. Solutions have been given by many authors for a finite number of homogeneous layers as well as for continuously ranging resistivities.

The practical importance of the new method of solution suggested in this paper lies in its convenience for approximative numerical calculations, especially when the $\rho\ (z)$ curve is not expressed by a formula but is given only in the form of a table or diagram. The formulas in this paper make possible the determination of the apparent resistivity for every kind of variation ρ with depth z increasing especially for variations characterized by continuous $\rho\ (z)$ functions. These formulas are derived with the aid of a new method of determining electrical potentials called "the iteration of lens-sources" and by application of the theory of linear integral equations of Volterra. Two

examples of numerical calculations of apparent resistivity curves by means of the new method are given.—*W. A.*

5226. Semenov, A. S., and Malchevski, V. S., Application of electrical logging in the search for sulphide ores within the area of boreholes [in Russian]: Razvedka Nedr, vol. 9, No. 6, pp. 35–43, Moscow, 1939.

The relation between the elements of an ore body and the effect produced by this ore body in boreholes is studied. The following three most characteristic examples depending on the shape of the ore bodies lying within the area of the boreholes are examined: (1) An isometric body (that is, one whose form is close to a sphere), (2) a layer (vein, lens) extending parallel to the axis of the borehole, and (3) a layer (vein, lens) extending perpendicular to the axis of the borehole.

Conclusions: (1) A sulphide ore deposit having a rather sperical form can be disclosed by electrical logging if its distance from the borehole is not greater than about one-half of its radius, (2) an ore body extending parallel to the axis of the borehole may be disclosed by the method of lateral logging if the size of the deposit along the borehole is greater than 10 times the distance of the deposit from the borehole, and (3) an ore body having a small size in the direction parallel to the axis of the borehole but extending greatly in any other direction may be disclosed by means of electrical-logging diagrams.—*W. A.*

5. RADIOACTIVE METHODS

5227. Landsberg, Helmut, and Klepper, M. R., Radioactivity tests of rock samples for the correlation of sedimentary horizons: Am. Inst. Min. Met. Eng., Tech. Pub., No. 1103, 9 pp., 4 figs., New York, 1939.

As this work was undertaken in a field where previous data were few, some changes in procedure were suggested during the course of the tests. Testing for radioactivity of rock samples by means of the Geiger-Müller counter affords an additional tool for stratigraphic work. It seems that core samples should be used for such tests in preference to outcrop material, in order to avoid the possibility of weathering. Furthermore, if samples are tested to about 1,000 impulses, inaccuracies in activity data should be reduced to less than 1 percent. Rock samples taken from two vertical profiles were used. In the vertical sequence three active and two barren horizons were indicated. The same trend of activity was evident from both profiles. The heavy mineral separation showed that zircon and associated minerals characterized the active horizons.—*W. A.*

6. GEOTHERMAL METHODS

5228. Arctowski, Henryk, Geothermic researches made at Boryslaw: Geog. Jour., vol. 66, No. 5, pp. 422–427, London, 1925.

Results of 824 measurements of temperature in 33 wells at Boryslaw, Tustanowice, and Mraznica are described. The distribution of these wells is shown in diagram 1. Although all the wells lie within a radius of 2,800 meters, the temperature at a given depth differs greatly; for example, the highest measured temperature at 1,000 meters was 34.9°, whereas the lowest was 27.35°. Temperatures measured at different depths in well 33 are shown in diagram 2. Principal causes

of the observed variations of gradient are discussed. Diagrams 3, 4, and 5 represent, respectively: (1) Isotherms at sea level, (2) mean gradients for 100 m. between depths of 500 and 700 m., and (3) mean gradients between 900 and 1,100 m. The data obtained are considered sufficient to establish the close connection that exists between the geology of the region and its thermic relations.

In concluding, the author draws attention to the fact that the geothermal gradient for different parts of the same well may vary between 71.5 m. and 23.5 m. and that for the same differences of level in various wells very different geothermic gradients were observed; for example, between 1,000 and 1,100 m. an increase of 1° for 23.5 m. was observed in well 32, whereas at the same depth in well 31 the figure was 39.2 m.—*W. A.*

5229. Bullard, E. C., Temperatures within the earth: Royal Astron. Soc. Monthly Notices, Geophys. Suppl., vol. 4, No. 7, pp. 534–536, London, 1939.

The assumptions made and the expressions obtained for the temperature below the radioactive layer by Jeffreys are quoted. The author obtains an expression for the temperature in a form in which its properties are more easily seen and results are tabulated. For radioactivity to produce a substantial increase in temperature it is necessary for the centroid of the distribution to be at least 10 km. down. Values tabulated show that radioactivity has little effect on the temperatures below 200 km. It is considered that determinations of the thermal conductivity of olivine and similar rocks should be made at high temperatures, since this quality is the most uncertain factor in the temperature in the absence or presence of radioactivity.—*R. S. R., Sci. Abstracts, vol. 42, No. 499, 1939.*

5230. French, R. W., Temperature in oil wells [abstract]: Symposium on temperature, November 2–4, 1939, under auspices of the Am. Inst. Physics, p. 25, New York, 1939.

Temperature observations in oil wells are usually incidental to routine subsurface-pressure surveys and are studied analytically in but few instances. Attention of the producing division of the petroleum industry has been directed toward the importance of subsurface temperatures by the physical problems arising in the drilling and operation of deeper oil wells. Analysis of field difficulties shows that increasing temperatures have reached values having critical effects on: The chemical treatment and performance of drilling fluid; the setting action of cement; and the use of various materials essential to successful operation of many tools and instruments. Growing use of the thermodynamic approach toward fluid-content and phase-behavior studies of reservoirs requires a definite knowledge of temperatures. The wide range and variance of geothermal gradients call for more extensive study and offer an increasingly useful source of supplementary information in the fields of geological correlation and geographical evolution.

5231. Mounce, W. D., Problems of temperature measurement concerning petroleum production [abstract]: Symposium on temperature, November 2–4, 1939, under auspices of the Am. Inst. Physics, p. 25, New York, 1939.

This paper outlines the several stages in the procedure of drilling and completing a producing oil well and describes the utility and

technique of making continuous temperature measurements of the fluid in the well at various stages of the development. Typical examples and data are given in which these measurements have been useful in locating the position of earth strata and cement behind casing and in determining the points at which liquids or gas enter the well. This information enables the producer to complete the well more efficiently than would be possible otherwise. An electrical thermometer whose measuring element is a low-resistance nickel wire exposed to the well fluid is described. The element and associated apparatus are connected through a single-conductor cable to the recorder at the surface. The sensitivity is variable from 4° to 36° F. per inch. When used in water, the instrument reaches thermal equilibrium in 0.2 sec. Changes in temperature of 0.05° F. may be observed, but a slow drift limits its measurement of actual temperature to about 0.5° F.

5232. Shishov, V. M., An example of applying thermal logging in regions of variable *SP* [in Russian]: Neftianoe Khoziaistvo, vol. 20, No. 6, pp. 19–22, Moscow, 1939.

Heat generated by the cement used in cementing boreholes is more quickly absorbed by permeable rocks than by solid ones. Thus, temperatures will be lower within the cement ring opposite permeable rocks and will be higher opposite solid rocks. This fact may be utilized for drawing temperature curves from which some characteristics of the layers penetrated by drilling may be established. An example of thermal logging in boreholes of the Makat oil fields is described.—*W. A.*

5233. Terry, M. C., Geothermal prospecting for oil [abstract]: Symposium on temperature, November 2–4, 1939, under auspices of the Am. Inst. Physics, pp. 25–26, New York, 1939.

