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GEOLOGICAL SURVEY BULLETIN 981-C

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

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

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GEOPHYSICAL ABSTRACTS 146, JULY–SEPTEMBER 1951

By MARY C. RABBITT and S. T. VESSELOWSKY

INTRODUCTION

Geophysical Abstracts are prepared by the Geophysics Branch of the Geological Survey, United States Department of the Interior, as an aid to those engaged in geophysical research and exploration. Periodicals, books, and patents are regularly searched for material dealing with geophysical exploration and with the physics of the solid earth.

Abstracts are grouped in three sections dealing with earth physics, exploration geophysics, and patents. The first section has been further divided into sections on gravity, magnetism and electricity, seismology, radioactivity, heat, tectonophysics and internal constitution of the earth. The section on exploration geophysics covers gravimetric, magnetic, seismic, electric, and radioactive methods, well logging, and technical aids. Patent abstracts are taken from the Official Gazette of the U. S. Patent Office. Within each group the order of the abstracts is as follows: general papers, bibliographies, and reviews; theory; instruments; methods and techniques; observations.

As many readers may not have ready access to the source material, an effort is made to include all significant new material in these abstracts. Where geographic names quoted differ from the decisions of the United States Board on Geographic Names, the latter are added in brackets.

Geophysical Abstracts 1–86 and 112–127 were issued as Information Circulars by the Bureau of Mines, and 87–111 were issued as Bulletins of the Geological Survey. Geophysical Abstracts 128 and following numbers have been published as Bulletins of the Geological Survey.

All Geophysical Abstracts published as Information Circulars are now out of print. Geophysical Abstracts issued as Bulletins of the Geological Survey (except Nos. 87 and 88 which are out of print) may be purchased as single copies or by subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. For subscription, the Superintendent will accept a deposit

of $5 in payment of subsequent issues. When this fund is near depletion, the subscriber will be notified. The deposit may also be used to purchase any other publication from the Superintendent of Documents.

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EARTH PHYSICS

GENERAL

12891. Paul, Martin. Beitrag zur Frage einer solaren Steuerung geophysikalischer Vorgänge [Contribution to the question of solar influence on geophysical phenomena]: Geofis. Pura e Appl., v. 17, pp. 13–36, 1950.

The most intensive geomagnetic disturbances during 1848–1942, stronger earthquakes recorded by the International Seismological Survey, those included in Sieberg's Erdbebenkunde, and deep focus earthquakes listed in Conrad's study were analyzed for periodicity of occurrence. It is concluded that the geomagnetic disturbances and earthquakes are characterized by a period of 34.19 days which is identical with the period of rotation of a hypothetical sun core. Harmonic analysis shows that there are two waves of this period, 180 days apart. The periodicity $(t\times 34.19)/(t-34.19)$ probably exists in geomagnetic phenomena, t being the period of rotation of any planet in the solar system.—*S. T. V.*

GRAVITY

12892. Haalck, Hans. Über den gegenwärtigen stand der Entwickelung der Gravimetrie und ihre Aufgaben [The present status of the development of gravimetry and its problems]: Gerlands Beitr. Geophysik, Band 61, Heft 4, pp. 257–271, 1950.

Progress in gravity measurements since 1900 is reviewed beginning with the discovery of the torsion balance by Eötvös followed by continuous improvements in the construction of pendulum apparatus and the extension of surveys to larger areas. Further advances were made by Vening Meinesz by his use of submarines in measurements of gravity. The most recent step has been the development of static instruments, especially the gravimeter. The next problem facing the designers of gravimeters is the construction of an instrument for airborne gravitational surveying. Tying of existing gravitational networks and extension of regional surveys can now be done much more easily than before, but they necessitate international organization of individual efforts. The same can be said about such studies as those of periodic variations of gravity.—*S. T. V.*

12893. Berroth, Alfred. Die gravitationelle Deklination, ihre Bestimmung und ihre Elimination [Gravitational declination, its determination and elimination]: Geofis. Pura e Appl., v. 19, fasc. 3–4, pp. 117–123, 1951.

The gravitational declination at a point on the earth's surface is defined as the difference between the astronomical azimuth and the geodetic azimuth, referred to a particular ellipsoid. It is a physical quantity resulting from the deviation of the corresponding plumb lines. From a map of gravitational isogonic lines, corrections can be applied to the plumb lines, thus obtaining vectorial quantities, all corresponding to the same reference ellipsoid. The declination can be computed from Laplace's equation as the correction to azimuths of two points whose longitudes are known. Observational procedure,

which necessitates a high degree of precision, is described. The essential point in the measurements is the simultaneity of readings which can be achieved, with an exactitude of ± 0.00002 sec, by using a special electronic spark chronograph developed by the U. S. Bureau of Standards, together with a quartz-controlled frequency generator with photographic recording. A map of Germany with the gravitational declinations is included.—*S. T. V.*

12894. Vajk, Raoul. Regional correction of gravity data: Geofis. Pura e Appl., v. 19, fasc, 3–4, pp. 129–143, 1951.

A brief history of existing methods for the removal of regional gradients from geophysical maps is discussed. These include mechanical mathematical methods, such as those used in the construction of residual and second vertical derivative maps, and graphical methods, such as the smoothing of profiles. It is concluded that both methods may give erroneous results unless the maps are analyzed properly. Mathematical methods such as the averaging processes employed in residual maps can not completely eliminate the effect of residual anomalies nor do they give correct fault indications. The method of graphically smoothing gravity and magnetic profiles is described as being entirely too arbitrary. For some cases, a graphical method is described as an alternative that, in Vajk's opinion, more correctly describes the regional field. The advantages of the method and illustrations of its use are presented.—*I. Z.*

12895. Voit, Heinrich. Über Unterschiede in der Phase bei berechneten und beobachteten tiden [The phase difference between computed and observed tides]: Geofis. Pura e Appl., v. 17, pp. 37–39, 1950.

Investigations have confirmed predictions of the effect of sun and moon on gravity of the earth and indicated a time lag between the computed and observed tides. This retardation was hypothesized to be the result of the finite velocity with which action of gravity propagates through space. The author believes it to be explained primarily by tidal friction and the deformation of the earth.—*S. T. V.*

12896. Tsuboi, Chuji. Is the condition $\Sigma(\text{Isostatic anomaly})^2$=a minimum a good criterion for determining the thickness of the isostatic earth's crust?: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 3, no. 7, 9 pp. 1950.

No.—*M. C. R.*

12897. Tsuboi, Chuji. Dependence on the isostatic depth on the horizontal scale of the topographies to be compensated: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 3, no. 6, 4 pp. 1950.

In determining the depth of isostatic compensation from gravimetric or deflection data, whether Pratt's or Airy's hypothesis is adopted, it has been customary to assume that the depth is uniform throughout the area in question, that is that the depth does not vary within the area and does not depend on the horizontal scale of the topographic features to be compensated. It has already been shown that the depth varies from one area to another. (*See* Geophys. Abstract 12348.) The area of the United States was divided into nine rectangles, the distribution of Bouguer anomalies and topographies expanded in series for each of nine rectangles, and the depth of the crust calculated for each harmonic, in effect assuming the topography to be composed of a number of sinusoidal components and determining at what depth each component is compensated locally.

The data shows a clear tendency of the depth to decrease as the order of harmonics increases. This means that larger topographies are compensated at greater depths and smaller ones at lesser depths. Thus gravimetric data prove the correctness of Wood's statement that "* * * at shallow depths such differences in pressure must be considerable. Over a small range of pressure at small depth the picture may be a very complicated one, over an area of regional extent. It should be simpler, and the pressure differences less, at greater depths * * *."—*L. E. B.* and *S. T. V.*

12898. Claridge, G. C. Preliminary investigation of gravity anomalies: Nature, v. 165, no. 4202, p. 774, 1950.

Data from 1285 gravity stations in the United States and Canada indicate a mean gravity anomaly for Canada a little greater than one-half the mean anomaly for the United States. When the data are divided among latitude regions 5° in width, the mean anomaly for latitudes 25° N. to 39° N. is almost four times the mean gravity anomaly for the 40° N.–59° N. range. The variation does not seem to be a function primarily of geographic latitude but of some factor or factors having latitude distribution.—*M. C. R.*

12899. Browne, B. C., Cook, A. H., McCarthy, E. J., and Parasnis, D. S. Gravity measurements at York, Newcastle-upon-Tyne, Edinburgh and Aberdeen: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 2, pp. 91–108, 1950.

The differences of gravity between Cambridge and York, Newcastle-on-Tyne, Edinburgh, and Aberdeen were found by pendulum observations. These stations together with Teddington form a satisfactory set of bases for measurements of gravity in Great Britain. If the value of gravity at Cambridge is taken as 981.2650 gals, the values at York, Newcastle, Edinburgh, and Aberdeen are 981.41485, 981.50622, 981.58008, and 981.69590 gals respectively. The standard deviation of each difference from Cambridge is ±0.00018 gals.—*M. C. R.*

12900. Donabedov, A. T. and Meshcheriakov, Ю, A. The relationship between the local anticlines and gravity anomalies in the Russian platform [In Russian]: Akad. Nauk SSSR Doklady, tom 79, no. 3, pp. 503-506, 1951.

Most anticlines in European U.S.S.R. may be characterized by either positive or negative gravity anomalies over the crest, while a few show neither maxima nor minima but a pronounced zone of higher gravity gradients. The inconsistency of gravimetric evidence makes geologic interpretation difficult and often leads to erroneous conclusions in oil and mineral exploration. By constructing a geologic map of the most important anticlines separated according to gravimetric characteristics, the observed differences may be shown to result from differences in the deep geology of various regions, such as the elevation or subsidence of ancient rocks.—*S. T. V.*

12901. Yüngül, Sulhi. "Rift" vadileri ve Hatay gravimetre etüdünün bazi tektonik neticeleri [Rift valleys and some tectonic results of the Hatay gravity survey] [in Turkish with an English résumé]: Türkiye Jeoloji Kurumi Bülteni, v. 3, no. 1, pp. 1–32, 1951.

To investigate the oil possibilities in the Amik plain, a gravity survey was made in 1949 of an area of about 1,175 sq km in Hatay province of southern Turkey. Results are given as a Bouguer anomaly map with contours at 2 mgal

intervals. Gravity decreases toward the center of the plain, the isogals becoming concentric with a gravity-low closure of −36 mgals at Amik Lake [Amik-Gölü]. Contrary to the usual relation, the gravity anomalies are parallel to the topography. Because of the similarities of gravity anomalies, tectonics, volcanism, seismicity, and morphology of the two areas, it is concluded that the Amik plain is a continuation of the African rift valleys. Several gravity-low axes are believed to represent basalt fissures.—*M. C. R.* and *S. T. V.*

MAGNETISM AND ELECTRICITY

12902. Toperczer, Max. Beitrag zur Methodik der magnetischen Landesaufnahme [Contribution to the methods of regional magnetic surveys]: Archiv. für Meteorologie, Geophysik und Bioklimatologie, ser. A, Band 1, Heft 1, pp. 127–140, 1948.

The basic principles of organizing and constructing regional magnetic surveys are described. Uniformity in different countries is of importance because every survey provides data for studying the whole geomagnetic field. For practical purposes, local magnetic anomalies are usually of greatest interest, but for the study of the geomagnetic field, the value of magnetic vector as a function of latitude and longitude of the point is needed. Temporal variations should be eliminated, and the final determinations reduced to a definite epoch.—*S. T. V.*

12903. Macht, H. G. The representation of the main geomagnetic field and of its secular variation by means of two eccentric dipoles: Am. Geophys. Union Trans., v. 32, no. 4, pp. 555–561, 1951.

The central magnetic dipole accounts for only the first-order portion of the spherical harmonic analysis of the Earth's magnetic-potential field. An eccentric dipole of equal strength shifted to the Earth's magnetic center accounts for a considerable portion of the second-order-potential constituent of the field and in general gives a somewhat better approximation to the observed field. In this paper the positions of two mutually perpendicular dipoles are determined in such a way that the first- and second-order portions of the potential expansion are completely fitted. Moreover it is found that 24 percent of the third-order portion is accounted for by this improved model.

The secular variation of the model was examined with the aid of the various spherical harmonic analyses since 1829. The transverse eccentric dipole lying in the equatorial plane has moved along an approximately elliptical curve in the past 120 years. If a continued migration is supposed, it would complete one cycle in about 500 years. The simultaneous displacements of the polar eccentric dipole are evident but less distinct. In addition to providing a basis for definition of an improved normal geomagnetic field, the model is believed to lend support to the hypothesis of a complex geomagnetic interior field consisting of a primary field originating in the deeper solid layers of the Earth and a secondary transverse field in the core.—*R. G. H.*

12904. Haalck, Hans. Zur Frage der Erklärung des erdmagnetischen Kernfeldes und des allgemeinen Magnetismus der Himmelskörper [The question of explaining the magnetic field of the earth's core and the universal magnetism of celestial bodies]: Gerlands Beitr. Geophysik, Band 62, Heft 1, pp. 1–8, 1950.

According to a suggested hypothesis, a highly ionized cosmic mass of high temperature rotating on its axis generates a magnetic field of the polarity observed on the earth and on the sun by thermokinetic random movements of its

free electrons. In the sun, a magnetic field may be produced as the result of nuclear transformations taking place in the sun's interior.—*S. T. V.*

12905. Kato, Yoshio. On the new theory of the magnetic storm. Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 1, no. 1, pp. 23–39, 1949.

Theories on the causes of magnetic storms are briefly reviewed. Hulbert assumes the storm to be due entirely to an increase of the sun's ultraviolet rays. Theories proposed by Chapman, Lindemann, Stormer, Birkland and others consider the origin of storms to be due to charged particles emitted from the sun. By considering the data at magnetic observatories scattered throughout Japan, a theory which combines the merits of both is developed.

From analysis of the records of the magnetic storms which occurred at the time of the total solar eclipses on June 13, 1936, and Sept. 21, 1941, the following conclusions are reached: the second or main phase of the magnetic storm is due to the action of charged particles ejected from the sun, the velocity of these particles being computed as 5,000 to 7,000 kmps; the first phase is due to ultraviolet rays radiating from the sun with the velocity of light, the interval of time between the first and second phase giving the velocity of the charged particle which produces the main phase. The existence of equatorial ring currents is partially confirmed by computing the change in magnetic moment due to these currents and comparing with the change of intensity of cosmic rays accompanying the magnetic storm.

According to the theories devised by Chapman and others, there should be no disturbance in the upper atmosphere. Investigating the electron density of the F_2 layer shows a distinct decrease indicating that the first phase must be at least due to some radiant ray entering the ionosphere.

Also, the records of dH/dt at the time of the magnetic storm demonstrate that the disturbances are due to radiant rays of two kinds and of different velocity.

As a consequence of the aforementioned observations and conclusions, the author proposes the following theory. The magnetic storm is caused by two different kinds of solar radiation. The first phase is due to the ultraviolent ray. A sudden increase of sun radiation pressure results in an ionic current moving in an eastward manner. This produces an increase in the magnetic field. The main phase is caused by additional increase of radiation pressure and eventual emission of charged corpuscles. These contain both an equal number of positive and negative ions and may be considered on the whole to be neutral. Because of the direction of incidence some of them form a ring current near the equator and others concentrate on the upper atmosphere near the poles. The large decrease of the magnetic field in this main phase is due to the equatorial ring current and the particles which enter the upper atmosphere give an oscillation superimposed on the amplitude. In the third and final phase the ions of the equatorial ring current recombine and eventually lose their charge. This is reflected in a return of the magnetic field to its normal value.—*I. Z.*

12906. Kato, Yoshio. Investigation of the magnetic disturbance by the induction magnetograph: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 3, no. 1, pp. 40–44, 1951.

The three components dH/dt of the time derivative of the magnetic field were observed at Onagawa, Katsuura, and Nemuro, Japan. The instrument used was an induction coil wound around a high permeability metal. Two phases of magnetic storms are distinguished, the first due to ultraviolet rays of extremely high velocity and the other due to particles emitted from the sun. The oscillation of dH/dt at the initial part of a bay disturbance is assumed to be caused

by the small fluctuation of the conductivity in the current system in the ionosphere of auroral zone at the initial time due to penetration of changed particles. The oscillations of dH/dt at sudden commencement which frequently occurred during the day is due to the fluctuation of conductivity of S_D as illustrated by E. H. Vestine and the gradual part in dH/dt of the sudden commencement is due to the symmetrical part which is called D_{st} by E. H. Vestine.—*I. Z.*

12907. Kato, Yoshio and Utashiro, Shinkichi. Investigation of the sudden commencement of the magnetic storm by induction magnetograph: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 2, no. 1, pp. 51–52, 1950.

The time rate of change, dH/dt, of the horizontal intensity of the earth's magnetic field during magnetic storms was observed on an induction magnetograph at Onagawa, Japan. The daytime oscillation amplitude of dH/dt was much greater than the night-time amplitude. This is the reverse of the statistical result obtained from usual variometer records of horizontal intensity and declination. Marked micropulsations of dH/dt frequently took place at sudden commencement in the summer while in the winter, the micropulsations were weak.—*R. G. H.*

12908. Kato, Yoshio and Kanno, Tsunekichi. On the variations of the cosmic-ray intensity associated with the magnetic storm: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 2, no. 3, pp. 153–157, 1950.

Variations in cosmic-ray intensity, $\Delta I_p/I_p$, during magnetic storms have been reported; however in general good correlations with variations in the horizontal intensity during the main phase have not been obtained. In this investigation an attempt is made to correlate $\Delta I_p/I_p$ with the radius of the equatorial ring current at the time of the magnetic storm. It is assumed that the ring current is produced by charged particles from the sun moving with their emission velocity; the particle velocity can be determined by the time difference between sudden commencement and the main phase; the intensity of the equatorial ring current is constant. Under these assumptions the radius of the ring current is determined by particle velocity. The variations of cosmic ray intensity in the mean were almost linearly related to the reciprocal of particle velocity, the coefficient of correlation being $r=0.64$. Weaknesses in the assumption account for the correlation being not as high as desired. The investigation shows that the velocity of particles is large in the early phase of the magnetic storm, is small in the last stage, and affects the maximum decrease of cosmic-ray intensity.—*R. G. H.*

12909. Kato, Yohshio and Utashiro, Shinkichi. The effects of the solar eclipse on the terrestrial magnetic field: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 1, no. 2, pp. 58–61, 1949.

Before the solar eclipse of May 9, 1948, a magnetic storm occurred making it possible to observe the effect of a corpuscular eclipse on the terrestrial magnetic field. Observations of dH/dt, the time rate of change of horizontal intensity, were made with instruments located at two stations on the same meridian in Japan. The ratio of the amplitudes of micropulsations for the two stations plotted against time showed a marked sinusoidal variation over a 4-hour period on May 9 that was attributed to the effect of a neutral corpuscular stream from the sun variously obstructed by the moon. By comparing calculations based on theoretical considerations with observed data the authors suppose the velocity of the corpuscles to be 3,400 kmps.—*R. G. H.*

12910. Kato, Yoshio. Relation between the time variation of the earth's magnetic field and the ionospheric disturbance on May 7, 1948: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 1, no. 2, pp. 64–66, 1949.

Observations of H, the horizontal intensity of the earth's magnetic field, and of dH/dt, its time rate of change, continuously recorded during the magnetic storm of May 7, 1948, are compared with the simultaneous radio exploration records of the ionosphere. At sudden commencement, the echo of 8.1 mc radio waves faded out, the field intensity of radio station KJE (15,850 kc) decreased somewhat, and echos from the E, F_1, and lower F_2 layers faded owing to absorption. The author believes that the data show characteristic correlations of magnetic storms with ionospheric disturbances and are evidence in support of his new theory of magnetic storms. (*See* Geophys. Abstract 12905.)—*R. G. H.*

12911. Romaña, A. Sobre el caracter general de la classificación de las bahias geomagneticas y su ley de aparición durante el dia [The general character of the classification of geomagnetic bays and the law of their appearance during the day]: Geofis. Pura e Appl., v. 18, pp. 148–154, 1950.

A comparative study of geomagnetic bays recorded at the Observatories of Cuajimalpa and Teoloyucan in Mexico and Ebro in Spain shows that the bays observed can be classified into eight fundamental types. They tend to recur in a cyclical sequence during the day, certain types appearing at the same time. The relative importance of different types and the time of their maxima vary with the geomagnetic latitude of the observatory where the bays are recorded. (*See* Geophys. Abstract 11940 for the analysis of the records made at Ebro Observatory, Tortosa, Spain).—*S. T. V.*

12912. Kato, Yoshio; Utashiro, Shinkichi; Shoji, Rikii; Ossaka, Justo; Hayashi, Masaaki and Inaba, Fumio. On the changes of the earth-current and the earth's magnetic field accompanying the Fukui earthquake: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 2, no. 1. pp. 53–57, 1950.

