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(Numbers 14805–15026)

GEOLOGICAL SURVEY BULLETIN 1002-D

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Geophysical Abstracts 155 October-December 1953

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

GEOLOGICAL SURVEY BULLETIN 1002-D

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GEOPHYSICAL ABSTRACTS 155, OCTOBER–DECEMBER 1953

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

GENERAL INFORMATION

Geophysical Abstracts attempts to provide informative abstracts of published material on the physics of the solid earth, the application of physical methods and techniques to geologic problems, and geophysical exploration. Related material of interest to individual geophysicists will also be found in other abstracting journals such as the Bibliography of Seismology, Chemical Abstracts, Meteorological Abstracts, Nuclear Science Abstracts, and Physics Abstracts.

The form of the bibliographic reference is believed to be self-explanatory. A list of abbreviations of journal titles was given in Geophysical Abstracts 152, 153, and 154. Additions to that list are given below. Unless specifically indicated otherwise, the language in which the article is written is the same as that given in the title. The system of transliteration used by the United States Board on Geographic Names is employed for transliteration of Russian names and titles. Translations of author's abstracts are indicated as "Author's Abstract" followed by the initials of the translator.

Geographic names included within brackets are those recommended by the Board of Geographic Names.

ABSTRACTORS

Geophysical Abstracts are prepared and compiled under the direction of Mary C. Rabbitt with the assistance of S. T. Vesselowsky and Dorothy B. Vitaliano. Patent information is compiled by Louis C. Pakiser, Jr. Other abstracts are prepared by the following: P. Edward Byerly, Roland G. Henderson, F. W. Stead, and Isidore Zietz.

LIST OF JOURNALS

The following list gives the full titles of journals referred to in this issue of the Abstracts and not included in previous lists. The sponsoring organization and place of publication are given where they are not part of the journal title.

Abbreviation	*Publication*
Adv. Sci	Advancement of Science. British Association for the Advancement of Science. London.
Agricultura (Madrid)	Agricultura. Francisco Jiménez Cuende, Madrid.
Am. Antiquity	American Antiquity. Society for American Archeology. Menasha, Wis.
Am. Mineralogist	American Mineralogist. Mineralogical Society of America. Menasha, Wis.
Ann. Rev. Nuclear Sci	Annual Review of Nuclear Science. Annual Reviews, Inc. in cooperation with National Research Council. Stanford, Calif.
California Univ. Geol. Sci. Pubs	University of California. Publications in Geological Sciences. Berkeley.
Ciel et Terre	Ciel et Terre. Société Belge d'Astronomie, de Météorologie et du Physique du Globe. Uccle, Belgium.
Ciencia (Mexico)	Ciencia. Mexico, D. F.
Główny Inst. Naftowego Prace	Główny Instytut Naftowego Prace, Katowice, Poland.
Hallische Mon	Hallische Monographien. Max Niemeyer Verlag, Halle/Saale.
Inst. Royal Colonial Belge Mem	Institut Royal Colonial Belge, Memoires. Brussels.
Inst. tech. bâtiment et travaux publics Annales.	Institut technique du bâtiment et des travaux publics, Annales. Paris.
Internat. Conf. (3d) Soil Mechanics and Foundation Eng Proc.	Third International Conference on Soil Mechanics and Foundation Engineering Proceedings. Zürich and Lausanne.
Nafta	Nafta. Instytut Naftowy (Petroleum Institute). Kraków, Poland.
Naturh. Ver. Rheinlande u. Westfalens Verh.	Verhandlungen des Naturhistorisches Vereins der Rheinlande und Westfalens. Bonn.
Rev. Sci	Revue Scientifique. Paris.
Schweizer. mineralog. petrog. Mitt	Schweizerische mineralogische und petrographische Mitteilungen. Verlag Leeman. Zürich.
Schweizer. naturf. Gesell. Verh	Verhandlungen der schweizerischen naturforschenden Gesellschaft. Aarau, Switzerland.
Sindicato Nac. Engenheiros Geógrafos Pubs.	Sindicato Nacional dos Engenheiros Geógrafos, Publicaçoes. Coimbra, Portugal.
South African Jour. Sci	South African Journal of Science. South African Association for the Advancement of Science. Johannesburg.

Abbreviation	*Publication*
Southwestern Jour. Anthropology	Southwestern Journal of Anthropology. University of New Mexico. Albuquerque.
Umschau	Die Umschau. Frankfurt am Main.
U. S. Civil Aeronautics Administration Tech. Devel. Rept.	U. S. Civil Aeronautics Administration, Technical Development Report. Washington, D. C.
Zeitschr. Naturforschung	Zeitschrift für Naturforschung. Tübingen, Germany.

GRAVITY

GENERAL AND THEORETICAL PAPERS INCLUDING THOSE ON ISOSTASY

14805. Castro, Honorato de. Gravitación [Gravitation]: Petroleos Mexicanos, 2ª época, tomo 1, no. 9, p. 672–678; no. 10, p. 760–763, 1953.

Hill's recent "radiant universe" theory attributes gravitational phenomena to "basic radiation" which exists in all space, whether or not it is occupied by material bodies. Castro demonstrates that the attraction of the moon by the earth is not equal to that exercised by the moon on the earth, because the moon absorbs less of the radiation than the earth. The "radiant universe" hypothesis was suggested by the 17th century scientist LeSage.—*S. T. V.*

14806. Marussi, Antonio. Sulla divergenza del campo gravimetrico [The divergence of gravitational field]: Geofisica Pura e Appl., v. 25, p. 1–5, 1953.

In some modern procedures for the study of gravity anomalies, the divergence of the surface gradient of gravity (second differential parameter of Beltrami) on a level surface is considered. Such divergence is connected with the geometrical and dynamical elements of the field by simple relations, in particular with the second derivatives of gravity along the lines of force. In the present paper the general formulae are applied to Somigliana's field referred to its intrinsic coordinates, and the values of the surface divergence and other elements of the normal field are given from 10° in 10° of latitude.—*Author's Abstract*

INSTRUMENTS AND METHODS OF OBSERVATION

14807. Frowe, Eugene W. Gravimeter apparatus, U. S. patent 2,660,062, granted Nov. 24, 1953. 5 claims. Assigned to Robert H. Ray Co.

A spring-suspended mass including an electromechanical servo-system for compensating vertical displacements of the moving system caused by gravity variations.

14808. Fay, Charles H., and Goodell, Richard R. Gravity meter, U. S. patent 2,657,581, granted Nov. 3, 1953. 4 claims. Assigned to Shell Development Co.

A vibrating string gravity meter, consisting of a mass suspended from a string which is vibrated at its natural frequency for a predetermined mode of oscillation by electrical means, and including a means of measuring the frequency.

14809. Cloud, Raymond T. Pendulum and acceleration compensation system, U. S. patent 2,663,088, granted Dec. 22, 1953. 17 claims. Assigned to North American Geophysical Co.

A means of compensating acceleration of a moving vehicle acting on a pendulum by controlling a servomotor to respond to a moving magnetic pickup coil.

14810. Cloud, Raymond T. Method of and apparatus for pendulum compensating, U. S. patent 2,659,985, granted Nov. 24, 1953. 8 claims. Assigned to North American Geophysical Co.

A means of compensating the acceleration of a vehicle acting on a pendulum mounted in that vehicle.

METHODS OF ANALYSIS AND INTERPRETATION

14811. Rosenbach, Otto. A contribution to the computation of the "second derivative" from gravity data: Geophysics, v. 18, no. 4, p. 894–912, 1953.

The computation of the second derivative from gravity data by a method which does not use a continuum of gravity values but requires only a series development is described. The approximate formulas necessary for routine calculations are derived. Two hypothetical examples, of a vertical fault and rectangular block and of two vertical faults (step-fault), are computed using the series formula and compared with those computed by Elkin's formula (*see* Geophys. Abs. 12620). A discussion by Elkins and Peters and reply by Rosenbach on the merits of the respective methods is included.—*M. C. R.*

14812. Malovichko, A. K. O reshenii obratnoy gravimetricheskoy zadachi [Solution of the inverse gravimetric problem]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 228–231, 1953.

The determination of the shape of a buried geologic body from gravimetric data can be reduced to the solution of a nonlinear integral equation of the first kind. A method of solving this equation by successive approximations is presented; the procedure is applied to the problem of determining the outline of the surface separating two underground formations on the basis of the gravimetric anomalies on the horizontal surface of the earth over this area, limiting the problem to the two-dimensional case. Ordinarily only a few approximations have to be computed to obtain a sufficiently accurate solution. As an example, the anomaly of a buried parallelepiped body of infinite length is analyzed.—*S. T. V.*

14813. Van Weelden, A. On the interpretation of gravity data: Geophys. Prosp., v. 1, no. 2, p. 75–81, 1953.

There are two schools of thought on the geologic interpretation of gravity data. One stresses the derivation of a mass distribution based on mathematical methods; the other stresses geologic controls which the interpreter uses to choose among an infinite number of solutions. Although the mathematical methods may have considerable use, particularly in increasing the resolving power of gravity surveys and establishing certain limits (for example maximum depth), gravity data are inherently ambiguous so their interpretation can become hazardous. The most efficient approach to gravity interpretation is "to consider the gravity data as one of the various sources of information and not as a self-sufficient method" and to use available geologic information with the gravity data to guess as to the probable geologic situation. The gravity field of this "guess" can then be calculated and compared with the actual gravity field; the first "guess" can then be modified as indicated.

The interpreter should not assume that there is a clear distinction between "regional" and "local" gravity features, and a graphical system of removing

the regional effect is ordinarily preferable to the mathematical approach.—*L. C. P.*

14814. Bott, M. H. P. Negative gravity anomalies over acid "intrusions" and their relation to the structure of the earth's crust: Geol. Mag., v. 90, no. 4, p. 257–267, 1953.

The almost invariable association of acid intrusions with negative Bouguer anomalies (see Geophys. Abs. 14410, 14411) is certainly often caused by direct density contrast between the acid intrusive and the denser country rock. Theoretical consideration of these observations suggests that a gravity survey may provide a criterion for testing the genetic type of a granite, as follows: A large negative anomaly may indicate magmatic origin; various patterns with no large anomaly may indicate granitization; a large positive anomaly may indicate association with a basic intrusion below, which has given rise to the "granite" either by differentiation, or by melting and reintrusion of the intruded sialic rocks. The paper includes a brief summary of the mechanics of intrusion.—*D. B. V.*

Kraus, E. C. On the explanation of the western Mediterranean positive gravity anomaly by means of the theory of subcrustal flow. *See* Abstract 15004.

14815. Saxov, Svend [E.] and Nygaard, Kurt. Residual anomalies and depth estimation: Geophysics, v. 18, no. 4, p. 913–928, 1953.

The residual gravity anomaly at a point is defined as the difference between the average anomalies along two concentric circles whose center is at the point divided by the difference between the radii. This may easily be computed by using a template designed for two concentric circles and averaging the figures thus obtained with a calculating machine. By using this method any subterranean anomalous spherical mass at a depth equal to twice the radius of the circle or the sum of the radii of the two circles is emphasized and the effect of masses at other depths is eliminated. The method is not suitable for a vertical fault. Residual anomalies determined by the average circle or average polygon method, and the second verticle derivative and, to some extent, the fourth are included in this definition of residual gravity anomaly.—*M. C. R.*

14816. Baars, B. Gravity effect of earth tides: Geophys. Prosp., v. 1, no. 2, p. 82–110, 1953.

The gravity effect of earth tides was measured simultaneously at 26 stations in various parts of the world. The ratio of the gravity variation for a yielding earth to that for a rigid earth was found to be 1.22, and no phase difference exists. This ratio is virtually invariable. Therefore the improvement of drift characteristics of modern gravity meters may permit less frequent returns to a base station because corrections for tidal gravity variations can be applied.—*L. C. P.*

14817. Boaga, Giovanni, and Tribalto, Giuseppe. Determinazione della densità media della Terra per mezzo di misure gravimetriche [Determination of the mean density of the earth by means of gravimetric measurements]: Accad. Naz. Lincei Atti, Cl. sci. fis., mat. e nat. Rend., v. 11, fasc. 5, p. 237–239, 1951.

Gravity measurements were made with a Western gravimeter both inside and outside the Murge di Bari (grottoes of Castellana). External stations were set

up along the axes of the caves, in the same vertical plane as the internal stations. Results are tabulated for 11 pairs of stations. From the formula $\Delta g = 4\pi\epsilon(\frac{2}{3}\rho m - \rho)\Delta Q$ (g=gravity, ϵ=constant, ρm=mean density, ρ=average density at surface, Q=depth), ρm is calculated to be 5.53±0.014 g per cm^2. Substituting this value in the same formula, ρ is calculated for each individual station.—*D. B. V.*

14818. Miller, Robert J., and Rodriguez, Daniel M. The use of multiples in gravimetric interpretation: Compass, v. 30, no. 1, p. 34–38, 1952.

Tables and graphs of gravitational anomalies of ore bodies having forms, dimensions, and depths, and designated as structures having multiples equal to one, are computed and drawn for selected parametric values. Then, for each type of structure a multiplier—a simple formula—is derived. By selecting various parameters better suited to the geology (or where previous experience gives us further information) in the area under investigation, the values of multipliers can be rapidly computed and the corresponding gravitational anomalies scaled off from the graphs.—*Authors' Abstract*

14819. Castro, Honorato de. Tablas para corregir, dentro de la republica Mexicana, las observaciones gravimetricas de los influjos luni-solares [Tables of corrections for lunisolar effects to be applied to gravimetric observations in Mexico]: Ciencia (Mexico), v. 12, no. 11–12, p. 301–310, 1953.

The method based on the formulas of spherical astronomy is developed to determine the effect of the moon and the sun on the force of gravity measured at a point on the surface of the earth, and numerical values are given for different points in Mexico. In computing these corrections, the deformation of the globe due to the tidal effect is not taken into consideration.—*S. T. V.*

OBSERVATIONS OF GRAVITY AND GRAVITY SURVEYS

14820. Garland, G. D. Gravity measurements in North America with the Cambridge pendulum apparatus: Royal Soc. London Proc., ser. A, v. 219, no. 1137, p. 215–233, 1953.

The Cambridge pendulum apparatus has been used to establish a line of nine fundamental gravity stations in North America, between Mexico City and Winnipeg. For this work considerable care was given to the elimination of magnetic disturbances, the most important precaution being the compensation of the vertical component of the earth's magnetic field by means of Helmholtz coils. The crystal frequency standard used to time the pendulums was rated for each observation against the precise carrier-wave frequencies broadcast by radio station WWV. In general, the values of gravity obtained are in agreement with those of previous observers, but detailed comparisons are difficult because of the need for a more consistent North American network. The total range in gravity covered by the line of stations is over 2,000 mgals, the extreme values being Mexico City: g=977.9415 cm/s^2, Winnipeg: g=980.9952 cm/s^2 relative to the adopted base value, Ottawa: g=980.6220 cm/s^2. The standard deviation of the difference of gravity has a mean value of 0.0003 cm/s^2.—*Author's Abstract*

14821. Sanders, P. État actuel des mesures gravimétriques en Belgique et au Congo Belge [Present state of gravimetric measurements in Belgium and the Belgian Congo]: Ciel et Terre, 68° année, fasc. 7–8, p. 151–164, 1952.

This paper begins with a theoretical discussion of absolute gravity measurements, and the adoption of the value of g=981,131.0 mgals for Uccle, which is the basis of the gravimetric network of Belgium. The minimum value measured in Belgium is 980,975.6±0.2 mgals at Saint-Hubert; the maximum is 981,203.2± 0.8 mgals at Heist. Three values listed for the Belgian Congo have already been given in Geophysical Abstract 14199. Measurements were made with a pendulum.—*D. B. V.*

14822. Gennaro, Ida. Determinazione di gravità relativa tra l'Istituto Idrografico della Marina in Genova ed il vertice di 1° ordine Monte Colma di Mombarone [The determination of gravity difference between the Istituto Idrografico della Marina in Genoa and the 1st order station at the summit of Monte Colma di Mombarone]: Accad. Naz. Lincei Atti, Cl. sci. fis. mat. e nat. Rend., v. 13, fasc. 6, p. 391–395, 1952.

Precise determinations of gravity were made on Monte Colma di Mombarone (45°35′08.05″ N. lat., 7°53′37.64″ E. long.) at a height of 2,371 m above sea level, using a Sterneck 4-pendulum apparatus. At the base station of the Istituto Idrografico in Genoa, g=980.557 gals; at Monte Colma di Mombarone, g=980.161±0.003 gals.—*S. T. V.*

Allen, Clarence H., and Smith, George I. Seismic and gravity investigations on the Malaspina Glacier. *See* abstract 14920.

14823. Cook, Alan Hugh, Hospers, Jan, and Parasnis, Dattatraya Shripad. The results of a gravity survey in the country between the Clee Hills and Nuneaton: Geol. Soc. London Quart. Jour., v. 107, pt. 3, p. 287–306, 1951 [1952].

A gravity survey made betwen the Clee Hills and Nuneaton shows close correlation of change of anomaly with thickness of the Coal Measures, and a somewhat less close relation with the thickness of the Triassic over the Forest of Arden. The corresponding density differences agree with densities of rocks measured at the surface. The remaining anomalies indicate about 4,000 ft of rather light rocks, probably Coal Measures, below the Triassic in the Forest of Arden, and about 2,500 ft of Triassic at Kidderminster.—*D. B. V.*

14824. Fuchs, Bruno. Geologische Erwägungen über das vermutete Erdölvorkommen von Zeitz unter Berücksichtigung neuerer Gravimetermessungen [Geologic considerations of the possible presence of petroleum at Zeitz with regard to recent gravimetric measurements]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1953, Heft 8, p. 329–336.

The gravity anomalies in the vicinity of Zeitz indicate a complete lack of possible oil-bearing structures. The anomalies are comparable to those of the surrounding area, which is underlain by granite. The traces of oil found in the region are the result of distillation of lignite, or waste products which have found their way into ground water and thence into wells.—*D. B. V.*

MAGNETISM

MAGNETIC FIELD OF THE EARTH

14825. Errulat, F[ritz]. Was ist über die Ursache des Erdmagnetismus bekannt? [What is known about the cause of terrestrial magnetism?]: Umschau, Jahrg. 52, Heft 5, p. 129–131, 1952.

This is a review of present theories of the origin of the magnetic field of the earth. The contributions of Vestine, Schlomka, Blackett, Runcorn, Ramsey, and Elsasser are described briefly. Most investigators agree that all but a small fraction of the total magnetism arises in the earth's interior, and the fluid motion hypothesis (*see* Geophys. Abs. 11987, 11988, 12957*Q*) seems to account for the intensity of the geomagnetic field and for its secular variations. A few, however, attempt to attribute the earth's magnetism entirely to the crust, and although there are certain difficulties in this concept it cannot be discarded entirely in view of our limited knowledge of the core. The possibility that a cosmic magnetic field exists in interstellar space is also mentioned.—*D. B. V.*

14826. Gaibar Puertas, C. Increase of the earth's mean magnetization: Geofisica Pura e Appl., v. 23, p. 6–20, 1952.

Studies of the magnetism of the earth by many scientists have led to the unanimous conclusion that during the last hundred years the average mean magnetization of the earth has been diminishing at the rate of about 1/1,500 annually. Observations collected by Gaibar Puertas from more than 60 observatories in all parts of the world for the period from 1922 to 1945 show a reversal of this tendency (*See* Geophys. Abs. 13568). From analysis of the geographic distribution of the signs and gradients of secular variation, Gaibar Puertas concludes that the sima layer shows greater resistance to changes of its magnetic state than does the sial, and that because of this, the Pacific area shows smaller secular variations than other areas of the globe.—*S. T. V.*

14827. Harlem, Jürgen von. Punktpole und erdmagnetisches Feld [Point poles and geomagnetic field]: Umschau, Jahrg. 52, Heft 20, p. 614, 1952.

Dirac and Malkus have suggested the existence of magnetic "point poles" possibly produced by cosmic radiation in the outermost atmosphere. If such unipoles impinged on the earth's surface as often as 1 particle per cm^2 per sec and combined with material of the earth's crust, they would disrupt the geomagnetic field within a month. Thus it may be concluded that fewer than 10^{-10} particles per cm^2 per sec have impinged in the last billion years.