There is considerable evidence that deep-seated geological structure is indicated by subsurface isogeotherms, because intrusion of high-conductivity material would disturb the normal gradient. Hence, if it is not necessary to make measurements at too great a depth, ground-temperature surveying is a possible means of prospecting for oil. Temperature measurements were made by copper resistance-thermometer coils wound on Bakelite tubes, through which the three-conductor, rubber-covered cable that served for suspension and electrical connection to the surface was threaded. The coils and cable connections were protected by rubber tubing vulcanized to the cable cover. Two coils were placed on each cable at depths of 100 and 200 feet. From the temperatures measured, the gradient and depth of a particular isogeothermal surface were computed. Temperature equilibrium required from 2 to 4 weeks. Profiles were run on the King ranch in south Texas and across Hastings and Friendswood, two adjacent producing fields near Houston. Little is known about the structure where the survey was run on the ranch, but no anomaly is suspected. The profile showed a dip in agreement with that characteristic for the region. Friendswood and Hastings are thought to be over deep-seated salt domes. Temperature data is still incomplete, but a 23° C. isothermal is about 100 feet higher on the fields than between them and drops more than 300 feet in 2 miles on the edge of Friendswood away from Hastings.

5234. Van Orstrand, C. E., Temperature of the earth in relation to oil location [abstract]: Symposium on temperature, November 2–4, 1939, under auspices of the Am. Inst. Physics, p. 26, New York, 1939.

A brief review is given of the mercury maximum-thermometer methods and the electrical methods of measuring deep-earth temperatures, particularly in the oil fields. It is highly desirable that standard units of measurements be adopted for expressing the gradient and the reciprocal gradient; and, furthermore, a standard method of graphical representation of the data of observation is needed. The paper contains a table of representative gradients throughout the world. The variation of the gradients with reference to thermal conductivities of the rocks and of the regional and structural geology of certain areas is discussed. Calculations based on rigorous mathematical theory provide a means of testing the hypotheses of radioactive heat and the generation of heat in oil beds.

5235. Vladimirov, O., Kraskovsky, S., and Semenov, A. S., Geothermal measurements in Monche-Tundra: Acad. sci. U. R. S. S. Comptes rendus, vol. 23, No. 4, pp. 355–358, Moscow, 1939.

Geothermal investigations in the region of Monche-Tundra (Kola Peninsula) were organized for the purpose of obtaining material from which distribution of temperature in holes drilled in crystalline rocks could be established. Temperature measurements were made with an electric-resistance thermometer and a maximum-mercury thermometer. A temperature curve for a hole typical of the region of Monche-Tundra is given. This borehole passes through 4 m. of morainic deposits, pyroxenite, peridotite, and dioritic gneiss. The average values of reciprocal gradients for the five deepest boreholes in this region are shown in a table. The values are very large (about 150 m. per degree Celsius) and exceed the normal values three or four times. This is attributed mainly to the high thermal conductivity of dense crystalline rocks of this region. Another purpose of these geothermal investigations was to check the possibility of applying thermometers for determining the location of sulphide veins. A hole has been selected with very favorable conditions for establishing the degree of influence of the sulphide veins on the distribution of temperature with depth. Sulphide veins failed to produce any effect.—*W. A.*

7. UNCLASSIFIED METHODS

5236. Cressey, G. B., Frozen ground in Siberia: Jour. Geology, vol. 47, No. 3, pp. 472–488, Chicago, 1939.

Permanently frozen ground underlies 3,728,000 square miles of Soviet territory, largely in eastern Siberia. Ice is not always present, but temperatures remain below 0° C. to depths down to 890 feet. In some places unfrozen layers are found between frozen ground. Most frozen ground has acquired its low temperature from the atmosphere.—*Author's abstract.*

5237. Developments and trends in geophysical petroleum prospecting [editorial]: Petroleum Engineer, vol. 10, No. 10, pp. 72–76, Dallas, Tex., 1939.

The trend in geophysical exploration for petroleum during the past year shows a definite shift in reconnaissance investigation from the

reflection seismograph and torsion balance to the use of the gravimeter and experimentation in soil and soil-gas analysis. The refraction seismograph has virtually been discontinued. Despite the signal success of the reflection seismograph (some new discoveries are mentioned) the total number of operating crews has decreased in the United States. In June 1938 about 225 seismograph crews were operating; in June 1939, about 100 crews. This curtailment of seismograph activity is due partly to a general policy of retrenchment and partly to the belief of many operators that much of the older oil-bearing territory has been covered adequately by this method. Gradual replacement of torsion balance by gravimeters is indicated. Probably not more than 15 torsion-balance crews were operating in the United States in June 1939. The use of gravimeters has definitely increased: within the last 12 months the number of gravimeter parties increased from 24 to about 60.

The increasing interest in the use of geochemical methods is one of the outstanding exploration developments. As far as information on oil-field discoveries throughout the United States is available it has been noted that of the oil fields found in 1937, 44 had estimated recoverable reserves exceeding one million barrels. During 1938, 64 fields of comparable importance were discovered.—*W. A.*

5238. Eby, J. B., Progress and trends in geochemical methods of prospecting: Petroleum Engineer, vol. 10, No. 10, pp. 78–82, Dallas, Tex., 1939.

The present status of geochemical exploratory methods is discussed briefly. A series of photographs illustrates many of the steps in conducting a geochemical investigation (collecting samples and analysing them in the laboratory). On completion of the analyses, the data concerning both wax and ethane content are placed on a map, on which the respective collection stations are also indicated. An example of such a map is given.—*W. A.*

5239. Gabriel, V. G., Probable discovery rates in the Gulf coast area: Oil Weekly, vol. 95, No. 1, pp. 46–53, Houston, Tex., 1939.

Detailed "geophysical tables" show the results achieved by seismic and torsion-balance exploration in the Gulf coast area prior to the middle of 1938. The first six columns of these tables contain information about the location of an oil field, the date of its finding, the date and means of its oil discovery, the amount of oil produced, and the ultimate oil recovery. The last column gives the amount of oil in thousands of barrels that should be credited to either seismic or torsion-balance methods.

Evaluations of the role played by geophysical and geological methods in exploration for oil are based on assumptions of oil reserves established for the Gulf coast area prior to 1938. It is established that 65 percent of the total estimated amount of oil discovered before 1938, and that 76 percent of the oil discovered from 1935 to 1937, inclusive, were the result of geophysical methods. Thus, geological exploration is credited with 35 percent from 1925 to the beginning of 1938 and with 24 percent from 1935 to 1937, inclusive.

If we accept $52,000,000 as the total sum spent on geophysical prospecting in the Gulf coast area prior to 1938, excluding electrocoring, the average cost of geophysical discovery amounts to $.023 per barrel of oil.—*W. A.*

5240. Gabriel, V. G., Geophysical prospecting: Canadian Min. Jour., vol. 60, No. 8, pp. 474–478, 525, Gardenvale, Quebec, 1939.

A historical outline of geophysical-prospecting work in Canada is given. Trends in the average prices and yearly production of some of the common metals mined in Canada for the years 1922–37 are shown graphically. The graphs may serve to evaluate the role played by geophysics in the Canadian mining industry. Data on the following are summarized in a table: (1) Method used, (2) by whom directed, (3) year, (4) locality, (5) material sought, (6) results achieved, and (7) approximate duration of the survey. These data indicate that geophysical exploration in Canada was very active from 1927 to 1929 and from 1935 to 1937, inclusive. Magnetic methods were used in exploring for iron-ore bodies, ilmenite deposits, gold-bearing placers, gold veins, and nickel-carrying sulphides; electrical methods were used in exploring for gold-bearing placers, gold veins, and various sulphides. Various structural and lithological problems were solved by both methods.—*W. A.*

5241. Geophysical surveying in northern Australia [editorial]: Chem. Eng. and Min. Rev., vol. 31, No. 369, pp. 359–364, Melbourne, 1939.

Details are given of surveys at Tennant Creek in Central Australia, and at Big Bell and Wiluna in Western Australia.

Magnetic methods were applied in the Tennant Creek gold fields for locating concealed bodies of ironstone at various depths and underlying or near operating mines. Details of the magnetic survey at the Peko mine are shown in a diagram. Fourteen major anomalies were revealed by the operations in 1937, some of which are considered to be important inasmuch as they indicate concealed ironstone bodies in close proximity to outcropping auriferous bodies.