Observations were made near the epicenter of the Fukui earthquake of June 28, 1948, to establish the effect of the earthquake on the magnetic field and earth currents. The magnetic dip exceeded by about two minutes of arc the expected value after allowances were made for secular variation.

To study changes in earth currents accompanying aftershocks a self-recording quadrant electrometer was used to measure the potential difference between two electrodes buried 100 meters apart. The potential difference increased before the aftershock, increased suddenly at the time of shock and returned to normal after several minutes. Also records of time variation of earth current exhibited irregularities believed to be associated with aftershocks.

A survey of the distribution of electric potential was made in the area in which the epicenter was located. Certain discontinuities are believed to indicate geologic boundaries. In the alluvium zone, the results correlate with a vertical component magnetic survey by Yumura.—*R. G. H.*

12913. Kato, Yoshio, Utashiro, Shinkichi and Ossaka, Justo. On the changes of the terrestrial magnetic field accompanying the Tochigi earthquake of Dec. 26, 1949: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 2, no. 2, pp. 149–152, 1950.

A severe earthquake with epicenter at 36.6° N. lat., 139.8° E. long. occurred near Imaichi, Tochigi-ken, Japan on December 26, 1949. The dip of the earth's

magnetic field had been observed for 2- or 3-month intervals at several stations near the epicenter from 1938 to 1942. The dip had again been determined in December 1947 and no significant change observed. In January 1950, observations for the dip indicated a pronounced decrease from the normal value. A minimum anomalous dip of 14 minutes was observed at Koga. Since no general observations were made between December 1947 and January 1950, it was difficult to ascertain whether the earth's magnetic field changed before or after the earthquake. However continuous readings at the Kakioka observatory located on the edge of the anomalous region, indicate there was a two minute decrease from the normal value several months previous to the earthquake. The authors conclude that this is undoubtedly due to the seismic activity preceding the earthquake.—*I. Z.*

12914. Kato, Yoshio and Utashiro, Shinkichi. On the changes of the terrestrial magnetic field accompanying the great Nankaidō earthquake of 1946: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 1, no. 1, pp. 40–41, 1949.

The Nankaidō earthquake occurred south of Katsuura which is on the south coast of Kii peninsula [Kii-hantō]. The diurnal mean value of declination at Katsuura was compared with that at the Magnetic Observatory at Kakioka to the northeast of Katsuura in Kii-hantō. The following features were noted: the existence of a small positive trend prior to the earthquake, a large decrease of 4.5′ in the dip angle immediately following the quake, and the gradual return of the declination to its original value by August 1947. The increase in magnetic activity is attributed to the greater stresses in the interior of the earth's crust. At the time of the earthquake, adverse stresses are added resulting in a magnetic low and after several months the declination returns to its original value.—*I. Z.*

12915. Kato, Yoshio. On the magnetic moment of the residual magnetism of the rock: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 3, no. 1, pp. 45–47, 1951.

Sample rocks from Izu, Japan, were analyzed chemically for magnetite content and the calculated magnetite content plotted against bulk susceptibility for each sample. By assuming that magnetite in a solid solution has a lower susceptibility than that in the pure crystalline state, it is possible to determine the state of the magnetite by noting its position on the graph. The author also observes that the intensity of magnetization increases when the magnetite contained in the rock exists in the state of solid solution.—*I. Z.*

12916. Nagata, Takesi, and Watanabe, Takeshi. Magnetic properties of the rocks containing maghemite (γ—Fe_2O_3): Tokyo Univ., Geophys. Inst. Geophys. Notes, v. 3, no. 21, 8 pp. 1951.

Although the magnetic properties of rocks are primarily related to their content of magnetite (Fe_3O_4) they can be affected by the presence of the ferric oxides, hematite (α—Fe_2O_3), and in particular maghemite (γ—Fe_2O_3). The change of magnetic susceptibility with temperature of maghemite-free gabbro shows a characteristic reversible curve of increasing susceptibility with increasing temperature to the Curie point at 600 C where the susceptibility drops sharply to zero. The heating curve of gabbro containing maghemite shows a pronounced peak at about 275 C, the temperature of the irreversible transition γ—$Fe_2O_3 \longrightarrow \alpha$—$Fe_2O_3$. The cooling curve and subsequent heating curves do not show the peak at 275 C. Although the two types of gabbro have essentially the

same magnetic susceptibility, the remanent magnetization of that containing maghemite is nearly 20 times greater than that of the maghemite-free gabbro. The natural remanent magnetization of the gabbro containing maghemite is on the order of 10 times greater than the thermoremanent magnetization by cooling the rock from a high temperature in a magnetic field. The natural remanent magnetization of maghemite-free gabbro is essentially equal to its thermoremanent magnetization.—*J. R. B.*

12917. Veldkamp, J. Geomagnetic anomalies in the Netherlands: Geol. Mijn., 13 jaarg. new ser. no. 6, pp. 218–223, 1951.

Measurements of H and Z were made with QHM (quartz horizontal magnetometer) and a BMZ (magnetometric zero balance) respectively at 1044 stations in the Netherlands. Local magnetic disturbances were avoided and at each station H was measured at two positions and Z at three 20 to 50 meters apart. All observations were reduced to basic value or determined at the Magnetic Observatory at Witteveen at epoch 1945.0 and the normal field as defined by Hartmann's formula subtracted from the adjusted data. The data are presented on a contour map of vertical intensity isogams, at 20 gamma intervals with the vertical anomaly value and the horizontal vector at each station. A tentative interpretation of the magnetics in terms of highs corresponding with massifs or with horsts and lows corresponding with grabens is made. A gravimetric map not included is also compared with the findings.—*W. J. D.*

12918. O'Dea, P. L. and Howe, H. H. Six additional years of spontaneous increase in magnetic moment: Am. Geophys. Union Trans., v. 32, no. 4, pp. 563–564, 1951.

A magnet composed of 36 percent cobalt steel used at the Tucson Observatory has shown a spontaneous increase in magnetic moment of nearly 1.5 percent since 1940. The rate of increase is now approaching zero. A similar magnet made in 1941 but not heat treated at the same time has shown a 6 percent decrease in magnetic moment.—*M. C. R.*

12919. Maple, E., Bowen, W. A. Jr., and Singer, S. F. Evidence for ionosphere currents from rocket experiments near the geomagnetic equator: Phys. Rev., v. 82, 2nd ser., no. 6, pp. 957–958, 1951.

Experimental evidence of the existence of the ionospheric current system believed to be the source of diurnal variation in the earth's magnetic field is reported. Two Aerobee sounding rockets equipped with total-field magnetometers were fired at different times from a seaplane tender off the west coast of Peru, near the geomagnetic equator. The decrease in magnetic field is plotted against altitude above sea level for each flight. Both flights show the effects of surface anomalies at low altitudes. Above 20 kilometers, the decrease is in accordance with that of a simple dipole. The second flight, made at a time when the diurnal variation at the surface was near maximum showed an additional decrease of about 4 milligauss between 93 km and 105 km, which is attributed to the penetration of a current system in the E layer.—*R. G. H.*

12920. Kato, Yoshio and Utashiro, Shinkichi. On the micropulsation of the earth current: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 1, no. 2, pp. 96–99, 1949.

Micropulsations of earth currents during the eclipse of May 9, 1948 are studied in relation to changes in the earth's magnetic field. Specially designed instru-

ments were used to measure the time rate of change of current, di/dt and the time rate of change of horizontal intensity, dH/dt. The general features of oscillation of the east-west component of earth current are similar to those of the north-south component of horizontal intensity; however the variations of shorter period are more conspicuous in $(di/dt)_{EW}$. The ratio $(di/dt)_{EW}/(dH/dt)_{NS}$ is inversely related to the period of pulsation, but the phase difference of $(di/dt)_{EW}$ and $dH/dt)_{NS}$ does not correlate with the period. The phase difference versus time curve for the earth current exhibits a marked variation during the eclipse.—*R. G. H.*

12921. Kato, Yoshio and Kikuchi, Takehiko. On the phase difference of earth current induced by the changes of the earth's magnetic field: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 2, no. 2, pt. 1, pp. 138–141; pt. 2, pp. 142–145, 1950.

Assuming an isotropic and homogeneous semi-infinite layer as the earth's crust, it has previously been shown, theoretically, that the phase difference between the magnetic and induced electrical field is 45°. Experiment shows, however, that for large periods the phase difference tends to zero and for small periods, the phase difference approaches 45°. To obtain closer agreement two horizontal, isotropic and homogeneous layers of different conductivities are assumed. The top layer is of finite depth extent while the bottom one is infinite. Assuming Maxwell's equation, the phase difference and the ratio of electrical to magnetic amplitudes are derived. The results are in slightly better accord with experiment. As the period increases, the phase difference does not approach zero but does become small in some finite range. As the period decreases to zero, the phase difference approaches 45°.

In the second part, the conductivity is assumed to be a function of depth $\sigma(Z)=\sigma_0\ (1+Z/a)^{-\beta}$ where $\beta>0$ and σ_0 is the conductivity of the earth's surface. The phase difference and amplitude ratio are again computed and plotted as functions of the period for $\beta=0$, 1, 3/2. It is concluded that these results are in good agreement with experiment with the phase difference converging to zero most rapidly for large periods when β becomes large.—*I. Z.*

12922. Burkhart, K. Erdstrom-Untersuchungen am Erdmagnetischen Observatorium in Fürstenfeldbruck [Earth-current investigations at the Fürstenfeldbruck Magnetic Observatory]: Geofis. Pura e Appl., v. 19, no. 1–2, pp. 19–38, 1951.

The installation at the magnetic observatory in Fürstenfeldbruck, Bavaria consists of three lines from 165 to 176 yards long, laid in the directions of magnetic E–W, geographic E–W and geographic S–N, with buried electrodes at the ends. Potential differences were recorded simultaneously with H and D values of geomagnetic vectors. Analysis of observations since 1948 shows that variations of H and D coincide with fluctuations of the components of earth currents perpendicular to them, and that the curves of the first derivatives of H and D almost coincide with the corresponding components of the earth current, thus indicating magnetic induction as the cause of variations of earth currents. There is a noticeable difference in amplitudes of the E–W and S–N components. The method used in the treatment of electric transformers is applied to electromagnetic relations between the systems of currents in the ionosphere and in the earth to explain the mutual relationship of the phenomena. Observations of earth currents in Germany since 1861, principally by J. V. Lamont in Munich, are also reviewed.—*S. T. V.*

SEISMOLOGY

12923. Nakamura, S. T. On visco-elastic medium: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 1, no. 2, pp. 91–95, 1949; v. 2, no. 1, pp. 66–77, 1950; v. 2, no. 2, pp. 146–148, 1950; v. 3, no. 1, pp. 48–52, 1951.

An attempt is made to improve on Hosali's studies of wave propagation in a viscoelastic medium by introducing time differentials of the stress components into Hosali's formulas. In this manner it is possible to obtain results more consistent with the fundamental properties of the viscoelastic medium.

In setting up the fundamental stress-strain relations for the medium it is found necessary to abandon the ordinary assumption that for a viscous medium the mean of three normal stresses on mutually orthogonal planes is equal to the statical pressure at a point. Formulas are derived for the strain components in the case of slow displacement in the medium under constant or linear pressure and for cylinders under various conditions of applied simple stress. The transmission of force is discussed in terms of the vector and scalar potentials of the external force. The components of stress and strain are computed for a sphere in which three double forces without moment act at the center. The stress component in this case is perpendicular to the spherical surface. The displacement in a viscoelastic body to which forces are applied in the neighborhood of a single point on a plane surface are computed as well as the tractions over the plane boundary.

The equations for the propagation of waves in the medium are derived from the equations of motion under the assumption that not very large velocities are involved. The equations are solved for one-dimensional waves. The equations for dilatational and shear waves are given together with expressions for velocity of propagation and damping coefficients. The velocity of Rayleigh waves is determined in much the same manner as in elastic media, the difference being that the parameters in the viscoelastic media involve complex quantities. Calculations show that the longitudinal waves of an earthquake are damped more slowly than the transverse waves as the epicentral distance increases.—*R. G. H.*

12924. Kilczer, J. Die theoretische Bestimming der Laufzeit [The theoretical determination of the travel time]: Geofis, Pura e Appl., v. 19, fasc. 3–4, pp. 144–155, 1951.

After a short introduction in which the propagation of waves in an elastic medium, the formation of wave fronts, and the determination of trajectories are discussed in accordance with the Huyghens principle, the travel time of a wave spreading from the point P_1 to P_2 over a path s is defined as the integral $\int_{P_1}^{P_2} \frac{ds}{v}$, where v is the velocity of propagation. The simplifying assumption is made that the waves are plane, which removes the source of the disturbance to infinity, but does not change the direction of the trajectory. The method is applied to two parallel strata, two oblique strata, and to four strata. The derived formulas are applicable with slight changes to reflected and refracted waves.—*S. T. V.*

12925. Bullen, K. E. Theoretical travel-times of *S* waves in the Earth's inner core: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 2, pp. 124–128, 1950.

Travel times have been computed for *J*, *KJK*, and *PKJKP*, where *J* corresponds to waves of the *S* type in the inner core, using the Jeffreys-Bullen 1940

tables and an earth model based on the compressibility theory. Travel times for *PKJKP* are given for epicentral distances of 180° to 275° from a surface focus and with allowances for depths to 0.12 the radius of the subcrust. For *P* waves incident normally against the inner core, no *J* waves would be produced but from rough calculations it seems that at an epicentral distance of 230° *PKJKP* would have about one-fifth the amplitude of the corresponding *PKIKP* at 130°.—*M. C. R.*

12926. Usami, Tatsuo. On the effect of ocean upon Rayleigh waves: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 3, no. 37, 6 pp., 1950.

The greater velocity of Rayleigh waves under the Pacific Ocean has been interpreted as indicating lack of a sialic layer under the ocean. The effect of the ocean on Rayleigh waves has been considered theoretically, using Sezawa's coordinate system and method of calculation. It is found that Rayleigh waves propagated on an ocean bottom show two dispersion curves according as the velocity is greater or less than the velocity of sound in water. The latter group has a velocity nearly equal to that of long waves in water and should be so considered. The former group has a velocity ranging from sound in water to distortional waves in ground and consists of many branches.—*M. C. R.*

12927. Newlands, Margery. Rayleigh waves in a two-layer heterogeneous medium: Royal Astron. Soc. Monthly Notices Geophys. Supp., v. 6, no. 2, pp. 109–124, 1950.

A method is developed for the solution of the equations for Rayleigh waves in a semi-infinite incompressible medium consisting of a single finite layer in which the rigidity varies linearly with depth overlying an infinitely deep layer in which the properties are constant. The method is then extended to compressible media, such as one where the elastic constant λ varies linearly with depth. Numerical computations are made in both cases for a model earth consisting of a crust 37.5 km thick in which the rigidity increases linearly from 2.3×10^{11} to 4.53×10^{11} dynes per sq cm over material of infinite depth in which the rigidity is 6.47×10^{11} dynes per sq cm. A distinct minimum group velocity is found when the wave length is approximately twice the depth of the upper layer, and in the compressible case, a less pronounced minimum when the wave length is about six times the depth of the layer. There is no real agreement between the calculated curves and two sets of data from Göttingen. The theory may be found useful, however, in the study of microseisms with periods of a fraction of a second, such as those generated by man-made disturbances.—*M. C. R.*

12928. Berson, I. S. Certain kinematic questions related to the propagation of diffracted seismic waves [in Russian]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 9 (136), pp. 67–83, 1950.

Travel time curves are computed for direct, reflected, and refracted waves, after their diffraction on an edge. The diffracting edge can be any three dimensional curve with continuously varying tangent. The established general relations are then applied to the special case of a diffracting edge which is a horizontal straight line. The computations show that the travel time curves are different in different planes of propagation and that the velocities of diffracted waves are usually much lower than the characteristic velocity of the medium.

The presence of diffracted waves, which may be assumed to be reflected, on seismograms may cause erroneous interpretations. One indication of the pres-

ence of diffracted waves is a change of profile with angle resulting from variations of velocity. The reverse problem of determining the position of the diffracting edge may be solved by using the isochron chart, as previously discussed. (*See* Geophys. Abstracts 9182 and 9400.)—*S. T. V.*

12929. Willmore, P. L. The theory and design of two types of portable seismographs: Royal Astron. Soc. Monthly Notices, Geophys. Supp., v. 6, no. 2, pp. 129–137, 1950.

Instruments meeting the dual requirements of being capable of recording tremors in the near-earthquake range of distance and retaining the sturdiness and portability of field instruments can be constructed using moving-coil seismometers with new magnetic materials.

Because power consumption in recording must be held to a minimum unless electronic amplifiers are used, only optical recording is feasible. From a consideration of the power required to maintain a critically damped suspended mirror in angular oscillations of sufficient amplitude to displace the reflected beam through an angle comparable with the width of the diffraction maximum and the power developed by a seismometer from ground motion, it is found that a seismometer mass of a few hundred grams is sufficient to detect ground motion of 10^{-7} cm without using an excessively small mirror in the recorder. Modern moving-coil galvanometers have sensitivities approaching the limit imposed by the inertia of the mirror, so small electromagnetic seismographs are theoretically capable of providing the highest sensitivity required in the field.

Two instruments based on these principles are described. In one the magnet is cylindrical with a ½-inch diameter hole drilled along the axis. A spindle which passes through the hole carries the coil and is screwed at each end into a brass disk. The suspended mass weighs 1.4 kg and the natural period is approximately ½ second. When operated in a recorder with optical beam length of 30 cm a magnification of 100,000 at 10 cycles per second was attained. The second instrument developed is one with a natural period of about a second. In this the magnet itself is used as the suspended mass and the coil is rigidly attached to the frame. Both seismometers may be adapted for vertical operation by a system of springs. Both instruments have closely similar response curves at higher frequencies. The instruments fit into the same kind of case and can be operated while buried in soft ground.—*M. C. R.*

12930. Gassmann, Fritz, and Weber, Max. Schwingungsmesser mit elektronisch regulierbaren Konstanten [Vibrometer with electronically adjustable constants]: Schweizer. naturf. Gesell. Verh., pp. 141–144, 1950.

Starting from the differential equation of a mechanical seismograph with one degree of freedom, a transition to electrical registration is made by adding two new equations determining first, the fixed ratio between the mechanical displacement and the generated voltage (for instance, in a piezoelectric crystal), and second, the ratio between the generated voltage and the output voltage of an amplifier. Finally a similar equation is established for the recording apparatus. By eliminating the intermediate values, a general equation of the seismograph is obtained which can be specialized for individual cases. The application of the suggested procedure is especially simple when the transformation of different quantities is linear and without distortion. It is indicated that the theory of the method is developed in detail elsewhere.—*S. T. V.*

12931. Meister, F. J. Eichon and Prüfen von Schwingungsmessgeräten [Calibration and testing of vibrometers]: Archiv. tech. Messen, Lief. 15, pp. T18–T19, 1949.

In calibrating vibrometers statically two values are measured, the moving mass m of the instrument and the elastic spring constant c. From these the constant $A_0=m_i/c\cdot g$ is computed, where A_0 is the deflection produced by the force of gravity. Static calibration does not take into account the influence of such factors as the frictional resistance of the instrument and its damping capacity. In many vibrometers these factors can be determined by observing free vibrations of the instrument, measuring the amplitudes, their decrease, and the number of oscillations. More reliable results can be obtained from the calibration of the vibrometers on a shaking table, several of which are described. In calibrating vibrometers with a low natural frequency it is necessary to check the operation of the instrument at frequencies up to fourfold the natural frequency to check for the possibility of secondary harmonics. In instruments with high natural frequency it is necessary to go only as high as 1½ times the natural frequency. A summary of certain errors often found in the operation of different vibrometers is included.—*S. T. V.*

12932. Ostrovskiĭ, A. E. An alarm instrument signaling intense earthquakes [in Russian]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 9 (136), pp. 132–133, 1950.