If such particles did not combine, however, but wandered about freely, they would have no appreciable effect on the geomagnetic field, for just as many with a north charge would move toward the one pole as those with a south charge would move toward the other. So long as they thus "lived" they would be undetectable, for the possibility of encountering an oppositely charged particle (in which event their energy would emerge as gamma radiation) is extremely small. More research data are needed before we can demonstrate the existence of such point poles, and possibly they never can be directly identified.—*D. B. V.*

14828. Gheri, Herma. 27^d Variation der harten Komponente der kosmischen Strahlung und Magnetfeld der Erde zur Zeit eines Minimums der Sonnenaktivität [27-day variation of the solid components of cosmic radiation and magnetic field of the earth at the time of a minimum of sunspot activity]: Zeitschr. Naturforschung, Band 6a, Heft 12, p. 775–780, 1951.

Observations of cosmic rays during 23 rotations of the sun show that only a small part of the 27-day variation can be explained on the basis of geomagnetic influences. After correcting for magnetism, 2 cycles still stand out clearly: 12 rotations with a maximum the first to the sixth day; 5 rotations with a maximum the ninth to the eleventh day. The former, which were mainly observed at the time of magnetic recurrence, can be explained as being due to atmospheric influences; an explanation of the latter can not be offered.—*D. B. V.*

14829. Martyn, D. F. The morphology of the ionospheric variations associated with magnetic disturbance. I. Variations at moderately low latitudes: Royal Soc. London Proc., ser. A, v. 218, no. 1132, p. 1–18, 1953.

A study is made of the variations in the heights and densities of the ionospheric regions, particularly the F_2 region, during magnetic disturbance. Data from three observatories in moderate latitudes, namely Watheroo, Canberra, and Washington are used, and the disturbance variations in both local time and storm time are exhibited. The former variations are found to be mainly diurnal in type; the latter are appreciable for about three days after the commencement of the magnetic storm. The initial shape of the curve of storm-time variation depends markedly on the local time of commencement of the magnetic storm.

A theory of these variations is developed, according to which all ionospheric disturbance variations are due to the effect of an electrostatic field which is developed in the auroral zone, and spreads over the earth through the ionosphere in such a way as to produce the current responsible for the disturbance daily magnetic variations. The interaction between these currents and the earth's magnetic field produces a drift in the ionization of the ionospheric regions. This drift is held to be directly responsible for the observed ionospheric variations. Thus all ionospheric disturbance variations, and also the worldwide disturbance magnetic variations, are attributed to a single cause, the electrostatic field produced by the intense impressed current system in the auroral zone.—*Author's Abstract*

14830. Chernosky, Edwin J. The phased-superposed-epoch method of analysis, and an application to geomagnetic activity: Am. Geophys. Union Trans., v. 34, no. 4, p. 519–528, 1953.

This paper describes the phased-superposed-epoch method in which data are grouped according to their phases for analytical treatment. The phases are those of increase, decrease, or no change in geomagnetic activity, and are determined by the characteristics of pairs of days, both individually and relative to each other, on the basis of previously chosen criteria. This method is otherwise similar in some respects to the Chree superposed-epoch method, in which the characteristics of only one day are considered in the grouping of data (selection of reference days). In a limited but demonstrative investigation, the daily magnetic *C* figures for 1932–1946 were classified according to their level of activity as disturbed *D*, intermediate *I*, and quiet *Q*. The groups of data thus referenced by the three Chree categories and by the nine phases were analyzed

on punch-card machines. Some of the results obtained by the phased method for the entire 15-year period, considered in terms of the averaged C values were as follows: (1) When magnetic activity remains at a generally disturbed, an intermediate, or a quiet level for at least two days, the second day tends to be slightly more quiet than the first. (2) The tendency for the magnetic activity of a sequence of two days to repeat itself after 26 to 28 days is strongest when the two days are at the same level of activity. (3) The phases that recur most strongly 26 to 28 days after their initial incidence are *II*, *QQ*, *DD*, and *QD*. (4) The phased method makes evident some trends in activity that are smoothed away or reduced in the use of the Chree method.—*Author's Abstract*

14831. Lapina, M. I. Geomagnetizm i seysmicheskiye yavleniya [Geomagnetism and seismic phenomena]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 393–404, 1953.

No reliable correlation has yet been established between geomagnetic and seismic phenomena although numerous observations suggest the existence of such correlation. To solve this problem Lapina suggests studying the micro-variations of the geomagnetic field with the aim of separating variations related to processes taking place in the earth's crust from very intensive ionospheric effects, studying secular magnetic variations in both seismically active and seismically quiet regions, and investigating the spatial distribution of the geomagnetic field and its correlation with tectonic and seismic characteristics of different regions.—*S. T. V.*

MAGNETIC PROPERTIES OF ROCKS AND MINERALS

14832. Grabovskiy, M. A., and Parkhomenko, Ye. I. Ob izmenenii magnitnykh svoystv magnetitov pod deystviyem bol'shikh szhimayushchikh napryazheniy [On the change in magnetic properties of magnetites when acted upon by strong compressive stresses]: Akad. Nauk SSSR Izv. Ser. geofiz, no. 5, p. 405–417, 1953.

Laboratory studies were made of the changes in the magnetic properties of ferromagnetic substances subjected to strong compressive stresses. Samples were placed in thick brass tubes and compressed by an axial force P_o, that produced, owing to the close fit of the sample in the tube, hydraulic pressure of the approximate intensity $P_r=P_o\ (\mu/1-\mu)$, where μ is Poisson's coefficient of the tested substance.

The brass tube holding the sample was provided with a coil connected to a ballistic galvanometer so that the variations of the magnetic properties of the compressed sample could be measured. The experiments indicate that the magnetic properties of magnetite acted upon by compressive forces in the described arrangement change greatly, especially the remanent magnetism; the susceptibility x of samples varies in accordance with the approximate formula $x=a/\sigma$, where $a=I_s^2/3\lambda_s$ (I_s is the intensity of magnetization at the saturation point, λ_s the corresponding magnetostriction) and σ mechanical stresses of the sample. If the deformation of the sample was carried into the plastic region, an irreversible decrease of the intensity of magnetization and of remanent magnetism was observed. This last may explain the decrease of remanent magnetization observed in fault zones and consequent local magnetic anomalies, as pointed out by G. N. Petrova and Yukhnovets (*see* Geophys. Abs. 14425).—*S. T. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

14833. Kalashnikov, A. G. Magnitnyy gradiyentometr s flyuksmetrom [Magnetic gradiometer with a fluxmeter]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 307–317, 1953.

Elimination of temporal effects, such as diurnal and other magnetic disturbances, in the precise measurement of magnetic vectors would be unnecessary, if instead of magnetic vectors their gradients were measured. The construction of a magnetic gradiometer, its operation, sensitivity, and sources of errors are described. The instrument consists of two coils placed on an axis rotating about its midpoint. Two similar pairs of coils placed crosswise can be used, thus increasing the precision of the instrument. The ends of the coils are connected to a fluxmeter, which measures the variation of the magnetic flux through the coils, when they are rotated. A commutator is provided around the axis of the instrument. By rotating the axis of the coils through 90°, 180°, 270°, and 360° and repeating the same procedure after having turned the instrument through 90°, a sufficient number of equations will be obtained for the determination of the gradients G_{xx}, G_{yy}, G_{zz}, G_{xz}, G_{yx}, and G_{yz}, where $G_{xx}=dH_x/dx$, $G_{xz}=dH_x/dz$ and so on. The Laplace equation $G_{xx}+G_{yy}+G_{zz}=0$ must also be taken into account. The gradiometer is calibrated by introducing into the field of action a cylindrical magnet of known moment and dimensions and measuring the effect of this auxiliary magnet on the indications of the fluxmeter. The sensitivity of the instrument built for the tests is about $G_{zz}=3\gamma$ per meter, but it can be substantially increased.—*S. T. V.*

14834. Egedal, J. On the magnetic *H*-balance for the Galathea deep-sea expedition: Geofisica Pura e Appl., v. 25, p. 26–28, 1953

This is a brief description of an instrument designed to record the horizontal component of magnetism in the deep sea, and capable of functioning even if moved up and down following the movements of the ship and with changing orientation. The instrument is a balance and is a monad magnet; magnet, mirror, and knives are made of the same piece of steel. In order to measure the horizontal force the balance is placed in a vertical position resting with its knives on plane agate surfaces. The horizontal field at the balance is reduced to a negligible quantity by a compass placed at the proper distance below the balance. By means of a small magnet placed in a vertical position above the balance it is possible to change the vertical field and the scale value of the instrument. The whole instrument is constantly revolved on a vertical axis by means of a clock work.—*M. C. R.*

14835. Heiland, Carl A. Method of and apparatus for aeromagnetic prospecting, U. S. patent 2,659,859, granted Nov. 17, 1953. 4 claims.

An earth inductor mounted in an airplane and continuously oriented in the direction of the earth's magnetic field.

14836. Wickerham, Warren E. Magnetic gradiometer, U. S. patent 2,663,843, granted Dec. 22, 1953. 3 claims. Assigned to Gulf Research and Development Co.

An apparatus for measuring the time rate of change of magnetic intensity.

14837. Lynn, Ralph D. Magnetic well logging apparatus, U. S. patent 2,664,542, granted Dec. 29, 1953. 5 claims. Assigned to Standard Oil Development Co.

Two vertically spaced, rotating coils suspended in a well, from which the variations in voltage output and phase angle are measured and correlated with depth.

14838. Sharpe, J. A. Aplicación y principios del método magnético de exploración [Application and principles of the magnetic method of exploration]: Petroleos Mexicanos, 2ª época, tomo 1, no. 9, p. 711–715, 1953.

The different factors contributing to the production of a magnetic anomaly and the four main types of magnetic anomalies caused respectively by a deep intrusion of igneous rock, by such an intrusion almost reaching the surface of the earth, by an intrusion protruding out of the surface of the earth, and by a topographic elevation on the surface are discussed. Magnetic profiles corresponding to each of these types of anomalies are discussed to aid in interpreting the results of magnetic surveys.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

14839. Mikov, D. S. Opredeleniye napravleniya namagnichennosti vozmushchayushchikh tel po rezul'tatam magnitnoy s"yemki [Determination of the direction of magnetization of disturbing bodies from the data of the magnetic survey]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 418–423, 1953.

Continuing his studies on magnetic parameters of disturbing bodies (see Geophys. Abs. 14240), Mikov gives a method of finding, by theoretical calculations, the magnetic axis of disturbing two-dimensional bodies from the data obtained in a magnetic survey, without using any gravitational measurements. For this purpose, curves are computed of the vertical and horizontal components of magnetic anomalies. Proof is given that the sum of positive portions of either of these curves is equal to the sum of negative ones. This equality remains valid for any direction of the magnetization. A further formula is derived for the angle formed by the magnetic axis of the disturbing body and numerical values of this angle are given in a table.—*S. T. V.*

14840. Morley, L. W. The areal distribution of geomagnetic activity as an aeromagnetic survey problem near the auroral zone: Am. Geophys. Union Trans., v. 34, no. 6, p. 836–840, 1953.

Aeromagnetic surveying within the auroral zone is complicated by the necessity of correcting records made during frequent severe magnetic storms by data obtained from a ground station. Data obtained at two simultaneously operated stations, at first 130 miles apart and later 87 miles apart in Alberta, show that such corrections would be seriously in error for separations of this order. It is suggested that a magnetic gradiometer which measures the difference in total field strengths between two closely spaced points would be a practical solution to the problem of conducting aeromagnetic surveys during severe magnetic storms.—*M. C. R.*

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MAGNETIC OBSERVATIONS AND SURVEYS

14841. Morais, J. Custódio de. Observações de magnetismo terrestre no Instituto Geofísico da Universidade de Coimbra [Geomagnetic observations at the Instituto Geofísico of the University of Coimbra]: Univ. Coimbra Mus. Mineralog. Geol. Mem. e Noticias, no. 33, p. 3–39, 1952.

This is an analysis of magnetic observations at the Instituto Geofisico de Coimbra since 1866; secular, annual, monthly, and diurnal variations are determined. Geomagnetic observations at Coimbra, at latitude 40° N, show typical polar characteristics during the winter and equatorial characteristics during the summer, in this respect resembling Tucson Observatory in the United States.—*S. T. V.*

14842. Olczak, Tadeusz. Wyniki pomiarów magnetycznych absolutnych wykonanych w 1942 r. [Results of absolute magnetic measurements made in 1942]: Państwowy Inst. Geol. Biul. 82, p. 43–46, 1952.

During the summer of 1942 absolute determinations of D, I, and H were made at nine Polish stations, using a magnetic theodolite system Chasselon and Schultze inductor. The results, reduced to the epoch 1942.5, are presented in a table.—*S. T. V.*

14843. Skorupa, Jan. Absolutne pomiary inklinacji magnetycznej na Dolnym Šlasku w 1947 [Absolute measurements of magnetic inclination in Lower Silesia during 1947]: Państwowy Inst. Geol. Biul. 82, p. 47–50, 1952.

During the summer of 1947, a magnetic survey was made in Lower Silesia, including among the stations occupied five belonging to German absolute magnetic surveys of 1898–1903. A table of the values obtained in 1947 and in previous surveys shows the general increase of the inclination in this region.—*S. T. V.*

14844. Dąbrowski, Adam. Pomiary absolutne na punktach wiekowykh w 1949 roku [Absolute measurements at secular points in 1949]: Państwowy Inst. Geol. Biul. 82, p. 21–42, 1952.

A report is presented of absolute magnetic measurements of D, I, and Z at twenty-two specially selected stations distributed throughout Poland, some of which had been included in the German absolute magnetic survey of 1901.0. The Z component was measured using the Schmidt variometer, specially calibrated with a Helmholtz coil and auxiliary magnets. D was determined with two Wild's theodolites, and I value was measured with an Askania magnetic inductor. Results of the survey are presented in the table reduced to the 1949.5 epoch.—*S. T. V.*

14845. Olczak, Tadeusz. Zmiany wiekowe magnetysmu ziemskiego na ziemiach polskich w pięćdziesięcioleciu 1900–1950 [Secular variations of terrestrial magnetism in Polish territory between 1900 and 1950]: Państwowy Inst. Geol. Biul. 82, p. 5–20, 1952.

Observational material collected between 1900 and 1950 by magnetic observatories of central Europe, especially those in Poland, is reviewed. The tendency of the total vector of the geomagnetic field over this area to decrease during the interval 1900–1925 and thereafter to increase is noted. A similar analysis is made of the H and Z components, and the variations of inclination

and declination. No explanation of these phenomena can be suggested yet. These secular variations must be taken into account when the separation of local from regional magnetic anomalies is made.—*S. T. V.*

14846. Dehalu, M. Observations magnétiques à la frontière du Congo belge et de l'Ouganda entres les latitudes 1°10′ Nord et Sud et en plusieurs points de l'Ouganda et du Kenya [Magnetic observations on the Belgian Congo-Uganda border between latitudes 1°10′ north and south and at several points in Uganda and Kenya]: Inst. Royal Colonial Belge Mem., tome 5, fasc. 4, 76 p., 1953.

The magnetic observations here reported were made in 1908–09. Six stations were reoccupied by Walter in his survey of Uganda in 1941 so that the secular variation of magnetic declination could be calculated. The border region is one of strong magnetic anomalies so it was impossible to construct isogonic maps.—*M. C. R.*

14847. Tsubokawa, Ietsune. Reductions of the results obtained by the magnetic survey of Japan (1948–51) to the epoch 1950.0 and deduction of the empirical formulae expressing the magnetic elements: Geog. Survey Inst. Japan Bull., v. 3, pt. 1, p. 1–29, 1952.

Maps showing lines of equal declination, horizontal intensity, and dip for the epoch 1950.0, the observations on which they are based, and the methods by which they were calculated are given.—*M. C. R.*

14848. Morelli, Carlo. Rilievo geofisico dell'altipiano di Asiago [Geophysical survey of the plateau of Asiago]: Annali Geofisica, v. 6, no. 2, p. 239–250, 1953.

Magnetic and gravimetric surveys were made of the Asiago plateau on which a new magnetic observatory is to be erected. The magnetic survey consisted of 215 stations and the gravimetric of 206. The results of the surveys show certain unimportant anomalies caused by volcanic intrusions below the calcareous layer to the south and to the west of the tableland, but normal conditions at the center and to the north of the plateau itself. The observed periodic magnetic variations are not considered important and will not affect the operation of the proposed observatory.—*S. T. V.*

ELECTRICITY

GENERAL AND THEORETICAL STUDIES

14849. Tarkhov, A. G. Modelirovaniye peremennykh elektromagnitnykh poley v tselyakh geofizicheskoy razvedki [Modeling of alternating electromagnetic fields as a method of geophysical exploration]: Akad. Nauk SSSR Izv. Ser. geofiz, no. 4, p. 318–323, 1953.

As the theoretical analysis of the propagation of electromagnetic waves through heterogeneous media, as most geologic formations are, is very difficult, model experiments have been used in studying such problems. The law of similarity between the parameters of the field and their values on models requires that $\gamma f_1 l_1^2 = \gamma_2 f_2 l_2^2$ and $e_1 f_1^2 l_1^2 = e_2 f_2^2 l_2^2$ where γ, $2\pi f_1$, l_1, and e_1 are the electrical conductivity, circular frequency, linear dimension, and dielectric constant of the ground, and γ_2, $2\pi f_2$, l_2, and e_2 are the corresponding values in the model.

A copper plate of known dimensions and physical properties was used as the model. The frequency of feeding alternating current, selected in accordance with equations (1) and (2) and considering the frequency normally used in field work, ranged from 60 to 300 kilocycles per second. The medium through which electromagnetic waves were propagated was a reservoir filled with water, in which differences in resistivity were obtained by varying the amount of salt dissolved in water.

Profiles obtained in the field can be clearly correlated with those obtained on the model. The depths of disturbing bodies determined from the experiments on models, however, were always greater than in the field, perhaps as the result of eddies of induced current.—*S. T. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

14850. Schouppé, Alexander v[on]. Ein neues Widerstandsmessgerät mit automatischer Umpolung zur Feststellung nicht sichtbarer Verbindungen von Wasserwegen [A new resistivity measuring apparatus with automatic antipolarization for determining concealed connections of water courses] : Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1953, Heft 9, p. 385–390.

This describes a resistivity apparatus designed to eliminate the difficulties, caused by polarization of electrodes, which were experienced in previous determinations of underground stream connections by the resistivity method [Geophys. Abs. 14465]. The apparatus is described in detail, with photographs and schematic diagram.—*D. B. V.*

14851. Belluigi, A[rnaldo]. Norme e risultati nell' uso del compensatore a corrente alternata "Bicaram" [Instructions for and the results obtained from the use of the alternating current compensator "Bicaram"] : Annali Geofisica, v. 5, no. 4, p. 519–550, 1952.

After a brief summary of previous studies leading to a new type of alternating-current compensator called Bicaram, a description is given of a series of experiments made with this instrument, including those on models. The model experiments are summarized in a graph which shows profiles of the electromagnetic field and the phase that together made possible the location of layers of good conductivity. The screening effect of such conductors is also investigated. The author calls attention to the possibility of employing the described compensator for the elimination of the primary electromagnetic field.—*S. T. V.*

14852. Belluigi, Arnaldo. Lineamenti teorici di nuovi metodi di carotaggio fisico : Matranslog & Phaselog [Theoretical features of new methods of physical logging : Matranslog and Phaselog] : Geofisica Pura e Appl., v. 25, p. 29–36, 1953.

The theory is developed for two new methods of drill-hole logging. In the first, called the Matranslog, changing patterns of an electromagnetic field around a drill hole during the transient period are used. The pattern of the field changing with time differs from one point to another in the area under investigation even though the frequency of the electric impulses remains constant, and this differently varying behavior of the eletromagnetic field can be utilized as a characteristic of the subsurface.

In the second method, called the Phaselog, the frequency of the applied electric impulse is varied and consequently the pattern of the electromagnetic field produced during the building-up interval also changes, but still is influenced by the electric properties of the ground at a specific point. The parameters of the field in both of these methods are computed by a purely analytical procedure and can be used as characteristics of the subsurface.—*S. T. V.*

14853. Chambrier, Pierre de. The MicroLog continuous dipmeter: Geophysics, v. 18, no. 4, p. 929–951, 1953.

A continuous record of the angle and direction of dip of formations traversed by a borehole, as well as the angle and azimuth of the borehole drift, may be obtained by use of MicroLogs. The instrument consists of three identical MicroLog devices separated from each other by 120° and with the centers of all in the same plane perpendicular to the axis of the apparatus which coincides with the axis of the borehole. The direction and angle of dip can be derived from the shifts in the recorded curves as the MicroLog devices cross formation boundaries. Direction and angle of the axis of the instrument (and consequently the axis of the borehole) are obtained from the teleclinometer attached to the dipmeter system.—*M. C. R.*

14854. Archambault, Jean. Quelques aspects de la prospection et de l'exploitation des eaux souterraines [Some aspects of the exploration and exploitation of ground water]: Inst. tech. bâtiment et travaux pub. Annales, 6e année, no. 67–68, p. 657–672, 1953.