Electrical surveys were made at the Big Bell and Wiluna gold mines. The geology and nature of the problems, as well as details and results of the surveys, are described and illustrated by diagrams.—*W. A.*

5242. Horvitz, Leo, On geochemical prospecting: Geophysics, vol. 4, No. 3, pp. 210–228, Menasha, Wis., 1939.

The first type of geochemical prospecting, that of searching for and recognizing visible oil and gas seeps, is one of the oldest methods of prospecting for petroleum deposits. A second type of geochemical prospecting, that of soil-gas analysis, has been on record in the literature for some 10 years and depends upon the microanalysis, for hydrocarbons, of "underground" or interstitial soil air. A third type of geochemical prospecting is described, that of soil analysis, which has been recently developed and depends upon the separation, identification, and quantitative determination of significant constituents which are entrained, occluded, and adsorbed by the soil particles. These significant constituents exhibit a wide range of molecular weights, from hydrogen through gaseous, liquid, and solid hydrocarbons and their derivatives. All these constituents tend to show the same significant patterns, which in general fall into two classes, the narrow elongated pattern characteristic of faulting, and the localized "halo" pattern, which tends to follow and define the edges of the under-

lying production. This "halo" pattern has been found over both structural and stratigraphic traps.—*Author's abstract.*

5243. How were the planets formed? (note from Harvard Observatory): Telescope, vol. 6, No. 5, pp. 111–112, Cambridge, Mass., 1939.

"The only theory on the origin of the solar system seriously considered in recent years is the 'encounter theory,' which postulates that several billion years ago two stars passed so close to each other that the gravitational attraction of each pulled vast streamers of gas out of the other, forming a cigar-shaped filament between the two stars. In some forms of the theory, an actual grazing collision is supposed to have taken place; that is, one of the stars sideswiped the other. In either case the gases in the filament so produced are assumed to have condensed first into liquids, then into solids, forming the earth and the planets."

This note refers to an article on the encounter theory as developed by Lyttleton and discussed by F. G. Watson in the March-April 1938 issue of the Telescope.—*W. A.*

5244. In focus [editorial note]: Telescope, vol. 6, No. 3, p. 53, Cambridge, Mass., 1939.

A large photograph of the lunar surface in the neighborhood of the crater Copernicus is given. The famous "ray" system associated with this crater is clearly shown. It consists of long lines extending approximately radially from the crater. The nature of the lunar rays is still a mystery. It is interesting to note that the rays show no marked interruption at any physical obstacle such as a mountain, another crater, an evident fault line, or even a mountain chain. The reproduction shows clearly an important but seldom mentioned formation that appears below and to the left of Copernicus. This consists of a long winding chain of more than 3 dozen craterlets. Strung along in so perfect a geometric pattern, this array of craters offers testimony for the correctness of the hypothesis of volcanic origin and against the hypothesis of meteoric origin. Such an arrangement could scarcely have come about as the result of chance impact of meteors. Yet it might well have been produced by a long fault, with a weak region of the crust forming the physical basis for the alignment.—*Editorial note, condensed by W. A.*

5245. Kannenstine, F. M., The relationship of geophysics to geology: Geophysics, vol. 4, No. 3, pp. 149–154, Menasha, Wis., 1939.

Geophysical methods of prospecting and their value in the discoveries of oil are outlined. Desirable prospects for structural exploration by geophysical methods are enumerated.

Considering the possibilities of all present methods, the author predicts that for the location and development of oil and gas structures during the next few years the geologist will depend mainly upon the reflection seismograph to at least as great an extent as in the past. The other methods, particularly gravimetric methods, will of course have their place also.—*W. A.*

5246. Ladner, A. L., and Billings, M. H., Recent trends in geophysical exploration: Mines Mag., vol. 29, No. 6, pp. 315–316, 348, 350, Denver, Colo., 1939.

Geophysical methods in recent years have maintained a rather steady rate of advance in improvements of instruments and technique. At the

present time the reflection seismograph and the gravity meter hold preeminent positions in the industry. Improvements allow exploratory work to be done cheaper, faster, and more thoroughly than ever before. Areas of difficult terrain, swamp, desert, and rough topography yield themselves to improved methods and devices, and it is probable that there is no area which cannot be worked by geophysics if sufficient money and time are available. New methods are yielding keys to problems once thought unsolvable by geophysical means, and, more hopeful than anything, the end is not yet in sight.—*Authors' summary.*

5247. McDermott, Eugene, Concentrations of hydrocarbons in the earth: Geophysics, vol. 4, No. 3, pp. 195–209, Menasha, Wis., 1939.

An hypothesis of the origin and accumulation of oil and gas fields, arrived at from the data of soil analysis, is presented. This hypothesis also offers an explanation of the quite different concentrations of subsurface waters in different geologic provinces. Furthermore, it seeks to explain the variation of type of accumulation with respect to depth below the surface and deformation of the sediments in which the accumulation occurs. Lastly, the value of the method of soil analysis as an exploration device is indicated.—*Author's abstract.*

5248. Mikhelson, I. S., Preliminary results of geophysical work of the West Siberian Geologic Department [in Russian]: Vestnik Zapadno-Sibirskago Geol. Upravleniia, No. 6, pp. 70–79, Novosibirsk, 1938.

Geophysical work in West Siberia was carried out in 1938 by 14 different parties, of which 7 used electrical methods, 3 magnetic, 1 seismic, and the remaining 3 used combined methods of prospecting. Results of field work and preliminary interpretation of data obtained by each party are briefly described. In comparison with the work done in 1937, it is stated that the number of parties increased four and five-tenths times and the budget about six times.—*W. A.*

5249. Rosaire, E. E., On the strategy and tactics of exploration for petroleum, part 3: Geophysics, vol. 4, No. 3, pp. 155–166, Menasha, Wis., 1939.

In the preceding paper of this series (see Geophys. Abstracts 93, No. 4389) it was pointed out that three of the Principles of War, those relating to Offensive, to Surprise, and to Security, were applicable to exploration for petroleum. In this discussion the author examines the similar applicability of two other Principles of War, the first relating to the Objective; the second, to Economy of Force.

In conclusion, the author estimates discovery costs. A table shows figures for (1) structural-prospecting methods (drill, reflection seismograph), and (2) stratigraphic-prospecting methods (eltran, eltran plus gravity meter). From estimates of the discovery costs to be expected from various exploration tactics, as well as from specific and general fact performance, it is concluded that stratigraphic-prospecting methods are better suited for finding and recognizing favorable structures than are structural-prospecting methods.—*W. A.*

5250. Steinmann, K. W., Use of the transient and soil-analysis methods in the search for oil: Oil and Gas Jour., vol. 38, No. 11, pp. 82–85, 88, Tulsa, Okla., 1939.

The electrical transient is a current that flows in a circuit for a short time following an electromagnetic disturbance. Principles and

field procedures of the transient and soil-analysis methods are discussed practically. The transient method measures lateral changes in the shallow sediments, which are indirect evidence of buried structures but are not a direct function of their depth or relief. Thus, the transient method relies entirely on lateral exploration and makes no attempt to predict depth. The equipment and the field procedure used in this method are described briefly.

As a transient survey involves the location of stations at which shallow holes are dug, the usual practice for a transient crew is to collect soil samples that are shipped to a laboratory for analysis of significant constituents.

Diagrams show the comparison of data derived from electrical methods and from soil-analysis methods for ethane.—*W. A.*

5251. Stormont, D. H., Progress in soil-survey methods: Oil and Gas Jour., vol. 38, No. 18, pp. 52–53, Tulsa, Okla., 1939.