A seismograph that produces an optical or acoustic signal and switches in additional instruments when the seismic displacement reaches a certain limit is described. The seismograph's operation is based on the insertion of one or more photocells along the scale of the recording galvanometer.—*S. T. V.*

12933. Ostrovskiĭ, A. E. Voltage stabilizer for seismic stations [in Russian]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 9 (136) pp. 127–131, 1950.

The sharpness of seismograms is often adversely affected by the variation of the voltage feeding the lamps of recording instruments. An improvement is suggested which keeps the tension on the lamps constant even though the line voltage drops to about 40 percent of normal. The suggested scheme consists of three component portions, which can also be applied separately. The first consists of a ferroresonant stabilizer, after which a transformer reduces the voltage from 110 v to 6, 9 or 12 v; the second element is a barretter (ballast tube) for lamp, 6 to 9 v, set up in the circuit feeding the lamps of the seismographs; the third element is a relay with a 200 μf electrolytic condenser connected in parallel. If the ferroresonant stabilizer is employed alone, the fall of the voltage in the network from 125 v to 59 v results in a voltage variation at the lamps of 14 percent. If the barretter alone is used, this variation is 20 percent. If both the stabilizer and the barretter are in operation, the final voltage drops by only 3.5 percent. An automatic switchover from one light source to another can be achieved in the proposed arangement.—*S. T. V.*

12934. Monakhov, F. I. The determination of the displacement vector produced by transverse waves [in Russian]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 9 (136), pp. 58–66, 1950.

Discrepancies between the observed value of the displacement produced by a transverse wave at the point of arrival at the surface, and that computed by the Galitzin formula have been attributed to irregular and accidental reflections in the upper layers. Galitzin's formula is $\tan\beta=\cos i\tan(\alpha_s-\alpha)$ where β is

the angle formed by the transverse wave with the earth's surface at the point of its arrival; i is the angle of incidence; α is the azimuth formed by the plane directed from the station toward the epicenter, and α_s is the azimuth of the plane of displacement caused by the incoming transverse wave. However, in the derivation of this formula, the effect of reflected waves on the displacement was neglected.

To take into account the effect of such waves, the components of the displacement vector along the coordinate axes were determined and an expression: $\tan \beta = k/2 \tan (\alpha_s - \alpha)$, derived, similar to Galitzin's formula, except that $\cos i$ is replaced by a more complicated function, denoted by $k/2$. Numerical values of k are given for the range from 3° to 90°. From analysis of the effect of the different parameters on k, it is concluded that the formula cannot give accurate values of β for i smaller than 45°, but gives very good results for i greater than 45°. The theoretically computed values of β are compared with those observed during the earthquakes in central Asia on December 20, 1947 and January 9, 1948.

In the last section of the paper, the effect of stratification is discussed. When the seismic wave crosses the boundary of two strata characterized by different velocities, the angle β is changed from β_1 to β_2. A table of the ratios is given; the maximum ratio is 1.048, when the angle of incidence is 59°.—*S. T. V.*

12935. Keilis-Borok, V. I. Determination of the dynamic characteristics of the focus of an earthquake [in Russian]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 9 (136), pp. 3–19, 1950.

In a previous paper (*see* Geophys. Abstract 12549) a method of finding the dynamic characteristics of the focus of an earthquake was suggested. Because of the extensive calculations involved, more simple procedure in which the seismic waves are treated as plane is described. Characteristics of the impulse at the focus are then found by comparing calculated displacements with the observations. The assumption of plane waves is admissible if the distances between observation points and the focus are sufficiently great. The method is applied to the earthquake of May 28, 1948, with epicenter at 38° 21′ N. lat., 69° 20′ E. long. and depth of focus 15 km. Faulting at the focus was found to be at an angle of about 75° with respect to horizontal.—*S. T. V.*

12936. Monakhov, F. I. The interpretation of observed data on deep-focus earthquakes at short epicentral distance [in Russian]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 9 (136), pp. 43–57, 1950.

The reflected and refracted waves generated when seismic waves going toward the surface meet discontinuities complicate seismograms especially from deep focus shocks but if properly interpreted give information on the subsurface structure. Travel-time curves of the direct waves and secondary waves produced by the stratification of the crust have been computed for several deep focus earthquakes in central Asia on the basis of existing evidence of the regional geologic structure and previously determined seismic velocities. The amplitudes of secondary waves in relation to the primary ones were also computed. The results were applied to seismograms of the earthquake of December 20, 1947, as recorded at five seismic stations at epicentral distances from 130 to 825 km. Computed times of arrival were in good agreement with those observed. Discrepancies were attributed to incomplete knowledge of the geology of the area.—*S. T. V.*

12937. Hiller, W. Über die Bestimmung des Azimuts von Fernbeben aus Oberflächenwellen [The determination of the azimuth of earthquakes from surface waves]: Gerlands Beitr. Geophysik, Band 61, Heft 4, pp. 221–231, 1950.

As *P* waves are frequently not clearly recorded or even absent, thus making impossible a determination of the azimuth by the usual method from the two horizontal components at the moment of the first arrival, a new method is suggested, based on the registration of both Love and Rayleigh surface waves. The direction from the observation point to epicenter is perpendicular to the plane of oscillation of Love waves and is in the plane of oscillation of the pure Rayleigh wave. Surface waves are distinguished by the absence or extreme smallness of the vertical component and phase difference between vertical and horizontal components of the Rayleigh waves. Several examples of the application of this method are given.—*S. T. V.*

12938. Di Filippo, Domenico, and Marcelli, L. Uno studio sul terremoto del Gran Sasso d'Italia del 5 settembre 1950 [Study of the earthquake of Gran Sasso d'Italia, September 5, 1950]: Annali Geofis. v. 4, no. 2, pp. 213–239, 1951.

The epicenter of the earthquake of September 5, 1950 on the slopes of Gran Sasso d'Italia, was determined from the differences of the times of arrival of P_g and S_g as 42°30.8±2.0′ N. lat., 13°19.6±5.4′ E. long. The epicenter is very near to a known fault which extends from north of Amatrice to south of Gran Sasso. The depth of focus was found from Inglada's formula and ranged from 3.2 km, when P_g was used, to 0.2 km for S_g. In the epicentral zone, the intensity was 8 while in Rome, 95 km distance, intensity of the most violent shock was only 4. The isoseismal lines are very irregular owing to the surficial character of the shocks and the geologic structure features of the region. The magnitude of the earthquake was computed as 5.45, and the energy liberated at the focus 10^{21} ergs. From the seismological data it is concluded that the initial motion was vertically upward.—*S. T. V.*

12939. Valle, P. E. Il terremoto Jonico del 22 aprile 1948 [The Ionian earthquake of April 22, 1948]: Annali Geofis., v. 6, no. 2, pp. 241–245, 1951.

The epicenter of the shock was located at 20°.48′±0°.04′ E. long., 38°49′±0°.04′ N. lat. The time of occurrence of the first shock was $10^h\ 42^m\ 40.8^s$ Greenwich time. The intensity of the earthquake at the epicenter was grade 9 of the modified Mercalli scale; the energy liberated at the focus was computed as about $10^{23.5}$ ergs.—*S. T. V.*

12940. Pinar, Nuriye. Etude géologique et sismologique du tremblement de terre de Karaburun (Izmir) de 23 juillet 1949 [Geologic and seismologic study of the Karaburun (Izmir) earthquake of July 23, 1949]: Instanbul Univ. Fen Fakültesi Mechmuasi ser A., tome 15, fasc. 4, pp. 363–375, 1950.

On July 23, 1949, an earthquake of intensity 7 occurred near the city of Karaburun in the Izmir region. The shocks observed were of a strictly local character. A geologic description of the surrounding area is given and the epicenters are determined by studies of the destruction produced and the seismograms from the observatory of Kandilli, about 360 km from the center of the earthquake.—*S. T. V.*

12941. Rothé. J. P. Tableau de la seismicité du globe pendant les années 1947–1948 (Chronique séismologique) [Summary of the seismicity of the earth during the years 1947–1948 (Seismologic chronicle)]: Rev. l'Étude des Calamités, tome 12, no. 28–29, pp. 19–46, 1950–1951.

Earthquakes of magnitude 7 or greater as well as several weaker shocks which provide data on the seismicity of certain regions are listed and briefly described. Epicenters and origin times of 238 earthquakes are given.—*M. C. R.*

12942. Tsuboi, Chuji. On seismic activities: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 3, no. 4, 22 pp. 1949.

A study of seismic activity has been based on the annual numbers and places of occurrence of "conspicuous" (felt more than 300 km from source) and "rather conspicuous" (felt beyond 200 but not 300 km from source) earthquakes in Japan from 1912 to 1940. Correlation coefficients between occurrence of earthquakes in neighboring "compartments" suggest seismic activities within 160–200 km are related to some degree. The concept of a seismic field or area in which the probability of occurrence of earthquakes is high and which has a finite extension is presented. The limiting width of the seismic field is 160–200 km, but smaller in southwestern Japan. The energy of these conspicuous earthquakes is calculated as 4 or 8×10^{22} ergs. The annual rate of discharge from a 150 km wide field is about 5×10^{23} ergs. If a great earthquake (10^{25} ergs) occurs every 50 yrs, then the mean annual rates of two classes are of same order of magnitude.—*M. C. R.*

12943. Asada, Toshi and Suzuki, Ziro. On microearthquakes having accompanied aftershocks of the Hukui earthquake of June 28, 1948: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 2, no. 16, 14 pp., 1949.

High-sensitivity electromagnetic seismographs were installed at Yamanaka, 24 km from Hukui [Fukui] to study aftershocks of the June 28 shock. The tripartite station method was used in measuring velocities and directions of approach of initial waves. Earthquakes of the smallest magnitude observed in Japan were recorded. The experimental formula of Ishimoto and Iida, relating frequency of occurrence to maximum amplitude, was found to hold even for these very small shocks.—*M. C. R.*

12944. Suzuki, Ziro and Asada, Toshi. Observations of microearthquakes in Sikoku district: Tokyo Univ. Geophys. Inst., Geophys. Notes, v. 2, no. 7, 4 pp., 1949.

Observations of microearthquakes at Wasisiki [Wajiki] on Shikoku are in agreement with the Ishimoto-Iida formula for the relationship between amplitude and frequency, but those at Kagami [Kagami-mura] are not.—*M. C. R.*

12945. Nakamura, S. T. On the seismic energy and the age of the earth: Töhoku Univ. Sci. Repts., 5th ser., Geophysics, v. 2, no. 3, pp. 206–208, 1950.

Various sources of heat are compared in an effort to ascertain the largest possible energy source for seismic activity. Only 0.05 to 0.1 km^3 of igneous rocks are sufficient to yield upon oxidation the 10^{25} ergs estimated for maximum seismic activity. The heat of crystallization of amorphous rock is the next largest source, the crystallizing of 1 km^3 being sufficient. Radioactive energy is also possible, but much larger masses of rock would be necessary.

Seismic, volcanic, and other tectonic activities can be explained on the assumption of the oxidation of a thin metallic alloy intermediate layer of the earth. If it is assumed that 20 large earthquakes occur every year, the oxidation of 10 microns of mother rock would be needed. At this rate it would take 6×10^{10} years to form continents 60 km thick.—*R. G. H.*

12946. Junger, Arne. Deep basement reflections in Big Horn County, Montana: Geophysics, v. 16, no. 3, pp. 499–505, 1951.

Reflections observed at 7.0 to 8.5 seconds on seismic records from Big Horn County have been attributed to a source at a depth of 18 to 21 km, possibly the base of the granite layer.—*M. C. R.*

12947. Nature. The granitic layer of the earth's crust: v. 166, no. 4234, pp. 1053–1055, 1950.

The composition of the outer crust of the earth was discussed at a Royal Astronomical Society meeting, the principal speakers being E. C. Bullard, H. H. Read, R. Stoneley, and P. L. Willmore. Bullard, in discussing whether the range of 5.6–6.5 kmps velocities observed at short distances represent layered structure or random variations within the crust, remarked that seismologists have favored the former, which may have been excusable when only a few records of a single earthquake were available, but which has produced a dangerous tendency for later workers to bias their readings in favor of preconceived ideas. As an example of this tendency, he cited the American study of the Helgoland explosions. Other speakers discussed determination of layers from surface-wave observations, recent data from explosions and their interpretation, and theories accounting for the origin of a granite layer.—*M. C. R.*

12948. Konishi, Ichiro, and Goto, Hisao. A dynamical consideration on earthquake damage to bridge piers: Kyoto Univ. Fac. Engineering Mem., v. 13, no. 2, pp. 77–93, 1951.

Investigations of damage to railway bridges caused by earthquakes, especially by the Fukui earthquake of June 1948, showed the importance of preserving intact the substructure of the bridge. During vibration tests after the earthquake on the Nakatsuno Bridge, spanning the Kuzuryu River [Kuzuryū-gawa], and on similar bridges, it was found that the piers showed a rocking vibration because of the elasticity of the ground. The free vibrations of a single pier, of all piers with their tops hinged together and of the bridge as a whole were computed, using Lagrange's equations of motion. Similar computations were made for forced vibrations resulting from seismic movements. From these experiments it was concluded that vibrations perpendicular to the bridge are of considerable importance.—*S. T. V.*

12949. Konishi, Ichiro. Investigation of the earthquake damage of the Goshō suspension bridge [in English]: Kyoto Univ. Fac. Engineering Mem., v. 12, no. 3, pp. 20–32, 1950.

The Fukui earthquake of June 28, 1948 damaged the 248 m Goshō suspension bridge [Fukui-ken, Japan]. The upper chords of the stiffening truss of the spans buckled horizontally in the central portion of the two spans, and the vertical members connected to them were bent. The saddles on the bridge towers were displaced towards the river center, the right bank towers being displaced 15 and 17.5 cm. The buckling of the upper chords of the stiffening truss is believed due to the displacement of the anchorage block, calculated as 24–29 cm.—*L. E. B.* and *S. T. V.*

12950. Kats, A. L. and Puchkov, S. V. On the vibrations of buildings caused by explosions [in Russian]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 9 (136), pp. 122–126, 1950.

The dynamic effect of the explosion of 1,180 kg of dynamite on a brick building 3,200 m from the shot point has been studied. The building was 20 m long, 7 m high, and 14 m wide, on a foundation 1.7 m deep, consisting of a layer of humus 0.7 m thick on dense clay. Three electrodynamic seismographs with a magnification of 50 and natural period of 1 second were used to measure vibrations, one imbedded in the ground 20 m from the building, another on the first floor, and the third on the second floor. Maximum amplitudes were 2400μ; periods ranged from 0.05 to 0.12 second. A table of observed amplitudes, periods, and velocities of consecutive waves at the different stations is included.—*S. T. V.*

RADIOACTIVITY

12951. Faraggi, Henriette and Berthelot, André. Sur la radioactivité alpha du bismuth naturel [The alpha radioactivity of natural bismuth]: Acad. Sci. Paris Comptes Rendus, tome 232, no. 23, pp. 2093–2095, 1951.

Study of nuclear emulsions impregnated with bismuth and carefully preserved for more than two years in comparison with nonimpregnated emulsions preserved under similar conditions for approximately the same time suggests the existence of alpha radioactivity of Bi^{209} with a half life of 2.7×10^{17} years, energy of 3.15 Mev, and range in air of 1.85 cm.—*M. C. R.*

HEAT

12952. Runcorn, S. K. Heat flow in the earth: Nature, v. 166, no. 4232, pp. 974–976, 1950.

At a discussion of problems of heat flow in the earth held at the Birmingham meeting of the British Association, Jeffreys spoke on "Potassium and the earth's thermal state" and Runcorn on "Geomagnetic secular change and thermal convection in the earth's core". Bullard's and Elsasser's theories on the latter are reviewed.—*M. C. R.*

12953. Mossop, S. C. A multi-thermometer method for temperature measurement in boreholes: Mining Jour., v. 236, no. 6024, pp. 105–106, 1951.

Three maximum thermometers are enclosed in closely fitting metal tubes and are then held in a sheath through which a suspension wire passes axially. Ten sheaths have been used at one time, attached to the wire at 200-foot intervals. Laboratory and field tests show that the thermometers attain the temperature of the borehole within 15 minutes. It has been possible to obtain readings at 200-foot intervals between depths of 3,000 and 4,800 ft. in 4 hours. Where accuracy of greater than ±0.01 C is unnecessary, specially calibrated clinical thermometers are considered suitable.—*M. C. R.*

12954. Jenke, A. L. Well temperatures in the Abilene area: Abilene Geol. Soc., Geol. Contr., pp. 82–87, 1950.

Certain thermal differences in the Abilene area are briefly described and an attempt is made to evaluate various hypotheses explaining them. The temperatures used as a basis of the report were measured with a maximum recording thermometer. A contour map of equal thermal gradients shows 3 apparent highs of unknown cause. In a vertical section between Coleman and Haskell

Counties the isogeotherms show a tendency to follow the regional dip of the enclosing rocks. The geothermal gradients in two wells were 1.1 F and 1.4 F per 100 feet, and the average temperatures 128 and 139 F. at depths of 2,840 and 3,400 feet respectively. It is suggested that evaluation of subsurface temperature data can be used as a supplementary geophysical tool in the detection of hidden structures or anomalous basement configuration.—*L. E. B.* and *N. A. S.*

VOLCANOLOGY

12955. Fries, Carl, Jr., and Gutiérrez, Celedonio. Activity of Parícutin volcano from July 1 to December 31, 1950: Am. Geophys. Union Trans., v. 32, no. 4, pp. 572–581, 1951.

Crater eruptions were somewhat weaker although short periods of intense activity occurred. The average volume of pyroclastic material erupted continued to decline. The outline of the cone was redetermined in October by intersection from triangulation stations around the volcano replotted on a new base. The top of the cone was found to have shifted toward the southeast, possibly over a period of four or five years. The west peak has risen 52 m in the past 4 years, and the highest point on the east rim 37 m. The only point of lava issue was the Nuevo Juatita vent at the northeast base of the cone.—*M. C. R.*

12956. Derruau, Max. Le Parícutin. Enseignements d'un volcan contemporain [Parícutin: Lessons from a contemporary volcano]: Rev. Géographie Alpine, tome 39, fasc. 2, pp. 325–330, 1951.

A discussion of the formation and evolution of the volcano based on publications of the U. S. Geological Survey.—*M. C. R.*

TECTONOPHYSICS

12957. Colloquium on plastic flow and deformation within the earth: Am. Geophys. Union Trans., v. 32, no. 4, pp. 499–543, 1951.

The following 18 papers and summary represent brief reports of the discussion at a colloquium held at Hershey, Pennsylvania, under the joint sponsorship of the International Union of Geodesy and Geophysics and the International Union of Theoretical and Applied Mechanics.

Part I.—Inelastic deformation of material

A. Burgess, J. M. Basic concepts concerning deformation of materials under stress (pp. 500–504).

The terms used in describing flow and deformation of materials under stress are defined and illustrated by means of flow diagrams. It is demonstrated that the relation between stress and deformation involves time in such a way that not only the duration of an experiment but the whole stress history of the specimen may have influence on the result. Both nonrecoverable or permanent deformation and recoverable or elastic deformation may occur, so care must be taken in each experiment to allow equilibrium to be reached.

B. Nadai, A. L. Some mechanical questions about the deformation of rocks (pp. 504–505).

The results of recent experimental and theoretical investigations of the plastic deformation and fracture phenomena of metals and rock at normal and elevated

temperatures are applicable to the outer crust of the earth. Further experiments under high mean pressures and high temperatures are required for studies of the deeper strata of the earth.

C. Griggs, David. Some experiments on the plasticity of rocks in the earth (pp. 505–507).

Plastic deformation demonstrated by experiments upon rocks is consistent with the results of more abundant experiments on metals and other solids, but this work has been done at temperatures and pressures which duplicate those of only the first 10 kilometers, or outer third of the earth's crust. The author predicts that within the next ten years it will not be possible to duplicate experimentally the conditions throughout the entire crust so it will be necessary to determine by means of the theoretical and applied mechanics whether extrapolation of the available data to the depths of the earth is warranted. The results of experiments involving plastic phenomena in rocks are summarized.

D. Benioff, Hugo. Crustal strain characteristics derived from earthquake sequences (pp. 508–514).

Plots of the accumulated energy of aftershocks show characteristic, if different, curves which are of the form indicated by laboratory experiments on the compressional and shearing creep recovery of rocks and other materials. Similar plots for the energy release accompanying a series of earthquakes along an extended major fault zone produce surprisingly smooth curves with sharp breaks, which are apparently produced by "welding" of the fault, and relatively level plateaus presumably produced by steady movement along the fault surface which did not cause earthquakes. A plot of the strain rebound characteristics of all the post-1904 earthquakes of the world having magnitudes 8.0 or greater seems to indicate that these events are not independent and that the release of strain by one shock affects the time and amount of strain release of subsequent shocks. The plot of all post-1904 deep focus earthquakes of magnitude 7.0 or greater also indicates that they are related to a single stress system.