In ground water exploration and development, the geophysical prospecting method most commonly used is the electrical, sometimes combined with seismic refraction. Exploratory borings are logged electrically by the Schlumberger method. Several profiles obtained by electrical measurements and later checked by drilling are reproduced, and practical examples taken from different localities in France and North Africa are cited.—*S. T. V.*

14855. Fernandez Bollo, Mariano. Estudio del agua subterránea por prospección geofísica [Exploration for underground water by geophysical methods]: Agricultura (Madrid), no. 227, p. 111–114, 1951.

Electrical, and less frequently seismic, methods are used in exploration for underground water resources. The resistivity method is chiefly employed, but it is always advantageous to combine this method with at least a certain amount of geologic investigation of the area. Spontaneous-polarization methods are also frequently used. The seismic method is less frequently used because of its high cost but has been successfully used in different regions of Spain, especially for exploration of deeper layers. Spontaneous-polarization surveys followed by geologic reconnaissance and resistivity measurements are recommended.—*S. T. V.*

14856. Fritsch, Volker. Geoelektrik Baugrunduntersuchung [Geoelectrical investigation of ground structure]: Umschau, Jahrg. 52, Heft 11, p. 330–331, 1952.

This paper describes the physical principles and the techniques of electrical exploration methods, illustrated by three practical examples.—*D. B. V.*

14857. Jung, Karl. Die Messung der tellurischen Ströme [The measurement of telluric currents] : Umschau, Jahrg. 51, Heft 3, p. 74–75, 1951.

This is a discussion of the principles and application of the geoelectric "four-point" method, pioneered by Schlumberger, which makes use of natural earth currents in obtaining data on underground structure.—*D. B. V.*

14858. Barret, William M. Method of prospecting with timed electric energy, U. S. patent 2,659,882, granted Nov. 17, 1953. 18 claims.

A method of transmitting electric energy into the ground and receiving the reflected pulse at the surface.

14859. Herbold, Robert J. Electrical method and apparatus for geophysical prospecting, U. S. patent 2,660,703, granted Nov. 24, 1953. 14 claims. Assigned to Lafayette M. Hughes.

A method of inducing an electrical pulse in the earth and of measuring the related characteristics of the transmitted and induced signals.

14860. Siegel, Harold O. Method for determining the size of a subsurface ore body, U. S. patent 2,663,004, granted Dec. 15, 1953. 2 claims. Assigned to Newmont Mining Corp.

An electrical potential method of outlining an ore body through which a hole has been drilled. One current electrode and one potential are placed on the surface; the other current and potential electrodes are placed in the drill hole. The configuration is varied to outline the ore body.

14861. Barret, William M. Transmitting and receiving apparatus and method for electromagnetic prospecting, U. S. patent 2,661,466, granted Dec. 1, 1953. 9 claims. Assigned to Engineering Research Corp.

14862. Donaldson, Charles A. Underground prospecting system, U. S. patent 2,657, 380, granted Oct. 27, 1953. 6 claims.

A low-frequency rectangular-wave electrical-reflection prospecting device, including a pulse transmitter and receiver and incorporating an oscilloscope for visually observing reflections from successive subsurface formations.

14863. Murphee, Eger V. Electrical resistivity dip meter, U. S. patent 2,655,632, granted Oct. 13, 1953. 10 claims. Assigned to Standard Oil Development Co.

An electrical resistivity apparatus for determining dip and strike in a bore hole, using a current electrode and, below it, three pairs of potential electrodes attached to caliper arms.

14864. Walstrom, John E. Method and apparatus for detecting fluid movement in well bores, U. S. patent 2,655,631, granted Oct. 13, 1953. 9 claims. Assigned to California Research Corp.

A method of detecting fluid flow in a bore hole by measuring the potential difference between an electrode in physical and electrical contact with the fluid and a second porous, insulator-covered electrode in ionic contact with the fluid. The electrodes are shielded from electrical potentials from the environment of the fluid.

ELECTRICAL SURVEYS AND WELL LOGGING

14865. Fritsch, Volker. Die geoelektrische Überprüfung der Baugrundverfestigung durch Zementinjektionen [The geoelectrical testing of subsurface reinforcements by cement injections]: Geofisica Pura e Appl., v. 25, p. 207–213, 1953.

During the construction of the Limberg Dam in Kaprun a space of approximately half a million cubic meters was consolidated by injections. Approximately 72 per cent of these injections were controlled by the geoelectric method. The calculations were based on the theory of Lorenz-Lorentz, the usefulness of which was demonstrated by these experiments. The final results of altogether 7,704 meters electrically controlled injections which were carried out in the subsoil of the Limberg Dam show that the electrically calculated results are in good accordance with the mechanical results. [See also Geophys. Abs. 13040]—*Author's Abstract*

14866. Böhm, Helmut, and Salzmann, Günther. Die geophysikalische Untersuchung der Arsenikalkieslagerstatte zu Reichenstein (Schlesien) [Geophysical investigation of arsenical pyrite deposits at Reichenstein (Silesia)]: Zeitschr. Erzbergbau u. Metallhüttenwesen, Band 5, Heft 10, p. 400–402, 1952.

Böhm and Salzmann disagree with Kamprath's evaluation of the results of the geophysical investigation at Reichenstein (Silesia) by Keunecke in search for arsenical pyrites (see Geophys. Abs. 13030). Referring to their own investigations they express a more favorable opinion as to the presence of arsenical ores.—*S. T. V.*

14867. Mosetti, Ferruccio. Su una prospezione geoelettrica in montagna. Rilevamento di falde acquifere fortemente ionizzate [On a geoelectric exploration in mountains. Survey of strongly ionized water-bearing layers]: Osservatorio Geofis. Trieste Pub. no. 31, 7 p., 1953.

Results are presented of an exploration of a mountainous area of very complicated structure near Trieste. The resistivity method with the Wenner electrode arrangement was used. Mosetti was primarily interested in the upper layer, down to about 30 m, because of certain engineering structures planned in the area. By constructing numerous profiles and comparing them with theoretically computed graphs, sufficiently detailed and reliable information on the geology of the area was obtained.—*S. T. V.*

Röthlisberger, H., and Vögtli, K. Geophysical investigations of the Stadlerberg. *See* abstract 14924.

SEISMOLOGY

ELASTIC WAVES

14868. Heelan, Patrick A. On the theory of head waves: Geophysics, v. 18, no. 4, p. 871–893, 1953.

When a combined longitudinal and transverse disturbance, diverging from a localized source, strikes a plane boundary between two solid elastic media, several systems of head waves and second-order boundary waves are generated, each associated with grazing incidence of one or the other of the reflected or

refracted waves. Associated with grazing incidence of P_1P_2, the refracted P-wave is the head wave system comprising $P_1P_2P_1$ (the "refracted wave" of seismic prospectors), and $P_1P_2S_1$ (a transverse head wave) in the upper medium, and $P_1P_2S_2$ (a transverse head wave) in the lower medium. There is no boundary wave in the lower medium. These three waves, with the second-order term of P_1P_2 (the first-order term is zero on the boundary) satisfy conditions of continuity of stress and displacement at the boundary. Moreover, the energy of the three head waves is derived completely from the second-order component of P_1P_2, which possesses a component of energy flow normal to the boundary. The amplitudes of $P_1P_2P_1$, $P_1P_2S_1$ and $P_1P_2S_2$ are calculated for certain cases.—*Author's Abstract*

14869. Tolstoy, Ivan, and Usdin, Eugene. Dispersive properties of stratified elastic and liquid media: A ray theory: Geophysics, v. 18, no. 4, p. 844–870, 1953.

The interference principle of wave-guide propagation is applied to the derivation of the period equations for a number of problems involving both elastic and liquid strata. In the case of undamped steady-state propagation in a solid or liquid stratum two arbitrarily chosen points at the same depth must be indistinguishable on an amplitude basis. This well known principle combined with the knowledge of the reflection coefficients enables us to derive, in a few simple steps, the period equations for a number of multilayer cases which heretofore had been avoided on account of algebraic difficulties. The period equations obtained by this method exhibit a singular simplicity and unity of form. As a consequence of this one may distinguish formally the M_1 and M_2 waves discovered by Sezawa and understand their physical significance.—*Authors' Abstract.*

14870. Ricker, Norman [H.]. Wavelet contraction, wavelet expansion, and the control of seismic resolution: Geophysics, v. 18, no. 4, p. 769–792, 1953.

When a charge of dynamite is fired in a shot hole the primary disturbance moves downward as a wavelet. Identical wavelets will be reflected back toward the surface from each of a series of reflecting beds provided the incidence is normal and the interfaces are not too closely spaced. A wavelet complex is formed by two or more overlapping wavelets; a reflection seismogram is itself an elaborate wavelet complex. The central valleys of a wavelet complex will be resolved if the separation of the wavelet centers exceeds 0.428 of the wavelet breadth. At smaller separations the valleys will merge. The inner maxima of a wavelet complex will be resolved at separations approximately three times those necessary to resolve the valleys. As a practical example, this means that if the velocity is 10,000 feet per second and the wavelet breadth 0.020 second, interfaces closer together than 42.8 feet cannot be mapped. Wavelet complexes in which one of the wavelets is inverted can be similarly analyzed.

A distortionless seismograph must satisfy two conditions: the phase characteristic must be a linear function of the frequency with an intercept on the phase axis of zero or an integral multiple of π, and the amplitude-response characteristic must be of the form $A=A_0e^{kf^2}$ where f is the frequency and A_0 and k are constants. If k is 0 the amplitude-response characteristic is flat. If k is negative the wavelet is broadened; this is the characteristic of a wavelet expander. If k is positive the wavelet breadth is reduced; this is the characteristic of a wavelet contractor. A wavelet contractor can be used to resolve wavelet complexes and, in practice, a contraction to 0.80 of the breadth of the input

wave is easy to realize. A wavelet expander can be used deliberately to reduce the resolving power and emphasize a few prominent reflectors.

Laboratory and field studies of the wavelet contractor demonstrate its ability to delineate subsurface formations with greater precision than does the conventional seismograph and to carry pinchouts and truncations farther than it is possible with conventional seismographs.—*L. C. P.*

14871. Tamate, Osamu. On the propagation of elastic waves along the infinitely long circular-cylindrical hole in an infinite solid: Tōhoku Univ. Tech. Repts., v. 17, no. 2, p. 1–20, 1953.

Solutions are obtained in terms of the displacement at the hole wall for elastic waves propagated along an infinitely long circular-cylindrical hole in an infinite elastic solid as the result of periodic normal stresses applied along the periphery of a cross section of the hole. In a large hole, the displacements at the hole wall, which is far from the source of the disturbance, consist of three waves travelling outward from the source, one being the modified Rayleigh wave propagating over the concave circular-cylindrical surface along its axial direction, the other trains of equivoluminal and irrotational waves. The velocity of the Rayleigh wave is slightly larger than that for a plane boundary, and the increase is proportional to the wave length so that the waves are dispersive. The motion at the surface is elliptical and the eccentricity of the orbit is somewhat smaller than that for a plane boundary. In a small hole, the displacements near the hole wall consist of waves travelling with the velocities of irrotational and equivoluminal waves, and the disturbances corresponding to Rayleigh waves are missing. With increasing distance from the source, the amplitude diminishes inversely, and the radial component of displacement becomes much smaller than the axial component.—*M. C. R.*

14872. Das Gupta, Sushil Chandra. Propagation of Rayleigh waves in soils: Geofisica Pura e Appl., v. 25, p. 13–16, 1953.

The ratio of Young's modulus E to the modulus of rigidity G is greater in sandy soils than in isotropic elastic media. Assuming that the velocity of Rayleigh waves is less than that of shear waves, and that Poisson's ratio is ⅓, the ratio E/G is found from the frequency equation for Rayleigh waves to be 3.6. Conversely, if the ratio E/G is assumed to be 5.35, the value obtained by Weiskoff, then the velocity ratio of Rayleigh waves in the medium is 0.962.—*M. C. R.*

14873. Förtsch, O(tto). Deutung von Dispersion- und Absorptions-beobachten an Oberflachenwellen [Explanation of dispersion and absorption observations in surface waves]: Gerlands Beitr. Geophysik, Band 63, Heft 1, p. 16–58, 1953.

Extensive investigations, both theoretical and experimental, have been carried out of the propagation of sinusoidal elastic waves, especially of Rayleigh waves in a two-layered medium in which the semi-infinite body is assumed to be completely rigid. The periodicity of the sine and cosine terms in the dispersion formula lead to multiple solutions which may be designated fundamental and harmonic waves. The Rayleigh wave consists of a longitudinal and a transverse wave linked through conditions at the boundary plane, and hence there arise two fundamental waves and two harmonics which can be called coupled waves. Phase and group velocities for these special Rayleigh waves and ratios

of horizontal to vertical earth movement are given. The phase difference of the two components is 90°, and therefore particles travel in elliptic orbits, partly in a positive and partly in a negative sense. Each wave has a definite minimum frequency.

Observations of surface waves at the Göttingen airport, produced by both explosions and machine vibrations, include waves corresponding to these special Rayleigh waves, propagated in a layer 6.1 m thick with a velocity of 165 m per sec. (The depth of the ground-water table is about 6 m.) A constant percent of the energy of the through-going wave will be absorbed longitudinally along a wave group, thus explaining the absorption observations. As these results do not fit the requirements of the theory of a viscoelastic medium, it follows that the rocks of the earth behave largely as ideal elastic media.—*D. B. V., M. C. R.*

14874. Kuhn, Werner, and Vielhauer, Siegfried. Analogieversuche zur Ausbreitung von Bebenwellen in einem homogenen Erdinnern-Beziehungen zwischen den Ausbreitungsgeschwindigkeiten von longitudinalen und transversalen Wellen in relaxierenden Medien [Model experiments on the propagation of seismic waves in a homogeneous earth-interior—Relation between the velocity of propagation of longitudinal and transverse waves in relaxation media]: Geochimica et Cosmochimica Acta, v. 3, no. 4, p. 169–185, 1953.

The velocity of propagation of longitudinal and transverse ultrasonic waves and the viscosity and density in a glasslike substance have been determined both above and below the softening point. Transverse waves continued to be propagated at temperatures 30°–40° above the softening point, demonstrating that transverse waves can be propagated in liquid media.

The longitudinal velocity decreased as the material passed through the softening range, which can be explained quantitatively by assuming that the relaxation of shear stress in the softening range involves a simultaneous relaxation of about 30 percent in the modulus of compressibility.

These results provide support for the theory that there is no discontinuous change in density and composition at the core of the earth. The decrease in longitudinal velocity at 2,900 km can be explained quantitatively by the assumption that the relaxation time of the shear stresses in the medium at that depth equals the period of the seismic disturbance and that the disappearance of the modulus of torsion results in a reduction of about 30 percent in the modulus of compression.

The modulus of compression in the outer 2,900 km of the earth calculated from the velocity of seismic waves is thus a dynamic quantity; if static pressure is applied for more than about 300 years the modulus of compressibility will be about 30 percent smaller. This should be considered when calculating changes in the density of the interior of the earth as a result of gravitational effects.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

14875. Nugent, L. E., Jr. Limitations of reflection seismograph: Am. Assoc. Petroleum Geologists Bull., v. 37, no. 11, p. 2513–2529, 1953.

The overall reliability of reflection-seismograph data is influenced by the precision of the instruments and computations and by the velocity conditions. A well-matched set of instruments should be accurate to within about 0.002 seconds, which is equivalent to depths of 6–16 feet, but phase shifts and fre-

quency changes may introduce substantial errors. Although an effort is made to keep errors resulting from the computation of "weathering" and datum corrections of the same order of magnitude as instrumental errors, the choice of method for making these corrections may influence their accuracy and, in unfavorable areas, errors in computation may be several times the combined instrumental error. The failure to "migrate" depth points, particularly in areas of steep dip, may result in a totally false structural interpretation. Variations in velocity near the surface and at depth, of either a local or gradual nature, may cause large errors in depth computations and in some instances may give false structures or obscure real ones.

However, in good shooting areas in which the maximum of care is used, relative depths may be accurate to within plus or minus 50 feet. In bad areas very large misclosures may be unavoidable. The reflection seismograph is the "best exploration tool now available, and major improvement lies in the geologist's ability to comprehend and mitigate the problems of the geophysicist and to use the data to the ultimate."—*L. C. P.*

14876. Fedoseyenko, N. Ye., and Groshevoy, G. V. Sposob kontrolya chuvstvitel'nosti i opredeleniya chastotnykh i amplitudnykh kharakteristik seysmopriyemnykh kanalov pri pomoshchi magnitoelektricheskogo generatora [Method of sensitivity control and determination of frequency and amplitude characteristics of seismic recording channels by using a magneto-electric generator]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 424–428, 1953.

To determine and adjust the sensitivity of seismic recording channels a small electrical generator has been constructed, especially designed for seismic work, to produce electric waves of pure sinusoidal shape; to operate with different frequencies used in seismic investigations, preserving the sinusoidal wave; finally, to remain free of external disturbances. The construction of the generator is described and response curves obtained in practical tests are reproduced.—*S. T. V.*

14877. Martin, Hans. Theorie der Aufzeichnung eines Stosses mit Hilfe des elektrodynamischen Erschütterungsmessers [Theory of the recording of an impulse by an electrodynamic vibrometer]: Gerlands Beitr. Geophysik, Band 63, Heft 3, p. 209–233, 1953.

Measuring and recording of forced vibrations is usually done with instruments adapted to a steady state of vibrations, but the transient period is of greater importance in seismologic investigations. Martin presents an analytical study of the differential equation controlling the transient vibrations, giving its general solution and particular solutions corresponding to different initial conditions. The solutions are presented in the form of a table. The relation between the deflection of the galvanometer and the variation of the disturbing impulse is especially investigated. Use of the instrument as an accelerometer rather than a vibrometer is also discussed.—*S. T. V.*

14878. Weber, Max. Über die Indikatorgleichung eines Seismometers [On the indicator equation of a seismometer]: Geofisica Pura e Appl., v. 23, p. 1–5, 1953.

The indicator equation is the differential equation representing the relation between the oscillations of the mechanical system and the output voltage of a seismometer. Two differential equations are derived, one controlling the oscillations of mechanical system, another determining the observed electric voltage

as function of the displacements of the mechanical system. From these two equations the final indicator equation is derived replacing the data on the stiffness of the system and its friction by values obtained from the observation of the decay of free vibrations of the system. An equivalent linear indicator equation is then calculated with these results.—*S. T. V.*

14879. Medi, Enrico. Una soluzione del problema delle registrazioni meccaniche [A solution of the problem of mechanical recording]: Annali Geofisica, v. 5, no. 4, p. 501–505, 1952.

An arrangement has been proposed which permits the beam of light reflected from the mirror of an instrument to fall constantly on the same surface of a photoelectric cell. The system consists of a concave mirror; the instrument and the photoelectric cell are placed near the center of curvature of this mirror. The concave mirror is opportunely and partially shielded with a form which modulates the intensity of the reflected light as a function of the position of the image of the source on the mirror, and thus a function of the deviation of the instrument.—*Author's Abstract*

14880. Wilson, Roger M. Dynamic testing of seismograph galvanometers: Am. Geophys. Union Trans., v. 34, no. 4, p. 600–602, 1953.

By using an ultra-low-frequency oscillator, a cathode-ray oscilloscope, and a high-frequency galvanometer it is possible to make frequency and phase calibrations of a seismograph galvanometer under simulated operating conditions both rapidly and simply. By combining such data with the mechanical and electrical constants of an ideal electromagnetic seismometer and the results of a single shaking-table test, the over-all response curve may be obtained.—*M. C. R.*

14881. Homma, S., and Yamagishi, N. A nomogram for dynamical magnification of a Galitzin's seismograph: Geophys. Mag., v. 23, no. 3, p. 203–204, 1952.

A nomogram and directions for its use, by which the amplitude of ground motion can be determined, is given.—*M. C. R.*

14882. Süsstrunk, August. Les procédés sismiques appliqués à l'étude du sous-sol en Suisse [Application of seismic methods to subsoil investigation in Switzerland]: Internat. Conf. (3d) Soil Mechanics and Foundation Eng., Proc., v. 1, p. 309–312, 1953.