The important role of oil and gas seeps in the discovery of oil fields, pointed out already (see Geophys. Abstracts 87, No. 3459), is outlined. Photographs show (1) the collecting of soil samples and placing them in an airtight container for transportation to laboratory, (2) the air-drying of soil samples in preparation for laboratory analysis, (3) the weighing of a sample on a gravimetric balance after the sample has been air-dried and ground to uniform size, (4) the separating of gases by fractionation in high-vacuum apparatus, (5) apparatus used for extraction of waxes and liquids from soil samples, (6) the plotting of results of a soil survey made to delineate the productive area of a field, and (7) a fast, mobile drill for soil sampling. A safe working depth for taking soil-survey samples is considered to be between 5 and 7 feet.—*W. A.*

5252. Trott, M. J., Geophysical prospecting in Kansas: Mines Mag., vol. 29, No. 6, pp. 311–312, Denver, Colo., 1939.

The torsion balance and seismograph are the instruments most used for geophysical prospecting in Kansas. The torsion balance is used in a general way to find a structure; the seismograph to localize it. An idea is given of the extent of oil prospecting in Kansas, where the seismograph is the only geophysical method that has brought in new oil fields.—*W. A.*

5253. Tucker, Mitchell, Soil analysis evaluated by means of test holes: Oil and Gas Jour., vol. 38, No. 5, pp. 36–37, Tulsa, Okla., 1939.

The outstanding question regarding the value of chemical-prospecting methods in exploring for petroleum is whether or not a direct relation exists between commercial accumulation of petroleum at depth and the phenomenon that is measured at the surface. The only final correct way to evaluate these methods is to drill wells. Information gathered from wells drilled after a soil-analysis survey has been made is very useful in determining (1) the proper method of laying out surveys on different-type prospects, (2) the magnitude of hydrocarbon-soil showings required under varying conditions to indicate commercial production, (3) the selectivity of the method in delineating producing limits within short distances, (4) the improvements in final interpretation of geochemical data, and (5) the application of the method as a reconnaissance and detailed exploration tool. Each of these points is discussed briefly.—*W. A.*

5254. Williams, Neil, Marsh buggy for geophysical crew: Oil and Gas Jour., vol. 38, No. 14, p. 58, Tulsa, Okla., 1939.

A "marsh buggy" for geophysical operations, developed by the McCollum Exploration Co., is described. Several features distinguish this buggy from other types. It provides ample carrying capacity for four men and complete equipment for a geophysical exploration; it weighs 7,500 lb.; and its maximum speed is 7 miles an hour.—*W. A.*

5255. Yurovsky, Y. M., Brief review of the present state of the gas survey [in Russian]: Razvedka Nedr, vol. 9, No. 3, pp. 35–40, Moscow, 1939.

Basing his investigation on the material that was gathered from gas surveys by various parties for about 6 years (1932–38), the writer considers that in view of the knowledge concerning the efficiency of a gas survey, the survey should be limited to reconnaissance problems. To increase the possibilities of applying a gas survey it is necessary (1) to develop a method of obtaining gas samples from below the horizon of ground water without the preliminary removal of the ground, (2) to construct a portable apparatus for analyzing the samples in the field, (3) to obtain greater knowledge of the composition of the heavy fraction, and (4) to supplement the present data obtained by the survey with new ones that may be characteristic in determining the type of the buried hydrocarbons.—*W. A.*

8. GEOLOGY

5256. Arnold, H. H., Jr., Salem oil field, Marion County, Ill.: Am. Assoc. Petroleum Geologists Bull., vol. 23, No. 9, pp. 1352–1373, Tulsa, Okla., 1939.

The Salem oil field, Marion County, Ill., was discovered by the Texas Co. on July 1, 1938. During the week of January 7, 1939, the field ranked seventh in the United States on the basis of daily production. Twelve months after discovery the field had produced 20,080,000 barrels of oil. All producing formations of the Salem field are Mississippian in age and include the Benoist sand, the Aux Vases sand, and the McClosky oölitic limestone. At present the Benoist sand is the principal formation being developed. A geologic study of the Illinois Basin indicates early periods of structural adjustment. Marked zones of influence are thought to have been established by these movements. In certain areas of the basin late Mississippian and early Pennsylvanian structural developments have a close relationship to these early established zones. Subsurface mapping of the Salem field on the Benoist sand and the McClosky oölitic limestone indicates close similarity in structural definition. No increase of structural relief with depth is apparent on the data supplied by present drilling. The Salem structure covers an area of approximately 14 square miles with a closure of more than 200 feet as mapped on the Benoist sand.—*Author's abstract.*

5257. Griggs, David, A theory of mountain building: Am. Jour. Sci., vol. 237, No. 9, pp. 611–650, New Haven, Conn., 1939.

A theory of mountain building by cyclic convection, thermal and not chemical in origin, is synthesized from (1) the suggestions of Holmes, (2) the mathematical analysis of Pekeris, Vening-Meinesz, and Hales, (3) the writer's experiments on solid flow of rocks, (4) thermal experiments and calculations, and (5) a dynamically similar model to demonstrate the action of cyclic-convection currents. The way in which

this theory predicts the intermittence of mountain building is discussed, and its ability to explain the diastrophic cycle.

Previous theories of orogenesis are briefly reviewed, and some of their points of inadequacy are discussed.—*Author's abstract.*

5258. Hoffman, M. G., Structural and magmatic processes in the isostatic layer: Am. Assoc. Petroleum Geologists Bull., vol. 23, No. 9, pp. 1320–1351, Tulsa, Okla., 1939.

In the continental areas the outer 60 miles of the earth is herein referred to as the isostatic layer. This is subdivided from the surface downward as follows: A 10-mile granitic and sedimentary layer, a 20-mile intermediate layer of basic crystalline rocks, and a 30-mile layer of tachylyte. The uppermost and intermediate layers are generally referred to as the crust. Below the isostatic layer the earth is cooling and shrinking. Stresses in the isostatic layer are piled up until the breaking point is reached, when these stresses are relieved by deformation of the crust. Mountain ranges are folded up and geosynclines are downwarped. Approximate isostatic balance is maintained throughout this series of events. Great masses of sediments will be deposited in the downwarps. A 2,000-foot basin will hold 12,000 feet of sediments because the deposited material is 5/6 as heavy as the material below that is replaced during periods of isostatic adjustment. The trough will be further deepened by rise of the level of base level. This is brought about by displacement of the sea water as the land masses are deposited in the ocean basins. Downfolding of the geosynclines will also occur as a result of geothermal changes. It is estimated that the rate of erosion exceeds the rate of thermal changes within the earth so that during a period of erosion the isogeotherms will be turned up. Downwarping will follow base leveling merely as the isogeotherms return to normal. This may amount to as much as 1,000 feet and may be added to the downwarping brought about by crustal collapse and deepening resulting from the rise of the level of base level. In general, about 9,000 more feet of sediments may be assigned to the basin through deepening brought on by thermal and base-level changes, making a total of 21,000 feet of beds. Collapse of the crust at this time will fold this prism of sediments into a great mountain system. The beds must be downfolded about six times as much as they are upfolded in order to maintain isostatic balance. Compressive stresses will be dominant, and the types of structures that will be formed are close folds, overturned folds, and thrust folds. Erosion of the mountain system will be accompanied by periodic vertical thrusts. These are effected as a result of isostatic adjustment. Compressive stresses will still be present, but they will be secondary and brought on as only incidental to the vertical movements. Final erosion of this mountain system will leave the isogeotherms turned up. As the isogeotherms return to normal, the resulting shrinkage will form a basin right where the high mountain range once stood. Crustal collapse will deepen the downwarp already begun and the new series of sediments will be separated from the first by a very marked angular unconformity.

Another series of events may be started during the late stages of erosion. The viscosity of the subcrustal tachylyte layer may be reduced, by removal of overlying rock pressures and slight rise of temperature, to the point where crystals of olivine may begin to form in it. Once this process of fractional crystallization commences

it will gain in momentum, and a magma will be formed. Convection currents will stir the liquid body, and it will work its way upward by selective fusion. When it reaches the zone of fracture it will be intruded and extruded. Repeated intrusions and extrusions will occur until the magma finally is solidified. Cooling of the magmatic zone will cause shrinkage and downwarping, and this area once again will become the site of a geosyncline.—*Author's abstract.*

5259. Lawson, A. C., Subsidence by thrusting; the discussion of a hypothetical fault: Geol. Soc. America Bull., vol. 50, No. 9, pp. 1381–1394, Washington, D. C., 1939.