Part II.—Formation of folded belts and geosynclines

E. Bucher, W. H. Fundamental properties of orogenic belts (pp. 515–517).

The orogenic belts are major structural features of the earth's crust characterized by similar fundamental properties. They contain folded sedimentary rocks of greater thickness than sediments of the same age outside. The original geosyncline from which they are formed is not associated with a bordering geanticline. Although the orogenic belts are characteristically sinuous, the geologic evidence indicates simultaneity of deformation irrespective of the trend. The post-Carboniferous orogenic belts are systematically arranged with one radial group focused in the central region of southwest Asia and another antipodal continuous band ringing the Pacific Ocean. Each belt has a limited history and represents the relief of local tangential pressure which existed for a specific period of geologic time. The characteristic great elevation of young orogenic belts is the result of vertical uplift and not of folding and thrusting under tangential stress. The continuity of the belts, their sinuosity, and the parallelism of the internal fold axes to the trends of the belts indicates to the author that they have been formed by tangential compression rather than by subcrustal currents.

F. Bijlaard, P. B. On the origin of geosynclines, mountain formation and volcanism (pp. 518–519).

The laws which govern the plastic deformation of metals can also be applied to rocks and indicate that yielding should take place at an angle of 55° to the direction of the stress. Compression of the crust will cause thickening at the yield point. To maintain isostatic equilibrium this thickened portion must sink and having sunk will be depressed further by additional compressive forces producing a geosyncline with an accompanying negative anomaly. The major structures bordering east Asia meet at 110° at Hokkaido, Kyūshū, Formosa, and Guam, demonstrating the compressive stress exerted by the Asiatic continent on the Pacific Ocean floor. The volcanoes accompanying these features may be formed by upswelling of magma through tension cracks formed parallel to the direction of stress inside the deformed belt.

G. Bullard, E. C. Remarks on deformation of the earth's crust (p. 520).

The thermal contraction theory of the formation of mountains can not supply the amount of shortening indicated by the geologic evidence of thrust faults and folds but may be consistent with the lesser amount of shortening indicated by gravimetric evidence. The convection theory seems more attractive, but it requires a temperature difference between matter beneath the ocean floor and that beneath the continents. This should be checked by comparing the rate of heat flow through the ocean floor and through the continents.

H. Glangeaud, M. L. Thermodynamic theory of peri-continental liminary zones (pp. 521–523).

The diffusive, elastic, thermal and other properties of rocks and minerals change in a complicated way with depth and though the changes can not be calculated, it can be presupposed that there exist thermodynamic-sensitive zones where rapid variations of thermodynamic potential exist. Where there is no horizontal variation in the composition of the crust no thermodynamic potential exists, but at vertical boundaries, particularly between the sial and sima, a lack of thermodynamic equilibrium is produced. This lack of equilibrium creates thermodynamic anomalies and energy gradients which may produce or localize the convection currents or tangential forces which cause the liminary ranges that border the continental land masses between the emerged areas and the ocean floor.

I. Vening Meinesz, F. A. Deformation of the earth's crust in geosynclines (pp. 523–524).

The assumed crustal downbuckles that accompany the major belts of negative anomalies have probably been produced by horizontal compression. If it is assumed that the movement is an elastic deformation, a stress amounting to ten times the strength of the crust is required, negligible strength of the subcrustal layer must be assumed, and the downbuckles should be straight belts at right angles to the direction of compression. Because such requirements are not reasonable, it seems likely that the failure must be by plastic deformation. This hypothesis is supported by Bijlaard's formula for failure by plastic deformation which postulates a 55° angle between the belt of deformation and the direction of compression. The angles of the intricate pattern of the Indonesia arcs seem to verify this conclusion.

Part III.—Gravity anomalies and postglacial uplift

J. Heiskanen, W. On the post glacial uplift of land in Fennoscandia (pp. 524–525).

To maintain isostatic equilibrium, the weight of the 2,000-meter thick Fennoscandia ice cap depressed the crust beneath it 700 to 800 meters producing outbound currents in the subcrustal layer. Relief of load by melting of the ice cap has been accompanied by an uplift of the crust of about 500 meters. This uplift is continuing at a rate of 34 to 92 cm per hundred years in Finland and must be accompanied by inbound subcrustal currents. Because the subcrustal mass moved under load conditions has not yet been completely replaced, a negative gravity anomaly exists. D. T. Griggs commented that the rate of uplift in Fennoscandia indicates a viscosity of the subcrustal layer of 10^{22} poises.

K. Heiskanen, W. On the large positive and negative gravity anomaly fields (pp. 525–526).

Mean positive and negative gravity anomalies amounting to 30 mgals exist over regions with a diameter of 2,000 to 3,000 km. These can be explained by assuming a triaxial ellipsoid as the figure of the earth. Any other hypothesis must assume these areas to be in isostatic equilibrium for the evidence of Fennoscandia shows that the crust is not sufficiently strong to support these loads.

Part IV.—Convection currents

L. Griggs, David. Summary of convection-current hypotheses of mountain building (pp. 527–528).

The modern convection-current hypotheses of mountain building require a layer in the earth's mantle that is free from stable density stratification or density gradients except for reversible pressure-induced changes. To date no seismic evidence clearly proves or disproves the existence of such a layer. Deep-focus earthquakes and the high rate of heat loss over the floor of the Pacific are consistent with the convection current hypothesis.

M. Hess, H. H. Comment on mountain building (pp. 528–531).

It has been assumed that geosynclines represent zones of weakness which yield under compression to form mountain chains whose early stages are characterized by the island arcs. The East and West Indian arcs have no such geosynclines and the Alps have no great thickness of preorogenic sediments. Some geosynclines, as the Appalachian, Venezuelan, and eastern Sumatran, have been produced by the island arc structures. Other geosynclines such as the Beltian, have existed undeformed for many millions of years. Crustal downbulges not accompanied by mountains can not be maintained by crustal forces alone. Geologic evidence of the East and West Indian island arcs is consistent with the theory of cyclic convection currents. The postulated downbuckle of the island arc can not be formed by a single layered crust but requires a multilayered crust with low friction between layers. Geologic evidence is consistent with a multilayered crust but low friction between layers seems unlikely. The belts of deformation crossing continents do not have the narrow downbulge characteristic of the island arc but are characterized by broad zones of crustal fracture.

The existence of convection currents in the mantle can not be proved or disproved, but the evidence of the deep-focus earthquakes may be explained by an outer (to 475 km) small convection cell and an inner (500 km to the base

of the mantle) large convection cell with opposite rotations. To form a unified theory of mountain building more information is required on the direction of shear of deep-focus earthquakes, the thermal gradient under the oceans, the high velocity of seismic waves on the ocean floor, and the change of physical properties of the mantle at ± 900 km.

N. Vening Meinesz, F. A. Convection currents in the mantle (pp. 531–533).

Convection currents of 400- to 700-kilometer diameter explain the sinking of deep basins in tectonically active areas and the location of intermediate and deep earthquake foci. Large convection currents extending to the base of the mantle explain the pseudoperiodicity of great tectonic activity and the third, fourth, and fifth order terms of Prey's development of the spherical harmonics of the topography at the earths' surface.

O. Birch, Francis. Remarks on the structure of the mantle and its bearing upon the possibility of convection currents (pp. 533–534).

The ratio of the bulk modulus to the density k/ρ of earth materials can be determined from the speeds of earthquake waves traveling through the earth or from laboratory experiment on rock specimens. The derivative of the bulk modulus with respect to pressure has been determined from the ratio k/ρ. The derivative "observed" from earthquake waves agrees closely with the laboratory results for the depth range 900 km to the base of the mantle but deviates widely in the depth range 200–800 km. This indicates that the lower part of the mantle is substantially uniform and that the upper part is not. The value of the "observed" ratio k/ρ is remarkably uniform for the range 700–2,800 km and although 50 percent higher than the corresponding figure for forsterite it indicates a homogeneous layer of what may be a high pressure form of an olivine-pyroxene composition. The most favorable region for convection seems to be the deep layer between 900 km and the base of the mantle, but the time required for overturn in such deep circulation may exceed the age of the earth. In the 200–800 km zone circulation might be limited by the presently unknown requirements of an exchange of latent heat, possible irreversibility of phase changes, and intrinsic differences of density.

P. Cox, J. F. On some possibilities offered by study at planetary scale of terrestrial phenomena (pp. 536–537).

Internal displacements within the earth can be detected astronomically by observing changes in the rate of rotation of the earth or in the variation of latitudes. Differences of the earth's rotation between summer and winter may be explained by transfer of momentum from the atmosphere of one hemisphere to the other.

Q. Vestine, E. H. Fluid motion of earth's interior as inferred from geomagnetism (pp. 537–538).

The rate and direction of change of secular variation can be explained by relative motion between the crust and the core of the earth. Measurements of the direction of magnetization of sedimentary rocks show that the earth's magnetic field has undergone fluctuations continuing for a few thousand years. Studies of the surface magnetic field and external electric currents permit estimates of electrical conductivity as a function of depth in the earth. Such studies will be useful in constructing convection theories, especially if there can be

established a difference in the electrical conductivity between the material under ocean and continental areas.

R. Gutenberg, Beno. Summary of colloquium on plastic flow and deformation within the earth (pp. 539–543).

A summary is presented of the discussions held among the 24 members of the Colloquium. Included are a bibliography and some information additional to that presented in the summaries prepared by the individual members.—*J. R. B.*

12958. Cecchini, Gino. Variazioni delle latitudini terrestri e fenomeni geofisici [The variations of terrestrial latitudes and related geophysical phenomena]: Geofis. Pura e Appl., v. 18, pp. 78–98, 1950.

Variation of latitude cannot be treated as an isolated phenomenon, but is of fundamental importance in the study of dynamic laws governing the universe. Displacement of the earth's axis would influence many geophysical phenomena, including those of seismic or meteorologic nature. Recent observations at the Mizusawa (Japan) Observatory established slight changes in both latitude and longitude, which may be closely related to seismic phenomena. It is concluded that among factors influencing the progressive displacements of the axis of rotation geologic and geophysical forces are predominant.—*S. T. V.*

12959. Jardetzky, W. S. Sur la migration des pôles [The displacement of the poles]: Poznań Soc. Amis. des Sci. et Lettres Bull., ser. B, sci. math. et nat., livr. 10, pp. 75–86, 1949.

Besides very small periodic displacements of the earth's axis, nonperiodic migration of the poles over enormous distances took place during the long history of the earth. Thus according to W. Köppen during the Carboniferous period, the present North Pole was in the Pacific Ocean, its coordinates being 30° N. lat, 145° W. long. According to astronomers this displacement of earth's axis had negligible influence of the position of the earth as a celestial body, but produced enormous geologic effects, being in turn influenced by geologic changes ensuing from the solidification of the earth from an initially liquid state. After a review of contributions made by astronomers and geologists in elucidating this problem, the author discusses, without the use of mathematical analysis, the mechanical effects of such factors as the solidification of the earth's crust, its slippage in relation to a still liquid inner core, vortical movements in it, asymmetry of continental masses, continental drift, unequal rate of cooling of the ocean bottom and of the substrata of the continent.—*S. T. V.*

INTERNAL CONSTITUTION

12960. Bullen, K. E. Venus and the Earth's inner core: Royal Astron. Soc. Monthly Notices, v. 110, no. 3, pp. 256–259, 1950.

If density changes inside the earth to a depth of 5,000 km are essentially due to pressure and conform to Bullen's model (*see* Geophys. Abstract 11982), and if Venus and the earth are of the same primitive composition, it is shown to be more probable than not that Venus has an inner core. This is taken to be further evidence that the earth's inner core is chemically distinct from the rest of the earth.—*M. C. R.*

EXPLORATION GEOPHYSICS

GENERAL

12961. Wagoner, G. E. Geophysical frontiers: Geophysics, v. 16, no. 3, pp. 385–390, 1951; Am. Assoc. Petroleum Geologists Bull., v. 35, no. 7, pp. 1523–1528, 1951. Condensed version in Oil in Canada, v. 3, no. 46, pp. 30–32, 1951.

With the virtual disappearance of unexplored areas in the United States, the development of new methods and the improvement of the methods now in use are of primary importance in the search for oil. Existing magnetic and gravity data will acquire new significance as better methods of interpretation are found. More intensive and varied field techniques, including interpretation of data while the survey is in progress, may locate small oil pools previously overlooked. Measurements will become more exact as better instruments are designed. Most fundamental of all is the need for a ready supply of high-caliber men experienced in the interpretation of geophysical data.—*E. K.*

12962. Rust, W. M., Jr. Exploration geophysics—yesterday, today, tomorrow: World Oil, v. 132, no. 5, pp. 76–78, 1951.

The development of geophysical prospecting is reviewed. Future success is said to depend not on some revolutionary technique but on the complete integration of geophysics and geology.—*M. C. R.*

12963. Weaver, Paul. Avenues for progress in geology and geophysics: World Oil, v. 132, no. 5, pp. 102, 104, 106, 114, 1951.

As the emphasis in petroleum exploration is on finding smaller structures, more careful treatment of data is needed. The construction of isopach maps, determination of sufficient velocity data, more careful analysis to avoid phantom horizons, recognition of small and complex structures which are geologically possible, and the avoidance of averaging and generalizing are considered the most promising "avenues of progress."—*M. C. R.*

12964. Beers, R. F. Better geophysical interpretations: whose responsibility?: World Oil, v. 132, no. 5, pp. 80–83, 88, 1951.

Better equipment, techniques, client-contractor relations, and personnel are needed, but the first line of improvement is the geophysicist.—*M. C. R.*

12965. Thralls, H. M. Some requirements for future progress in geophysical prospecting: World Petroleum, v. 22, no. 3, pp. 50–51, 94, 1951.

Management must obtain a better understanding of geophysical work and problems and the geophysicist must become an expert geologist or have an expert geologist as consultant if rapid progress is to be made.—*M. C. R.*

12966. Kelly, S. F. The rise of geophysics: Canadian Min. Jour., v. 71, no. 7, pp. 47–53, 1950.

Geophysics is defined as "the integrated application of the disciplines of physics, chemistry, and geology, to the solution of problems involving the materials of our earth, their nature, their movements and changes in energy states, and their transformations". The historical summary which follows is devoted chiefly to the instruments and methods of geophysical prospecting.—*M. C. R.*

12967. Neuman, L. J. New developments in geophysical prospecting: World Oil, v. 132, no. 5, pp. 90, 94, 96, 1951.

Among the developments briefly summarized are the following: in reflection seismic exploration, the use of pressure-type detectors mounted in cables and towed at some level above the bottom in water-covered areas, the use of automatic volume controls, and detonation of changes in air: in gravity meter exploration, the use of diving bells and remote-controlled and automatic-levelling and reading devices in surveys of water-covered areas; in magnetic surveys, the development of instruments that can be installed in the wing or tail of a plane and the use of multilevel surveys.—*M. C. R.*

12968. Anden, J. B. The bearing of geology on multipurpose projects: Indian Sci. Cong., 38th, Bangalore, 44 pp., 1951.

This is the presidential address before the Section of Geology and Geography of the Indian Science Congress of 1951. Geologic factors related to projected engineering structures, especially hydraulic dams, are discussed. One important factor to be considered is the great seismicity of many sites, especially in the Himalayas.—*S. T. V.*

12969. Eckhardt, E. A. Geophysical activity in 1950: Geophysics, v. 16, no. 3, pp. 391–400, 1951.

In the United States the decline of seismic and gravity operations by the oil industry was reversed, although the total amount of activity was less than for 1949. In the world total the lower figures for the United States are balanced by increased activity elsewhere, notably in Canada and Europe, with an estimated $205,000,000 spent on geophysical research and development. Expenditures in mining geophysics, which were between 1 and 2 percent of the oil industry's total for the same period seem to have decreased. Emphasis has shifted from magnetic to electrical methods with self-potential and electromagnetic methods showing large increases.—*E. K.*

12970. Kelly, S. F. Geophysics: Min. Eng., v. 190, no. 2, pp. 136–140, 1951.

A review of geophysical exploration activity in different parts of the world during 1950.—*M. C. R.*

12971. Saskatchewan Department of Natural Resources. Part I Schedule of wells drilled for oil and gas to 1951, Part II Exploration, drilling and production data to 1951; 129 pp., Regina, Thos. H. McConica, King's Printer, 1951.

Geophysical exploration for the years 1948–1950 in Saskatchewan totaled approximately 21 million acres by gravity meter survey, 11 million acres by airborne magnetometer, 10 million acres by seismograph and 2½ million by ground magnetometer. Lists of wells, tables of production and geologic data, maps and graphs comprise most of the report.—*L. E. B.*

12972. Kastrop, J. E. Geophysical costs outrun prices: World Oil, v. 132, no. 6, pp. 55–58, 1951.

A survey of the operating costs and revenue of geophysical companies specializing in seismograph exploration.—*M. C. R.*

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12973. Rosairie, E. E. Studies in non-structural petroleum prospecting. 1, A non-structural working hypothesis for petroleum prospecting: Geophysics, v. 16, no. 3, pp. 456–467, 1951.

Nonstructural petroleum prospecting is meant to be more general than structural petroleum prospecting. This hypothesis postulates that anomalies of possible significance may originate not only in structure but also in stratigraphic variations associated with petroleum accumulation, with complete gradation between the two depending on the relative magnitude of the two effects. Resolution of anomalies by the nonstructural hypothesis depends on their identification as pure structural, pure stratigraphic, or mixed, and a working knowledge of two subhypotheses, the "special structural" and "special stratigraphic" hypotheses which are outlined.—*M. C. R.*

12974. Smith, N. J. Accuracy factors in geophysical prospecting: World Oil, v. 132, no. 5, pp. 85–88, no. 6, pp. 73–78, 1951.

Of the three major methods used in petroleum prospecting, the magnetic is least definitive, the seismic most precise, and the gravity method somewhere between. The reliability of all methods depends on the amount of related geologic and geophysical data available, instrument quality, personnel involved, and the amount of time allowed for the problem.—*M. C. R.*

12975. Krumbein, W. C. Regional stratigraphic analysis as a guide to geophysical exploration: World Oil, v. 132, no. 5, pp. 99–100, 1951.

Regional stratigraphic analysis provides information on probable areas of reservoir-rock occurrence and areas where adequate thickness and extent provide favorable conditions. Within these first-choice locations, geophysical exploration can then be used to determine structural anomalies.—*M. C. R.*

12976. Keunecke, Otto. Erzlagerstätten-Erzgeophysik [Ore deposits and mining geophysics]: Zeitschr. Erzbergbau u. Metallhüttenwesen, Band 4, Heft 5, pp. 185–189, 1951.

The development and use of geophysical exploration methods are advocated in the search for metal ores. Geophysical work should include regional exploration for geologic structures favorable for ore deposits, the simultaneous use of several different methods in the same survey, and airborne exploration, which may be the only available method in many regions.—*S. T. V.*

12977. Hager, Dorsey. Practical Oil Geology (6th Edition), 589 pp., New York, McGraw-Hill Book Co., Inc., 1951.

Chapter 9, on Geophysics, of the 6th edition of this practical handbook for oil men discusses magnetic, gravimetric, seismic and electric equipment and methods. Throughout the text frequent references are made to results of geophysical explorations.—*L. E. B.*

12978. Tiratsoo, E. N. Petroleum geology, 449 pp., London, Methuen and Co., Ltd., 1951.

This textbook has been designed to meet the needs of Honours Students at the Royal School of Mines. A section on geophysics includes a brief discussion of the standard methods of exploration.—*M. C. R.*

12979. Russell, W. L. Principles of petroleum geology, 508 pp., New York, McGraw-Hill Book Co., Inc., 1951.

This is intended as an advanced text and reference volume for petroleum geologists. Electrical and radioactivity well logging and the magnetic, gravi-

metric, electrical, and seismic methods of prospecting are discussed in four chapters.—*M. C. R.*

12980. The Institution of Civil Engineers. Civil engineering code of practice No. 1: Site investigations, 128 pp., London, 1950.