The seismic refraction method has been frequently used in Switzerland in exploration of dam sites and other important engineering structures. The results of such exploration, if sufficiently detailed, are usually very satisfactory and in good agreement with control drilling. Two examples of such investigations are briefly described. A table of the seismic velocity and moduli of elasticity in different formations is included.—*S. T. V.*

14883. Menzel, H[einz]. Seismische Untersuchungen auf See [Seismic exploration at sea]: Umschau, Jahrg. 53, Heft 21, p. 650–652, 1953.

This is a review of the seismic reflection and refraction methods as applied to marine surveying. This field of geophysics is invaluable both in exploration for oil on the continental shelf and in purely scientific investigation of the sea floor.—*D. B. V.*

14884. Cordell, Ralph L. Seismometer, U. S. patent 2,659,065, granted Nov. 10, 1953. 10 claims. Assigned to Stanolind Oil and Gas Co.

An electromagnetic seismometer.

14885. Piety, Raymond G. Rotational seismometer, U. S. patent 2,659,064, granted Nov. 10, 1953. 17 claims. Assigned to Phillips Petroleum Co.

14886. Oliphant, Charles W. Seismic prospecting, U. S. patent 2,658,578, granted Nov. 10, 1953. 3 claims.

A method of recording the three components of longitudinal and transverse waves created by a seismic disturbance.

14887. Press, Frank. Seismic exploration system, U. S. patent 2,654,874, granted Oct. 6, 1953. 5 claims. Assigned to Socony-Vacuum Oil Co.

A method of cancelling surface waves in reflection seismic exploration by generating signals from air waves produced by resonant coupling of the earth motion caused by surface waves at each detector position and mixing the generated signals with the actual signal.

14888. Piety, Raymond G. Apparatus for seismic exploration, U. S. patent 2,657,373, granted Oct. 27, 1953. 12 claims. Assigned to Phillips Petroleum Co.

An apparatus combining translational and rotational seismometers whose output is transformed so that one voltage is attenuated with respect to the other. The two voltages are then mixed, amplified, and recorded.

14889. Bardeen, Thomas. Suspension system for seismograph detectors, U. S. patent 2,657,374, granted Oct. 27, 1953. 18 claims. Assigned to Gulf Research and Development Co.

A seismic detector in which a coil moves in the air gap of a permanent magnet and including a magnetic leakage yoke.

14890. Poulter, Thomas C. High explosive disk-shaped charge for seismic exploration, U. S. patent 2,656,003, granted Oct. 20, 1953. 6 claims. Assigned to Institute of Inventive Research.

A disk-shaped charge for seismic air shooting, having a cavity of V-shaped cross section around the disk.

14891. Wolf, Alfred. Method and apparatus for recording dip of geological strata, U. S. patent 2,661,464, granted Dec. 1, 1953. 6 claims. Assigned to Geophysical Research Corp.

A seismic system using a modulator for each geophone, mixing signals with 90° phase shift and filtering.

14892. Henson, Robert L. Seismographic amplifier mixing circuits, U. S. patent 2,662,126, granted Dec. 8, 1953. 4 claims. Assigned to Sun Oil Co.

14893. McManis, Louis B., and Cooper, Jack R. Attenuator for seismic gain control, U. S. patent 2,663,002, granted Dec. 15, 1953. 3 claims. Assigned to Stanolind Oil and Gas Co.

14894. Loper, George B. Gain control system for seismic amplifiers, U. S. patent 2,656,422, granted Oct. 20, 1953. 5 claims. Assigned to Sacony-Vacuum Oil Co.

A gain-control circuit with variable series-connected condenser.

METHODS OF ANALYSIS OF EARTHQUAKE OBSERVATIONS

14895. Oliveira, J. Tiago de. Distribution-free methods for the statistical analysis in Geophysics: Sindicato Nac. Engenheiros Geógrafos Pubs., 1–a sér., no. 3, 8 p., 1952.

This paper presents some new results that may be useful in the statistical analysis of the largest values of random variables, such as earthquake magnitudes, pressures, temperatures, precipitations, floods. The problem is considered from the point of view of one series of n observations and of m series of n observations.—*S. T. V.*

METHODS OF ANALYSIS OF SEISMIC SURVEY DATA

14896. Conklin, Glenn M. Problem areas for the seismologist: Geophysics, v. 18, no. 4, p. 827–843, 1953.

"In the interpretation of seismic records it is assumed usually that data obtained from good records give reliable maps and likewise that poor data produce unreliable maps. . . . The purpose of this discussion is to point out instances when data, apparently quite good, must be used with extreme caution to avoid erroneous interpretations."

In southern Florida, where reflection work has been unsatisfactory, multiple refractions are observed. In Beaver County, Okla., extreme variations in velocity, which are thought to be due to differential salt solution, cause distortion of reflections and introduce apparent dips which are erroneous. In the Plainview basin of the Texas Panhandle and in Hancock County, Miss., multiple reflections are troublesome.

All available velocity information and geologic data must be used in making interpretations, and care must be exercised in selection of reflections for mapping. These reflections should be examined for possible distortion by velocity variation or by multiples.—*M. C. R.*

14897. Officer, Charles B., Jr. The refraction arrival in water covered areas: Geophysics, v. 18, no. 4, p. 805–819, 1953.

A solution is given for the refraction arrival in water covered areas in terms of the evaluation of a branch line integral for an impulsive point source. The physical significance of the mathematical solution is discussed, and experimental verification of the theoretical predictions is presented. The character, frequency, and range dependence of the refraction arrival agree with theory.

Using the results of this theory and the conventional interpretation techniques for refraction seismograms, it is posible to determine the velocities and depths of the seismic refraction horizons from the record of a single receiver. The velocities of the refraction layers can be determined from the frequency of the refraction arrivals, the depth of water, and the velocity of sound in water. Then, from the travel times, the depths of the horizons can be computed.

This method could be of importance in reconnaissance measurements of geologic structure over the continental shelves.—*Author's Abstract*

14898. Van Melle, F. A., and Weatherburn, K. R. Ghost reflections caused by energy initially reflected above the level of the shot: Geophysics, v. 18, no. 4, p. 793–804, 1953.

At Bellaire, Tex., during parts of 1945, 1948, and 1950, a series of tests demonstrated the existence of reflections from the base of the weathered layer above the shot point. Both direct and reflected signals were recorded at a subshot detector buried at a depth of 407 feet from shots fired at several depths down to 370 feet. An up-hole detector was used to assist in locating the reflector position. The direct and reflected signals were 180 degrees out of phase. The effect of reflections from the shot image on deep reflections at a surface seismometer-spread was also examined and ghost reflections were observed at several shot depths. When the shot was placed at a quarter wave length below the reflector (weathered layer interface), strong signals were observed. Shots successively detonated downward at the speed of the advancing wave from the top of a helix of primacord tended to eliminate ghost reflections. Shots detonated upward from the bottom tended to result in a seismogram consisting entirely of ghosts.—*L. C. P.*

14899. Berson, I. S. O razgranichenii oblastey registratsii otrazhennykh i prelomlennykh voln po kombinirovannym godografam [Delineation of the regions where the recorded waves are reflected or refracted using the composite travel time curves]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 209–214, 1953.

Delineation of regions where the waves are reflected or refracted can be made by an appropriate analysis of the combined travel time curve. The following procedure is suggested: the travel time curve is constructed, assuming the wave undergoes only reflection in its path. The obtained curve is then transformed into a quadratic system of coordinates, where the new coordinates are the squares of the initial ones. With these coordinates, the travel time curve of the reflected wave becomes a straight line, and the travel time curve of the refracted wave becomes a parabola. The computed curve is then compared with that obtained from observations and constructed in the same coordinate system. The suggested transformation of coordinates makes the effect of refraction on the travel time curve more clearly visible, especially where the ratio of the velocities in the layers is greater than 2. For V_1/V_2 between 1.5 and 2 this is less clearly visible, and for V_1/V_2 less than 1.5 the method cannot be used.—*S. T. V.*

14900. Dürbaum, Hansjürgen. Possibilities of constructing true paths in reflection seismic interpretation: Geophys. Prosp., v. 1, no. 2, p. 125–139, 1953.

Seismic reflections have been observed in surveys of the Heide salt structure which apparently come from the interior of the salt dome. Such observations are not susceptible to ordinary computation and interpretation techniques. A rigorous mathematical treatment is given to the case of a subsurface medium consisting of a series of plane reflecting beds with constant layer velocities but with any strike, and formula are derived by which contour maps of the reflections may be constructed.—*M. C. R.*

14901. Schneider-Riquelme, Oscar. Nomogram for computation of exact values of normal move-out times: Geophysics, v. 18, no. 4, p. 824–826, 1953.

A nomogram is presented for conveniently computing the exact value of normal move-out times in terms of the velocity at the near surface datum, the rate of

increase of velocity with depth, the reflection time, and the shot-receiver distance.—*Author's Abstract*

14902. Daly, John [W.] A universal slide rule for computing the dips of reflecting horizons on the assumption of linear increase of velocity: Geophysics, v. 18, no. 4, p. 820–823, 1953.

A slide rule is described by which the dip of reflectors can be computed rapidly and accurately for the case where instantaneous velocity can be assumed to increase linearly with depth. Values for initial velocity V_0, rate of increase of velocity k, and the spread distance Δx, can be introduced into the device easily and changed at will. In conjunction with a previously described instrument, normal move-out graphs and wave front charts can be constructed quickly and precisely.—*Author's Abstract*

14903. Ito, Ichiro. On the relationship between seismic ground amplitude and the quantity of explosives in blasting: Kyoto Univ. Faculty Eng. Mem., v. 15, no. 2, p. 79–87, 1953.

The relation between the amplitude of ground motion and size of explosive charge in blasting operations was studied in a series of experiments. Charges of 200, 500, 1,000, and 1,500 grams of ammonia gelatin dynamite (Shinkiri) were detonated in shot holes 2 m deep in an area underlain by red clay and sands and the resulting ground motion recorded by Sasa seismographs at distances of 10, 20, 30, and 50 m. A simple power relationship, though somewhat different from results obtained by previous investigators, was found. As the properties of the medium through which the waves propagate must influence the wave, different results are expected from blasting in hard rock.—*M. C. R.*

OBSERVATIONS OF SEISMIC WAVES

14904. Vestine, E. H. Note on analytical tests for distinguishing types of seismic waves: Jour. Geophys. Research, v. 58, no. 3, p. 401–404, 1953.

Surface gradients of ground displacements should prove of assistance in identifying and distinguishing the nature of seismic signals. If the origin O of right-handed rectangular axes x, y, z is taken at the surface, such that the Ox axis is directed away from the shot and Oz vertically downwards, and if u, v, w are the respective displacements along these axes at the free surface $z=0$, then $u\delta w/\delta x>0$ is a criterion for attenuation of amplitude with depth to the first order and hence may be useful in distinguishing surface waves from body waves. From the ideal theory it is encouraging to note that u and $\delta w/\delta x$ should be in phase for Rayleigh waves. For Rayleigh waves, it is shown that $u(\delta w/\delta x)-w(\delta u/\delta x)>0$ whereas the expected result for P waves is $u(\delta w/\delta x)-w(\delta u/\delta x)=0$.—*P. E. B.*

14905. Vestine, E. H., and Forbush, S. E. Statistical study of waves from blasts recorded in the United States: Jour. Geophys. Research, v. 58, no. 3, p. 381–399, 1953.

Statistical techniques are applied in the study of waves from blasts recorded at distances at which reflections from the Mohorovičić region might be expected, and also at a station a great distance from a blast. The process involves predicting the behavior of the record in future intervals from its behavior in previous intervals and analyzing the residue in these future intervals after

removal of the predicted time function (*see* Geophys. Abs. 14676). It was found that relatively stationary levels of autocorrelation exist, sometimes for considerable intervals of time, in various phases of the record. Under these conditions, the record is successfully analyzed into an autocorrelated part and a randomly disposed part closely described by the normal-error law in the records examined here. A statistical test based on sampling is applied to test the reality of extraneous signals or residuals. After analysis, in one case a "spike" signal due to the reflection of a compressional wave from the Mohorovičić discontinuity was probably found, although it was not distinguishable among other similar pulses in the original record.

The average duration of fluctuations in vertical ground velocity at a great distance from a particular blast fall into three stationary levels, nearly stationary also in energy exhibited. If these stationary levels are ascribed mainly to three sets of surface waves, proceeding without large loss in energy, these supposed surface waves evince no significant periodicity in time. They would then necessarily be badly broken up or scattered. It is suggested that the source distribution of surface waves can be found from the autocorrelation function, using methods analogous to those used in the theory of scattering and turbulence in fluids.—*P. E. B.*

14906. Jardetzky, W. S., and Press, Frank. Crustal structure and surface-wave dispersion, Part III: Theoretical dispersion curves for suboceanic Rayleigh waves: Seismol. Soc. America Bull., v. 43, no. 2, p. 137–144, 1953.

Theoretical Rayleigh-wave dispersion curves have been calculated for three different cases of suboceanic basement layering: a single layer with velocity of 7.90 kmps, two layers with velocities of 5.5 and 8.1 kmps, and two layers with velocities of 6.9 and 8.1 kmps, assuming the depth of the first layer to be equal to the depth of the ocean. The first and third are essentially the same in the range from 15 to 40 seconds, but the curves diverge for periods greater than 40 seconds. A layered basement approximating the third case with ocean depth of 5.57 km will explain the observed dispersion of Rayleigh waves in the Pacific and is consistent with refraction measurements in the Atlantic and Pacific Oceans.—*M. C. R.*

14907. Stoneley, Robert S. The transmission of Rayleigh waves across Eurasia: Seismol. Soc. America Bull., v. 43, no. 2, p. 127–135, 1953.

The problem of the propagation of Rayleigh waves in a double surface layer, although mathematically tractable, would involve very lengthy computations, scarcely justified by the rather inaccurate data available.

An approximate treatment by "Rayleigh's principle" gives, for any postulated ratio of the thicknesses of the layers, an overestimate of these thicknesses which needs reduction by 10 or 15 percent. Applied to W. Rohrbach's data on the velocities of transmission (i. e., the group velocities) of Rayleigh waves of known period, this method yields values which are consistent with those previously obtained for Eurasia from Love waves.

For a single uniform granitic layer of thickness T_1 resting on uniform ultrabasic material of great depth the Rayleigh-wave velocities from a track from the Kwen Lun [Kunlun] Mountains to Göttingen give T_1=39.4 km, without use of the Rayleigh approximation. This may be compared with the estimate of 34.6 km obtained on slightly differing hypotheses from Love waves.

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If the granitic layer is underlain by a uniform layer of basic rock of thickness T_2, some hypothesis must, in our present state of knowledge, be made concerning the ratio $T_2 : T_1$. For Rayleigh waves the Kwen Lun earthquake gives, on the two hypotheses $T_2=T_1$ and $T_2=2T_1$, the values 27 km and 19 km respectively for T_1. Reduced by, say, 15 percent these values are 23 km and 16 km, which may be compared with the estimates 22.1 km and 17.6 km derived on the same data from Love waves.

For a shock in Eastern Bengal the Rayleigh waves (both vertical and E–W components) give 30 km and 25 km on the two hypotheses, that is, "reduced values" of 25.5 km and 21 km, which exceed the Love-wave estimates of 22.1 km and 17.6 km quoted above. However, these tracks cross the Himalayas and the excess values are not surprising.

There is evidently scope for further investigations along these lines.—*Author's summary*

14908. Caloi, Pietro. Struttura geologico-sismica dell'Europa centro-meridionale, dell'Italia e del Mediterraneo centro-occidentale, quake risulta da recenti ricerche compiute in Italia [Geologic-seismic structure of south-central Europe, of Italy, and of the central Mediterranean according to the results of recent studies in Italy]: Annali Geofisica, v. 5, no. 4, p. 501–518, 1952.

The thickness of the P_g layer in the eastern and southern Alps is about 35 km; the thickness of the P^* layer in the same area is 10–15 km. Both the Alps and the Apennines have roots. In the central part of the Alpine system the roots seem to extend to about 40 km, and in the Apennines to 25–30 km, decreasing toward southern Italy. The average thickness of the granite layer in the central-western Mediterranean is about 15 km. In much of central Europe, the granite layer is only 20 km thick but this thickness tends to increase toward the Alps. Earthquake foci are shallow in the Alps and very shallow in the Apennines. In the southern part of the Mare Tirreno [Tyrrhenian Sea] there are volcanic shocks close to the surface and intermediate shocks at depths of 100–300 km. The mechanism at the focus as indicated by the surface distribution of compressions and rarefactions is faulting in the Alps and Tyrrhenian Sea, sinking of layers in the central Adriatic, and rising in the Apennines.—*M. C. R.*

14909. Ingram, R. E. Vibration angle of *S* wave: Seismol. Soc. America Bull., v. 43, no. 2, p. 145–151, 1953.

The vibration angles (SH/SV) were measured on Pasadena records of several shocks in South America and Japan-Kamchatka region, as well as a few other shocks. There is some evidence, at least in the shocks in South America, that the vibration angle is related to the direction of faulting, but this is inconclusive. Results are tabulated.—*M. C. R.*

14910. Gamburtsev, G. A. O korrelyatsionnykh metodakh izucheniya zemletryaseniy [Correlation method applied to investigations of earthquakes]: Akad. Nauk SSSR Doklady, tom 92, no. 4, p. 747–749, 1953.

The correlation method consists of the identification and tracing of individual waves along their path of propagation, using records obtained at successive points of observation. This method can be applied either at an individual station or at several closely spaced stations. In the first case at least one 3-component seismograph is necessary and several vertical seismographs placed along crosswise intersecting profiles, with a centralized recording on one film. This makes

it possible to use either the azimuthal correlation method (see Geophys. Abs. 14292) or the method of "axially inclined" seismographs, with instruments placed along the axis of their greatest sensitivity. When several seismic observatories are located near each other, it is sometimes possible, by centralized recording of their observations, to create conditions similar to the above described installation.

Tests of this method were made during 1951–52 in the northern Tien Shan and in the southwestern portion of the Turkmen S. S. R., during local earthquakes, which are very frequent in this area. The magnification of the shocks was as much as 10 million. It was found by the correlation method it was possible to determine reliably the epicentral azimuths and the angle of arrival of incoming waves.—*S. T. V.*

EARTHQUAKE OCCURRENCES AND EFFECTS

14911. Yoshiyama, Ryoichi. The hypocentral region of earthquakes: Seismol. Soc. American Bull., v. 43, no. 2, p. 153–158, 1953.

The magnitude of the hypocentral region (see Geophys. Abs. 11550), expressed as a radius r_0, has been computed for several earthquakes and related to the energy involved. For r_0 between 3 and 10 km, the energy E is given by $\log_{10} E=16.7+3.9 \log_{10} r_0$; for r_0 between 10 and 30 km, $\log_{10} E=16.0+4.6 \log_{10} r_0$. Because r_0 cannot yet be computed for destructive shocks because of the complexity of the seismograms, an attempt is made to relate the magnitude of the hypocentral region to the period of seismic waves, based on the intensity-distance relation. From relations between intensity, acceleration and absorption the formula $\log_{10} E=23-6 \log_{10} (k\times100)$, where k is absorption, is developed. From this and the preceding it follows that $k=0.15\ r_0^{-0.8}$. The period of the wave, which determines the seismic intensity of an earthquake, is then proportional to $r_0^{0.4}$, provided the energy is absorbed by viscosity only.—*M. C. R.*

14912. Nishimura, Eiichi, and Hosoyama, Kennosuke. On tilting motion of ground observed before and after the occurrence of an earthquake: Am. Geophys. Union Trans., v. 34, no. 4, p. 597–599, 1953.

Tilt observations at Ogoya, about 40 km from the epicenter of the destructive earthquake of March 7, 1952, showed a large and continuous anomalous westward tilt for 3 months preceding the day of the earthquake, and a gradual eastward tilt following the shock. Secular tilt may be associated with occurrence of earthquakes and thus be useful in studies of the prediction of shocks.—*M. C. R.*

14913. Buwalda, John P., and St. Amand, Pierre. The recent Arvin-Tehachapi, Southern California, earthquake; Science, v. 116, no. 3024, p. 645–650, 1952.