If a low-angle thrust cuts through the sial into the dunite of the sima, the region affected is uplifted by thickening of the crust. This concentration of mass puts the crust locally out of isostatic balance. The measure of uplift may be the same throughout a section transverse to the strike, but the excess load will vary with the density of the rocks intersected on the dip. If recovery of equilibrium be slow and the uplifted surface be subjected to erosion, there will be notable hypsometric contrasts in the profile of the region when it attains isostatic balance. The surface in that part of the section where the thickening is wholly in the dunite will be much lower than in the part where the thickening is wholly in the sial. It is suggested that in this principle may be found the explanation of certain large structural valleys like that of the Great Valley of California.—*Author's abstract.*

5260. Miller, Willard, The relationship of structure to petroleum production in eastern Venezuela: Econ. Geology, vol. 34, No. 5, pp. 524–537, Lancaster, Pa., 1939.

This paper presents the relationship of oil production to structure in eastern Venezuela. The exploration and development are confined to the Maturin Basin, a geosynclinal area characterized by sediments ranging in age from Cretaceous to Recent. A thick blanket of Pleistocene and Recent deposits covers practically all of the oil formations. The present commercially producing fields are located near seepages, but the areas now being developed were located by scientific exploration. Each of the developed fields is discussed separately, giving attention to the operating problems and the technique developed in order to obtain the oil.

The geological structure of eastern Venezuela is only partially worked out at the present time because of the recency of discovery. From the reports of geophysical and geological parties (12 geological crews, 4 magnetometer, 9 gravity, and 14 seismographs), the Maturin Basin is one of the most promising oil areas in the world, and it is only a matter of time until several new fields will be producing on a commercial basis.—*Author's summary and conclusion.*

5261. Osborn, E. F., Structural petrology of the Val Verde tonalite, southern California: Geol. Soc. America Bull., vol. 50, No. 6, pp. 921–950, Washington, D. C., 1939.

Micrometric analyses of the Val Verde tonalite were made on samples taken along a line extending from the border of the intrusive to a point 5 miles out in the intrusive. An attempt was made to evaluate sampling errors and to determine variation in mineralogic composition

and radioactivity. The border of the intrusive was found to be more sodic and higher in radioactivity than the central part, and this is thought to be due to assimilation of quartz-biotite schist. Inclusions in the tonalite are believed to be xenoliths of gabbro and quartz-biotite schist.

Petrofabric analyses of the schist country rock and the tonalite indicate that (1) schist was deformed primarily by rotation of mineral grains about a horizontal axis, (2) during intrusion of the tonalite a gneissoid structure developed in it parallel to the contact with the country rock with a linear element lying in the plane of foliation and paralleling the dip, (3) later stresses directed parallel to the strike of the foliation caused rotation of mineral grains in the tonalite about an axis parallel to the dip. The orientation of the minerals in the tonalite is thus believed to be due to a combination of magmatic flow and post-magmatic deformation.—*Author's abstract.*

5262. Wilson, C. W., Jr., Probable connection of the Nashville and Ozark domes by a complementary arch: Jour. Geology, vol. 47, No. 6, pp. 583–597, Chicago, 1939.

After the final deformation of the sediments accumulated in a geosyncline, four parallel, genetically associated tectonic belts are believed to occur: (1) Deformed hinterland, (2) intensely faulted and folded anticlinorial mountainous belt, (3) folded synclinorium, and (4) a complementary arch, which consists of a succession of domelike swells connected by arches or saddles. The occurrence, relationship, origin, and distribution of complementary arches in eastern United States are discussed. Based upon several lines of evidence, a complementary arch is postulated to have connected the Nashville and Ozark domes before it sagged and was covered by sediments of the Mississippi embayment.

Much geophysical prospecting has been done in the northern part of the Mississippi embayment. Magnetometer maps by Spraragen and Jenny were used for local control in locating the suggested alternative positions of a complementary arch across the embayment.—*Author's abstract.*

9. NEW BOOKS

5263. Bierens de Haan, D. Nouvelles tables d'intégrals définies [New tables of definite integrals], 716 pp., New York, G. E. Stechert and Co., 1939.

This is a corrected edition of 1867. The construction of the tables is explained in the introduction. An English translation of the introduction is given by Prof. J. F. Ritt, of Columbia University.

5264. Conrad, V., Ergebnisse der Kosmischen Physik [Results of cosmic physics], vol. 3, 333 pp., 152 figs., Wien, Akademische Verlagsgesellschaft m. b. H., Leipzig, 1938. Price, R. M. 32.

This volume was edited by V. Conrad. Among the articles of special interest in connection with applied geophysics may be mentioned Zenneck's "Physik der hohen Atmosphäre," which deals with the results of the research on ionization, and Steinmaurer's "Die Erforschung der kosmischen Strahlung im letzten Jahrfünft," which discusses the influence of the earth's magnetic field on cosmic radiation, the theory of geomagnetic effects, and the capability of penetration of the radiation.

5265. Earthquake notes, J. H. Nelson, editor, vol. 11, No. 1/2, 22 pp., Seismol. Soc. America, Eastern section, Washington, D. C., 1939.

This issue contains the following notes: (1) Seismic observations in the Antarctic, by N. H. Heck; (2) Missouri earthquake of April 15, 1939, by Florence Robertson; (3) Washington Assembly of the International Union of Geodesy and Geophysics; (4) Nature of epicentral area of earthquake; (5) Deep earthquake felt in Solomon Islands; (6) Earthquake in Smyrna; (7) On seismic waves, by Beno Gutenberg and C. F. Richter; (8) Geological Society sponsors radio programs on geophysics; (9) Gold Coast earthquake, June 22, 1939; (10) Epicenters; (11) Earthquake insurance; (12) Earthquake record on magnetograph; (13) Proceedings of the Fordham meeting: (a) Minutes of the fourteenth annual meeting, (b) Report of the chairman, (c) Report of the secretary, (d) Report of the treasurer, (e) Report of the committee on microseisms, (f) Report of the committee on amateur seismology, (g) Report of the committee on methods and operations, (h) Resolutions, (i) Rules and regulations of the Eastern section of the Seismological Society of America.

Papers presented at the meeting: (1) History and development of the University of Pittsburgh Seismological Station, by D. C. Bradford; (2) Importance of the time signal relayed to the seismogram, by R. R. Bodle; (3) A revision of epicentral determinations of recent earthquakes in the New England area, by J. J. Devlin; (4) Earthquake history of the northeastern area, by E. R. Powers; (5) The problem of earth deformation, by M. K. Hubbert; (6) A new speed control for seismograph drums, by A. C. Ruge; and (7) Recent earthquakes in the eastern area, by Daniel Linehan.

5266. Huebner, Walter, Geology and allied sciences; a thesaurus and a coordination of English and German specific and general terms, part 1, German-English, New York, Veritas Press, 1939. Price, $7.50.

This thesaurus, which is alphabetically arranged, contains more than 25,000 specific and general terms.

5267. Lane, A. C., Report of the committee on the measurement of geologic time 1938–39, National Research Council, 114 pp., Washington, D. C., September 1939.

This report of the committee, of which A. C. Lane is the chairman, was presented at the annual meeting of the Division of Geology and Geography, April 29, 1939.

Contents: (1) Annotated bibliography of articles related to the measurement of geologic time, compiled by J. P. Marble; (2) Work at Washington, D. C.; (3) Work at Massachusetts Institute of Technology; (4) Work at Harvard University; (5) Work in Fennoscandia; (6) "Dewey-decimal" methods of estimating geologic age, by A. C. Lane; (7) Recent astronomic data; (8) Work of R. L. Slobod and M. Dole at Northwestern University; (9) Reports of committee meetings; (10) Report of the vice chairman; (11) Work of G. H. Henderson on pleochroic haloes, Dalhousie University.