The British Institution of Civil Engineers in coooperation with other interested organizations prepared this code as recommended standard practice in investigating sites for engineering structures. It contains the basic principles of engineering geology, description of the properties of the surface layers, and the methods of their investigation. Geophysical methods, electrical, magnetic, and seismic are also included.—*S. T. V.*

12981. Wilson, J. H. Geophysical evaluation of the Marfa basin of Texas: Geophysics, v. 16, no. 3, pp. 494–498, 1951.

The Marfa basin presents a difficult exploration problem because of the lava flows at or near the surface. Gravity, magnetic, and seismic surveys have been made since 1943. A comprehensive exploration program would include aerial mapping, airborne magnetometer and radiation surveys, a gravity meter survey to outline the basin, and seismic surveys to explore anomalies indicated by other methods. Data on the density and susceptibility of typical rocks are given.—*M. C. R.*

12982. Bryan, C. L. Regional geology and geophysics of the Ark-La-Tex area: Geophysics, v. 16, no. 3, pp. 401–415, 1951.

The Ark-La-Tex area defined by the author as the 36,000 square miles in Arkansas, Louisiana and Texas bounded by the Luling-Mexia fault zone, the southern Ouachitas, the Monroe uplift and the Gulf Coastal Plain, includes three major structural features, the East Texas basin on the west, the North Louisiana basin on the east, and the Sabine uplift which separates the two basins. These features are reflected in a very general way by the trends on the regional magnetic map, with lows over the basins and a group of highs over the Sabine uplift, although the size of the magnetic features suggests variations within the basement rocks. The regional Bouguer map shows a gravity minimum parallel but west of the axis of the East Texas basins, and a gravity maximum associated with the North Louisiana basin. A pronounced gravity maximal axis over the Sabine uplift may indicate the involvement of the basement in the uplift. This uplift was active through the Cretaceous and into the Eocene, at varying rates, producing a number of unconformities, some of which become angular locally, providing stratigraphic traps for oil. Seismic reflection surveys are the most useful geophysical method in this area, as reflections are obtained from many of these unconformities, even below the Mesozoic, but there has been a tendency to ignore valuable information below known producing zones.

The Ark-La-Tex area has produced four and a half billion barrels of oil in the past 45 years, principally from anticlinal structures. There is only one possible instance of association with a salt dome, although there are 33 known shallow piercement domes. In spite of the presence of salt throughout the area, these domes are concentrated in the two basins, where overburden and salt thickness may have been most favorable. The absence of oil may be only apparent, as exploration of the domes has been very inadequate, the oil may have escaped through fractures produced by the salt movement, or the domes were formed so late that the oil had already accumulated elsewhere.—*E. K.*

12983. Jones, C. T. and Mason, S. L. Exploración marina en el Golfo de México [Marine exploration in the Gulf of Mexico]: Asociación Mexicana Geologos Petroleros Bol., v. 2, no. 10, pp. 589–598, 1950.

Exploration operations in the Gulf of Mexico are described briefly. Illustrations show typical anomalies, methods of exploration and exploitation and distribution of offshore activities as of September 1, 1948.—*M. C. R.*

12984. Johnson, W. E. and Breston, J. R.—Directional permeability measurements on oil sandstones from various states: Producers Monthly, v. 15, no. 4, pp. 10–23, 1951.

Measurements on core samples from oil pools in Pennsylvania, New York, Ohio, Kansas, and Oklahoma indicate that consistent trends of directional permeability exist in some but not all sandstone reservoirs. By orienting the samples either by drill pipe or magnetic orientation, the geographic direction of maximum permeability may be measured. The former method was found more accurate in the Bradford field. It is suggested that directional permeability may have some value in prospecting and exploration work.—*M. C. R.*

GRAVITY METHODS

12985. Haalck, Hans. Über die zweckmässigste Form der Anwendung der Eötvösschen Dredwaage und der Bearbeitung ihrer Messergebnisse [The most advantageous use of the Eötvös torsion balance and the processing of the data]: Gerlands Beitr. Geophysik, Band 62, Heft 1, pp. 57–73, 1950.

A modification of the torsion balance in which the balance is built with two mutually perpendicular frames, and several changes in the method of processing the data of the survey are suggested. In the calculations, determinations of curvature may be omitted, but the derivatives W_{xz} and W_{yz} should be determined with high precision, using graphical interpolation. From these values the derivative W_{zzz} may be computed from $\delta W_{xz}/\delta x+\delta W_{yz}/\delta y=-W_{zzz}$. The distribution of disturbing masses may be determined from the isoanomalies of W_z and W_{zzz} as the disturbing effect of a mass on W_z varies with the second power of depth and with the fourth power on W_{zzz}. Masses lying near the surface are then indicated by W_{zzz} and those at greater depth by W_z. An example from a survey over a salt dome in Hohensalza, Germany [Inowrocław, Poland] illustrates the procedure.—*S. T. V.*

12986. Nature. Concealed coalfields of the Midlands: v. 166, no. 4221, pp. 505–506, 1950.

A discussion on the concealed coalfields of the Midlands at the British Association meeting in Birmingham included an account by G. M. Lees of geologic deductions from geophysical work of the Anglo-Iranian Oil Co. Gravimeter surveys indicated several gravity lows which persisted after allowance was made for known and estimated thicknesses of Mesozoic rocks. On the basis of the known association of gravity lows with coal basins of the Kent and Bristol fields, the gravity lows in a belt south of Worcester and in areas near Oxford, Redhill, and in the Thames estuary were regarded as indicating other Coal Measure basins. In some areas the gravity surveys were followed by seismic work, the results of which seemed to support the interpretation of the gravity data.—*M. C. R.*

MAGNETIC METHODS

12987. Haalck, Hans. Prinzip und theorie einer für besondere Aufgaben der praktischen Geophysik zweckmässigen Feldwaagenkombination [The principle and theory of a combination magnetic field balance particularly adapted to special problems of applied geophysics]: Gerlands Beitr. Geophysik, Band 61, Heft 4, pp. 235–239, 1950.

While the Schmidt magnetic balance is usually the best instrument in prospecting for magnetic ores, it is not completely satisfactory when the ores are found in numerous small lodes or when disturbing influences such as electric railways or industrial installations are found in the surveyed area. An instrument of a new design, but built on the well-known principles, is suggested. This consists of two identical horizontal balances placed one over the other in the same vertical plane and so adjusted that in an undisturbed geomagnetic field the system points to zero when initially oscillating in planes at angles of about +45° and —45° with the magnetic meridian. When placed in a magnetically disturbed field the indications of the balances in the same positions of oscillation are slightly different, making the determination of the direction toward the disturbing mass possible. The indications of the new instrument are independent of temperature changes, and diurnal variations. The attainable accuracy of the suggested design is said to be 1–2 gammas.—*S. T. V.*

12988. Meisser, Otto. Die Spannbandmagnetnadel [The torsionally suspended magnetic needle]: Geofis. Pura e Appl., v. 19, fasc. 1–2, pp. 60–74, 1951.

A comparison is made of the functioning of a magnetic needle supported on a jewel bearing and a needle suspended between two torsionally strained wires. The frictional moment and the limit of sensitivity are computed for both forms of suspension, and in all respects the first design is inferior. Another advantage of the latter design is the possibility of constructing zero reading instruments. The method of adjustment using permanent magnets or Helmholtz coil is described. The period of natural oscillation of such a needle is determined assuming the torsion wire to be composed of different materials such as quartz, brass, steel, tantalum, or tungsten. An extended discussion of the magnetic moments and other characteristics of permanent magnetic materials to be used as auxiliary deflection magnets is included. The computed characteristics for various shapes and materials of the magnets are given in graphs, optimum parameters for the design of these instruments are determined, and their calibration discussed.—*S. T. V.*

12989. Meisser, Otto and Jung, H. Magnetische Prospektorgeräte [Magnetic prospecting instruments]: Geofis. Pura e Appl., v. 19, fasc. 1–2, pp. 75–91, 1951.

An accuracy of 0.1 percent is sufficient in magnetic instruments used by exploration geologists and mining engineers. The sensitivity of such an instrument makes it possible to neglect diurnal variation and still be adequate for localization of disturbing magnetic masses. A new type of universal magnetometer has been developed, using a torsionally supported magnet needle, as suggested by Meisser. It is built as a zero indicating instrument; the compensating magnetic field is produced by auxiliary magnets, formed of special alloys, characterized by high stability of magnetic properties and low temperature coefficient. To make possible use of the name needle, oscillating horizontally, for measurement of both the horizontal and the vertical components of geomagnetic field, special deflectors are employed, as suggested by Lamont. The ver-

tical component Z induces in the deflectors magnetic moments proportional with the intensity of Z. Therefore the deflection of the needle again measures its intensity with a new calibration constant. A detailed discussion of the functioning of deflectors is presented with several graphs and tables, and the construction of the instrument is described in detail.—*S. T. V.*

12990. Hawkes, H. E. Magnetic exploration for chromite: U. S. Geol. Survey Bull. 973–A, pp. 1–21, 1951.

Chromite, $(Mg,Fe)O\cdot(Cr,Fe,Al)_2O_3$, is a member of a mineralogic group which contains magnetite, $(FeO\cdot Fe_2O_3)$, magnesiochromite, $(MgO\cdot Cr_2O_3)$, spinel, $(MgO\cdot Al_2O_3)$, and ferrochromite, $(FeO\cdot Cr_2O_3)$. Although the group is not a complete isomorphous series, the composition of chromite may be regarded as varying from magnetite to magnesiochromite and spinel with some substitution of FeO for MgO. The magnetic susceptibility of chromite varies from practically nil, for chromite approaching the composition of magnesiochromite, to high values for chromite approaching the composition of magnetite and shows a rough parallelism between increasing magnetic susceptibility and increasing iron content. Magnetic prospecting is of little help in the direct location of high-grade, nonmagnetic chromite, but may be useful in locating ore containing magnetic chromite, generally considered low grade because of its high iron content. Under favorable conditions magnetic surveys may be helpful in prospecting for chromite by supplying geologic information such as the location of favorable host rocks or ore-bearing structures or zones. However, although magnetic methods seem to give some promise in certain areas, they cannot be considered a generally successful means of locating chromite and to date there is no report of a discovery of commercial-grade chromite directly attributable to a magnetic survey.—*J. R. B.*

12991. Canada Geological Survey. Ground Magnetic Survey, Preliminary Maps of the Province of Quebec, Abitibi County. Scale 1 inch=1,000 feet, contour interval=100 gammas: Dept. of Mines and Resources, Mines, Forests and Sci. Services Branch, 1948 and 1949.

Magnetic maps of the following quadrangles have been published as Geophysical Papers 3 and 4; G. P. 3, Northern Dubuisson (2 sheets) and G. P. 4, Southwest Vasson; and as Papers 13, 1, and 11; 48–13, Louvicourt, (4 sheets), 49–1, Southeast Dubuisson, and 49–11, Southeast Vassan. The magnetic information on these blue line maps was supplied through the courtesy of the individual property owners, and compiled by George Shaw and D. MacCallum. These areas have been geologically mapped on the same scale (1 inch=1,000 feet). An attempt has been made to reduce all surveys to a common magnetic base, but individual surveys have not otherwise been changed.—*L. E. B.*

12992. Cornell, J. H. Airborne aids to oil development in Canada: World Petroleum, v. 22, no. 4, pp. 56–57, 1951.

Among the aids described are aerial photography for mapping; the airborne profile recorder, a refinement of the radar altimeter, which produces an elevation profile accurate to within 10 feet; the use of helicopters for air surveying and geophysical exploration; and the airborne magnetometer.—*M. C. R.*

12993. Jensen, Homer. Aerial exploration: Min. Cong. Jour., v. 37, no. 2, pp. 106–107, 1951.

The advantages, limitations, and special applications of the airborne magnetometer are discussed. Advantages noted are great sensitivity (a recent mag-

netic map was made with a 1-gamma contour interval); reliability (surveys have been made involving 60 consecutive days of flight operation and 10,000 traverse miles per month); cost ranges from $7–$25 per linear mile of traverse; instrument gives a continuous record, rapid response, and is drift free; the survey is conclusive; "the whole answer is achieved in one operation". Limitations due to the generalization of information resulting from elevation are partially compensated by flying at an altitude of 500 feet. This altitude effect aids in showing a truer location of a large ore body than does data taken at the surface. Aeromagnetic surveys for ores are most economically applied when a susceptibility difference exists between the ore and surrounding rock. High-precision aeromagnetic maps aid in solving structural problems and will show dikes, intrusions, faults, and folds. More than 5 million square miles have been surveyed in four years of commercial operation—*J. L. M.*

12994. O'Malley, T. M. Airborne magnetometer: Eng. Jour., v. 34, no. 3, pp. 177–179, 1951.

The airborne magnetometer, first developed as a submarine detector, was modified for geophysical use and first flown in 1941. The geophysical equipment consists of a continuously recording magnetometer, a stabilized continuous strip camera, and a recording radio altimeter. Parallel traverses are flown at an altitude of 500 feet and the three records obtained are worked and numbered simultaneously. Aerial photographs are used for flight guidance but Shoran is used under some circumstances. A series of overlapping closed loops and tie lines are flown as survey base lines so that no measurement is more than 1½ minutes from a control point. Diurnal variation is measured on the ground while surveys are being made and flights are cancelled if the variation is large. The location coordinating works are plotted from strip film, to photographs, to base maps, and values scaled from the magnetic profile are contoured. Surveys have been made to search for magnetic ores, nonmagnetic ores in magnetic host rock, and to solve structural problems including dykes, intrusions, faults and folds. A byproduct of the surveys is the incidental aerial photographs which may be taken and used to prepare topographic maps and controlled mosaics for subsequent ground exploration surveys and photogeologic interpretations.—*J. L. M.*

12995. Lundberg, Hans and Wilson, B. T. Airborne geophysical methods make further strides in 1950: Eng. and Min. Jour., v. 152, no. 2, pp. 106–107, 1951.

The application of geophysical methods to mineral exploration has developed two recent trends. The first, supported by exploration departments of the larger mining companies, contends that the company geological staff should be supplemented by at least one member qualified to make geophysical surveys in small areas as needed, while the survey of larger areas would be conducted by established geophysical firms. The second trend is that all geophysical exploration should be accomplished by the specialized geophysical firms and firms retained as consultants after completion of the survey to revise the interpretation as new geologic information is found. The reasons offered for the geophysical companies conducting the surveys are that they are better qualified to carry out the work and interpret the results as well as having modern equipment and more varied methods available. Another trend noted is placing the responsibility for development of mining exploration geophysical techniques on Government organizations. The results have been favorable but many believe

there is danger of Government work encroaching into the private development field. Many advances were made in 1950 in instrumentation and methods in prospecting for sulfides, oil structures, and radioactive minerals. Airborne methods for radioactive detection were employed using Geiger-Müller counter and scintilometer equipment.—*J. L. M.*

12996. O'Malley, T. M. Alberta flying magnetometer survey completed: World Oil, v. 132, no. 6, pp. 235–237, 1951.

An illustrated account of operations during Canadian Aero Services aeromagnetic survey of 16 million acres in northwestern Canada.—*M. C. R.*

12997. U. S. Geological Survey. Total intensity aeromagnetic maps of Missouri. Geophysical Investigations Maps GP77–GP81. Scale 2 inches=1 mile, contour interval=50 gammas, 1951.

A continuation of the series listed in Geophys. Abstracts 11818 and 12254. Maps of Berryman quadrangle, Sullivan quadrangle and part of Union quadrangle, part of Marquand quadrangle, part of Higdon quadrangle and part of Weingarten quadrangle, by William Dempsey and Jack Meuschke, have been issued.—*L. E. B.*

12998. U. S. Geological Survey. Total intensity aeromagnetic maps of Indiana. Geophysical Investigations Maps GP82–GP90. Scale 1 inch=1 mile, contour interval=10 gammas, 1951.

A continuation of the series listed in Geophys. Abstracts 11816, 12253, 12634, and 12820. Maps of Bartholomew, Dearborn, Fayette, Jackson, Jay, Monroe, Ohio, Rush and Switzerland Counties by J. R. Henderson have been issued.—*L. E. B.*

12999. Canada Geological Survey. Preliminary aeromagnetic map of the Province of New Brunswick. Scale 1 inch=1 mile, contour interval=10, 20 or 100 gammas, depending on the intensity of the anomaly: Dept. of Mines and Tech. Surveys, 1950.

Paper 50–38, Point Verte quadrangle in Restigouche and Gloucester Counties, on Chaleur Bay, in the Gulf of St. Lawrence, shows the total magnetic intensity at about 500 feet above ground level by means of contour lines on a blue line map.—*L. E. B.*

13000. Canada Geological Survey. Aeromagnetic maps of the Province of Ontario. Scale 1 inch=1 mile, contour interval=20, 100, and 500 gammas, depending on the intensity of the anomaly: Department of Mines and Resources. 1951.

In 1950, the Geological Survey of Canada operated airborne magnetometers over 84,823 miles of profiles, covering an estimated 81,685 square miles of territory, the greatest amount yet covered in one season.

National Topographical Series quadrangle maps have been issued overprinted with aeromagnetic data. The total magnetic intensity at about 1,000 feet above ground level is shown by contour lines on the following maps: G. P. 7, sheet 31 F/8, Arnprior; G. P. 8, sheet G/5, Ottawa; G. P. 9, sheet 31 G/4, Kemptville; G. P. 10, sheet 31 B/13, Merrickville; G. P. 11, sheet 31 C/16, Perth; G. P. 12, 31 F/1, Carleton Place; G. P. 13, 31 C/5 Campbellford; G. P. 14, 31 C/12, Bannockburn; G. P. 15, 31 F/4, Bancroft; and G. P. 16, 31 C/13, Coe Hill.

According to the Canadian Geophysical Bulletin, (vol. 4, no. 3) an anomaly was disclosed on the Campbellford sheet which has since been drilled and found to be due to a body of commerical ore.—*L. E. B.*

13001. Canada Geological Survey. Aeromagnetic maps of Northwest Territories. Scale 1 inch=1 mile, contour interval=10, 20, 100, or 500 gammas, depending on the intensity of the anomaly: Dept. of Mines and Tech. Surveys. 1951.

Aeromagnetic maps of three quadrangles in the District of MacKenzie, on the north shore of Great Slave Lake have been published as the following Geophysics Papers: 39 G, Yellowknife Bay; 40 G, Prosperous Lake; and 41 G, Quyta Lake. The total magnetic intensity at about 500 feet above ground level is shown by contour lines on these blue line maps.—*L. E. B.*

13002. Canada Geological Survey. Aeromagnetic maps of the Province of Alberta. Scale 1 inch=1 mile, contour interval=5, 25, 100, or 500 gammas, depending on the intensity of the anomaly: Dept. of Mines and Tech. Surveys. 1951.

Aeromagnetic maps of the eleven quadrangles in the Edmonton, Alberta region have been published as the following Geophysics Papers: 24, Morinville; 25, Redwater; 27, Willingdon; 28, Edmonton East; 29, Edmonton West; 30, Snake Hills; 31, Two Hills; 32, Leduc; 33, Cooking Lake; 34, Mundare; and 35, Astotin Lake. The total magnetic intensity at about 1,000 feet above ground level is shown by contour lines on these blue line maps.—*L. E. B.*

13003. Canada Geological Survey. Preliminary Aeromagnetic maps of Quebec Province. Scale 1 inch=1 mile, contour interval=10, 20, 100, or 500 gammas, depending on the intensity of the anomaly: Dept. of Mines and Tech. Surveys. 1950 and 1951.

Papers of the following quadrangles are blue line maps in an area northwest of Ottawa: 50–30, Macamic; 50–31, Desboues; 50–33, Taschereau, all in Abitibi County; 50–35, Clericy, in Abitibi and Temiscamingue Counties, and 51–2, La Motte in Abitibi County. The total magnetic intensity at about 1,000 feet above ground level is shown by contour lines.—*L. E. B.*

13004. Canada Geological Survey. Aeromagnetic maps of the Province of Quebec, Abitibi County. Scale 1 inch=1 mile, contour interval=10, 20, 100, or 500 gammas, depending on the intensity of the anomaly: Dept. of Mines and Tech. Surveys. 1951.

Geophysics Papers 36 and 37, of Fournière and Amos quadrangles in Abitibi County, northwest of Ottawa, are blue line maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level.—*L. E. B.*

13005. Canada Geological Survey. Aeromagnetic maps of Province of New Brunswick. Scale 1 inch=1 mile, contour interval=10, 20, 100, or 500 gammas, depending on the intensity of the anomaly: Dept. of Mines and Tech. Surveys. 1951.