The strongest earthquake in California since the San Francisco earthquake shook the southern end of the San Joaquin Valley on July 21, 1952. The magnitude of the shock was 7.5, and the intensity in the most heavily shaken zone, 10 (modified Mercalli scale). Damage was extensive. The earthquake originated through slip on the White Wolf fault, which lies across the southern end of the San Joaquin Valley at right angles to the valley and the San Andreas fault. It is suggested that the aftershock sequence indicates that the strain relieved by the earthquake was mainly of the compressional type rather than the shearing type common in shocks in the Coast Ranges.—*M. C. R.*

14914. Schwarzbach, M. Erdbebenchronik für das Rheinland 1950–51 und Mitteilung über die Errichtung eines Erdbebenbeobachtungsdienstes der nördlichen Rheinlande [Earthquake chronicle for the Rheinland 1950–51 and a note on the establishment of seismologic observatories in the northern Rheinland]: Naturh. Ver. Rheinlande u. Westfalens Verh. Band 105/106, p. 49–50, 1952.

Two earthquakes, more intense than usual, occurred in the Rheinland during these 2 years, both with epicenters near Euskirchen, the most important seismotectonic zone of the region. The second earthquake of March 14, 1951, was the strongest earthquake in more than 200 years, reaching intensity 8. Isoseismal maps of both earthquakes are given.—*S. T. V.*

14915. Båth, M[arkus]. Seismicity of Fennoscandia and related problems: Gerlands Beitr. Geophysik, Band 63, Heft 3, p. 173–208, 1953.

A study has been made of the seismicity of Fennoscandia (Finland, Norway, Sweden) by means of macroseismic observations during the years 1891–1930. Instrumental records of these earthquakes exist only in exceptional cases. The following matters have been specially calculated and studied: depths of hypocentres; number, energy, and geographical distribution of earthquakes; time variations of seismic activity (diurnal, annual, long-period); relation of earthquakes to other geophysical phenomena, notably the land uplift in Fennoscandia. It has been shown that the strain energy accumulated by the land uplift is equal to the energy released in earthquakes.

The application of modern methods, especially those developed by Gutenberg, Richter, and Benioff at the Seismological Laboratory in Pasadena, has made it possible to deepen our knowledge at the same time as it entails a reevaluation of earlier statistics.—*Author's summary*

14916. Galanopoulos, A. [G.]. On the intermediate earthquakes in Greece: Seismol. Soc. America Bull., v. 43, no. 2, p. 159–178, 1953.

Records of earthquakes in Greece given as intermediate by Gutenberg and Richter have been further investigated. At Athens the criterion for the recognition of seismograms of nearby intermediate shocks seems to be the sharp onset of *P* and its gradual diminution so that the *S-P* interval is clearly defined. The only unquestioned intermediate shocks seem to be those in the Aegean Sea where there is evidence of modern or recent volcanic activity. The initial motion from shocks in a given region exhibits a predominant direction, but exceptions indicate possible changes in the mechanism at the focus. There is evidence that the depth of the Mohorovičić discontinuity in the Aegean Sea area is greater than 50 km.—*M. C. R.*

14917. Byus, Ye. I., and Rubinshteyn, M. M. Novyye dannyye o roye zemletryaseniy 1941 goda v zapadnoy Gruzii [New data on the swarm of earthquakes in western Georgian S. S. R. in 1941]: Akad. Nauk Gruzinskoy SSR Soobshcheniya, tom 13, no. 9, p. 519–524, 1952.

Between June 11 and 20, 1941, about 500 earthquakes of moderate and approximately equal intensity were felt over an area of about 15,000 sq km in western Georgian S. S. R. in the Caucasus. Only 5 shocks of greater intensity were observed. From the seismograms of Russian observatories focal depths

ranging from 13 to 19 km were determined. The epicenters followed a zigzag line from Aski to Abedati, Nakalakevi, Mikha-Tskhakaya, and Poti. These shocks have been correlated with displacements of Pliocene and post-Pliocene structures established by previous geologic investigations along the line of the epicenters.—*S. T. V.*

14918. Girlanda, Antonino. Il terremoto della Hokkaido del 4 marzo 1952 [The Hokkaido earthquake of March 4, 1952]: Annali Geofisica, v. 6, no. 2, p. 173–181, 1953.

A seismic shock of unusual magnitude (8¼ according to Pasadena) occurred on March 4, 1952, near Hokkaido, Japan. The epicenter determined from the records of 33 observatories with the method of Caloi and Peronaci was 42°14′38.8″±04′19.5″ N. lat; 143°30′00.3″±03′35.4″ E. long. The origin time of the shock was $1^h22^m41.5^s \pm 0.3^s$ Gct.—*S. T. V.*

14919. Junge, Chr. Schwankungen eines Brunnenspiegels durch Fernbeben [Fluctuations of water level in a well due to distant earthquakes]: Umschau, Jahrg. 53, Heft 7, p. 203, 1953.

Short-period fluctuations in water level measured in a well at Inheiden appear to be related to seismograph records of distant earthquakes. The maximum change of level was about 5 cm. The change corresponds to the long-period waves; short-period waves, such as the preliminary waves between *P* and *S*, had no effect on the well level.

The explanation offered for this natural seismograph is that the water flows freely underground to the well through highly cleaved basalt formations. The whole mass of water in the reservoir reacts to horizontal earth movement as an inert mass, and currents are set in motion which produce the "slopping" observed in the well.

The possibility that compression resulting from the seismic waves forces water up into the well boring has been considered but rejected as the short-period waves do not affect the water level.—*D. B. V.*

Lapina, M. I. Geomagnetism and seismic phenomena. *See* abstract 14831.

SEISMIC SURVEYS

14920. Allen, Clarence R., and Smith, George I. Seismic and gravity investigations on the Malaspina Glacier, Alaska: Am. Geophys. Union Trans., v. 34, no. 5, p. 755–760, 1953.

During July and August 1951, seismic and gravity surveys were made on the Malaspina Glacier, southeastern Alaska, to determine the thickness of the ice and the configuration of the subglacial floor. Seismic reflections along a 10-mile profile approximately parallel to the assumed direction of ice flow indicate ice thicknesses ranging from 1130 to 2050 feet. The subglacial floor is below sea level along the entire profile, 700 feet below in the central part. The ice becomes thinner northward toward the mountains and southward toward the ice margin. Gravity measurements along the central 3 miles of the seismic profile indicate the trend of subglacial topographic features is northwest-southeast. Seismic refraction measurements beyond the glacial margins indicate that the proglacial deposits are more than 500 feet thick.—*M. C. R.*

14921. Rockwell, D. W., and Garcia Rojas, Antonio. Coordination of seismic and geologic data in Poza Rica-Golden Lane area, Mexico: Am. Assoc. Petroleum Geologists Bull., v. 37, no. 11, p. 2551–2565, 1953.

The Golden Lane oil fields, located along the crest of a buried lower Cretaceous ridge south of Tampico, have produced 1,120 million barrels to date.

From the initial discovery in 1908 until 1927, production was extended to San Isidro, south of the Tuxpan River, largely on the basis of trend.

Commencing in 1942, a renewed effort employing seismic and gravity surveys was made to extend production southward, culminating in 1952 with a major discovery, the Ezequiel Ordoñez field, about 50 kilometers farther southeast.

Interpretive problems, stemming principally from reflection data discontinuities, are resolved through coordinated study with subsurface geologic data. In terpreted in this light, the seismic sections clarify the relationship of the Golden Lane ridge to the Poza Rica oil fields and to its regional setting. They have been proved valuable not only for locating Cretaceous reef highs, but also for detailing Tertiary strata overlying and flanking the Cretaceous.—*Authors' Abstract*

14922. Jung, K[arl]. Erdölsuche im Watt [Petroleum exploration in the tidal flats]: Umschau, Jahrg. 51, Heft 5, p. 146–147, 1951.

This is a brief description, with photographs, of seismic operations on the tidal flats between Cuxhaven and Scharnhörn, in northern Germany. The results of the survey have previously been published by Müller-Deile [Geophys. Abs. 12265].—*D. B. V.*

14923. Kehrer, Wilhelm, and Andres, Jakob. Ergebnisse neuerer geophysikalischen Untersuchungen im nördlichen Schleswig-Holstein und Versuche ihrer geologischen Deutung [Data of recent geophysical investigations in northern Schleswig-Holstein and attempts at their geologic interpretation]: Neues Jahrb. Geologie u. Paläontologie Abh., Band 97, Heft 1/3, p. 79–89, 1953.

This paper represents preliminary results of seismic-reflection surveys which were begun in 1950 by several companies and are not yet completed. Two great structural elements are distinguished. The Husum-Tønder region on the west is characterized by essentially flat-lying strata with broad, gentle Hercynian structures; in the Flensburg-Eckernförde region on the east, the strata are disturbed by salt domes.—*D. B. V.*

14924. Röthlisberger, H[ans], and Vögtli, K. Geophysikalische Untersuchungen auf dem Stadlerberg [Geophysical investigations of the Stadlerberg]: Schweizer. naturf. Gesell. 132 Jahresvers. Verh., p. 126–128, 1952 (1953).

The region around the Stadlerberg in the Zürich canton of Switzerland was explored by the students and faculty members of the Institut für Geophysik, using geoelectric and seismic methods. The results obtained are presented in a short table indicating the velocity of seismic waves propagating through different geologic formations.—*S. T. V.*

14925. Kreis, Alfred, Florin, Reto, and Süsstrunk, August. Die Ergebnisse der seismichen Sondierungen des Unteraargletschers 1936–1950. [The results of seismic exploration of the lower Aar glacier]: Schweizer. naturf. Gesell. 132 Jahresvers. Verh., p. 125–126, 1952 (1953).

A brief review of the seismic investigations of the Aar glacier is presented. The results of soundings are presented on a map of the glacier. The thickness

of the ice is as much as 450 m. An unusual feature is the appearance of two consecutive reflections, suggesting an intermediate reflecting layer of ice. The cause of this phenomenon is not fully explained.—*S. T. V.*

14926. Kislow, A. Warunki zastosuwania seismicznej metody refleksyinej na pvzedgórzu Karpat [Results of the application of the seismic reflection method in the Carpathian foreland]: Nafta, no. 2, p. 33–36, 1951.

Typical of the Carpathian foreland is the occurrence of a thick Miocene series which includes a layer of anhydrite that produces very clear reflections. Kislow concludes that it is feasible to determine every horizon, with but few exceptions, using the seismic reflection method. He recommends keeping the distance between geophones as well as the distance from the shot point small, so that there are sharp angles of incidence and clear seismograms.—*S. T. V.*

MICROSEISMS

14927. Gutenberg, B[eno]. Seismische Bodenunruhe und Wetter [Microseisms and weather]: Umschau, Jahrg. 52, Heft 21, p. 646–648, 1952.

This paper is a review of present knowledge and theories concerning microseisms.—*D. B. V.*

14928. Gutenberg, B[eno]. Microseisms, microbaroms, storms, and waves in western North America: Am. Geophys. Union Trans., v. 34, no. 2, p. 161–173, 1953.

Microseisms of 5- to 8-second periods recorded at stations near the Pacific coast between November 29, 1951 and January 4, 1952 have been analyzed in relation to meteorological conditions and ocean waves. A late November storm was apparently caused by a tropical disturbance off the tip of Lower California, but several intervals of large microseismic activity in December were related to nontropical disturbances approaching the coast north of California and travelling inland. In all storms the increase and decrease of amplitude was delayed with increasing distance from the storm center. In southern California the maximum amplitude usually coincided with the highest waves. No clear relation between microseisms and microbaroms (sinusoidal pressure waves of 3- to 6-second period in the atmosphere) was observed at Pasadena and Palomar.—*M. C. R.*

RADIOACTIVITY

INSTRUMENTS AND METHODS OF OBSERVATION

14929. Carlton, Paul F., Belcher, D. J., Cuykendall, T. R., and Sack, H. S. Modification and test of radioactive probes for measuring soil moisture and density: U. S. Civil Aeronautics Administration Tech. Devel. Rept. no. 194, 13 p., 1953.

A brief analysis is given of the physical basis for the measurement of soil moisture and density by the nuclear method, and the construction, method of operation, and operational characteristics of the probe-type nuclear meters for measuring soil moisture and density are described. Both the moisture and density probes previously described (see Geophys. Abs. 13241) have been redesigned; the 100-millicurie Ra-Be source in the moisture probe has been replaced by a 22-millicurie RaD-Be source, and a 2 millicurie Co^{60} source replaced the 4-millicurie Ra source in the density probe. Other improvements include a new density standard and improved methods of placing the access tubes. Labora-

tory and field tests of the improved instruments indicate an average precision of ±0.8 pounds of water per cubic foot of soil for the moisture probe, with no noticeable effect due to soil type, and ±3.0 pounds per cubic foot for the density probe.—*M. C. R.*

14930. Gentner, W., and Husmann, O. Ein Zählrohrgerät zur Untersuchung von Thorium-und Uraniummineralien [A counting tube apparatus for the investigation of thorium and uranium minerals]: Neues Jahrb. Mineralogie Monatsh., Jahrg. 1952, Heft 7, p. 202–212.

This is a description of the principles of and the apparatus used in the relatively simple and inexpensive "coincidence method" of determining the uranium-thorium content of minerals. The apparatus, suitable for field use and sensitive to an intensity of 10^{-2} microcuries, can distinguish between uranium and thorium gamma radiation and indicate the proportions of each.—*D. B. V.*

14931. Sulimirski-Lubicz, S. Badania promieniotwórczosci skal w odwercie naftowym [Investigation of the radioactivity of rocks in an oil well]: Nafta, no. 12, p. 334–339, 1949.

Good agreement is found between the results of well logging made with instruments of Polish manufacture and the lithologic profile obtained in drilling.—*S. T. V.*

14932. Sulimirski-Lubicz, S. Interpretacja wynikow pierwszego profilowania elektronicznego w odwiercie naftowym [Interpretation of the results obtained from the first radioactive logging of an oil well]: Główny Inst. Naftowego Prace, 5 p., 1950.

A drill hole was logged using a standard Geiger-Müller counter. The results compare favorably with the profile constructed from lithologic samples obtained when drilling.—*S. T. V.*

14933. Mięsowicz, M., Jurkewicz, L., and Mikucki, A. Aparatura do profilowania gamma w odwiertach naftowych z rejestracja ciągłą [Apparatus for continuous registration of gamma rays when logging oil wells]: Główny Inst. Naftowego Prace, 5 p., 1951.

To increase speed of well logging, certain improvements have been added to the standard Geiger-Müller equipment. These consisted in the use of a set of several (up to 7) G. M. tubes instead of one, suspended one above another on the cable, and addition of an automatic integrator for continuously recording the electronic impulses so that repeated raising and lowering of the apparatus in the well was made unnecessary. A description of the installation illustrated by seven figures is given.—*S. T. V.*

14934. Sulimirski-Lubicz, S. Interpretacja profilowania elektronicznego odwiertu aparatem z integratorem i urzadzeniem rejestrujacym [The results of radioactivity logging on an oil well with equipment including an integrator and a recording device]: Główny Inst. Naftowego Prace, 3 p., 1951.

The improved well logging apparatus (*see* preceding abstract) was tested by radioactive logging of a previously explored drill hole. The log obtained with the new instrument was identical with the previously obtained curve and both

logs were in good agreement with the geologic log constructed from lithologic sampling.—*S. T. V.*

14935. Herzog, Gerhard. Prospecting, U. S. patent 2,656,470, granted Oct. 20, 1953. 7 claims. Assigned to The Texas Co.

A pulse-type gamma-ray detector for mounting on vehicles.

14936. Herzog, Gerhard. Prospecting, U. S. patent 2,656,471, granted Oct. 20, 1953. 12 claims. Assigned to The Texas Co.

An apparatus for measuring gamma-ray intensities above the earth with an efficiency much greater than ½ percent and simultaneously detecting the intensity of background radiation with an efficiency no greater than ½ percent for gamma rays.

14937. Goldstein, Ladislas. High-energy radiation counter, U. S. patent 2,657,315, granted Oct. 27, 1953. 2 claims. Assigned to International Standard Electric Corp.

A Geiger-Müller type counter for high-energy radiation.

14938. Crumrine, Kenneth C. Voltage stabilizing amplifier system for neutron detector, U. S. patent 2,662,188, granted Dec. 8, 1953. 2 claims. Assigned to The Texas Co.

14939. Scherbatskoy, Serge A. Radioactivity well logging system, U. S. patent 2,659,014, granted Nov. 10, 1953. 21 claims. Assigned to Perforating Guns Atlas Corp.

14940. Arps, Jan Jacob. Geophysical exploration using radioactive material, U. S. patent 2,659,046, granted Nov. 10, 1953. 27 claims.

A method of studying the rate of flow of a liquid in a borehole by circulating a fluid containing a detectable tracer signal and measuring variations in the signal.

ISOTOPE STUDIES AND AGE DETERMINATIONS

14941. Alpher, Ralph A., and Herman, Robert C. The origin and abundance distribution of the elements: Ann. Rev. Nuclear Sci., v. 2, p. 1–40, 1953.

This is a review of present knowledge of the abundances of the elements and theories of their origin and abundance distributions. It is concluded that "None of the theories presented is without serious difficulties. However, it is the belief of the authors, and perhaps not without prejudice, that the theory of element formation principally by neutron-capture reactions in the expanding universe may suffer from fewer difficulties than other theories." A bibliography of 197 items is included.—*M. C. R.*

14942. Lopez de Azcona, J. M. Interpretación geofísica de las variaciónes isotopicas naturales de los elementos químicos [Geophysical interpretation of natural isotopic variations of chemical elements]: Rev. Cienc. Apl., año 7, fasc. 3, no. 32, p. 193–202, 1953.

This is a discussion of the measurements of the isotopic composition in different minerals and of the use of these data in the determination of geologic age. The properties of some 30 elements, ordinarily used in such investigations, are

reviewed, beginning with hydrogen, and the sources of possible errors in measurements due to chemical reactions with the surroundings taking place simultaneously with the main radioactive process, are discussed. The advantages of using such isotopes as H^1 and H^2 are emphasized, because the latter is twice as heavy as the first and therefore the two can be easily differentiated.—*S. T. V.*

14943. Wickman, Frans E., Blix, R., and Von Ubich, H. On the variations in the relative abundance of the carbon isotopes in carbonate minerals: Jour. Geology, v. 59, no. 2, p. 142–150, 1951.

The C^{12}/C^{13} ratio is given for 45 samples of 11 carbonate minerals. The ratios of dolomites are all under 89, the ratios of carbonates from the oxidation zone of ores are all over 89, and the ratios of other carbonate minerals range from 88 to over 90. It is tentatively concluded that, in general, carbonate minerals show the same range of variations as calcium carbonate; that the minerals of the oxidized zone show some enrichment of C^{12} in comparison to sedimentary limestones and dolomites; and that the minerals formed by "cation metasomatism" (especially dolomite and magnesite) show enrichment in C^{13}. These conclusions are shown to agree with theoretical possibilities.—*D. B. V.*

14944. Mars, K. E. A preliminary investigation of the relative abundance of the carbon isotopes in Swedish rocks: Jour. Geology, v. 59, no. 2, p. 131–141, 1951.

The C^{12}/C^{13} ratio is given for 18 samples of graphite and 23 of limestone, all but 1 from Sweden. The measurements, ranging from 90.1 to 92.4 for graphite, and from 88.1 to 89.2 for limestone, confirm earlier investigations in showing that carbon in carbonates shows lower values than carbon in noncarbonate rocks. Further study is planned to seek an explanation of these findings.—*D. B. V.*

14945. Anderson, Ernest C. The production and distribution of natural radiocarbon: Ann. Rev. Nuclear Sci., v. 2, p. 63–78, 1953.

This is a review of studies of natural radiocarbon from the point of view of nuclear science. Applications to archaeology and geology are not discussed. A bibliography of 73 items (through December 1951) is included.—*M. C. R.*

14946. Götte, Hans. Der radioactive Kohlenstoff in der Forschung [Radioactive carbon in research]: Umschau, Jahrg. 51, Heft 17, p. 513–515, 1951.

This discussion is primarily of the use of radioactive carbon isotopes in chemistry, biology, and medicine, but includes brief mention of C^{14} dating.—*D. B. V.*

14947. Blau, Monte, Deevey, Edward S., Jr., and Gross, Marsha S. Yale natural radiocarbon measurements, I. Pyramid Valley, New Zealand and its problems: Science, v. 118, no. 3050, p. 3–6, 1953.

