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GEOLOGICAL SURVEY BULLETIN 981-A

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

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GEOPHYSICAL ABSTRACTS 144, JANUARY–MARCH 1951

By MARY C. RABBITT and S. T. VESSELOWSKY

INTRODUCTION

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

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

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

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

All Geophysical Abstracts published as Information Circulars are now out of print. Geophysical Abstracts issued as Bulletins of the Geological Survey (except Nos. 87 and 88 which are out of print) may be purchased as single copies or by subscription from the Superintendent of Documents, Government Printing Office, Washington 25, D. C. For subscription, the Superintendent will accept a deposit of $5 in payment of subsequent issues. When this fund is near depletion, the subscriber will be notified. The deposit may also be used to purchase any other publication from the Superintendent of Documents.

Acknowledgments.—Special thanks are due James R. Balsley, Jr., William J. Dempsey, Roland G. Henderson, H. R. Joesting, Nancy Ann Smead, and Isidore Zietz who have prepared the abstracts signed J. R. B., W. J. D., R. G. H., H. R. J., N. A. S., and I. Z.

GRAVITY

12514. Robbins, A. R. Deviation of the vertical: Empire Survey Rev., v. 11, no. 79, pp. 28–36, 1951.

The procedure for the precise determination of the deviation of the vertical, sources of errors, and the necessary equipment are described.—*S. T. V.*

12515. Lozano Calvo, Luis. Las necesidades cartográficas de las medidas de gravedad [Cartographic requirements in the measurement of gravity]: Rev. Geofís., v. 9, no. 34, pp. 113–122, 1950.

The International Congress of Geodesy and Geophysics of 1948 at Oslo emphasized the necessity of systematic gravitational measurements over oceans for the determination of the form of the geoid. In computing isostatic anomalies of gravity from these measurements, it is necessary to have precise topographic maps of the region around the point of observation. Such maps are scarce for the ocean areas, and their precision is insufficient. The component terms of topographic reduction for different zones around the point of observation are analyzed and it is shown that an error of 0.075 mgal may result from an inaccuracy of 10 m at a point 1500 m deep. A table is given indicating the extreme zone to be used in computations for different depths, if a limit of the error is prescribed. Several graphs are given to facilitate these determinations.—*S. T. V.*

12516. Niem, G. de. Berechnung der Schwereintensitat prismatischer Korper [Calculation of the gravitational force of prismatic bodies]: Gerlands Beitr. Geophysik, Band 61, Heft 2, pp. 66–69, 1949.

The disturbing effect of a prismatic body of square cross section and finite length, buried in different positions underground at a given depth, is calculated. Results of the computations are shown by graphs.—*S. T. V.*

12517. Aquilina, Carmelo. Sul gravimetro Atlas [The Atlas gravimeter]: Annali Geofis., v. 3, no. 4, pp. 459–473, 1950.

The Atlas gravimeter consists of a system of springs, three of them being cylindrically wound quartz wires, the others being formed of tiny rods strained torsionally. The main mass is a quartz rod 6 mm long and 0.3 mm in diameter. The system is encased in a vacuum chamber and is carefully isolated from exterior thermal influences and free from barometric influences. The weight of the complete instrument is less than 5 kg, the exterior housing has a diameter of 15 cm and is only 40 cm high. The system has good temperature compensation and the drift of the instrument is very low and quite regular. The sensitivity is about 0.1 mg per scale division. The gravimeter has been tested in the field with satisfactory results.—*S. T. V.*

12518. Vening Meinesz, F. A. A remarkable feature of the earth's topography: K. Nederland. Akad. Wetensch. Proc., v. 53, no. 7, pp. 973–974, 1950.

The development in spherical harmonics of the earth's topography by A. Prey is discussed, and the fact is emphasized that the members of the third, fourth and fifth order are very large. This indicates some special significance for the earth's topography. Detailed analysis will follow, but the suggestion is made that this feature provides a strong argument against Wegener's hypothesis of continental drift.—*S. T. V.*

12519. Boulanger, IU. D. The recently determined value of the acceleration of gravity at the Geophysical Institute of the Academy of Sciences of the U. S. S. R. [in Russian]: Akad. Nauk SSSR, Geofiz. Inst. Trudy, no. 5 (132), pp. 76–93, 1949.

Relative measurements of gravity were made in June 1948 at the Geophysical Institute of the Russian Academy of Sciences in Moscow, using a Nørgaard gravimeter. The final value of g at the Geophysical Institute was determined as 981.5468±0.00075 gals. Related calculations are given in detail.—*S. T. V.*

12520. Boulanger, IU. D. Preliminary results of gravimetric determinations at the first-order station in Obi-Garm [in Russian]: Akad. Nauk SSSR, Geofiz. Inst. Trudy, no. 5 (132), pp. 94–99, 1949.