Geophysics Paper 57, Bathurst quadrangle, in Gloucester and Restigouche Counties, on Chaleur Bay in the Gulf of St. Lawrence, is a blue line map with contour lines showing the total magnetic intensity at about 1,000 feet above ground level, while Geophysics Paper 59, Tetagouche Lakes quadrangle, in Restigouche, Gloucester, and Northumberland Counties, shows the total magnetic intensity at about 500 feet above ground level.—*L. E. B.*

13006. Canada Geological Survey. Aeromagnetic maps of the Province of Quebec. Scale 1 inch=1 mile, contour interval=10, 20, 100, and 500 gammas, depending on the intensity of the anomaly: Dept. of Mines and Tech. Surveys. 1951.

Geophysics papers of the following quadrangles, 38 G, Kanasuta River, in Abitibi and Temiscamingue Counties; 42 G, Opasatica, in Temiscamingue County, and 44 G, Palmarolle, in Abitibi County, are blue line maps showing by contour lines the total magnetic intensity at about 1,000 feet above ground level.—*L. E. B.*

13007. Canada Geological Survey. Aeromagnetic map of Province of Ontario. Scale 1 inch=1 mile, contour interval=10, 20, 100, or 500 gammas, depending on the intensity of the anomaly; Dept. of Mines and Tech. Surveys, 1951.

Geophysics Paper 47, Larder Lake quadrangle, District of Timiskaming, Ontario, is a blue line map with contour lines showing the total magnetic intensity at about 1,000 feet above ground level.—*L. E. B.*

SEISMIC METHODS

13008. Krumbein, W. C. Some relations among sedimentation, stratigraphy, and seismic exploration: Am. Assoc. Petroleum Geologists Bull., v. 35, no. 7, pp. 1505–1522, 1951.

This is the 24th annual address of the president of the Society of Economic Paleontologists and Mineralogists. The relations between seismic velocity data and conventional sedimentary-stratigraphic principles are reviewed. Investigation of velocity variations and the sedimentary factors which control them and the extension of areal analysis to include patterns of rock density, elasticity, and other physical properties should be of fundamental importance to both geologists and geophysicists.—*M. C. R.*

13009. Lyons, P. L. A seismic reflection quality map of the United States: Geophysics, v. 16, no. 3, pp. 506–510, 1951.

The map presented designates as good, fair, or "poor to NG" all sedimentary areas of the United States with respect to reflection quality in seismic exploration. Of the possible reflection areas, only 17 percent yield good reflections. Areas of lava flows constitute the worst areas, and those with near-surface high velocity beds are also poor. In general, Paleozoic areas are better than Mesozoic, which in turn are better than Cenozoic.—*M. C. R.*

13010. Daly, J. W. Velocity information needed for seismic interpretation: World Oil, v. 132, no. 7, pp. 86–88, 1951.

Velocity data are needed for identification of reflections with lithologic or time stratigraphic changes, for correlation between wells, and to aid in detailed interpretations of structures.—*M. C. R.*

13011. Press, Frank and Ewing, Maurice. Ground roll coupling to atmospheric compressional waves: Geophysics, v. 16, no. 3, pp. 416–430, 1951.

A theoretical treatment of ground roll in a layered medium shows that effective coupling exists for surface waves whose phase velocity equals the speed of sound in air. In hole shots a geophone records ground roll as an orderly sequence of dispersive Rayleigh waves, but an air microphone records a constant frequency train following the abrupt arrival transmitted with the speed of sound in air.

In air shots, however, the ground roll recorded by a geophone predominates after the arrival of the direct air wave and then only as a train having a constant frequency and phase velocity. The character of the record is independent of the height of charge above the ground surface. If the Rayleigh wave velocity exceeds the speed of sound in air, coupling cannot exist, and the ground roll is essentially the same for both air and hole shots. The paper includes samples of records obtained in field tests that corroborated these results.—*D. F. B.*

13012. Dyk, Karl, and Eisler, J. D. A study of the influence of background noise on reflection picking: Geophysics, v. 16, no. 3, pp. 450–455, 1951.

The ability of trained interpretational personnel to pick reflections was determined by using multitrace records of a controllable amount of synthetic reflection energy superimposed upon random ground unrest. The number of correct picks is inversely related to the signal-to-noise ratio, but visual recognition is possible for ratios as low as —2db to —6db.—*D. F. B.*

13013. Girard, H. J. Miniature seismograph features performance plus portability: Oil and Gas Jour., v. 50, no. 3, pp. 96–97, 128–129, 1951.

An illustrated account of the use of Southwestern Industrial Electronic Co.'s P–11 equipment by various geophysical parties, chiefly in Canada.—*M. C. R.*

13014. World Petroleum. Seismic oil prospecting with an air-cleaned drill: v. 22, no. 3, pp. 46–48, 1951.

Substitution of air for water in drill shot holes has been successfully made in dry, cold, and cavernous areas. If air in sufficient volume and at sufficient pressure is forced down the drill pipe and across the teeth of the rotary rock bits, drill cuttings may be brought to the surface from shot holes 150 feet or more deep.—*M. C. R.*

13015. Stormont, D. H. New seismic test—Oil companies to resume offshore exploration after developing black-powder methods to reduce fish kill: Oil and Gas Jour., v. 50, no. 13, p. 40, 1951.

In the past seismic work in shallow waters off southern California, large numbers of fish were killed. Recent experiments show that by using a slow-burning black powder with its pressure peak of small amplitude, in place of dynamite with its sharp, abrupt and high pressure peak, there is no lethal effect on fish. Permit has been granted by the California Fish and Game Commission to resume seismic operations, as a result of these experiments.—*L. E. B.*

13016. Harris, Sidon. Exploring for Pennsylvania reef reserves in west Texas: World Petroleum, v. 22, no. 3, pp. 40–42, 1951.

Exploration during the past few years has defined a broad reef trend extending from the Jameson area in Cobe County in a generally northwest direction to Hockley County. Reef pools have also been found in the eastern part of the Permian basin. Many of these reefs have been discovered by reflection seismic surveys. Detection of reefs depends on use of modern equipment, an intensive shooting pattern, and careful working of data.—*M. C. R.*

13017. Closs, Hans. Die geophysikalosche Erschliessung des Emslandes. [Geophysical exploration of the Ems basin]: Erdöl u. Kohle, Jahrg. 4, Heft 5, pp. 250–259, 1951.

Exploration of the Ems basin in northwestern Germany has been primarily directed toward investigation of salt domes. Results of gravity surveys have

been previously discussed. (*See* Geophys. Abstract 12245.) In the present paper, the results of seismic surveys by both government institutions and private companies are reviewed. A geologic map and several profiles are included.—*S. T. V.*

13018. Szurovy, G. Geological structure of the southern part of the great Hungarian plain: Historico-Naturales Mus. Nationalis Annales, v. 41, no. 1, pp. 1–24, 1948.

A gravity map of the southern part of the plain has been compiled from torsion balance measurements made at various times since 1908. Twenty-seven gravity maxima and 20 minima were found. Most of the maxima have been interpreted as elevations of the basement rock. The more conspicuous structures were checked by seismic reflection and refraction surveys. In general, the seismic measurements confirmed the gravity interpretations.—*M. C. R.*

13019. Cantos Figuerola, José. Investigación sismica en Baños de la Encina (Jaén) [Seismic exploration in Baños de la Encina (Jaén)]: Rev. Geofís., v. 10, no. 37, pp. 1–19, 1951.

In a study of the hydrological possibilities of the region between the Río Guadiela and the Baños de La Encina, seismic methods were used to determine subsurface stratification. Eleven profiles of a total length of 13,500 m were made at a distance about 900 m apart. The characteristic velocities of the formations in the geologic profiles are as follows: alluvium, 1,100 to 1,300 m per sec; marl and sandstone, 1,800 to 2,300 m per sec; Triassic sandstone, 2,000 to 3,400 m per sec, and granite, 4,700 to 6,500 m per sec.—*S. T. V.*

13020. Kato, Yoshio, Shoji, Rikii, and Noritomi, Kazuo. The report of the prospecting of the deep underground structure by the seismic method: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 1, no. 2, pp 100–102, 1949.

A refraction seismic survey was made of the deep (about 400 m) underground structure at the southern end of the Jōban coal fields [Jōban-tanden] in Isohara district [Isohara-machi], Ibaraki-ken. Coal-bearing beds at the base of the Tertiary lie uncomformably on the granite or schist basement rocks. From the time-distance curves along four profiles it was possible to make a contour map of the basement.—*R. G. H.*

13021. Kato, Yoshio, and Shoji, Rikii. Prospecting of the underground structure of the new volcano "Showashinzan" by the seismic method: Bull. volcanologique, ser. 2, tome 10, pp. 129–130, 1950.

Seismic prospecting showed that the underground structure of the new volcano "Showashinzan" dips downward 3° to 8° in all directions from the central dome. This eliminates the possibility of a cryptodome at depths less than 150 meters.—*D. F. B.*

13022. Süsstrunk, A. Sondage du glacier par la méthode sismique [Seismic sounding of glaciers]: La Houille Blanche, 6^{me} année, no. A, pp. 309–318, 1951.

Seismic studies of glaciers have been made in Switzerland using a portable seismograph designed by Kreis and since 1949 a Century 6-channel instrument. Maps and sections show the results of measurements on the Gorner glacier, [Gornergletscher], Mont Collon, and the Mer de Glace (Mont Blanc). On the Mont Collon glacier, layers of fossil ice separated by an alluvial layer 4 to 10 m thick were discovered. The Mer de Glace was found to have a V-shaped cross

section. Variations in velocity in this glacier were attributed to the presence of crevasses.—*M. C. R.*

13023. Leet, L. D. Vibration studies—Blasting and rock bursts: Canadian Min. Met. Bull., v. 44, no. 470, pp. 415–418, 1951.

A review of work by the Bureau of Mines, F. J. Crandell and Leet on vibrations from blasting, and studies of rock bursts at Kirkland Lake, Ontario and at the Witwatersrand.—*M. C. R.*

13024. Fish, B. G. Fundamental considerations of seismic vibrations from blasting: Mine and Quarry Eng., v. 17, no. 4, pp. 111–114, 1951.

This first article of a series reviews the generation and measurement of vibrations from blasting and practical problems arising therefrom in mining and quarrying operations. Morris' equation $A=k\sqrt{E}/d$ (where A is the maximum amplitude in inches, E the weight of explosive in pounds, d the distance in feet and k a constant) has been found to give reasonably consistent results. Values of k vary from one site to another, but fall between 25 and 400, chiefly between 50 and 150.—*M. C. R.*

13025. Fish, B. G. Effect on installations of seismic vibrations from blasting: Mine and Quarry Eng., v. 17, no. 5, pp. 145–148, 1951.

The effect of vibrations on such installations as buildings, shafts, and underground excavations is discussed. Morris has calculated the horizontal amplitudes at the base of simple brick piers sufficient to cause cracking of pointing in brickwork as 15×10^{-3} in. This figure is modified by an appropriate "psychological factor" depending on the status of the persons involved. For property of retired persons of means, the limiting amplitude is reduced to 3.75×10^{-3} in. The maximum instantaneous charge to produce these amplitudes is calculated from $A=k\sqrt{E}/d$ and a table given for k equal to 50, 100, 150, 200, 250, and 300.—*M. C. R.*

13026. Fish, B. G. Seismic vibrations from blasting. Reduction by means of short delay initiation. Mine and Quarry Eng., v. 17, no. 6, pp. 189–192, 1951.

Experiments have demonstrated the success of short-period-delay blasts, initiated by detonators and sequence switches, in reducing vibrations. By deriving an equivalent weight ratio, the ratio between the weight of charge fired instantaneously and the weight fired on each individual delay in a series producing the same maximum amplitude, an empirical rule was established that two-thirds of an instantaneous charge can be fired on each delay.—*M. C. R.*

13027. Fish, B. G. Seismic vibrations from blasting. Solution of the problem in specific cases: Mine and Quarry Eng., v. 17, no. 7, pp. 217–222, 1951.

Type situations in which vibrations from blasting must be evaluated are described, as well as instrumental methods of so doing.—*M. C. R.*

ELECTRICAL METHODS

13028. Ito, Ichiro. Effects of anisotropy of media on the self-potential curves of electrical prospecting: Kyoto Univ. Fac. Engineering Mem. v. 12, no. 5, pp. 105–119, 1950.

Formulas are derived for the potential generated by a spontaneously polarized ore body of the rod type in a single anisotropic medium. The degree of anisotropy

is represented by α the ratio of the resistivity in the horizontal direction to that in the vertical. A transformation of coordinates is made which leaves the vertical coordinate unchanged and which expands or contracts the horizontal coordinates according as $\sqrt{\alpha}$ is greater than or less than unity. In the new coordinate system the potential satisfies the Laplace equation for a homogeneous isotropic medium. Thus the solution already known for the isotropic medium is available for solving the problem of an anisotropic medium. The problem of an anisotropic medium with two horizontal strata is also treated using similar linear transformations of coordinates. Again the potential satisfies Laplace's equation for isotropic media. The transformations together with formulas for the potential satisfying boundary conditions on the interface facilitate the calculation of the potential at any point.

Numerical examples are given for different thicknesses of the strata and for different portions of the point source. Graphs are computed for various degrees of anisotropy of the ground. The results show that when the anisotropy coefficients are much larger or smaller than unity, there are considerable effects on the surface potential curve.—*R. G. H.* and *S. T. V.*

13029. Slichter, L. B. An electromagnetic interpretation problem in geophysics: Geophysics v. 16, no. 3, pp. 431–449, 1951.

The author discusses a theoretical problem in electromagnetic prospecting. A flat earth in which the electrical properties of the subsurface vary only with depth is subjected to an oscillating magnetic dipole above the surface with axis perpendicular to the surface. The solution for the dielectric constant and conductivity is obtained in the form of Taylor's series whose coefficients may be derived from known values of the horizontal or vertical components of the magnetic intensity at the surface. The log of the permeability function is given as the first integral of a Taylor's series. The evaluation of the permeability and of the dielectric constant requires observations at two frequencies while the conductivity is determined by observations at a single frequency. The mutual dependence of the vertical and horizontal components of magnetic intensity above the surface is demonstrated by an equation which is independent of the electrical characteristics of the ground. The author concludes that the method is feasible only if the number of terms in the power series solutions for the electrical properties is small. If the function is oscillatory, as often happens, the method is impractical.—*I. Z.*

13030. Keunecke, Otto. Die Bedeutung geoelektrischer Untersuchungen für die Aufsuchung und Erschliessung von Erzlagerstätten [The value of geoelectrical investigations in exploration and discovery of ore deposits]: Zeitschr. Erzbergbau u. Metallhüttenwesen, Band 4, Heft 7, pp. 257–265, and Heft 8, pp. 307–318, 1951.

Electrical methods are usually used in prospecting for nonferrous deposits because of the greater electrical conductivity of many sulfide ores. One difficulty results from the fact that porous strata, containing water, may have even greater conductivity than ores. The electromagnetic induction procedure is believed to be the best method, especially the modification of the original Elbaf method. A horizontal circular emitter of rubber-insulated cable forms a coil 20 to 30 meters in diameter through which alternating current of about 500 cycles per sec is pulsating. The power used may be as much as 1 or 2 kw. The coil is placed horizontally on the ground, inducing in it an alternating elliptically-polarized electromagnetic field. The intensity of this field is measured along radial profiles for distances of 800 to 1,000 meters. From the field pattern,

it is possible to detect anomalies caused by underground deposits. The depth of penetration may be as much as 500 meters. Several examples from different countries are included, as well as directions on the best use of the method and the interpretation of measurements.—*S. T. V.*

13031. Kato, Yoshio and Shoji, Rikii. New type of earth inductor and its uses for the prospecting of the underground structure: Tōhoku Univ. Sci. Repts. 5th ser., Geophysics, v. 1, no. 1, pp. 50–52, 1949.

A new type of earth inductor designed by the authors consists of a rotor, coil and a drum-shaped high-permeability magnetic core within the coil. The rotor induces an alternating electromotive force in the coil which after rectification may be read by a millivoltmeter. The magnetic field is determined by means of an auxiliary magnet of known moment and distance from the rotor producing a zero reading on the millivoltmeter. Using this instrument an area rich in magnetite was surveyed north of Abukuma [Abukuma-sammyaku]. The resulting map correlated well with the known geology.—*I. Z.*

13032. Turlygin, S. Ia and Karelina, N. A. Nonpolarizable diffusion electrodes: Akad. Nauk SSSR Doklady, tom 79, no. 6, pp. 965–968, 1951.

In studying telluric currents under different conditions, the authors experienced difficulties with existing types of nonpolarizable electrodes, especially when using them in sea water, and have worked out a new design. In these the use of protective films was eliminated, as eventual source of unstable electrical dipoles. The new electrode is designed as a reversible system, the metallic terminal of the electrode being protected against contact with the ions of other metals by a solution of its own salt, covered with a substantial layer of a gel, again containing the same salt in the same concentration, and thus made conductive. One of the possible realizations of this principle consists of a zinc rod passing through a rubber stopper and immersed at its extremity in a solution of $ZnSO_4$ contained in a long tube with corrugated walls; the end section of the tube is filled with agar-agar in which $ZnSO_4$ is dissolved. Two such electrodes were tested during six months in the field work. The potential drop across such electrodes is less than 0.1 millivolt at the temperature near the freezing. A disadvantage is the variation of potential with temperature.—*S. T. V.*

13033. Müller, Max. Eine Induktions-Impulsemethode für den Nachweis des Erdöls [An induction-impulse method for the detection of petroleum]: Geofis. Pura e Appl., v. 17, pp. 54–60, 1950.

According to the author's experiments, the electrical resistivity of rocks as a rule increases and the dielectric constant decreases under the action of alternating current in the frequency range from 20 to 10,000 cycles per second. The nature of the formation, the depth, and the wave shape of the applied current determine the changes. By varying the different controlling elements of the primary field, as suggested in the paper, any desired wave shape may be obtained. The functioning of the proposed scheme is studied theoretically and the correlation of component members determined. The author found the graphs representing the variation of the relaxation time of vertical component in the secondary impulse field to be highly characteristic of the physical properties of underground formation, especially of their water or oil content. Two graphs of data obtained from a depth of 2,000 feet are given. The author thinks that the proposed method of exploration can be used to depths of 6,000 feet. (*See* Geophys. Abstract 12274).—*S. T. V.*

13034. Fritsch, Volker. Einige geoelektrische Untersuchungen mit Gleichstrom [Some geoelectrical investigations with direct current]: Geofis. Pura e Appl., v. 14, fasc. 3–4, pp. 250–282, 1949.

The use of the electrical-resistivity method in geophysical investigations made in Austria since 1946, in connection with hydroelectrical projects, the construction of dams, and prospecting for minerals is described. Among these were the supervision of the reinforcement of foundation rocks of dams by cement injection, by measurements of the resistivity of the virgin formation, of concrete samples, and of the formation after injection. (*See* also Geophys. Abstract 13040.) In electrical sounding in regions consisting of two layers with distinct electrical properties, different arrangements of electrodes as well as electrodes in drill holes at different levels were used. The results were worked out using formulas and numerical tables derived by R. Menzel. In geoelectrical investigation of stratified formations, measurements on models were made, or the method of auxiliary electrodes employed. The final results of the investigations were compared with the findings of fifty drillings; the agreement was very good, even in different geologic conditions, such as moraine over solid rock, or quicksand over loam. It was also found that the depth of the water table could be determined quite accurately.—*S. T. V.*

13035. Gohara, Yasuma. On the prospecting for the ground water [In Japanese with English summary]: Tokyo Research Inst. Nat. Resources, Rept. 16, pp. 33–42, 1950.

The volume of pore space of soil or rocks is a fundamental factor in the presence of ground water. Porosity is primarily dependent on geologic conditions so chief consideration in prospecting for ground water is simply geologic recognition of the area. The electrical-resistivity method is useful as it indicates the apparent porosity which is determined by the volume of supplied water, atmospheric conditions, and modified by the relative difference of porosities among the successive layers.—*L. E. B.*

13036. Foster, J. W. and Buhle, M. B. An integrated geophysical and geological investigation of aquifers in glacial drift near Champaign-Urbana, Ill.: Econ. Geology, v. 46, no. 4, pp. 367–397, 1951.