The Geochronometric Laboratory at Yale University "considers that methodologic investigations deserve first place, and although samples of unknown age are accepted for dating, preference is given to those materials whose analysis seems likely to throw light on the reliability of C^{14} dating in the widest variety of situations." Calibration analyses of modern wood and shells show a consistent series of C^{14} values for modern wood, but contradictory results for the shells. It is suggested that if marine animals deposit metabolic carbonate in their shells, the isotope ratio would reflect that of their food source and be close to that of

wood, but if they deposit ocean carbonate directly or if the calcium carbonate laid down at the edge of the mantle exists for some time in a form that can exchange with ocean carbonate, the shell will have a higher specific activity than wood. The biogeochemistry of carbon is still too little understood to permit the uncritical application of radiocarbon dating to all carbonaceous materials regardless of their origin.

An age of 670 years for the crop contents of a large *Dinornis* from the moa deposit at Pyramid Valley suggests that *Dinornis* was contemporary with primitive men and exterminated by them. Ages of marl, peat, and wood from the same deposit are given and discussed.—*M. C. R.*

14948. Anderson, E [rnest] C., Levi, Hilde, and Tauber, H. Copenhagen natural radiocarbon measurements: Science, v. 118, no. 3050, p. 6–9, 1953.

Carbon-14 measurements at Copenhagen are made using the technique developed by Anderson, Arnold, and Libby and later modified by Kulp, but with a double-screen-wall counter. Age determinations are reported for a series of samples from the late glacial Alleröd oscillation, part of an investigation of the relation between radiocarbon and pollen-analysis dating. The transition between Alleröd and Younger Dryos is calculated to be 10,870 ±160 years.—*M. C. R.*

14949. Fromm, Erik. Nya C 14-dateringar av Allerödtiden [New C^{14} datings of Alleröd times]: Geol. Fören. Stockholm Förh.; band 75, Häfte 3, p. 403, 1953.

Recently published C^{14} dates [Geophys. Abs. 14947, 14948, 13378] agree remarkably well with varve chronology [*see* Geophys. Abs. 14734], and indicate that the older part of the Alleröd period lasted over 1,000 years.—*D. B. V.*

14950. Flint, Richard Foster. Les événements importants du Pleistocene datés au moyen du radio-carbone (^{14}C) [The important events of the Pleistocene dated by means of radiocarbon (C^{14})]: Rev. Sci., 90e année, fasc. 1, p. 25–30, 1952.

This is a French version of the paper abstracted in Geophys. Abs. 13171.—*D. B. V.*

14951. Cressman, L. S. Western prehistory in the light of carbon-14 dating: Southwestern Jour. Anthropology, v. 7, no. 3, p. 289–313, 1951.

This is a reexamination of prehistory west of the Rockies in the light of precise determinations of ages at key sites by the radiocarbon method, adjusting the chronology where necessary.

Although the C^{14} method is not considered reliable under all conditions, Cressman believes that errors in the method would probably be constant in nature, and therefore the relative results need not be invalid. To solve the problem of dating of wet materials and establish the full validity of the method, an experiment is required in which dry and wet material of the same horizon must be secured and each determined; then as a check, determinations should be made on a series of wet materials which bracket the material thus dated. This could be done in the pumices of Mount Mazama in south-central Oregon, for instance.—*D. B. V.*

14952. Abel, Lee. Radiocarbon dates—a suggestion: Am. Antiquity, v. 19, no. 2, p. 158, 1953.

The present system of radiocarbon dating should be revised in the interests of clarity. Each year that elapses since a determination is made adds to the margin of error, with corresponding decrease of accuracy. In order for dates published now to have meaning in future years, it will be necessary to know the year in which the tests were made. If the present method must be continued, the date of the test should be included thus: "8431±475 (B. 1952)"; but Abel suggests that it would be far simpler to refer to the Gregorian calendar and write "1058 B. C.±225 years" instead of "3010±225 B. P."—*D. B. V.*

14953. Die Umschau. Das Alter der Erde [The age of the earth]: Umschau, Jahrg. 52, Heft 6, p. 183, 1952.

This is a short note on recent age determinations. Holmes' value of 3,300 million years, determined from the isotope ratio of lead ores in granite, dates a relatively late point, for granite was formed sometime after the first stage of the history of the earth as a cosmic body. Voitkevich has tried to determine the maximum age of the earth by using U^{235} of probable cosmic origin, and has found a value of 5,700–6,000 million years on the basis of the lead isotope ratio in meteorites, and of 5,300 million years for the age of iron meteorites determined by the helium method.—*D. B. V.*

14954. Damon, Paul E. Lead istope ratios and geologic time: Am. Geophys. Union Trans., v. 34, no. 6, p. 906–914, 1953.

The consistency of recent data with Nier's data and with the Nier-Holmes hypothesis for the isotopic abundance of common lead ores is examined. It can be shown that, although individual samples deviate markedly from expectation according to age alone, the data taken together are in agreement with the basic hypothesis. The deviations tend to be non-random. Possible causes of these deviations are discussed. One consequence of the Nier-Holmes hypothesis is that the lead ores should have been derived from the granitic rocks of the Earth's crust rather than from a deep-seated source. The study of lead isotopic ratios may be applied to geologic problems other than that of geologic time.—*Authors Abstract.*

14955. Collins, C. B., and Freeman, J. R. Geological age determinations in the Canadian shield: Royal Soc. Canada Trans., ser. 3, v. 45, sec. 4, p. 23–30, 1951.

This paper describes the method of geologic age determinations used at the University of Toronto, where, by means of a mass spectrometer, as many as 4 samples may be analyzed in 1 day by the lead method. Data are given for 12 samples selected as a test of the apparatus and general procedure. Three specimens from areas previously investigated by Nier show good agreement with his results. A comprehensive survey of carefully selected samples is in preparation.—*D. B. V.*

14956. Vultée, Joachim v. Radioaktivität als Wegweiser in der Erdrinde [Radioactivity as a guide to the earth's crust]: Umschau, Jahrg. 52, Heft 13, p. 385–386, 1952.

This paper describes briefly the principles and techniques of radioactive age determinations and radioactive explorations for oil and mineral deposits.—*D. B. V.*

14957. Rodgers, John. Absolute ages of radioactive minerals from the Appalachian region: Am. Jour. Sci., v. 250, no. 6, p. 411–427, 1952.

This paper assembles all the absolute age determinations made on minerals from the Appalachian region and reestimates them in the light of presently accepted formulas and constants. Four orogenies are indicated, occurring 800, 600, 350, and 260 million years ago. The Appalachian orogeny, curiously, is feebly recorded. The Triassic igneous rocks are about 170 million years old.—*D. B. V.*

14958. Kulp, J. Laurence, Volchok, Herbert L., and Holland, H. D. Age from metamict minerals: Am. Mineralogist, v. 37, no. 9–10, p. 709–718, 1952.

Various specimens of metamict zircon, samarskite, microlite, fergusonite, pyrochlore, and ellsworthite have been subjected to alpha activity measurement, differential thermal analysis, and X-ray diffraction analysis. The ratio of the area under the thermal curve peak (which is proportional to the lattice disorganization), to the alpha activity increases with the age of the mineral. Furthermore in the case of eleven specimens of samarskite of the same geologic age from the Spruce Pine District it was found that the DTA peak area increases with alpha activity over a considerable range. It appears that a new method of age determination is available although much detailed study will be required before accurate geologic dates can be derived.—*Authors' Abstract*

RADIOACTIVITY OF ROCKS, WATERS, AIR

14950. Palumbo, Donato. Teoria per la determinazione del contenuto radioattivo dei minerali [Theory of the determination of radioactive content of minerals]: Annali Geofisica, v. 6, no. 2, p. 229–238, 1953.

A plane lamina containing alpha-radioactive atoms and exposed to nuclear emulsion is considered; the thickness of the lamina is great with respect to the range of the α particles. The number of tracks is determined as functions of their lengths, as well as their horizontal and vertical projections, assuming, as is usual, that the range of α particles in the investigated substance is proportional to that in air. Formulas are derived for the number of tracks produced per square centimeter during one second whose total length or horizontal and vertical projection in the emulsion is greater than x (x being expressed in cm and corrected for the air equivalent). The derived formulas are independent of any hypothesis as to the state of equilibrium of the radioactive series present in the mineral.—*S. T. V.*

14960. Sanderman, L. A., and Utterback, C. L. The radium content of varved clay: Am. Geophys. Union Trans., v. 34, no. 6, p. 915–920, 1953.

The radium content of varved clays, selected from an exposure of about 470 pairs of beds, has been determined. The results have been calculated for unit mass and unit volume of the dry varve, and unit volume of the varve particles. With one exception the radium content of the winter layer exceeds that of the summer layer. When plotted against time, the radium content shows a periodicity in concentration with no indication of either a general increase or decrease, over the span of years, in the summer layers or the winter layers.—*Authors' Abstract*

14961. Jaffe, Gilbert, and Hughes, James H. The radioactivity of bottom sediments in Chesapeake Bay: Am. Geophys. Union Trans., v. 34, no. 4, p. 539–542, 1953.

The radioactivity of 58 samples of bottom sediments from Chesapeake Bay was determined using a thin-walled Geiger-Müller tube enclosed in a section of glass tubing with the sample between the tube walls. The results are tabulated in terms of net counts per minute, that for sand averaging 28.6 counts, fine sands 39.5, silts and clays 44.7. This dissimilarity is not the result of sample packing. The distribution of activity in the sediments of lower Chesapeake Bay is apparently independent of nearness to shore or water depth, but is apparently influenced by the source and the adsorption qualities of the sediments.—*M. C. R.*

14962. Arndt, Robert H., and Kuroda, Paul K. Radioactivity of rivers and lakes in parts of Garland and Hot Springs Counties, Arkansas: Econ. Geology, v. 48, no. 7, p. 551–567, 1953.

A reconnaissance survey of radioactivity of streams and lakes in the vicinity of Hot Springs and Potash Sulphur Springs, Ark., showed that the radon content of streams ranges from 0.0084 to 1.07 millimicrocuries per liter of water, that of lakes from less than 0.001 to 0.123 millimicrocuries per liter. Streams flowing over Ordovician and Mississippian black shales contain an average of 0.275 and 0.046 millimicrocuries of radon per liter, respectively. The methods of radon determination in stream water in the field are believed applicable to prospecting for low-grade uraniferous deposits, especially in black shale areas, in areas of heavy overburden, and in areas of saturation by ground water where ordinary detection devices may be somewhat limited.—*D. B. V.*

HEAT

GENERAL AND THEORETICAL STUDIES

14963. Sbrana, Francesco, and Bossolasco, Mario. Sul regime termico degli strati superiori della crosta terrestre [On the thermal regime in the upper layer of the earth's crust]: Geofisica Pura e Appl., v. 23, p. 21–26, 1952.

Heat flow near the continental shelf or similar structures is analyzed with the basic assumption that heat dissipation through the ground goes on according to the Laplace differential equation whose integral function can be approximately represented by a polynomial of second degree. Its coefficients can be determined from boundary conditions, such as a known and constant temperature along the free surface of the earth and a thermal gradient within the continental mass which asymptotically approaches a constant and known value with increasing distance from the shore line. A cross section perpendicular to the shore line can be divided into three parts: the first the ocean bottom where the temperature T increases linearly with the depth y so that $T=xy$; the second, bounded by the vertical line separating the continent from the ocean and by the straight line directed under the continent at 45°, in which the temperature varies in accordance with the formula $T=xy(1-x/h)$, where y is the depth at the point, x its distance from the shore and h the depth of the ocean, and finally the third part, the remaining continental mass where $T=x(1+y/h)$. It is emphasized that the formulas are valid only when

geologic conditions and the shape of the shell justify the assumptions made in the analysis.—*S. T. V.*

14964. Castoldi, Luigi. Sulla distribuzione della temperatura negli strati superiori della crosta terrestre. On the temperature distribution in the upper layers of the earth's crust: Geofisica Pura e Appl., v. 23, p. 27–35, 1952.

This is an analysis of the temperature distribution to be expected in the upper layers of the earth near discontinuities found near continental shelves or around steep-walled depressions on the ocean bottom.

The problem is identical to that in the preceding abstract, but the treatment is strictly mathematical, based on the theory of complex variables and using conformal mapping and the Schwarz transformation.

The results of computations are applied to determination of the temperature to be expected at certain depths and at assumed distances from the shore, so that it will be possible to compare them with future measurements in drill holes.—*S. T. V.*

OBSERVED TEMPERATURES IN THE CRUST AND HEAT FLOW

14965. Balleisen, Charles E., and Hoffman, Herbert I. Determination of thermal properties of undisturbed soil samples: Texas Jour. Sci., v. 5, no. 3, p. 313–319, 1953.

Temperature measurements were made at the surface and at depths of 5, 34, 63, and 92 inches below the surface of the earth thrice daily for several months. From the amplitude or the temperature cycles at two depths, the average diffusivity can be determined. The diffusivity, as anticipated, decreased during the dry summer months.—*M. C. R.*

14966. Higashi, Akira. On the thermal conductivity of soil, with special reference to that of frozen soil: Am. Geophys. Union Trans., v. 34, no. 5, p. 737–748, 1953.

Using the Angstrom principle, a new apparatus for measuring the thermal diffusivity of soil was designed. In order to give the sinusoidal boundary condition, the apparatus was constructed to change the applied voltage of a heater. A simple autotransformer and a special cam were used for this purpose. Using this apparatus, the thermal diffusivity of frozen soil as well as wet soil was measured. In the case of frozen soil, the samples were prepared under the conditions similar to natural frost formation. Thermal conductivity was computed from the diffusivity thus obtained and the volume specific heat of the soil. Moisture relationship of the thermal diffusivity and the thermal conductivity of frozen soils are represented by an empirical formula of exponential form. The formula hold only in the range of moisture content below the saturation. These relationships are shown graphically. Similar measurements were carried out with wet soil at room temperature. In nature, we often observe the segregation of ice in frozen soil. Such a frozen soil usually contains more water than that of saturation. Samples of various modes of segregation of ice were artificially prepared and their thermal diffusivity was measured. For the moisture ratio above saturation, the rate of increase of the thermal diffusivity with respect to moisture ratio is smaller than that expressed by the above

formula. The variation of the thermal diffusivity of the frozen soil in relation to the direction of heat flow is comparatively small.—*Author's Abstract*

14967. Jung, Karl. Kühlt sich die Erde ab? [Is the earth cooling down?]: Umschau, Jahrg. 51, Heft 17, p. 516–517, 1951.

Since the initial solidification of the earth's crust, transfer of heat from the interior to the surface has been going on very slowly. Nevertheless the crust is substantially warmer than it should be from pure heat conduction in the absence of heat-generating processes. Heat is generated in the earth's crust by decomposition of radioactive substances. But more heat is lost into space than is developed in the earth, so that the earth is constantly, if slowly, cooling off.—*Author's summary, D. B. V.*

VOLCANOLOGY

14968. Verhoogen, J[ean]. Mechanics of ash formation: Am. Jour. Sci., v. 249, no. 10, p. 729–739, 1951.

Conditions which might lead to formation of ash are investigated, and it is found that they do not depend in any simple way on viscosity or gas content of the magma. The most important single factor appears to be the number of bubbles which form per unit volume and unit time. The problem is similar to that of nucleation of crystals; and it is argued that differences in behavior of erupting volcanoes may depend more on the kinetics of the processes involved than on original differences in composition, gas content, depth, etc.—*Author's Abstract*

14969. Kuno, Hisashi. Formation of calderas and magmatic evolution: Am. Geophys. Union Trans., v. 34, no. 2, p. 269–280, 1953.

Japanese calderas may be classified into two types. The first type includes calderas formed by collapse following the eruption of a tremendous amount of pumice (calderas of Krakatau type of H. Williams). The second type includes those formed without the pumice eruption (calderas of Glencoe type of H. Williams). In both types, post-caldera eruptions build up cones or domes, usually inside the calderas but sometimes on their margin. Most of the pre-caldera lavas consist of rock series originating through fractional crystallization of basaltic magma. In the calderas of Krakatau type, the post-caldera lavas comprise a rock series formed through contamination of the same magma by granitic material, whereas in those of Glencoe type the post-caldera lavas represent an advanced stage of crystallization of the pre-caldera lavas. In the former type, the explosive eruption of the pumice probably shattered the roof of the magma reservoir and facilitated the contamination, whereas in the latter the subsidence took place along a simple system of ring fissures without fracturing of the subsided mass and without giving opportunity for contamination.—*Author's Abstract*

14970. Williams, Howel. Recent eruption on San Benedicto Island, Revilla Gigedo group, Mexico: Volcano Letter No. 517, p. 7, 1952.

Volcanic activity at a new vent on Isla San Benedicto began probably in July 1952. In September when the island was visited, the cone was 1,500 feet high and eruptive activity had largely ceased. The eruption is significant as

being the first historic pumice eruption in the eastern part of the Pacific Ocean.—*M. C. R.*

14971. Umschau, Die. Regelmassige Beobachtung eines lebenden Vulkans [Regular observations of an active volcano]: Umschau, Jahrg. 52, Heft 10, p. 311, 1952.

This summarizes the results of observations made every 6 months at Parícutin from the summer of 1948 until the summer of 1951. For each interval, the table gives the area covered with lava, estimated average thickness of lava, and estimated volume of lava for the whole interval and average volume for each day. The table also includes data for the whole year 1943 and for a 4-year period from the middle of 1944 to the middle of 1948.—*D. B. V.*

14972. Fries, Carl, Jr. Volumes and weights of pyroclastic material, lava, and water erupted by Parícutin volcano, Michoacán, Mexico: Am. Geophys. Union Trans., v. 34, no. 4, p. 603–616, 1953.

Estimates of the weights of pyroclastic material and lava erupted by Parícutin Volcano from early 1943 to early 1952 have given a pyroclastic weight of some 2,230 million metric tons and a lava weight of about 1,330 million metric tons, making a total of 3,560 million metric tons of solids. The weight of pyroclastic material ranged from a maximum daily average of more than 10 million metric tons in the first two weeks of eruption to a minimum of some 65,000 metric tons in 1951. The weight of lava ranged from a maximum daily average of about 650,000 metric tons in 1943 to a minimum of some 170,000 metric tons in the second half of 1950.

The only period for which an estimate of the average daily weight of water vapor expelled by the Volcano could be made was the spring of 1945, when some 13,000 metric tons of water were expelled through the crater daily, besides some 500 metric tons contained in the lava extruded concurrently. Since the weight of pyroclastic material and lava erupted by Paricutin in the spring and summer of 1945 is estimated to have averaged about 1.2 million metric tons a day, the water expelled at that time amounted to about 1.1 percent of the total weight of material erupted. If the proportion of water had been nearly constant throughout the active life of the Volcano, the total weight of water would have amounted to some 39 million metric tons.—*Author's Abstract*

14973. Williams, Howel. Volcanic history of the Meseta Central Occidental, Costa Rica: California Univ. Geol. Sci. Pubs., v. 29, no. 4, p. 145–180, 1952.

The glass shards in the welded tuffs of Costa Rica show a heterogeneity which is difficult to explain. It cannot be attributed to successive eruptions of different magmas; on the contrary, magma of heterogeneous character seems to have effervesced simultaneously from the feeding vents. There is no sign of solution or dismemberment of the included lithic fragments. If the differences result from contamination, the process must have taken place at depth and proceeded so far as to leave no indubitable evidence. It is suggested that the fissures from which the avalanches issued tapped different magma chambers or different levels of a common reservoir. More thorough field study is recommended. Absence of vesicularity in most of the glass fragments is noteworthy, and suggests that effervescence ended almost immediately on eruption and before

final emplacement of the tuffs. Absence of microliths suggests sudden quenching of the magma after distension and then disruption into shards.—*D. B. V.*

14974. Williams, Howel. The great eruption of Cosegüina, Nicaragua, in 1835: California Univ. Geol. Sci. Pubs., v. 29, no. 2, p. 21–46, 1952.

The great eruption of Cosegüina differed from most eruptions of comparable violence in being preceded by few earthquakes. It began suddenly, reached a quick climax, and declined rapidly to extinction. It was a truly Plinian outburst. Almost all the ejecta were discharged high into the air, then drifted by winds, finally to fall in showers. Toward the end, glowing avalanches seem to have occurred, but no lava was erupted. The present huge crater probably owes its origin chiefly to engulfment brought about by rapid drainage of the underlying magma chamber.