5268. National Research Council, Transactions of the American Geophysical Union, 20th annual meeting, April 26–29, 1939.

The present volume consists of four parts: Part 1 (pp. 1–140) is devoted (*A*) to the joint South Pacific Regional Meeting of the

Section of Hydrology and of the Western Interstate Snow Survey Conference, at Los Angeles, Calif., December 1938, where 27 papers and reports were presented, and (*B*) to the joint North Continental Divide Regional Meeting of the Section of Hydrology and of the Western Interstate Snow Survey Conference, at Spokane, Wash., December 1938, where 12 papers and reports were presented. Parts 2, 3, and 4 contain the papers and reports presented at the 20th annual meeting of the Union at Washington in April 1939. Part 2 (pp. 141–234) includes 14 papers presented before the Section of Hydrology in a "Symposium on floods"; part 3 (pp. 235–484), the reports and papers presented before tde General Assembly and all the Sections except that of Hydrology; part 4 (pp. 485–741), the reports and papers presented before the Section of Hydrology.

Seven resolutions were adopted at the General Assembly. The subjects of these were as follows: Long-range weather forecasts; geophysical and geological study of oceanic basins; geophysical and geological study of continents; seismological activities of the Eastern section of the Seismological Society of America; Naval Observatory time signals; and two resolutions of thanks for cooperation of the Smithsonian Institution and of the George Washington University.

A feature of the 20th annual meeting was the announcement of the William Bowie medal, established on March 1, 1939, to be awarded for distinguished attainment and outstanding contribution to the advancement of cooperative research in fundamental geophysics. The first medal was presented to Dr. William Bowie, April 28, 1939. Following this award, there was a "Symposium on geophysical prospecting" of eight papers (pp. 242–305). These concerned petroleum and mining exploratory methods, photographing of sections of boreholes, telluric currents and prospecting at surface, radioactivity for stratigraphic studies, and governmental activities in geophysical prospecting. The published papers form an excellent general view of this subject.

At the session of the Section of Geodesy, eight papers and reports (pp. 306–332) detailed progress along geodetic lines as follows: Relation of inch and meter; procedure at triennial assemblies of the International Association of Geodesy; astronomic work on delineation of boundaries; relation of physiographic provinces to topography; new methods of representing terrain; and progress reports on geodetic work in Mexico and the United States.

The Section of Seismology held only one short session, at which procedure at triennial assemblies of the International Association of Seismology and arrangements for the coming Assembly at Washington of that Association were discussed (pp. 333–336).

The seven papers and discussions (pp. 337–356) before the Section of Meteorology were concerned largely with upper-air developments. Among them were: Measurements and origin of ozone; research concerned with air navigation over the Atlantic Ocean; factors controlling winter-time precipitation; upper-air observations in the Pacific; precipitation and low temperatures aloft; and sidereal barometric-pressure wave.

Two extended sessions of the Section of Terrestrial Magnetism and Electricity heard 22 papers (pp. 357–398). These were concerned with the following subjects: Instrumental features (5), secular variation

(3), the earth's quadrupole moments (1), cosmic radiation (3), auroral phenomena (3), solar and ionospheric relations (2), atmospheric electricity (2), earth currents (2), procedure at triennial assemblies of the International Association of Terrestrial Magnetism and Electricity (1). Besides these papers, 4 progress reports were received on magnetic activities in Mexico and the United States.

The Section of Oceanography (pp. 399–428) was given over largely to five progress reports of Federal and private organizations. Two papers discussed the influence of turbulence on the characteristics of waters at middepths and the new bathymetric chart of the Caribbean area.

Seven communications to the Section of Volcanology (pp. 429–452) related to the Tuscan Soffioni, crystallization of a basaltic magma, Borabora lavas, features of basaltic flow, grooved lava, the Livingston formation, and volcanic sequence in Utah.

The Section of Hydrology, in four sessions, had a lengthy and valuable program. The 15 reports and appendixes of the Section's standing research committees and subcommittees (part 4, pp. 485–740) showed splendid progress and included lengthy bibliographies and abstracts. Besides these reports, 16 papers were presented which discussed observational and experimental data on rivers, wells, subterranean water, soil moisture, drainage basins, evaporation, infiltration capacity, rainfall, and run-off.

Minutes of the General Assembly and Sections occupy pp. 454–484 of the "Transactions."—*From the Introduction by J. A. Fleming, General Secretary, American Geophysical Union, condensed by W. A.* Copies of Transactions may be purchased by nonmembers of the Union as follows: Orders, with checks payable to American Geophysical Union, should be addressed to the General Secretary, American Geophysical Union, 5241 Broad Branch Road, NW., Washington, D. C., U. S. A. Price: Parts 1, 2, 3, and 4, $5; part 1, $1.25; part 2, $1; part 3, $1.75; and part 4, $1.75.

5269. Perret. F. A., The volcano-seismic crisis at Montserrat, 1933–37, Carnegie Institution of Washington, Pub. 512, 76 pp., 51 figs., Washington, D. C., 1939.

The present report on the period of abnormal volcano-seismic conditions at Montserrat is based on observations made by the author during a series of 12 visits to the island from 1934 to 1937. A diagrammatic volcano-seismic chart shows the sequence in time of the various events: The grouping and relative importance of all the larger shocks, their relation to lunisolar influences, and their relation to soufrieric activity. The development of three new instruments needed for the investigation is described: (1) An automatic gas recorder that was developed from a recording thermometer, (2) a universal microphone unit, and (3) an experimental model of a "seismeter." In summing up the services rendered by these instruments, the author shows that the gas recorder has given continuous service and has eliminated human idiosyncrasy and error; that fumarolic gas pressure has been measured; that a recording form of apparatus for measuring gas pressure has been suggested; that microphones have had many applications; that a new standard form of microphone has been devised; and that the "seismeter" has given valuable information in recording in three dimensions powerful shocks and in registering thus (perhaps for the first time) strong earthquakes at or near their epicentra.—*W. A.*

5270. Recent marine sediments, Trask, P. D., editor, 736 pp., 139 figs. Published by the American Association of Petroleum Geologists, Tulsa, Okla.; London, Thomas Murby & Co., 1939. Price, $5 ($4 to A. A. P. G. members and associate members, libraries, and colleges).

This is a symposium prepared under the direction of a subcommittee of the Committee on Sedimentation of the Division of Geology and Geography, National Research Council, Washington, D. C.

The book is divided into seven main parts: (1) Transportation, (2) Relation of oceanography to sedimentation, (3) Deposits associated with strand line, (4) Near-shore sediments—hemipelagic deposits, (5) Pelagic deposits, (6) Special features of sediments, and (7) Methods of study.

The book contains a bibliography of 1,000 titles; 72 pages of authors names; and a subject index.

5271. Terrestrial Magnetism and Electricity, edited by J. A. Fleming, 794 pp., fully illus., New York, McGraw-Hill Book Co., Inc. Price, $8.

The book was prepared by a committee of the National Research Council and is volume 8 of the Council's monographs, Physics of the Earth. It sets forth the present status of our knowledge of terrestrial magnetism and electricity. Contents: (1) The earth's magnetism and magnetic surveys, by J. A. Fleming; (2) Magnetic instruments, by H. F. Johnston, J. A. Fleming, and H. E. McComb; (3) Magnetic prospecting, by C. A. Heiland; (4) Atmospheric electricity, by O. H. Gish; (5) Instruments used in observation of atmospheric electricity, by O. W. Torreson; (6) Earth currents, by W. J. Rooney; (7) On causes of the earth's magnetism and its changes, by A. G. McNish; (8) Some problems of terrestrial magnetism and electricity, by J. Bartels; (9) Radio exploration of the earth's outer atmosphere, by L. V. Berkner; (10) The upper atmosphere, by E. O. Hulbert; (11) The aurora polaris and the upper atmosphere, by L. Vegard; (12) Thunder clouds, shower clouds, and their electrical effects, by B. F. J. Schonland; (13) Bibliographical notes and selected references, by H. D. Harradon.

10. PATENTS

5272. Means for seismic survey; John P. Minton, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,160,224, issued May 30, 1939.