Detailed geological and geophysical studies and test drilling of the glacial drift have greatly extended the proved ground-water resources of the Champaign-Urbana area. Geologic methods included mainly studies of drill cuttings. Geophysical methods included electrical-resistivity surveys on the surface and electric logging of boreholes.

These studies have shown that the glacial drift with resistivities exceeding 8,000 ohm-cm is composed of clean sand and gravel capable of yielding abundant ground water whereas deposits with resistivities between 6,000 and 8,000 ohm-cm contain enough silt or clay to make them less productive. Water is rarely found in drift with resistivities of 4,500–6,000 ohm-cm and is never found in useful amounts where the resistivity is less than 3,500 ohm-cm.

Electric logs have permitted more accurate depth determinations, qualitative determinations of permeabilities, correlation of electrical horizons and detection of thin water-bearing beds.

Glacial drift of Kansan age, which rests on bedrock in much of the Champaign-Urbana area, contains the most productive acquifers. The Illinoian drift contains moderately productive acquifers, whereas the shallow Wisconsin drift contains acquifers generally suitable only for domestic or small-scale use.—*H. R. J.*

13037. Moore, R. W. Development of geophysical methods of subsurface exploration in the field of highway construction: Highway Research Board Bull. 28, pp. 73–99, 1950.

Electrical-resistivity and seismic-refraction surveys have been conducted by the Bureau of Public Roads since 1933 to determine shallow subsurface conditions in connection with problems of highway engineering. Direct-current resistivity units and three-component seismic units especially designed for portability are used. Field surveys have been made in many parts of the United States. These have given the required information on bedrocks and on thickness and type of overburden more rapidly and cheaply and in many cases more satisfactorily than would have been possible with boreholes alone. Numerous field surveys and the interpretation of the resulting geophysical data are discussed in the report. A brief description of the theory and practice of resistivity and seismic-refraction methods is also included.—*H. R. J.*

13038. Scharon, H. L. and Cleaves, A. B. Geophysics on the Pennsylvania Turnpike: Mining Engineering, v. 3, no. 4, pp. 351–355, 1951.

Electrical resistivity surveys were made to determine depth of bedrock at 245 proposed cuts and sites of structures along the Philadelphia and western extensions of the Pennsylvania Turnpike. Selected examples are discussed to show the different geologic conditions found, including areas of limestone outcrops and sinkholes, Triassic shales and sandstones, a Triassic diabase sill, nearly horizontal Pennsylvanian shales, and Recent gravels over Pennsylvanian shales. Accuracy in determining overburden thickness, as demonstrated in 104 cut sections, is said to be approximately 1.88 ft.—*M. C. R.*

13039. Pendley, L. C. Subsurface earth exploration by electrical resistivity method: Kentucky Acad. Sci. Trans., v. 13, no. 3, pp. 189–200, 1951.

A brief description of the electrical-resistivity method for subsurface reconnaissance is given, primarily for the needs of civil engineers. Examples of resistivity curves, along with the evidence obtained from drill cores at the same sites are presented.

It is concluded that by using this method, in conjunction with some properly located drill holes, it is possible to map the subsurface conditions of large areas at a saving of both time and money; that the depth to bedrock can be determined with sufficient accuracy for general highway work; and that the amount of moisture present is the major factor in determining resistivity.—*S. T. V.*

13040. Fritsch, Volker. Die geolektrische Überprüfung von Zementinjektionen zur Verfestigung des Baregrundes [Use of geoelectrical testing of cement injections for reinforcement of the ground]: Geofis. Pura e Appl., v. 19, fasc. 1–2, pp. 92–99, 1951.

During the construction of the Limberg dam in Austria, it was discovered that the bedrock around the foundation had many deep crevasses. For reinforcement these crevasses were filled with liquid cement. The extent of the crevasses and their filling may be determined by measuring the electrical resistivity of the ground before the injection of the mortar and during its setting. If the electrical properties of the mortar are known from laboratory determinations, the effectiveness of the grouting may be evaluated.—*M. C. R.*

13041. Ball, H. W. and Garson, M. S. Geophysical survey of the Blantyre-Limbe area: Nyasaland Geol. Survey Ann. Rept. 1950, p. 10, 1951.

An isoresistivity map of the area north of Blantyre and Limbe has been made on the basis of east-west resistivity traverses at 2,000-foot intervals. The area consists of granulitic gneisses and some biotite schist with syenite intrusions, and water supplies are found chiefly in shear zones in the syenite. In general, the schists had lower resistivity values than syenite or syenite gneiss. Most values lie between 10,000 and 40,000 ohm-cm with good water-bearing zones below 10,000 and massive syenite above 50,000 ohm-cm. Below the weathered zone, the value in fresh syenite was over 300,000 ohm-cm. Aquifers were located by depth probes and the results found to be reasonably accurate.—*M. C. R.*

RADIOACTIVE METHODS

13042. Pringle, R. W. The scintillation counter: Nature, v. 166, no. 4209, pp. 11–14, 1950.

The important features of the method of scintillation counting and some of its more striking applications are reviewed. Among these is the use of portable counters for geologic field work. (*See* Geophys. Abstracts 12067, 12278 and 13043).—*M. C. R.*

13043. Pringle, R. W., Roulston, K. L., and Brownell, G. M. Ultrasensitive portable gamma-ray spectrometer: Nature, v. 165, no. 4196, p. 527, 1950.

Construction of a portable crystal detector and its successful operation in northern Canada are reported. A crystal of approximately 100 g is used as the gamma-sensitive scintillation element and with an integration time for counting of only a few seconds, a detection sensitivity of 10^{-10} R per sec has been achieved.—*M. C. R.*

13044. Peirson, D. H. The background counting rate in a Geiger-Müller counter: Physical Soc. Proc., Sec. B, v. 64, pt. 5, no. 377B, pp. 427–428, 1951.

During a radioactivity survey of southwestern England-northern Wales during the summer of 1950, the counting rate due to gamma-ray background was measured in several places and related to radiometric assays of soil activity. Background measurements were made by placing the probe unit on open flat ground to obtain rate-meter readings corresponding to a solid angle of 2π. Soil samples were assayed by a standard radiometric method, the results being expressed in terms of alternative percentage concentration of U_3O_8, ThO_2, or K_2O. The rate-meter readings converted to a specific counting-rate scale (counts per minute per sq cm cross-sectional area) are given in a table. The rate extrapolated to zero soil activity is 1.8—*M. C. R.*

13045. Day, F. H. X-ray calibration of radiation survey meters, pocket chambers, and dosimeters: U. S. Nat. Bur. Standards, Circ. 507, 11 pp., 1951.

The primary objective was to determine correction factors of detectors for different qualities of radiation. For this purpose more than 300 instruments of 17 different types were calibrated for radiations generated by applying X-ray tube potentials ranging from 30 to 1,200 kv. Correction curves for different in-

struments are given and their important features described. Most of the Geiger-Müller counters tested have wide variations in quality dependence. Except for million-volt radiations, their readings are not accurate.—*S. T. V.*

13046. Brownell, G. M. Radiation surveys with scintillation counter. Queensland Government Mining Jour., v. 51, no. 590, pp. 980–983, 1951.

This is a reprint of the paper in Economic Geology. See Geophys. Abstract 12067.—*N. A. S.*

LOGGING AND BOREHOLE METHODS

13047. Bowles, R. H. Old well log data as an exploratory tool: Independent Petroleum Assoc. of America Monthly, v. 22, no. 1, pp. 16–17, 1951.

A restudy of old logs in the light of increased skill in interpretation may lead to new production. Factors which must be considered are tabulated.—*M. C. R.*

13048. Pirson, S. J. Review of quantitative methods of electrical-log interpretation: Oil and Gas Jour., v. 50, no. 3, pp. 102, 106, 108, 110, 1951.

Electrical logs may be considered as a system of simultaneous equations, one corresponding to each curve. The self-potential curve permits evaluation of formation water salinity, the resistivity curve with short spacing, an evaluation of porosity in the invaded zone, and the resistivity curve with long spacing an evaluation of the true resistivity of the formation in place. Further calculations, an example of which is given, permit estimation of connate-water saturation and the oil and/or gas productivity of a specific formation. A schematic representation of electrical logs under various assumed resistivity ratios and water saturations is given as a guide in deciding whether or not a detailed quantitative study is warranted.—*M. C. R.*

13049. Petroleum Engineer. Underground magnetic logging device: v. 23, no. 6, pp. B 87–89, 1951.

The Magnolia Petroleum Co. has announced development of two magnetic logging instruments. One is 4 ft long, 3 in. in diameter, and weighs 80 lbs, is designed to withstand pressures of 10,000 psi and, with some of its apparatus housed in a form of thermos bottle is unaffected by temperatures up to 250 F. The second device, which has not been thoroughly tested, is a saturable core magnetometer which measures the total field as a function of depth in the borehole.—*M. C. R.*

13050. Guyod, Hubert. Electric logging. Johnson Nat. Drillers' Jour., v. 23, no. 3, pp. 11–12, 1951.

A simple description of electric logging and its use in investigations of groundwater supplies.—*M. C. R.*

13051. Keller, G. V. An improved electrode system for use in electric logging: Producers Monthly, v. 13, no. 10, pp. 12–15, 1949.

A shielded monoelectrode has been devised which permits a horizontal depth of sampling independent of the vertical thickness of a formation and measures resistivity to horizontally flowing current. The electrode consists of two long cylindrical electrodes placed above and below a shorter cylindrical electrode, all three being maintained at the same or nearly the same potential with respect to a ground electrode at the surface. The current flowing from the center elec-

trode is thus constrained to flow in a horizontal pattern and as only the current from the center electrode is measured, only the resistance of a cylinder of rock of the same vertical thickness as the length of the center electrode is measured. The electrode is particularly useful for determining the true resistivity of relatively thin beds. Another advantage, as indicated by laboratory experiments, is that the horizontal depth of sampling may be varied without altering appreciably the vertical sampling thickness by varying the length of the shielding electrodes.—*M. C. R.*

13052. Jansen, Hermann, and Schuster, Alfred. Kapazitive Hochfrequenzmessung in Erdölbohrungen [Capacity measurements with high frequency currents in oil wells]: Erdöl u. Kohle, Jahrg. 4, Heft 4, pp. 173–174, 1951.

The water-oil content of formations penetrated in a drill hole may be determined by lowering a coil into the well and measuring the frequency in the electrical circuit including the adjoining portions of surrounding formations, whose specific capacity and self-induction influence the frequency of the circuit. Variation in the water content or the appearance of oil changes the indications of the instrument and furnishes a curve which, with the resistivity and self-potential logs, is used in the study of the borehole. The new curve gives a sharp delineation between the water-saturated and oil-bearing strata. The frequency used ranges from 5,000 to 20,000 cycles per second. The paper contains reproductions of several such logs from oil fields of northwestern Germany.—*S. T. V.*

13053. Licastro, Pasquale. Investigation of resistivity changes during flooding of the Bradford sand: Producers Monthly, v. 15, no. 6, pp. 30–33, 1951.

Cores of the Bradford sand were saturated and then flooded by solutions of various salinities under closely controlled laboratory conditions to observe characteristics of the flood front. It was found that the flood front is electrically sharp, but sharper when fresh water replaces salt water; that the total change in resistivity during flooding does not indicate complete replacement of connate water by flood water or a nonconductive rock framework; and that the width of the flood front is proportional to the logarithm of the distance it has travelled.—*M. C. R.*

13054. Jones, P. J. Electric log invasion of filtrate into water, oil and gas sandstone beds; World Oil, v. 132, no. 5, pp. 204, 206, 208, 212, 1951.

A summary of information on the invasion of filtrate into water, oil- and gas-bearing sandstone beds. Recognizable differences on an electric log may be caused by the different mechanisms of invasion involved.—*M. C. R.*

13055. Barnes, Kenneth B. New log interpreter: Oil and Gas Jour., v. 50, no. 10, pp. 55–56, 1951.

A slide rule has been developed for determining porosity, permeability, and saturation from the Archie and Tixier equations. Instructions are given for 10 different possible computations.—*M. C. R.*

13056. Kerr, A. J. Determination of porosity of the Palo Pinto Reef by radioactivity logging: Abilene Geol. Soc. Geol. Contr., pp. 39–45, 1950.

The quantitative-interpretation method of radioactivity logs is shown by an example, using a base well which had been logged and cored, determining a neutron-derived porosity curve and applying it to an unknown well. The derived

curve is applicable within the limitations of bore size and lithology in the same field, after proper allowance has been made for consideration of log sensitivity.—*M. C. R.*

TECHNICAL AIDS

13057. Ostrovskiĭ, A. E. A recording moving-coil oscillograph with high velocity of the drum [in Russian]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 9 (136), pp. 134–138, 1950.

A moving-coil oscillograph allows registration of several simultaneous processes, an important advantage over the cathode-ray instrument. With waves of high frequency (over 20,000 cycles per second) the velocity of the recorded drum must be very great to make the highest harmonics visible. The design of such an instrument, with the velocity of 40 m per sec is described with a detailed picture of vibrations produced in the ground by a strong explosion. In this instrument deflection of the coil causes deflection of the light beam, of brightness up to 90,000 stilbs falling on a moving photographic film. Greatest measurable deviation of the oscillating medium is 0.2 mm; its period 10 microseconds. The instrument can record 150 waves. This oscillograph successfully recorded vibrations produced by explosions in oil wells.—*S. T. V.*

13058. Smith, A. E. Graphic adjustment by least squares: Geophysics, v. 16, no. 2, pp. 222–228, 1951.

The adjustment of closed circuits by the method of least squares is presented using a graphical rather than an algebraic approach. The method is practicable in that it offers a more speedy solution than the analytical method. Essentially, the adjustment is made by applying weighted corrections to each line so as to meet the two necessary conditions for a least squares solution, that the algebraic sum of the corrected difference around any circuit be zero and that the sum of the weighted corrections at any junction be zero. The adjustment is made in several stages by trial and error until the necessary prerequisites are fulfilled. A small network is solved illustrating the method.—*I. Z.*

PATENTS

GRAVITY METHODS

13059. Clamping device for gravity meters. Adelbert Barry, Houston, Tex., assignor, by mesne assignments to Standard Oil Devel. Co., Elizabeth, N. J., a corporation of Delaware: U. S. patent no. 2,560,326, issued July 10, 1951.

In a device for prospecting subsurface formations including a diving bell, a gimbal suspension, a meter suspended in the diving bell by the gimbal suspension, the lower portion of the meter defining a contact surface having its center on the same vertical line as the center point of the gimbal suspension when the diving bell is level, the combination with said diving bell of a clamping arm pivoted to the diving bell and defining a contact surface engaged with the contact surface of the meter when the vertical axes of the meter and the diving bell coincide and the arm is in a first position and wholly out of contact with the meter when the arm is in a second position, a spring means biasing the arm to its first position, a solenoid, releasable means actuated by the solenoid for retaining the arm in its second position and releasable to allow it to assume its first position and a switching means located remotely from and outside said diving bell for actuating said solenoid and connected electrically therewith. Claims allowed, 6.

MAGNETIC METHODS

13060. Aerodynamic body for carrying detection apparatus. Gerhard O. Haglund, Buffalo, N. Y.: U. S. patent no. 2,551,596, issued May 8, 1951.

In towed airborne magnetic field detecting apparatus, an aerodynamic body adapted to be towed from an aircraft in flight, means within the body for detecting the total value of the magnetic field traversed by the body, signal responsive means within the body for continually aligning the detecting means with the lines of force of the magnetic field as the detecting means deviates therefrom in response to slow angular movements of the body due to changes in heading of the aircraft, a cable for supporting and towing said body at a distance from the aircraft, said cable including means for transmitting electrical signals between said detecting and aligning means and control apparatus in the aircraft, a gimbals arranged at the cross sectional center of form of said body and above the center of gravity thereof thereby to prevent sudden angular movements of the body in flight with respect to the cable, said gimbals being adapted to support the body, and means for securing the cable to said gimbals.

A device for supporting a body for dynamic flight comprising, a gimbal mechanism including an outer ring pivotally secured to said body and an inner ring pivotally secured to said outer ring, a cable including a strain member, a support having two separable portions, one of said portions being secured to the inner gimbal ring, the other portion being secured to said strain member, and means for clamping said separable portions together. Claims allowed, 13.

13061. Readily locatable magnetic go-devil. John M. Pearson, Swarthmore, Pa., assingor to Sun Oil Co., Philadelphia, Pa., a corporation of New Jersey: U. S. patent no. 2,558,977, issued July 3, 1951.

A go-devil adapted to transport a magnetic field for use in pipe-line exploration comprising in combination a nonmagnetic shaft, a plurality of nonmagnetic brushes and rubbers mounted on said shaft, magnetized retentive cylindrical metal segments enclosing said nonmagnetic shaft and spaced between said brushes and rubbers, the magnetic fields of said segments being additive to provide a large magnetic moment of the complete go-devil. Claims allowed, 1.

13062. Unbalanced magnetometer. Otto H. Schmitt, Port Washington, N. Y., assignor to the United States of America as represented by the Secretary of the Navy: U. S. patent no. 2,560,132, issued July 10, 1951.

In a magnetometer, the method of producing an output voltage consisting of a series of pulses of alternate polarity whose difference in magnitude is dependent upon the magnetic field, which comprises the steps of impressing an alternating driving voltage upon a pair of substantially identical magnetometer elements by means of a bridge circuit for driving the cores of said elements into saturation, unbalancing said bridge circuit by associating an impedance with one of said elements so as to unbalance the circuit in zero magnetic field, and utilizing as said output voltage the voltage that appears across a diagonal of said bridge circuit. Claims allowed, 2.

13063. Magnetic compass compensation device. Eugene M. McNatt, Tulsa, Okla., assignor to Standard Oil Devel. Co., a corporation of Delaware: U. S. patent no. 2,560,464, issued July 10, 1951.

A compensation device for a compass carried by a moving vehicle consisting of at least one coil mounted adjacent to the compass having the axis of the coil

parallel to the longitudinal axis of the vehicle, a direct-current generator driven at a speed proportional to the speed of the vehicle, and a capacitance, said coil, generator and capacitance being connected in series whereby a current is set up in the coil proportional to changes in speed of the vehicle operative to minimize errors of the compass. Claims allowed, 1.

13064. Apparatus for measuring intensity of magnetic field. Gary Muffly, Penn Township, Allegheny County, Pa., assignor to Gulf Research & Devel. Co., Pittsburgh, Pa., a corporation of Delaware: U. S. patent no. 2,564,-854, issued Aug. 21, 1951.

A self-orienting magnetometer comprising a magnetic-field-responsive element producing an electrical signal in proportion to the intensity of the magnetic field along its principal axis of sensitivity, support means holding stationary thereon said element, magnetic-field-deviating means adjacent said element rotatably mounted on said support, means for rotating said field-deviating means about an axis which substantially coincides with the principal axis of sensitivity of said element whereby the field affecting said element is modulated in synchronism with said rotation and the output of said element is modulated whenever its axis of sensitivity is not coincident with the total undeviated magnetic field, a universal mounting for said support means, orienting servo means connected respectively to the axes of said universal mounting, and means responsive to quadrature components of modulation in the output of said element controlling respectively said servo means. Claims allowed, 4.

13065. Wave-train magnetometer. Walter H. Brattain, Chatham, N. J., assignor to the United States of America as represented by the Secretary of the Navy: U. S. patent no. 2,565,799, issued Aug. 28, 1951.

A magnetometer for measuring the strength of a magnetic field comprising, in combination, a magnetic core disposed in said field, oscillator means for periodically saturating said core in alternate senses including a winding associated with said core, and a resonant circuit including said winding constructed and arranged so that the resonant circuit will resonate at a multifrequency of the drive frequency and have a resistance below a critical value so that decay occurs before the next cycle commences, thereby providing a series of wave trains having an envelope the maximum amplitude of which is a function of the strength of said magnetic field. Claims allowed, 2.

SEISMIC METHODS

13066. Seismographic prospecting apparatus. Robert L. Henson, Jr., Beaumont, Tex., assignor to Sun Oil Co., Philadelphia, Pa., a corporation of New Jersey: U. S. patent no. 2,558,954, issued July 3, 1951.