Next to the violence and brevity of the eruption, the most remarkable feature is the fineness of the ejecta. The total volume of material discharged may not have exceeded 10 cu km, rather than 50–150 cu km as previously estimated. The cause of the eruption is believed to be sudden ultravesiculation of the magma. The temperature of the magma was probably high. Whether the initial outbreak was induced by increase in vapor tension consequent upon crystallization, or by release of pressure consequent upon rise of magma into the crater by fluxing of a plugged conduit, remains a matter for speculation.—*D. B. V.*

14975. Weyl, Richard. Aktiver und erloschener Vulkanismus in El Salvador—Mittelamerika [Active and extinct volcanoes in El Salvador, Central America]: Umschau, Jahrg. 53, Heft 2, p. 46–48, 1953.

This is a brief popular description of some of the more important volcanoes of El Salvador. A few pertinent facts are given for each, such as elevation and dates of known eruptions.—*D. B. V.*

14976. San Miguel de la Cámara, M[aximino], Fúster Casas, J. M., and Martel, M. Las erupciones y materiales arrojados por ellas en la Isla de La Palma—Junio–Julio de 1949 [The eruptions and materials emitted by them in La Palma Island, June–July, 1949]: Bull. volcanolog., sér. 2, tome 12, p. 145–163, 1952.

This is a detailed description of the volcanic activity on La Palma, one of the Canary Islands, which began on June 24, 1949, and continued through July. The last previous activity had been in 1712. Earth tremors indicating renewal of activity had been felt since 1936.

The first explosive manifestations were accompanied by earthquakes and subterranean noises. Ashes, puzzolana, lapilli, and incandescent rocks were ejected from a new crater near the base of Mt. Duraznero, and later from a new opening within the original crater. On July 8, after a violent shock, lava was erupted from a large fissure halfway up the slope known as Llano del Banco, 1,250 m in altitude and 3 km northeast of Duraznero. On July 12, gases, ash, and incandescent rocks were erupted from Hoyo Negro, 350 m north of Duraznero. Lava ceased to flow from Llano del Banco on July 26, but poured from a new opening on Duraznero on July 30. Fumarole activity was important during the entire eruption, with temperatures fluctuating between 360 and 420 degrees. It originated from the same causes as the volcanic manifestations, the qualitative difference between them depending only on temperature.

A petrographic description of the lavas and ejecta concludes the paper.—*D. B. V.*

14977. Wolff, Ferdinand von. Der Vulkanismus des Mittelmeerraumes [The volcanism of the Mediterranean region]: Hallische Mon., no. 8, 15 p., 1949.

This study of five Mediterranean volcanoes (Vesuvius, Etna, Stromboli, Santorin, and Vulcano) attempts to generalize their activity. Applying the laws of thermodynamics to various types of magma, Wolff deduces the type of eruption, fluidity of the lava, ejection of bombs, and other features of different volcanoes on the basis of chemical composition of magma or presence of water vapor and gases under known pressure and temperature.—*S. T. V.*

14978. San Miguel de la Cámara, Maximino. Bibliografia volcanologica española [Spanish volcanological bibliography]: Bull. volcanolog., sér. 2, tome 12, p. 203–214, 1952.

This is a bibliography of works on volcanoes and volcanic rocks of Spain, arranged chronologically, from 1820 to 1951.—*D. B. V.*

14979. Meyer, A. Le volcan Nyamuragira et son éruption de 1951–1952 [Nyamlagira volcano and its eruption of 1951–1952]: Inst. Royal Colonial Belge Bull., tome 24, no. 1, p. 233–287, 1953.

After ten years of rest Nyamuragira [Volcan Nyamlagira] erupted in November 1951 and continued active until mid-January 1952. Meyer gives a detailed geologic description of the volcano and of its previous history. During the last eruption a series of active centers appeared along a zone of weakness in the body of the volcano, and violent explosions followed the first eruption. The paper includes chemical and physical analyses of the lava and of ejected gases and a detailed description of the structure of the volcano.—*S. T. V.*

14980. Hübschmann, Eberhard W. Dramatische Werden und Vergehen eines Vulkans [Dramatic formation and destruction of a volcano]: Umschau, Jahrg. 52, Heft 23, p. 726, 1952.

On September 17, 1952, a new submarine volcano was discovered by a Japanese fishing boat about 240 km south of Tokyo, in violent eruption and giving off clouds of sulfur-yellow smoke. In a few days lava masses had been built up above water level. The new island, named Myojin, attained a length of 150 m and width of 110 m. The crater reached a height of 30 m above sea level. On September 23 the island was shattered by a last violent eruption and sank, destroying an observation ship carrying 22 meteorologists and oceanographers.

The origin of submarine volcanoes is no different from those on land, but their angle of slope is less steep. This is due to the fact that when the erupted lava strikes cold sea water, a thick crust is formed quickly, which insulates the interior and keeps it hot and fluid longer.—*D. B. V.*

TECTONOPHYSICS

FORCES IN THE EARTH AND OROGENESIS

14981. Heaps, H. S. Stresses in the earth's crust under an axial symmetrical load: Am. Geophys. Union Trans., v. 34, no. 5, p. 769–775, 1953.

Explicit formulas are obtained for the stresses produced in a thick plate by an arbitrary surface loading symmetrical about some vertical axis when the lower surface of the plate is supported in such a manner that, at any place, its

vertical displacement is proportional to the vertical stress acting across it. By suitable choice of the constant of proportionality, the formulas may be applied equally well to a consideration of a thick slab supported by an elastic foundation and to the problem of the crust of the Earth subject to isostatic compensation. The formulas are applied to an estimation of the stresses in the lower portion of the Earth's crust during loading by an ice cap.—*Author's Abstract.*

14982. Boutakoff, N. The great-circle stress pattern of the earth: Australian Jour. Sci., v. 14, no. 4, p. 108–111, 1952.

This is a condensed version of a paper presented at the 18th International Geological Congress. Boutakoff shows that the earth's larger lineaments combine into groups of great-circle trends, forming a pattern by intersection. The planes of the great circles are distributed around a common axis of symmetry, which coincides with the planet's axis of rotation. These planes form a series of rectangular conjugate pairs.

He concludes that this pattern is a natural, spherical-surface expression of a peculiar arrangement of deep-seated gravity surfaces of planetary weaknesses and is, in its widest aspect, both isostatic and epeirogenic. This pattern also has an orogenic expression and directly controls several major characteristically straight and, therefore, great-circle mountain belts. The pattern is usually hidden under orogenic garlands at the time of their appearance, but reasserts itself later through block movements. The consequent integration of great-circular lineaments with small-circular arcs is a characteristic of compound orogenic belts. Experiments with various types of spheres bear out these conclusions.—*D. B. V.*

14983. Russo, P. Essai sur les origines de la morphologie terrestre génèrale [Essay on the origins of the general morphology of the earth]: Rev. géomorphologie dynamique, 4e année, no. 4, p. 184–200, 1953.

The theory presented here is developed from ideas recently proposed by Chevallier (Geophys. Abs. 14361). Russo concludes that the continents have been displaced along crescents having one point toward the west, the other toward either pole. Geosynclines are formed by the action of convection currents which result from differences in temperature between suboceanic and subcontinental sial. Marginal mountain ranges arise from the geosynclines. Coalescence of continents and geosynclines may produce seemingly intracontinental ranges. Displacement of continents is a function of mass; moving westward, a heavy continent presses upon a lighter one to the west of it and draws away from a lighter one to the east.

The original masses of the continents were created by ruptures apparently displaced 120 degrees with respect to one another. The continents were set in motion toward the equator and toward the west by centrifugal force, Coriolis' force, and lunisolar attraction. Over a long period of time, prolapse of the earth toward the apex seems to have played a role in formation of the boreal blocks by causing ovoid deformation.

Russo warns that these ideas should be accepted with caution, for the basic assumption of viscosity of rocks is not precisely measurable, and hence values cannot be given for rapidity of displacement. It seems reasonable to consider that the three terrestrial envelopes—lithosphere, hydrosphere, and atmosphere—obey analogous laws at speeds which depend on their viscosity. The speed for rocks is thus about 10^{19} times weaker than that for air.—*D. B. V.*

14984. Jeffreys, Harold. Mechanical aspects of continental drift and alternative theories: Adv. Sci., v. 8, no. 29, p. 79–80, 1951.

The basis of the continental-drift theory and many "convection" theories is the opinion that the earth has no strength and behaves like a liquid under long-continued stress. However, there is no positive evidence whatever for absence of strength above the core, whereas there is plenty of evidence for its presence at least to the depth of the deepest earthquakes. Jeffreys suggests that no more time be spent on discussion of the drift theory "until a mechanism for it is produced; what it has done, and continues to do, is to distract attention from the serious problems of geophysics."—*D. B. V.*

14985. Andrée, Karl. Geologische Konsequenzen einer Erdentstehung auf kaltem Wege [Geologic consequences of a cold origin of the earth]: Geol. Rundschau, Band 39, Heft 1, p. 147–149, 1951.

This is a review of the origin and development of the concept that the planets were formed out of cold materials, a concept which necessitates "revised and renewed consideration of the structure and dynamics of the earth's crust."—*D. B. V.*

14986. Wegmann, E. Über gleichzeitige Bewegungsbilder verschiedener Stockwerke [On contemporaneous movements of various stories]: Geol. Rundschau, Band 41, Sonderband, p. 21–33, 1953.

An important part of kinematic tectonics is concerned with the interaction of events taking place contemporaneously at the upper, middle, and lower levels of the earth's crust. This paper is a discussion of the methods of deciphering the geologic evidence for the complex space-time relations of crustal movements. The title is derived from an analogy to medieval religious plays, where events are pictured as taking place on earth, in heaven, and below, interdependently.—*D. B. V.*

14987. Bederke, E. Regionalmetamorphose und Granitaufstieg [Regional metamorphism and emplacement of granite]: Geol. Rundschau, Band 41, Sonderband, p. 33–40, 1953.

Granite in the heart of mountain ranges is to a great extent the result of metamorphism or ultrametamorphism. The magma formed by this process rises according to the Eskola principle, and at the same time provides the source of heat necessary for regional thermal metamorphism, and of mineralizing solutions. All these phenomena are connected with late stages of orogenesis. They are so intimately related that the granite can be either a cause or a result of regional metamorphism, depending upon the depth considered (see Geophys, Abs. 14986).

But whether the granite is emplaced as a simple intrusion, or by granitization of preexisting rocks, it entails considerable increase in volume, which results in uplift or uparching of overlying rocks. This is somewhat reminiscent of the "plutonic uplift" theory of more than a century ago. Bederke believes that no current orogenic theories adequately explain the presence of primitive rocks in the highest uplifted areas, least of all those theories which assume downwarping and engulfment of sediments at the bottom of geosynclines.—*D. B. V.*

14988. Korn, H., and Martin, H[ans]. Der Intrusionsmechanismus der grossen Karroo-Plutone in Sudwestafrika [The mechanism of intrusion of

the great Karroo batholiths in South-West Africa]: Geol. Rundschau, Band 41, Sonderband, p. 41–58, 1953.

The large volcano batholiths in South-West Africa owe their peculiar character to a combination of caldera subsidence and magmatic intrusion, both of which resulted from the formation of ring fractures. The blocks loosened by these fractures sank into the magma chamber, while the magma simultaneously was squeezed upward in the ring fractures and permeated the roof strata, fully assimilating or altering them. Many existing calderas are probably comparable at depth.—*D. B. V.*

14989. Lees, George Martin. Foreland folding: Geol. Soc. London Quart. Jour., v. 108, pt. 1, p. 1–34, 1952.

A study of foreland folded zones indicates that the cover of sedimentary rocks plays a passive role and accommodates itself to movements of the basement beneath. Lateral pressure exerted along a sedimentary cover from a thrust mountain front, such as implied by Buxtorf's "Abscherung" theory of Jura structure, is improbable. Mountain building is the result of contraction of the interior of the earth, and crustal compression from this cause has been dominant throughout known geologic time.

A crystalline basement can warp and form the cores of anticlines with, in some cases, little or no faulting. Oil-exploration borings to basement rocks in Venezuela, Sumatra, and elsewhere have shown that there has been movement of the basement and not just sheared, rootless folding in the sedimentary cover produced by lateral pressure. The degree to which basement rocks have been faulted, folded, or flexed in some foreland zones is in marked contrast to more rigid behavior in others.—*D. B. V.*

14990. Barth, Tom F. W. Orogeny and geochemistry: Schweizer. mineralog. petrog. Mitt., Band 32, Heft 2, p. 354–360, 1952.

Barth analyzes the three chief theories which have been advanced to explain the ultimate causes of orogeny (contraction on cooling, continental drift, and convection currents); finds weaknesses in all of them; and presents a new theory, the effect of degassing of the earth.

The processes of degassing may be summed up as follows: In the beginning, the earth was more homogeneous than today and there was no iron core. Gradually the heavier compounds sank and the lighter rose toward the surface. The iron oxides were reduced as they sank, and the released oxygen percolated upward. This process probably was largely completed before the beginning of geologic history, but because the degassing must be asymptotic in time, like all such processes, a small amount of oxygen must still be present at great depths, even in the core. The degassing is associated with a general, large-scale radial diffusion, leading to geochemical adjustments in composition of the earth's shells. This flow is aided by "entrapped solar gases" (van Bemmelen, Geophys. Abs. 13663). Thus energy and water together with other volatiles percolate upward.

Degassing causes shrinkage of the earth, which in turn produces folding, thrusting, and general mountain building in the crust. It is significant that no folded mountains exist on Mars or the moon. Deeper structural patterns of the earth also seem to be related to degassing, radial diffusion, and concentric structure.—*D. B. V.*

14991. Mason, Brian. Polymorphism and orogeny: Am. Geophys. Union Trans., v. 34, no. 6, p. 921–923, 1953.

Two distinct causes are currently invoked to explain orogeny: thermal contraction of the Earth, and subcrustal convection currents. The purpose of this paper is to examine a third possibility: contraction as a result of a polymorphic change of the material within the earth. In 1936 Bernal suggested a polymorphic change of $(Mg, Fe)_2SiO_4$ to explain the 20° discontinuity within the mantle; this suggestion is extended by proposing that the relative amounts of the polymorphic forms have varied during geological time. An increase in the amount of a denser polymorph would lead to a contraction of the Earth as a whole, resulting in crustal shortening and orogeny. Calculations show that the observed crustal shortening during geological time can be explained on this hypothesis.—*Author's Abstract*

14992. Werenskold, W. Geosynclines: Am. Geophys. Union Trans., v. 34, no. 5, p. 776, 1953.

It is suggested that the series of deep narrow trenches along the coasts of the Pacific in front of folded mountain chains is discontinuous because off certain coasts, where there is a great supply of the products of denudation, the trenches have been filled up, forming geosynclines, whereas off desert coasts the trenches remain.—*M. C. R.*

14993. Tams, Ernst. Über den seismophysikalischen Nachweis des Bruchcharakters der randstandigen Teifseerinnen und die globale Verkoppelung von Grossbeben nach H. Benioff [On the seismophysical evidence of the fault character of the marginal deep sea troughs and the global relationship of strong earthquakes according to H. Benioff]: Gerlands Beitr. Geophysik, Band 63, Heft 3, p. 241–250, 1953.

Hypotheses explaining the genesis of ocean troughs are discussed. Tams supports the explanation that the troughs are dislocations along fault lines rather than synclines. He points to the close relations of deep sea troughs to seismic phenomena; they contain the foci of strong earthquakes. Also important are the gravitational anomalies of these tectonic features.

According to Benioff (Geophys. Abs. 11735) the total energy of an earthquake can be deduced from the elastic tension along the focal line and thus from the magnitude of the resulting mass movement along the line. Calculations of such energy are presented, according to the method of Gutenberg and Richter.—*S. T. V.*

14994. Gibson, William, and Nichols, Haven. Configuration of the Aleutian Ridge: Rat Islands—Semisopochnoi I to west of Buldir I: Geol. Soc. America Bull., v. 64, no. 10, p. 1173–1188, 1953.

The configuration of a 150 by 200 mile section of the Aleutian Ridge, extending from the Aleutian Trench on the south to the floor of the Bering Sea on the north, is presented by means of depth curves at 50-fathom intervals. . . .

. . . Many implications relative to the formation of mountains, island arcs, and trenches may be seen in the configurations. Vertical and horizontal movement may take place along inclined step faults. The step faults and canyonlike transverse faults may outline irregular crustal blocks where differential movement would occur. Great distortion of the bottom occurs along the edges of the sea valleys. Most of the earthquake epicenters may be aligned along inferred step faults by allowing for probable uncertainties in their locations. Definite correlation between earthquakes and submarine topography, if possible, must

wait for more accurate epicenter determinations along the Aleutian Ridge.—*Authors' Abstract, abridged*

14995. Solle, Gerhard. Ein technisches Grossexperiment zur Deutung einer geologischen Hypothese [A large-scale technical experiment for explanation of a geologic hypothesis]: Umschau, Jahrg. 53, Heft 23, p. 724–726, 1953.

In the theory of subcrustal flow to explain orogenesis, proposed by Ampferer and developed by Kraus, objections were raised to the contraction theory. The behavior of glass melts, here discussed and illustrated by photographs, although proving neither theory, is nevertheless entirely consistent with the theoretical behavior of the magma layer according to the subcrustal flow hypothesis.

The ultimate cause of the convection currents is probably differences in temperature within the crust resulting from such factors as the thermal gradient from core to surface, differences in crustal thickness, radioactivity, and differences in temperature under continents and oceans. According to Stille, the velocity of deep motion in the earth is of the order of 1 to 10 cm per century; it can be assumed that nearer the surface, convection currents are of the order of a few decimeters to perhaps 2 m per century, which over a long period of time is ample to account for mountain building.—*D. B. V.*

14996. Umbgrove, J. H. F. The case for the crust-substratum theory: Adv. Sci., v. 8, no. 29, p. 67–71, 1951.

In this contribution to a symposium on continental drift, Umbgrove argues against the drift theory, favoring Vening-Meinesz' hypothesis that the earth's topographic features are governed by equations in spherical harmonics. A world-encircling sial layer is the starting point of both hypotheses; the fundamental difference is the time in which movement of sial flakes occurred. He believes it had to be in very early pre-Cambrian if at all.

One of the major arguments for the drift theory is the presence of abruptly ending orogenic belts on opposite sides of the Atlantic Ocean. An alternative explanation is suggested here, whereby a potential geosynclinal zone is assumed to have crossed the ocean basin. Lack of sedimentation away from the continents would result, on buckling, in a sialic root of small dimensions with a smaller isostatic anomaly than in the contemporaneous extension of this zone on the continents. Thus a transoceanic connection need never have existed above sea level, but the stratigraphy, tectonic structure, and epoch of folding would be analogous on either side.—*D. B. V.*

14997. Kraus, E. [C.] Unterströmungstheorie und Schwerkrafts-Gleittheorien [The subcrustal flow theory and gravity-sliding theories]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1953, Heft 7, p. 295–302.

Kraus compares the extent to which Haarman's oscillation theory, van Bemmelen's undation theory, and Ampferer's "Unterströmung" (subcrustal flow) theory of orogenesis explain 20 different observed tectonic phenomena. He concludes that the oscillation and undation theories, based on the principle of sliding under gravity, do not adequately explain the most important, indisputable observations of mountain structure. However, the subcrustal flow theory, which likewise assumes sliding mechanics (in the geoplasma), is based on sound observations of numerous mountain structures. Furthermore, the gravity-sliding hypotheses do not postulate gravity as the ultimate motive power behind oro-

genesis, but assume deep mass displacements of one sort or another. Thus they are really only variants of the subcrustal flow theory in its broadest sense, which involve mechanical concepts applicable only near the surface.—*D. B. V.*

14998. Solle, Gerhard. Die Entstehung der Alpen [The origin of the Alps]: Umschau, Jahrg. 52, Heft 20, p. 615–618, 1952.

This is a presentation of Kraus' "Unterströmung" (subcrustral flow) theory of orogenesis, illustrated with examples of Alpine structure. In brief, the basic concept is that convection currents in the magma below the crust form the mechanism of mountain building. Such currents are generated by heat rising from the interior of the earth, unequal cooling under continents and oceans, heat released by radioactivity, and differentiation in the magma. The velocity of these currents is small, about a few decimeters or perhaps 1 or 2 meters per century.

Where the upper part of the currents moves horizontally, the magma carries overlying crust along with it. When two opposing currents meet and turn downwards, the crust is carried down and engulfed. Deep in such zones, the sediments are metamorphosed into highly crystalline rocks. Higher in the same zones, there is less metamorphism, but strata originally horizontal are dragged downward on both sides to form a fan-shaped structure with essentially vertical beds in the center. Rocks of the highest zones, especially thick limestones, escape engulfment but are dragged around and involved in thrust surfaces in which the active, deeper masses are thrust under the passive, higher zones.