The value of gravity at Obi-Garm, in the Tadzhik S. S. R. has been determined as 979.5363±0.00078 gals. Five sets of pendular apparatus were used and precautions taken to eliminate the disturbing effect of terrestrial magnetism on invar pendulums, to control temperature and humidity conditions and to prevent vibration of supports. The accuracy of the determinations of g is said to be ±0.0004 gal.—*S. T. V.*

12521. Boulanger, IU. D. The recent gravimetric tying of the All-Union Scientific Research Institute of Metrology with Pulkovo Observatory [in Russian]: Akad. Nauk SSSR, Geofiz. Inst. Trudy, no. 5 (132), pp. 100–114, 1949.

Comparative gravity measurements were made at Pulkovo Observatory and the Institute of Metrology in Leningrad using two Nørgaard gravimeters transported 22 times from Leningrad to Pulkovo and back with readings made independently by two observers.

Possible sources of errors and methods of their determination are discussed in detail, and a method suggested for reduction of the error caused by drift. Assuming that the transport does not affect the drift of the instrument, the correction can be computed exactly by interpolating linearly between consecutive readings at one station to the time when the intermediate reading was made at the other station. This procedure reduced the error due to drift to a negligible value. The difference in gravity between stations was found to be 31.4±0.18 mgal. As g at Pulkovo Observatory is 981.8994±0.00054 gals, the gravity value at the Institute is 981.9308±0.00058 gals. A detailed discussion of procedures and tables of numerical computations are included.—*S. T. V.*

12522. Worzel, J. L. and Ewing, Maurice. Gravity measurements at sea, 1947: Am. Geophys. Union Trans., v. 31, no. 6, pp. 917–923, 1950.

A long range program of gravity measurements at sea was begun aboard U. S. Navy submarines in 1947. The Vening Meinesz pendulum apparatus was used with improved timing provided by a Bell Laboratories crystal chronometer and timing marks inserted by spoked wheels of a synchronous motor. A Vening Meinesz long-period pendulum apparatus was used to observe data for second-order correction terms. During 1947, 104 gravity observations were made along the east coast of the United States north of Cape Hatteras, 86 observations were made along the west coast of South America, and 56 along the north coast of South America.—*M. C. R.*

MAGNETISM AND ELECTRICITY

12523. Chapman, Sydney. The earth's magnetism and its changes: Indian Jour. Physics, v. 24, no. 9, and Indian Assoc. Cultivation Science Proc., v. 33, no. 9, pp. 1–16, 1950.

This is the Ripon lecture delivered to the Indian Association for the Cultivation of Science in 1949.—*S. T. V.*

12524. Price, A. T. Recent theories of the earth's magnetic field: Royal College Sci. (London) Sci. Jour., v. 20, pp. 125–138, 1949.

A summary of theories on the origin of the earth's magnetic field without elaborate mathmetical arguments. The ideas of Elsasser and Bullard are especially emphasized.—*S. T. V.*

12525. Bullard, E. C., Freedman, Cynthia, Gellman, H., and Nixon, Jo. The westward drift of the earth's magnetic field: Royal Soc. London Philos. Trans., ser. A, v. 243, no. 859, pp. 67–92, 1950.

The non-dipole field is calculated by removing the predominant dipole field whose strength is equal to that given by Vestine, Laporte, Cooper, Lange and Hendrix in the publication "Description of the Earth's Main Magnetic Field and its Secular Change, 1905–1945." The results are given in tables and graphs for the North, East and Vertical components for the years 1907 and 1945. It is found that a westward drift exists which is independent of the latitude. For the non-dipole field the rate of drift is $0.18\pm.015°$ per year and for the secular variation, $0.32\pm.067°$ per year. The results are verified by applying harmonic analysis between 1829 and 1945. The method is described of calculating the westward drift, secular variation and uncertainties involved.

The drift is explained by assuming the earth's magnetic field to be produced by a self-exciting dynamo. The radial motion is due to thermal convection currents produced by radioactive heating in the liquid material of the core. In order to conserve angular momentum, calculations show there must be a radial variation of angular velocity. The material near the outside of the core rotates with an angular velocity which is less than that towards the center. Secular variation is ascribed to the field produced by electromagnetic induction in the material moving near the surface of the core. Electromagnetic forces provide a coupling with the core as a whole rather than the outer portion. The couple thus allows the outer part of the core and with it the non-dipole field and secular variation to drift westward relative to the mantle. Calculations are included to give relative velocities and maximum toroidal field.—*I. Z.*

12526. Korneva, L. A. The anomalous geomagnetic field and its equivalent system of electric currents in the world's ocean [in Russian]: Akad. Nauk. SSSR Doklady, tom 71, no. 1, pp. 49–52, 1951.