An amplifier for the output of a seismic detector including variable gain amplifying means, and means for controlling the gain of said amplifying means, the last mentioned means comprising a filter for providing a direct bias to said amplifying means, said filter having a pair of input terminals, a conducting path permanently connecting said input terminals, a grid-controlled thermionic tube having its anode connected to one of said terminals, and having its cathode connected to the other of said terminals through a time-variable network, said network comprising a fixed source of potential and, in series with said fixed source of potential, a parallel arrangement of a condenser and resistor, a potential source for charging said condenser, switching means for disconnecting the last mentioned potential source from charging relationship with said condenser,

so that said condenser may discharge through said resistor, and means connecting the grid of said thermionic tube to the output of said amplifier. Claims allowed, 2.

13067. Seismic recording system. Malcolm D. McCarthy, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y. a corporation of New York: U. S. patent no. 2,558,868, issued July 3, 1951.

A system for seismic prospecting comprising a geophone for converting direct, refracted and reflected seismic waves produced by a shot into electrical signals of frequencies within the range from about 20 to about 80 cycles, and means for producing from said signals of the geophone a record trace readily interpreted in ascertainment of the depths and contours of subterranean strata comprising signal amplifier channels in parallel and upon which the aforesaid signals are impressed, one of said channels including a frequency-selective network favoring transmission therethrough of lower frequencies of said range and another of said channels including a frequency-selective network favoring transmission therethrough of higher frequencies of said range, an automatic gain-control system for the amplifier of said one of said channels effective in the recording interval subsequent to said shot progressively to increase the gain at said lower frequencies as a predetermined function of time, an automatic gain-control system for the amplifier of said other of said channels effective in said recording interval sequentially to decrease, increase and decrease the gain at said higher frequencies as a predetermined function of time, electrical means effective in response to occurrence of said shot to initiate the aforesaid time-variation of the gains of said amplifiers by said gain-control systems, and a recorder upon which the outputs of said channels are impressed to produce a single record of said waves in which record, by virtue of the different time-variation of the gains of said amplifiers for said different frequencies, the direct, refracted and reflected waves are clearly distinguishable. Claims allowed, 5.

13068. Seismographic prospecting apparatus for directing explosive energy. Norman B. Blake, Beaumont, Tex., assignor to Sun Oil Co., Philadelphia, Pa., a corporation of New Jersey: U. S. patent no. 2,558,924, issued July 3, 1951.

Seismographic apparatus for directing explosive energy in boreholes within the earth comprising a borehole casing, an explosive charge suspended within and above the bottom of the casing and a substantial distance above the bottom of the borehole, the part of the casing enclosing the explosive charge being of substantially greater thickness than the remainder of the casing, a readily disruptable member closing the bottom of the casing, and a liquid column resting on said member and extending to a substantial distance above the explosive charge. Claims allowed, 4.

13069. Method and apparatus for seismic underwater prospecting. Phillip P. Gaby, Oakland, Calif., assignor by mesne assignments, to California Research Corporation, San Francisco, Calif., a corporation of Delaware: U. S. patent no. 2,561,309, issued July 17, 1951.

In underwater seismic surveying, the steps of placing an isolated explosive charge in substantially direct contact with the surface of the earth below an unconfined body of water, exploding said charge and directing products of the explosion in a confined continuous stream to the atmosphere and under the

influence of the primary impulse from said explosion, whereby occurrence of secondary waves in said body of water is prevented. Claims allowed, 4.

13070. Frequency-adjustable seismic wave detector. Dayton H. Clewell, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,562,983, issued Aug. 7, 1951.

In a seismic-wave detector including a frame, an inertia mass, a suspension system including spring means for directly supporting said mass from said frame, magnetic-reluctance means respectively supported from said mass and frame for producing output signals in response to seismic waves, the combination of a circular magnet supported from said frame concentrically of said suspension system, a member of magnetizable material adjustably carried by said system in magnetic attractive relationship with said magnet in a position nearer said mass than that of said magnet and acting in the same direction as said spring means for introducing a negative stiffness factor into said suspension system, a damping coil disposed within said circular magnet, resistance means in circuit with said coil for controlling the degree of damping produced thereby, and means for adjusting the position of said mass comprising means for establishing and controlling the energization of said coil to develop an attractive force on said member of desired magnitude. Claims allowed, 7.

13071. Method and apparatus for underwater seismic prospecting. William E. Pugh, Tulsa, Okla., assignor to Seismograph Service Corp., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,564,128, issued Aug. 14, 1951.

Apparatus for generating seismic waves beneath the surface of a body of water while substantially preventing the generation of undesired non-primary waves, comprising explosive means including a portion provided with a cavity for concentrating and directing toward the surface of the water at least a portion of the explosive energy resulting from detonation of said explosive means, means for supporting said explosive means beneath the surface of the water with said cavity facing the water's surface, and means for detonating said explosive means. Claims allowed, 3.

13072. Underwater prospecting device. Eugene W. Frowe, Houston, Tex., assignor to Robert H. Ray Co., a partnership composed of Robert H. Ray and J. C. Pollard, both of Houston, Tex., independently and as trustees: U. S. patent no. 2,568,680, issued Sept. 18, 1951.

An apparatus for submerging a detector instrument upon subsurface water covered areas including a container, comprising a lower body portion to receive a detector instrument, a cover therefor, a seal between said base and cover to exclude water, releasable means to clamp said cover and base to retain the instrument water tight, a bail pivoted to said container, a tow cable connected to said bail, a stabilizing base on said lower body comprising a circular base plate extending horizontally of said body, means on said body portion and said base plate to affix the body centrally thereof, a plurality of water-passage openings circumferentially arranged in said plate and spaced radially outward from said body, an upstanding flange about the periphery of said base to provide a uniform condition of water turbulence between said flange and body to minimize destructive effects on the detector instrument. Claims allowed, 1.

13073. Detector carrier for seismic exploration. John W. Flude, Houston, Tex.: U. S. patent 2,568,851, issued Sept. 25, 1951.

A detector carrier for seismic exploration, comprising a capsule-shaped casing formed from two cup-shaped halves, the lower of said halves being substantially heavier than the upper, a holder for a seismic detector on the lower of said halves for supporting the seismic detector upright in said casing with the lower end thereof in said holder and the upper end thereof extending into the upper half, the weight of the lower half of the casing with respect to the combined weight of the upper half of the casing and the weight of the detector being such as to maintain the seismic detector in an upright position in the casing and an eye at the forward end of said casing to receive a towing cable. Claims allowed, 2.

13074. Seismographic prospecting. Lacoste G. Ellis, Beaumont, Tex., assignor to Sun Oil Co., Philadelphia, Pa., a corporation of New Jersey: U. S. patent 2,569,411, issued Sept. 25, 1951.

A method of reflection shooting comprising providing an array of detectors, adapted to receive reflections from deep strata, adjacent to the surface of the earth at different distances from the top of a bore hole penetrating deep reflecting horizons the orientation of which is sought, and firing successively within said bore hole a series of shots, one of said shots being fired below one of said deep-reflecting horizons, and a subsequent shot being fired above said horizon and below the next higher reflecting horizon, so that in the case of said second shot reflections to said detectors will occur from said first-mentioned horizon, from which no direct reflection to said detectors will occur due to said first-mentioned shot, the reflections from said horizons being received by said detectors substantially later than direct waves from said shots. Claims allowed, 1.

ELECTRICAL METHODS

13075. Instrument for and method of geophysical exploration. Bjarni S. Bjarnason, Toronto, Ontario, Canada, assignor to Hans T. F. Lundberg, Toronto, Ontario, Canada:, U. S. patent no. 2,559,586, issued July 10, 1951.

In combination with a maneuverable aircraft, an instrument designed for geophysical exploration therefrom, said instrument comprising, a loop composed of material sensitive to magnetic effects and having a plurality of substantially parallel portions which are spaced from each other so that electromotive forces of measurable difference can be generated in said portions when the loop is moved through a magnetic field in a direction substantially at right angles to the longitudinal axes of said portions, and output take-off means connected to one of said portions for detecting differences in said electromotive forces generated in said portions when the loop is moved as above set forth, said loop being positioned on the craft with said substantially parallel portions extending substantially at right angles to the longitudinal axis of the craft and the portion of the loop to which the output take-off means is connected being nearer the rear end of the craft than the other said portion of the loop. Claims allowed, 6.

13076. Location of conducting and/or magnetic bodies. Stanley Whitehead and Benjamin Rosenblum, London, England; said Rosenblum now by change of name Benjamin Roston: U. S. patent no. 2,560,834, issued July 17, 1951.

Apparatus for the location of electrically conducting bodies and magnetic bodies, comprising means including an electrically conducting loop and alternat-

ing-current-supply means connected to said loop, for producing an alternating magnetic field of substantial strength over a large area, and search apparatus for searching over said area and having dimensions which are small relatively to those of said loop, said search apparatus being movable relatively to said loop and including four substantially equally-spaced starch coils arranged in a substantially straight row, an indicating device, means connecting the two outer coils in said row to said indicating device, and means connecting the two inner coils in said row to said indicating device, said connecting means serving to connect said two outer coils in opposition with said two inner coils, said four search coils being of equal area turns, and the turns of all said coils lying in parallel planes. Claims allowed, 7.

13077. Means for generating low-frequency electrical oscillations. Ulrik Krabbe, Odense, Denmark, and Sven-Eric Hedström, Ludvika, Sweden, assignors to Allmänna Svenska Elektriska Aktiebolaget Vasteras, Sweden, a corporation of Sweden: U. S. patent no. 2,567,383, issued Sept. 11, 1951.

Means for generating low frequency oscillations, comprising a direct-current saturable reactor, a source of alternating current, a load fed by said source in series with said reactor, means for saturating the reactor with direct-current ampere turns including means variable with changes in the alternating current traversing the reactor to vary the number of such saturating ampere turns in direct proportion with variations in such alternating current so as to maintain them substantially equal to the ampere turns of such alternating current, and means for feeding additional saturating ampere turns to said reactor, said last means including a resonance circuit containing elements capable of independent oscillation, and means to supply current to such circuit. Claims allowed, 14.

RADIOACTIVE METHODS

13078. Radiation detection. Charles F. Teichmann, Crestwood, N. Y., assignor to Texaco Devel. Corp., New York, N. Y., a corporation of Delaware: U. S. patent 2,562,969, issued Aug. 7, 1951.

In geophysical exploration, the improvement which comprises disposing light-sensitive bodies respectively at a plurality of horizontally spaced locations in an earth zone to be investigated, causing gamma rays emitted from the earth at each of the locations to produce light by impingement upon a relatively large area of fluorescent material, concentrating the light at each location onto a small area on the light sensitive body, exposing the bodies to the action of the concentrated light produced at the respective locations, subjecting the bodies to photographic development, and comparing the developed intensity of the bodies. Claims allowed, 7.

13079. Detection and measurement of penetrative radiation. Clifford G. Ludeman, Scarsdale, N. Y., assignor to Texaco Devel. Corp., New York, N. Y., a corporation of Delaware: U. S. patent no. 2,559,219, issued July 3, 1951.

A phosphor element for use in the detection and measurement of penetrative radiation such as gamma rays comprising a phosphor material in relatively small amount having of itself relatively small effective dimensions for the interception and conversion of penetrative radiation to more easily detectable and measurable radiation in other ranges of the spectrum, and a matrix of relatively large volume capable of conducting said last-named radiation, said phosphor material being substantially homogeneously distributed throughout said matrix

whereby the original relatively small effective dimensions of said phosphor material for the interception and conversion of penetrative radiation are enlarged to the volume of said matrix, the element formed by said phosphor material and said matrix being formed with at least one section for exposure to and interception of penetrative radiation and at least one second section for exposure to a detecting and measuring device capable of detecting and measuring the converted radiation, said first and second sections being spaced from one another to insure exposure of the penetrative radiation to a substantial portion of the volume of said element. Claims allowed, 7.

13080. Method of determining path, rate of flow, etc., in subsurface strata. Howard H. Hinson, Ponca City, Okla., a corporation of Delaware: U. S. patent no. 2,560,510, issued July 10, 1951.

The method for determining the fluid conductance of subsurface strata vertically and laterally, comprising the use of at least two wells and the steps of making a natural radioactivity log of the formation in situ in each well; injecting sequentially different radioactive fluids down and out of one of such wells into such subsurface strata as will receive such fluids, making separate radioactivity loggings of each well after each injection. Claims allowed, 3.

13081. Prospecting. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,562,914, issued Aug. 7, 1951.

In prospecting, the improvement which comprises measuring the intensities of gamma radiation at different elevations above a ground surface to determine the elevation above said ground surface at which the contrast between a series of determinations of the intensities of gamma rays emanating from the ground surface and background radiation is substantially maximum, flying a detector for such radiation across said surface at approximately that elevation and determining the intensities of said radiation at that approximate elevation at a series of points along the course of flight. Claims allowed, 6.

13082. Prospecting. Arthur H. Lord, Jr., Houston, and Evan Pancake, Bellaire, Tex., assignors to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,562,929, issued Aug. 7, 1951.

In prospecting, the improvement which comprises locating a gamma-ray anomaly manifested by differences in the intensity of gamma rays emitted from different locations on a traverse along an earth surface, and determining the direction of origin of the anomaly by disposing a detector sensitive to gamma radiation at a location in the neighborhood where the anomaly is manifested, and determing the intensity of gamma radiation arriving at the detector so located from a plurality of different directions by shielding the detector from gamma radiation arriving at the detector from all directions except the one under investigation, orienting the detector in different directions towards the earth's surface and measuring the intensity of gamma radiation in each direction. Claims allowed, 8.

13083. Prospecting. William M. Stratford, New York, and Charles F. Teichmann, Mount Vernon, N. Y., and Gerhard Herzog, Houston, Tex., assignors to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,562,961, issued Aug. 7, 1951.

In exploration for mineral deposits involving the taking of earth samples at a series of known points, the improvement which comprises conducting a pre-

liminary survey by determining the intensity of background radiation at a plurality of locations and selecting that location at which the background intensity is the lowest and detecting the comparative intensities of gamma rays emitted by each sample by determining the respective sample masses and at the selected location detecting the intensity of gamma radiation emitted by each sample together with the intensity of the background radiation, and subtracting the separately determined background radiation from the intensity measurements made for the respective samples. Claims allowed, 2.

13084. Prospecting. William M. Stratford, New York, N. Y., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,562,962, issued Aug. 7, 1951.

In prospecting a stream drainage system to locate therein a gamma-ray anomaly associated with a mineral deposit to be found, the improvement which comprises determining the approximate average intensity of gamma rays per unit mass emitted by the rocks in the area of the drainage system, taking a first earth detritus sample at a starting point downstream in the drainage system and determining the intensity of gamma rays per unit mass of said detritus sample, comparing the determined intensity of said detritus sample with the average intensity determined for the rocks of the drainage system so as to find which intensity is higher, taking earth detritus samples from each branch of a fork in the drainage system upstream from the starting point and determining which of these upstream samples emits the higher intensity of gamma radiation per unit mass, proceeding up the branch whose sample has the higher relative intensity per unit mass when the intensity per unit mass of the detritus sample from the starting point is higher than the average intensity per unit mass of the rocks, but proceeding up the other branch when the intensity per unit mass of said detritus sample is lower than the average intensity per unit mass of the rocks. Claims allowed, 1.

13084. Prospecting. William M. Stratford, New York, N. Y., assignor to The D. Lee and Arthur H. Lord, Jr., Houston, Tex., assignors to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,562,968, issued Aug. 7, 1951.

In geophysical investigations involving the determination of the intensity of gamma radiation emitted from an earth surface in one direction in the presence of cosmic rays approaching the earth from a different direction, the improvement which comprises detecting the intensity of the gamma radiation emitted from the earth together with the penetrating component of the cosmic radiation with a first detector while it is substantially unshielded on the side from which said gamma waves arrive, simultaneously detecting the intensity of the cosmic radiation with a second detector disposed near the first and substantially unshielded on the side from which the cosmic waves arrive, the proportion of gamma rays from the earth detected in the first detector being higher than the proportion of gamma rays from the earth detected in the second detector, and measuring the difference in the intensities of the radiation detected by the respective detectors. Claims allowed, 4.

13086. Geophysical prospecting using gamma-ray detectors. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,563,333, issued Aug. 7, 1951.

In geophysical prospecting apparatus, the combination which comprises two gamma-ray detectors, one of which has a different detection efficiency than the

other for gamma rays of one energy and a still different detection efficiency with respect to the other for gamma rays of a second energy the two detectors being disposed close together, and means for comparing the gamma-ray response of one detector to the gamma-ray response of the other. Claims allowed, 4.

13087. Methods of and means for detecting nuclear particles. Ernest G. Linder, Princeton, N. J., assignor to Radio Corp. of America, a corporation of Delaware: U. S. patent 2,566,089, issued Aug. 28, 1951.

Apparatus for determining the quantity of nuclear-particle radiation including: a series of secondary-emission charged-particle responsive means exposed to said radiation, a series of means progressively radially disposed with respect to said responsive means for multiplying and collecting said secondary particles, means for biasing said multiplying and collecting means in respect to said radiation responsive means, and means coupled to said collecting means and quantitatively responsive to said collected particles, the extent of response of said last-mentioned means being a measure of the quantity of radiation. Claims allowed, 11.

LOGGING METHODS

13088. Well surveying instrument. Roland Ring, Houston, Tex., assignor to Sperry-Sun Well Surveying Co., Philadelphia, Pa., a corporation of Delaware: U. S. patent no. 2,559,373, issued July 3, 1951.

In combination, a switch arranged to control an electrical circuit, and mechanism for controlling said switch, said switch comprising a rotary member, and said mechanism comprising a spring operatively connected to said rotary member for driving said rotary member, an escapement, a rotary element controlled by said escapement, and disengageable-clutching means for positively clutching said rotary member to said rotary element so that movement of the rotary member is controlled by the escapement and for disengaging said rotary member from said rotary element so that the rotary member may be manually rotated forwardly or backwardly for winding or unwinding said driving spring. Claims allowed, 7.

13089. Acoustical well sounder. Alexander Wolf, Houston, Tex., assignor to Keystone Development Corporation, Houston, Tex., a corporation of Texas: U. S. patent no. 2,560,911, issued July 17, 1951.

An acoustical well-sounding device, comprising, a hollow casing closed at its ends, a partition member extending transversely of said casing intermediate the ends thereof, an axial orifice of restricted area through said partition member, means for establishing communication between the interior of said casing on one side of said partition member and a well to be sounded, sound-generating means mounted in said casing on said one side of said partition member, sound-receiving means mounted in said casing on the opposite side of said partition member and spaced therefrom, and imperforate-baffle means disposed between said orifice and said sound-receiving means. Claims allowed, 3.

13090. Well logging system. Marcel Schlumberger, Paris, France, assignor to Schlumberger Well Surveying Corp., Houston, Tex., a corporation of Delaware: U. S. patent 2,562,992, issued Aug. 7, 1951.

In a well-logging system, the combination of a first electrode adapted to be moved through a well, a pair of electrodes disposed on opposite sides of said

first electrodes for movement in fixed space relation therewith, a first electrical circuit having a terminal connected to said pair of electrodes and another terminal connected to a reference point, a second electrical circuit, independent of said first circuit, having a terminal connected to said first electrode and another terminal connected to a reference point, a source of electrical energy in one of said electrical circuits, and electrical recording means in the other of said electrical circuits. Claims allowed, 9.

13091. Method and apparatus for borehole logging. John E. Sherborne, Whittier, Calif., assignor to Union Oil Co. of California, Los Angeles, Calif., a corporation of California: U. S. patent 2,564,861, issued Aug. 21, 1951.

A method of investigating the earth formation traversed by a bore hole filled with a column of conductive fluid which comprises electrically segregating a small horizontal section of said earth formation, establishing electrical contact with said small horizontal section by pressing a solid electrical conductor against said horizontal section, and determining the potential difference between said small horizontal section and another section of said earth formation. Claims allowed, 9.

13092. Well logging. Benjamin W. Sewell, Tulsa, Okla., assignor to Standard Oil Development Company, a corporation of Delaware: U. S. patent 2,569,390, issued Sept. 25, 1951.

In an apparatus for the rotary drilling and simultaneous logging of a bore hole, a rotatable drill stem, a head on said drill stem comprising a pair of spaced hollow arms in fluid communication with the interior of said drill stem, a reel journaled in said arms with its longitudinal axis perpendicular to the longitudinal axis of said drill stem, a cable wound on said reel, signal producing means carried by said cable, signal conducting means carried by said cable, signal receiving means mounted on said drill stem for rotation therewith and independent of said reel, signal transmitting means connecting said signal conducting means with said signal receiving means and means for taking off a signal from said conducting means. Claims allowed, 3.

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