In combination with an electrical seismograph, an electric circuit for detonating electric blasting caps comprising in combination a source of energy; common means for retarding the rate at which the current is built up in the cap circuit and eliminating spurious voltages such as commutator-ripple voltages from the blasting circuit; electric derivating means for taking the derivative electrically of a transient voltage; recording means; and signal communicating means connecting said blasting circuit to said recording means, whereby a definite indication of the instant of detonation of the cap may be recorded. Claims allowed, 5.

5273. Geophysical instrument; Harry A. Fore and Albert K. Edgerton, Los Angeles, Calif.: U. S. patent 2,160,356, issued May 30, 1939.

In a geophysical instrument, the combination of a radio transmitter and receiver, each being mounted in a case and each having a loop antenna, means to position the loop antenna at substantially a constant distance apart and at substantially right angles one to the other, at least one of such antennae being constructed to have a high distributed electrostatic capacity compared with variations in the capacity to the ground or surrounding objects. Claims allowed, 6.

5274. Electric earth transient in geophysical prospecting; Ludwig W. Blau and Louis Statham, Houston, Tex., assignors to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,160,824, issued June 6, 1939.

This invention relates to the method for the determination of electrical properties of matter, which comprises passing an electric current between spaced electrodes in the matter whereby a plurality of transients are obtained, thereby producing transient potentials outside of the electrodes, the time constants of which are functions of the distances of the transient potentials from the electrodes and the electrical properties of the matter, separately receiving some of the transient potentials, combining the transient potentials, and exhibiting the effects of the combination of the transient potentials. Claims allowed, 10.

5275. Apparatus for determining the hardness of subsurface formations; John C. Karcher, Dallas, Tex., assignor to Geophysical Service, Inc., Dallas, Tex., a corporation of New Jersey: U. S. patent 2,161,256, issued June 6, 1939.

This invention relates to apparatus for determining the variation in hardness of earth formations encountered by a rotary-drill bit while drilling, said apparatus including a conducting disc rigidly and coaxially attached to the drill stem, a stationary electrically conducting coil, and a permanent magnet adjacently arranged and positioned near the periphery of said disc, and a similarly arranged coil and permanent magnet positioned on the opposite side of said disc. Claims allowed, 3.

5276. Method and means for recording seismic waves; John P. Minton, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,161,764, issued June 6, 1939.

This invention relates to an electric seismograph, comprising in combination a vacuum-tube amplifier; a geophone connected to the input of said amplifier; a galvanometer connected to the output of said amplifier; timing means associated with said galvanometer; and means alternately disposed between successive stages of the amplifier for electrically taking a plurality of derivatives of a signal when passing through the amplifier and amplifying them, whereby the wave front of the signal is given predetermined characteristics. Claims allowed, 8.

5277. Electrode for well logging; Finley T. Robidoux, Houston, Tex., assignor to Halliburton Oil Well Cementing Co., Duncan, Okla.: U. S. patent 2,161,976, issued June 13, 1939.

This invention relates to an electrode assembly adapted for use in electrical well-logging operations, said assembly including an electrode

adapted to make electrical contact with mud or other fluid in a well, and means for holding the electrode out of direct contact with the wall of a well as it is moved therein, thereby avoiding interference in some electrical property being logged due to intermittent contact between the electrode and the wall of the well, said means including a tip made of insulating material secured to the lower end of said electrode and member made of insulating material adjacent the upper end of said electrode, said tip and member being of a greater diameter than said electrode. Claims allowed, 3.

5278. Means and method of making geophysical explorations; Kenneth C. Woodyard, Welsh, La., Clifford A. Putnam, Kountze, Tex., and Harold Prescott, Ponca City, Okla., assignors to Continental Oil Co., Ponca City, Okla., a corporation of Delaware: U. S. patent 2,164,196, issued June 27, 1939.

This invention relates to a means and method of eliminating the effect of extraneous electrical disturbances. In an apparatus for making geophysical explorations, a seismophone, a thermionic tube having a grid and a cathode, a conductor connecting said grid and said seismophone, a conductor connecting said cathode and said seismophone, and means for equalizing the impedance of said conductors. Claims allowed, 6.

5279. Method and apparatus for identifying the nature of the formations in a borehole; Conrad Schlumberger, Paris, France, assignor, by mesne assignments, to Schlumberger Well Surveying Corporation, Houston, Tex., a corporation of Delaware: U. S. patent 2,165,013, issued July 4, 1939.

This invention relates to the method of identifying the nature of the formations traversed by a borehole containing water or mud, particularly for distinguishing water-bearing and oil-bearing beds, which method comprises the steps of passing an electric current at various given depths in the borehole into the water or mud contained therein; cutting off said current for generating a residual potential difference in the neighboring soil; and measuring the said residual potential difference at various depths in the borehole, from which measurements may be deduced the nature of the formations traversed by the borehole at the said various depths. Claims allowed, 8.

5280. Electrical-transient well logging; Ludwig W. Blau and Louis Statham, Houston, Tex., assignors to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,165,213, issued July 11, 1939.

This invention relates to the method of logging a well in earth strata of different electrical properties from each other between the terminals of an exploring circuit, which comprises moving one of the terminals along the well and grounding the other terminal at a distance from the well; passing an electric current through the circuit and the earth strata at a point of travel of said moving terminal, whereby a transient is obtained which is modified by the passage through the strata of the current at said point of travel of said moving terminal; and exhibiting an indication of the transient of said current as modified by its passage through the strata upon an indicating instrument arranged in the circuit. Claims allowed, 16.

5281. Geophysical prospecting with short electromagnetic waves; Ludwig W. Blau and William B. Lewis, Houston, Tex., assignors to Standard Oil Development Co., a corporation of Delaware: U. S. patent 2,165,214, issued July 11, 1939.

This invention relates to the method of geophysical prospecting, which comprises passing short electromagnetic waves, including wave lengths which are capable of being absorbed by hydrocarbons, through a medium associated with the earth in the area to be investigated in such a way as to contain any hydrocarbons which may be passing through said earth, whereby the presence of hydrocarbons in said medium will be indicated by an absorption of energy of the aforesaid wave lengths; receiving said waves after they have passed through said medium; and measuring the energy of the received waves. Claims allowed, 6.

5282. Apparatus for recording seismic waves; John P. Minton, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,167,124, issued July 25, 1939.

In a system for seismic surveying the combination of a plurality of geophones, means for making separate records of the reactions of each of the geophones, and additional means for simultaneously making a composite record of the reactions of the geophones without interfering with their separate records. Claims allowed, 5.

5283. Apparatus for locating concealed conductive bodies; Thomas Ryan, Milwaukee, Wis., assignor to two-fifths to Henry B. Burr, Milwaukee, Wis.: U. S. patent 2,167,490, issued July 25, 1939.

This invention relates to apparatus for locating a concealed electrically conducting body, comprising an exploring coil in which a voltage is induced by an alternating magnetic field; a support on which said coil is being transverse to its rotational axis; and means including a vacuum-tube amplifier for indicating the induced voltage, said amplifier including an inductive coupling device rotatable with said exploring coil to prevent false pick-up by said device. Claims allowed, 8.

5284. Electrical-prospecting method and apparatus; Charles B. Bazzoni, Wallingford, and Joseph Razek, Llanerch, Pa., assignors to Sperry Sun Well Surveying Co., Philadelphia, Pa., a corporation of Delaware: U. S. patent 2,167,630, issued August 1, 1939.

This invention relates to the means for determining the location and character of formations penetrated by a borehole comprising an exploring unit, said exploring unit including a crystal-controlled generator of high-frequency oscillations; means for establishing thereby an electromagnetic field penetrating formations in the vicinity of the borehole, said last-named means forming a part of a tuned portion of the generator circuit; means responsive to variations in operation of the generator circuit due to changes of impedance of the field establishing means resulting from different materials in the vicinity thereof; and means for supporting said unit for movement within and lengthwise of the borehole. Claims allowed, 14.

5285. Method and apparatus for electrical exploration of subsurface; John Jay Jakosky, Los Angeles, Calif.: U. S. patent 2,167,950, issued August 1, 1939.