The convection currents do not flow constantly, but rather, have long periods of quiescence during which isostatic adjustment takes place. The masses that are dragged down, being lighter than the surrounding rocks, slowly rise as a block, and the mountains, formed structurally at depth, finally become mountains in the morphological sense.—*D. B. V.*

14999. Kuenen, Ph. H., and Carozzi, A. Turbidity currents and sliding in geosynclinal basins of the Alps: Jour. Geol., v. 61, no. 4, p. 363–373, 1953.

It is shown that sliding and turbidity currents have formed an important mechanism of sedimentation in several Mesozoic and Tertiary basins of the Alps. It is argued that the features developed under these conditions, if applied on a regional scale to the study of sedimentation, provide a valuable tool for paleogeographic and orogenic investigations.—*Authors' Abstract*

15000. Anderson, E. M. Lineation and its relation to subcrustal convection currents: Geol. Mag., v. 89, no. 2, p. 113–123, 1952.

Subcrustal convection currents are suggested as a possible cause of the lineation developed in the Scottish Highlands and elsewhere. While it is recognized that these are to some extent conjectural, the directions of lineation are shown to correspond to results that would be expected from theoretical considerations, in areas where this structure has been investigated. For instance, two sets of currents meeting head on before descending into the depths, could have produced the results observed near Bergen and Bygdin in Norway and in the Scottish Highlands.—*D. B. V.*

15001. Matschinski, Matthias. Les volcans du Chili et le "troisième arc" de Vening-Meinesz [The volcanoes of Chile and the "third arc" of Vening-Meinesz]: Soc. géol. France Comptes Rendus, no. 13, p. 274–276, 1952.

Matschinski applies Vening-Meinesz' idea of triple island arcs (Geophys. Abs. 13675) to the southern part of South America and finds evidence of similar triple structure on the continent.—*D. B. V.*

15002. Matschinski, Matthias. Lois générales du relief terrestre [General laws of terrestrial relief]: Acad. Sci. Paris Comptes Rendus, tome 234, no. 11, p. 1192–1195, 1952.

Generalizing two correlations he has already established, that between mean altitude and area of continents and that between curvature of volcanic arcs and density of their volcanoes, Matschinski arrives at two geographic laws: law 1, the relative mean altitude of a segment of the earth's crust to the interior of a closed isohypse increases with the area circumscribed by that isohypse; law 2, the mean inequality of a segment of a volcanic chain increases with the mean curvature of the segment. Neither law is a simple proportion.—*D. B. V.*

15003. Glangeaud, Louis. Interprétation tectono-physique des caractères structuraux et paleogéographiques de la Méditerranée occidentale [Tectonophysical interpretation of the structural and paleogeographic features of the western Mediterranean]: Soc. géol. France Bull., 6e sér., tome 1, fasc. 8, p. 735–762, 1951.

The structure of the western Mediterranean region cannot be explained on the basis of any single geophysical phenomenon (drift, subcrustal currents, or the like) but only by a combination of several of these. Four stages are recognized: separation into different fragments at the end of the pre-Cambrian and beginning of the Paleozoic; independent preliminary evolution of the edge of certain of these fragments during the Paleozoic; squeezing of the blocks by the coming together of Europe and Africa, between middle Eocene and upper Oligocene; and relaxation, with operation of isostatic forces and subcrustal currents during Miocene and Plio-Quaternary times.—*Author's Abstract, D. B. V.*

15004. Kraus, E. C. Zur Erklärung der westmediterranen Überschwere-Anomalie durch die Unterströmungstheorie [On the explanation of the western Mediterranean positive gravity anomaly by means of the theory of subcrustal flow]: Deutsch. Geol. Gesell. Zeitschr., Band 104, Teil 2, p. 316–320, 1953.

Hofman and van Bemmelen (*see* Geophys. Abs. 14209) have criticized the subcrustal flow theory, claiming that it would require negative anomalies in the western Mediterranean region contrary to actual fact. By assuming secondary tension due to continental drift in addition to the primary Tellobetic orogeny, Kraus shows that the positive anomaly is a normal result of isostasy, entirely consistent with the theory of subcrustal flow. It is moreover a much simpler explanation than that offered by Bemmelen's undation theory.—*D. B. V.*

15005. Balk, Robert. Faltenachsen in Überschiebungzonen [Axes of folding in overthrust zones]: Geol. Rundschau, Band 41, Sonderband, p. 90–103, 1953.

Lineation and lamination in the slate complex near the eastern base of the Taconic Range in Vermont are believed to be identical in origin with corresponding structures in rolled steel and glass. However, the folds with axes parallel to the direction of thrusting require additional shear stress acting perpendicularly to the direction of thrusting. It is suggested that unequal rates of yielding

of local rock masses below the thrust block (due to inhomogeneity of composition, strength, and mobility) generated these supplementary stresses, producing slight sidewise movements of small masses. That this explanation is reasonable is shown by experiments on salt dome structure by Escher and Kuenen.—*D. B. V.*

15006. Melchior, Paul J. Les déplacements du pole à la surface de la Terre [The displacements of the pole at the earth's surface]: Ciel et Terre, 68e année, fasc. 1–2, p. 29–39, 1952.

The crust and core of the earth deform differently under rotation, because of the difference in their rigidity. This gives rise to two different elongations of the Chandler period and therefore to interference phenomena which produce the observed variations in the pole. The moduli of rigidity of crust and core, calculated on the basis of this hypothesis, agree exactly with the values obtained by Jeffreys on the basis of Herglotz's theory.—*D. B. V.*

15007. Homma, S. Some problems on the thermo-elastic deformations of the earth's crust: Geophys. Mag., v. 23, no. 2, p. 125–144, 1952.

Strains in a tunnel resulting from diurnal and annual variation of temperature at the surface of the ground are considered mathematically and with reference to certain specific examples. The effects on the inclination are negligible, but elongations of the order of 10^{-9} (diurnal) and 10^{-7}–10^{-8} (annual) may occur. Still larger strains occur in small horizontal galleries. Stresses in the crust resulting from temperature variations, when half the crust is covered by water and when land exists between two oceans, were also investigated but were found to be so small that it is doubtful that they have any relation to the frequency of earthquakes.—*M. C. R.*

15008. Tomaschek, R. Non-elastic tilt of the earth's crust due to meteorological pressure distributions: Geofisica Pura e Appl. v. 25, p. 17–25, 1953.

Observations of the deformations of the earth's crust and their correlation with atmospheric pressure were made in a salt mine at Winsford, Cheshire, at a depth of 143 m below the earth's surface. The temperature in the mine during the observation was constant to within ±0.1 C. Two horizontal pendulums of high sensitivity were used. Simultaneously with these measurements, meteorological observations were made. A measureable but very small tilt of the earth's surface was observed simultaneously with the variation of barometric pressure, but the direction of the tilt was opposite to that expected. Causes are being investigated and will be discussed in a later paper.—*S. T. V.*

15009. Lagrula, Jean. Sur l'eustatisme [On eustatism]: Acad. Sci. Paris Comptes Rendus, tome 234, no. 25, p. 2476–2477, 1952.

This is a mathematical study of the effect of variations in the total volume of continental ice on sea level, on the basis of the Airy hypothesis. According to these calculations, relative sea level was probably stationary enough on certain coasts (for example, Africa) to allow development of a beach level at an altitude somewhere between 9 and 23 m. Geologists should look for evidence of this level.—*D. B. V.*

15010. Polli, Silvio. Il graduale aumento del livello del mare lungo le coste italiane [The gradual rise of sea level along the Italian coast]: Geofisica Pura e Appl., v. 25, p. 123–129, 1953.

The mean value of the secular variation of sea level at 11 Italian stations corresponds to an increase of 16 cm per century, that for the earth as a whole is 11 cm per century. The higher value for the Italian coast is attributed to a contemporaneous sinking of the coasts at Naples and Venice.—*M. C. R.*

ELASTIC CONSTANTS AND STRENGTH OF ROCKS

15011. Baule, Heinrich. Laufzeitmessungen an Bohrkernen und Gesteinproben mit elektronischen Mitteln [Travel time measurements on drill cores and rock samples by electronic means]: Geophys. Prosp., v. 1, no. 2, p. 111–124, 1953.

Supersonic pulses are transmitted into rock samples and cylindrical drill cores of about 10 cm to about 100 cm in length by a magnetrostrictive driver attached to one end. The pulses are received at any chosen distance along the core by a small crystal geophone resting on the specimen. The beginning of the supersonic pulse and the wave form of the received disturbance, together with the marks of an accurate timer by a quartz clock, are made visual and stationary on the screen of a cathode-ray oscillograph and the travel-time is measured. Thus the core is picked up at different distances and a travel-time curve is drawn from which the velocity of the waves is determined.

The method is interpreted and the measuring device described. Graphs give several travel-time curves of different rock samples, drill cores, metal rods and rods of other solid materials. The elastic moduli E of samples are communicated, and an example is given for determining Poisson's ratio δ from longitudinal and transversal velocities on two cores of sandstone.—*Author's Abstract*

15012. Kienow, Sigismund. Experimentelle Untersuchungen über des Festigkeitsverhalten und der Deformationsmechanismus von trockenem Ton unter verschiedenen allseitigen Drucken [Experimental investigations of the strength and the mechanism of deformation of dry clay under different uniform pressures]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1951, Heft 2, p. 39–52.

This paper describes experiments in which dry clay bodies were subjected to different degrees of uniform pressure on all sides. It was discovered that the strength and mechanism of deformation changed abruptly at about 100 atmospheres of pressure. Below that limit, the clay responded as a friable body or as a plastic, by formation of gliding planes; above the limit, the clay was folded. The folds which were formed at pressures below 550 atmospheres were angular; at higher pressure, compression folds with schistose false cleavage were produced. In actual structural deformation of clay rocks, the stage of angular chevron folds is usually passed abruptly. The compression folding observed in the experiment corresponds to the transverse false cleavage (Kienow's "folding schistosity") in nature.—*D. B. V.*

INTERNAL CONSTITUTION OF THE EARTH

15013. Bleksley, A. E. H. Origin of the solar system: South African Jour. Sci., v. 49, no. 6, p. 224–228, 1953.

This is a brief survey of the various theories of the origin of planets. It is concluded that, as yet, no theory adequately explains all the features of the solar system.—*D. B. V.*

15014. Gamow, G[eorge]. Die erste halbe Stunde der Schöpfung [The first half hour of creation]: Umschau, Jahrg. 51, Heft 7, p. 193–195, 1951.

This is a summary of Gamow's concept of the formation of the universe with its diversity of elements. The original high temperature, age of the universe (4×10^9—1×10^9 years), the expanding universe, and disappearance of heat are discussed briefly. According to the theory, all the elements were formed in the first half hour after the beginning of expansion.—*D. B. V.*

15015. Gignoux, Maurice. Visions de la Terre [Concepts of the earth]: Rev. Sci., 89e année, fasc. 1, p. 11–55, 1951.

After a review of present geologic concepts of the nature of the earth, Gignoux concludes that physicists reduce matter to mathematical formulas, in which time is merely a fourth variable in addition to the three coordinates of space. Geologists, on the other hand, show that the constants, coefficients, and even the formulas of physics lose their validity for the behavior of the earth's crust, when time is considered in units of millions of years.—*D. B. V.*

15016. Ter Haar, D. The age of the universe: Sci. Monthly, v. 77, no. 4, p. 173–181, 1953.

Ter Haar tabulates all the various estimates of the age of the earth (calculated on the basis of cooling of the crust, salinity of the oceans, formation of sedimentary rocks, and radioactivity); of the age of the moon (based on tidal friction); of the age of meteorites (based on radioactivity); and of the age of the universe (based on distribution of stars among spectral classes, distribution of kinetic energy in stars, distribution in separation of binaries, dynamics of star clusters and galaxy clusters, and the expanding universe). The results agree surprisingly well, all pointing to a time scale of the order of a few (1–5) billion years.—*D. B. V.*

15017. Verhoogen, J[ean]. Elasticity of olivine and constitution of the earth's mantle: Jour. Geophys. Research, 1. 58, no. 3, p. 337–346, 1953.

A recent paper by Birch (Geophys. Abs. 14075) indicates that available seismic data do not support the test assumption of homogeneity in the depth range 200–900 km of the earth's mantle and "it is suggested that, beginning at about 200–300 km, there is a gradual shift toward high pressure modifications of the ferro-magnesian silicates, probably close packed oxides, with the transition complete at about 800 to 900 km." The analysis is based on the equation $1-g^{-1}d\varphi/dr=(dK_t/dP)_T-(2\text{ terms})$ where $\varphi=K_s/P=V_p^2-4V_s^2/3$, the Adams-Williamson equation, and K_t and K_s are the isothermal and adiabatic compressibilities respectively.

Verhoogen points out that the use of a continuous distribution of seismic velocity is incompatible with notable phase changes, for these would presumably be accompanied by discontinuities of elastic properties. Equilibrium between a low- and a high-pressure form is usually univariant, and the nonexistence of such discontinuities would require that the actual temperature gradient fit simultaneously the univariant equilibrium curves of phases of several mineral species or that there exist suitable multicomponent systems of which all components are mutually soluble. It is not likely that the latter case exists over the necessary pressure-temperature range, and the former is out of the question. By analogy with a system of coupled anharmonic oscillators it is suggested that the influence of different interatomic bonds in silicates at different temperatures

and pressures might vary so that $\delta K_t/\delta P_T$ would pass through a maximum. This could explain the apparent inhomogeneity without significant discontinuities in elastic properties, such as might be expected with the conversion of SiO_2 to a rutile-type structure. Such an explanation is compatible with a continuous velocity distribution. It is noted that "there is still no clear picture of the physical constitution of the mantle, no definite seismic indication as to its homogeneity or otherwise, and there is yet no way of extrapolating to zero pressure the elastic properties of its deeper parts."—*P. E. B.*

15018. Levin, B. W. Nekotoryye voprosy razvitiya, stroyeniya i sostava zemli [Some questions on the development, structure, and constitution of the earth]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 289–306, 1953.

The origin of the earth, according to Levin by the condensation of cold solid particles of a primeval substance, its gradual growth, and present constitution are discussed. The earth was never a glowing body, and the present high temperature of its interior is the result of radioactive disintegration throughout the earth, not only in the crust. Stratification of the earth is caused not by the gravitational separation of parts of initially different chemical composition, but by the physical process of formation of new phases from initially homogeneous chemically identical material as a result of increasing pressure and temperature. These phase modifications cause shrinkage of the surface of the earth and settling with the consequent tectonic effects. Levin does not believe in the existence of an iron core in the center of the earth, and does not consider it as the main source of terrestrial magnetism.—*S. T. V.*

15019. Fischer, Georg. Granit und Sial [Granite and sial]: Geol. Rundschau, Band 39, Heft 1, p. 32–77, 1951.

Fischer reviews the problem of the origin of granite comprehensively, hoping to stimulate new thought on the subject. He emphasizes the following points: The present concept of granite as "ultrametamorphite" does not solve the problem of its ultimate origin. No theory can be regarded as adequate which does not also account for the origin of sial. The amount of sial has increased in the course of geologic time by separation of juvenile sial from sial sima and addition to the continental layers from below upon isostatic uplift of folded orogenic zones. The continents are growing; they serve as outlets for the light material at depth. The homogeneity and widespread distribution of "granite" suggest stable equilibrium.—*D. B. V.*

15020. Miczaika, G. R. Die Edelgase als Schlüssel zur Erforschung der Atmosphärenentstehung [The inert gases as clue to the origin of atmospheres]: Umschau, Jahrg, 51, Heft 6, p. 182–184, 1951.

Rarity of the inert gases of the earth's atmosphere, in comparison to the other gaseous elements, is shown to indicate that the atmosphere owes its origin to secondary chemical processes taking place after the formation of the planet.—*D. B. V.*

15021. Pratje, Otto. Erdrindenforschung in des Tiefsee [Deep-sea investigation of the earth's crust]: Umschau, Jahrg. 52, Heft 6, p. 165, 1952.

This is a brief account of the geophysical investigation of the structure of the crust underlying ocean basins. Next to gravity and magnetic measurements, the seismic refraction method is most prominent. Seismic refraction measure-

ments made at a point in the North Atlantic basin, under 2,400 m of water, indicated 2,800 m of homogeneous porous sediments, 2,600 m of harder rock, and at least 4,500 m of basement rock. The time necessary to accumulate 2,800 m of sediment is calculated to be 2,000 million years. Even if the true figure is only a quarter of that, such deposition must have begun in the early days of the earth's history, showing that the Atlantic Ocean has always been present at this site.—*D. B. V.*

15022. Pratje, Otto. Die Erforschung des Meeresbodens [The exploration of the ocean floor]: Geol. Rundschau, Band 39, Heft 1, p. 152–176, 1951.

This is a discussion of methods of exploration and present knowledge of the ocean floor, including the submarine portions of the earth's crust. A 9-page bibliography is included.—*D. B. V.*

GENERAL GEOPHYSICAL EXPLORATION

15023. Smith, W. O., and Nichols, Herbert B. Mapping water-saturated sediments by sonic methods: Sci. Monthly, v. 77, no. 1, p. 36–41, 1953.

A new method of geophysical investigation is based on the velocity with which sound waves of very low frequency penetrate water-saturated sediments. The instrumentation is based on the sonar principle, using a sonic signal given off by a transducer slung out over the side of a vessel.

The method has been used successfully to provide data on the approximate useful life of Lake Mead; to map bedrock contours offshore under Lake Michigan along a proposed water tunnel route to Chicago; and to outline the bottom conditions influencing location of structures at the mouths of Passamaquoddy and Cobscook Bays. These three problems are discussed in detail.

Frequency is critical insofar as penetration of sediments by sound is concerned. Frequencies of 50 kc and higher do not penetrate satisfactorily; frequencies below 15 kc do. Frequencies and power levels now obtainable can locate bedrock beneath underwater sediments ranging in thickness from a feather edge to several hundred feet. The principle appears adaptable for ground-water investigations whenever the water is near the land surface; however, further investigation in this direction is needed.—*D. B. V.*

15024. Lögters, H. Erdölerschliessung in Deutschland [Petroleum development in Germany]: Umschau, Jahrg. 53, Heft 1, p. 6–8, 1953.

This is a résumé of current oil development in Germany. Exploratory drilling in areas determined to be favorable by seismic methods is about 20 percent successful, a ratio not inferior to results in the United States. In 1952 over 400,000 m of borehole were drilled. The structural characteristics and production of the main oil regions are described.—*D. B. V.*

15025. Tschopp, H. J. Oil exploration in the Oriente of Ecuador: Am. Assoc. Petroleum Geologists Bull., v. 37, no. 10, p. 2303–2347, 1953.

The Ecuadorian El Oriente is part of a broad foreland belt which spreads between the Andes Mountains and the Brazilian shield. Structurally, it represents an asymmetric sedimentary basin filled with 324–1,000 m of mostly marine Cretaceous sediments and as much as 4,500 m of Tertiary brackish- and fresh-water sediments. The axis of the basin lies 80–100 km east of the Andes. West of the axis is the sub-Andean zone of foothills; to the east are low basement ridges between Yasuni and Lorocachi.

Between 1939 and 1946 more than 6,300 gravity stations were taken in the area. There is an east to west regional gravity gradient of more than 150 milligals. In the sub-Andean zone the gravity anomalies often agree with the geologic and seismic data, but in the eastern El Oriente only the Yasuni flexure or fault structure has a gravity effect. Other gravity anomalies in the eastern El Oriente are caused by deep basement masses.

A reflection seismic survey which included profiles of some 3,000 km was conducted from July 1943 to August 1949. Velocities were determined from refraction lines and from well shooting. Two good reflections were persistent over the area. Most of the Cretaceous and Tertiary structures mapped represent flexures or fault structures caused by faults with eastern or western downthrow reaching into the basement. Significant variations of thickness were disclosed.

Five anticlines and one fault structure were drilled and negligible quantities of heavy oil or water only were found. Most of the reservoir rocks had been flushed by fresh water.—*L. C. P.*

MISCELLANEOUS PATENTS

15026. Rieber, Frank. Geophysical display system, U. S. patent 2,658,579, granted Nov. 10, 1953. 20 claims. Assigned to Geovision Inc.

An apparatus for displaying visually on a television screen several phonographically reproducible tracks of variable light reaction.

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