This invention relates to the method of determining the geologic nature and characteristics of the subsurface, which comprises passing an electric current through the earth between two spaced energizing electrodes electrically connected to the earth and spaced from one another a known distance along the earth's surface, to create a potential difference between two spaced points on the earth's surface adjacent

one of said electrodes and separated from one another by a distance less than one-fifth of said known distance, at least one of said points being within a distance from said one electrode, which is also less than one-fifth of said known distance; and measuring said current when the potential difference between said points has a known value. Claims allowed, 7.

5286. Electrical method of geophysical exploration; Haakon Muus Evjen, Houston, Tex., assignor to Shell Development Co., San Francisco, Calif., a corporation of Delaware: U. S. patent 2,169,685, issued August 15, 1939.

In a method of geophysical exploration, the steps of forcing an electric current from a single electromotive source to flow through the ground in a plurality of streams through a plurality of current electrodes: varying the relative intensities of said current streams; registering said relative intensities; and measuring the potential difference generated by the flow of said streams between two grounded potential electrodes for different intensities of said streams. Claims allowed, 11.

5287. Method of electrical prospecting; Lawrence F. Athy and Harold R. Prescott, Ponca City, Okla., assignors to Continental Oil Co., Ponca City, Okla., a corporation of Delaware: U. S. patent 2,172,271, issued September 5, 1939.

A method of making geological explorations, including the steps of passing an alternating current of predetermined frequency through the earth between two separated points adjacent the surface of the earth; receiving the potential difference between two points adjacent the earth's surface lying between said current source points; rejecting alternating potentials higher in frequency than the predetermined frequency; measuring the remaining potential difference; and simultaneously measuring the alternating current being passed through said separated points adjacent the earth's surface. Claims allowed, 6.

5288. Electrical method of geophysical exploration; Haakon Muus Evjen, Houston, Tex., assignor to Shell Development Co., San Francisco, Calif., a corporation of Delaware: U. S. patent 2,172,557, issued September 12, 1939.

In a method of geophysical exploration, the steps of passing through the ground a plurality of current streams from a single electric source; causing said streams to penetrate the ground to different depths by adjusting the intensities of said streams to different relative values; and observing the characteristics of the current in each stream. Claims allowed, 9.

5289. Process for investigating permeable strata traversed by boring; Conrad Schlumberger, Paris, France; Anne Marguerite Louise Doll, administratrix of said Conrad Schlumberger, deceased, assignor to Société de Prospection Électrique, Procédés Schlumberger, Paris, France, a corporation of France: U. S. patent 2,172,625, issued September 12, 1939.

This invention relates to a process for the investigation of the permeability of the strata traversed by a drill hole and which consists in effecting, at different depths in the drill hole, a first series of measurements of a predetermined physical parameter of the rocks forming the wall of the hole, said parameter being a function of the liquid impregnating these rocks; then changing the nature of the liquid contained in the pores of the permeable rocks and effecting a second series of measurements of said meter; and finally determining, by

comparison of the two series of measurements, the places along the drill hole where penetration of the said liquid into the permeable strata has modified the value of the physical parameter, the impervious strata being characterized by the constant value of the said parameter. Claims allowed, 9.

5290. Electrical apparatus and method for geologic studies; William M. Barret, Shreveport, La., assignor to Engineering Research Corporation, Shreveport, La.: U. S. patent 2,172,688, issued September 12, 1939.

In an electromagnetic means of determining geologic features, an apparatus comprising a generator of electromagnetic waves; a means of maintaining constant the frequency of the waves of said generator; a means of adjusting the power level of said generator; a means of maintaining constant the power level of said generator; and an antenna adapted to concentrate in the earth a large part of the electromagnetic energy radiated by said generator. Claims allowed, 16.

5291. Method and apparatus for geological exploration; William Josiah Taylor, Jr., Shreveport, La.: U. S. patent 2,172,778, issued September 12, 1939.

This invention relates to the method of electrically exploring the earth's crust, which comprises causing a current to flow through the earth between grounded conductors at separated stations and deflecting such current from its normal path by causing another current to flow through the earth between substantially the same stations in the same direction. Claims allowed, 11.

5292. Feststellvorrichtung für den Waagenbalken von Drehwaagen [Locking device for torsion-balance beams]; Gewerkschaft Elwerath in Hannover: German patent 663,042, issued March 28, 1939.

This invention relates to the locking device of the torsion-balance beam and is characterized by the feature that the casing of the balance beam is made movable in respect to the suspension part of the balance, preferably in vertical direction, and that by lifting the casing the beam comes in contact with the casing and is stopped in this position by means of two bolts secured to the immovable part of the balance. Claims allowed, 5.

5293. Pendelapparat für Schweremessungen, dessen Pendel von einer Blattfeder getragen wird [Pendulum apparatus for gravity measurements, the pendulum of which is supported by a leaf spring]; Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij in The Hague, Netherlands: German patent 671,482, issued February 8, 1939.

This invention relates to pendulum apparatus for gravity measurements, the pendulum of which is supported by a leaf spring and the locking device of which is characterized in that the pendulum rod is pressed toward two pins, one of which is secured near the lower end of the leaf spring and the other at the upper end of it. Claims allowed, 1.

5294. Pendelapparat für Schweremessungen [Pendulum apparatus for gravity measurements]; Naamlooze Vennootschap de Bataafsche Petroleum Maatschappij in Haag, Netherlands: German patent 673,560, issued March 24, 1939.

This invention relates to leaf-spring pendulum apparatus, in which the material from which the pendulum rod is manufactured and the

distribution of mass with respect to a fictitious axis of rotation are selected in such a way that the influence of the leaf spring, the elasticity of which changes with temperature, upon the period of oscillation of the pendulum is compensated by the position of the center of gravity of the pendulum changeable with temperature. Claims allowed, 1.

5295. Vorrichtung zur Messung von Schwerkraftsunterschieden [Apparatus for measuring gravity differences]; Askania Werke A. G. of Berlin-Friedenau: German patent 674,167, issued April 6, 1939.

This is an addition to patent 650,566 (see Geophys. Abstracts 97, No. 5001). It is characterized in that the centers of the quicksilver levels of the two quicksilver columns are arranged vertically one above the other. Claims allowed, 4.

5296. Verfahren und Vorrichtung zur Ermittlung elastischer Wellen im Erdboden [Method and apparatus for determining elastic waves in the ground]; Seismos, G. m. b. H., of Hannover: German patent 676,809, issued June 12, 1939.

This invention relates to the method for determining elastic waves in the ground. The method employs changes in frequency and magnitude of the current occurring between two electrodes as a means for disclosing the corresponding properties of the elastic waves. The apparatus consists of a trough provided with two electrodes and filled with a certain kind of electrolyte. The trough is placed on the ground, the oscillations of which produced by elastic waves are transmitted to the electrolyte. The electric line leading to the trough is coupled, by means of a transformer, with a secondary circuit containing the recording instrument. Claims allowed, 4.

5297. Electrical seismograph; A. G. Ivanov: Russian patent 54,368, issued in January 1939.

This invention relates to an electrical seismograph for prospecting by the method of the directed receiving of reflected waves (method of grouping) and is characterized in that its electrical scheme within the case is made of double transmission in order that the same seismograph may be inserted into two adjoining groups simultaneously; for example, in the form of two independent windings by which the relative oscillations of the mass of the seismograph may be transferred independently one from another to the electrical circuits of two different groups of seismographs simultaneouly. Claims allowed, 1.

5298. Seismograph; A. F. Vulfius: Russian patent 54,495, issued in February 1939.

This invention relates to a seismograph with one or several permanent magnets and windings, through which electrical current is induced during the oscillations of the inert mass, and is characterized in that the magneto-conducting wire consists of one or several parallel branches provided with terminals having the same polarity and carrying the coils of the winding, and that between these terminals the above-mentioned inert mass is placed, the mass being made from soft iron and secured to a spring, the polarity of the mass with respect to that of the terminals being of the opposite sign. Claims allowed, 1.

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JANUARY–DECEMBER 1939

COMPILED BY V. E. CLEVER