The magnetic field of the earth is ordinarily assumed to be composed of a fundamental field, with its axis perpendicular to the plane of the magnetic equator and at an angle of 11.5° to the polar axis of the earth, and an anomalous field which is the difference between the observed geomagnetic field and the fundamental one. Recent discoveries of a correlation between the mechanical rotation of a body and its magnetic field [Blackett, et al] suggest that the fundamental geomagnetic field is the one whose axis coincides with the polar

axis, and that the anomalous field should be defined as the difference between the observed field and such a fundamental field.

The assumption is made, following V. V. Shuleikin, that electrical currents circulating in the ocean are the main factor generating the anomalous magnetic field. Because of the high electrical conductivity of ocean water, the intensity of these currents may be large. Such currents form a closed circular path, because of the lower conductivity of the continental masses. The total effect of these currents and their secondary magnetic field is computed on the basis of the very meager observational data available.

A model of the earth was constructed with continents built of insulating material and the oceans of copper sheets. The fundamental geomagnetic field was initiated by a solenoid placed in the center of the model. The influence of the earth's field was eliminated by several Helmholtz coils. Finally a small electromotive force was artificially introduced at two points on the equator. With the intensity of the fundamental magnetic moment equal to 8×10^{25} cgs and the intensity of the ocean currents ranging from 0.10 to 0.17 amp per cm, the magnetic field of the model was approximately that of the actual geomagnetic field with the resulting magnetic axis declined from the axis of rotation by about the same angle. The most important discrepancy between the pattern of the magnetic field of the model and the actual geomagnetic field was over the Asiatic continent. This would disappear if an additional assumption were made that a vertical current is circulating along the boundary of this continent.—*S. T. V.*

12527. Shuleikin, V. V. The magnetic field of the earth and the influence of the world's ocean on its pattern [in Russian]: Akad. Nauk USSR Doklady, tom 76, no. 1, pp. 57–60, 1951.

An explanation based on the experiments and theory of L. A. Korneva (*See* Geophys. Abstract 12526) is given for the striking similarity between the contours of the shore lines of continents and the shape of isolines of the geomagnetic elements. Cosmic rays are suggested as an additional important factor influencing the pattern of the terrestrial magnetic field. Protons, composing the streams of cosmic showers, are believed to be practically absent below five kilometers, but very numerous at higher levels. They disappear in proportion to their penetration into the atmosphere and generate electrical currents proportional to the decrease of their number with height. An important temperature difference that exists in the upper layers of the atmosphere over oceans and continental masses directs the path of cosmic showers and consequently of the electric atmospheric currents toward the continents, thus causing the contours of isolines to follow the shore lines.—*S. T. V.*

12528. Fisher, I. Z. On the gravitational field of magnetic moment [in Russian]: Zhurnal eksperim. i teoretich. fiziki, tom. 20, no. 10, pp. 956–957, 1950.

The relation between the gravitational field and magnetic moment is analyzed. Proof is presented that the gravitational field produced by a rotating nonmagnetic mass, deprived of electric charge, is equivalent to that produced by a magnetic dipole. From the investigations of V. A. Fock, it can be inferred that the static gravitational field cannot be produced by magnetic masses distributed over a certain length. It is concluded that both magnetic and electrical dipoles produce a gravitational field identical with a static gravitational one. Finally Blackett's relation between the magnetic moment and mechanical angular momentum is derived as a corollary.—*S. T. V.*

12529. Tsubokawa, Ietsune, Harada, Yoshimichi, and Amagai, Shonei. Magnetic survey in the southweastern part of Japan: Geog. Survey Inst. Japan Bull., v. 2, pt. 1, pp. 77–79, 1950.

A magnetic survey in southwestern Japan was made by the Geographical Survey Institute during 1949–50. Ten magnetic base stations were established to study secular variation and the magnetic map of Japan. The instrument used in the survey was the new G. S. I. magnetometer (*See* Geophys. Abstract 12359). Measurements of three geomagnetic elements were made at each station every hour for several days, eliminating the days of magnetic storms, and the results reduced to the epoch 1950. Three maps of the area showing horizontal intensity, inclination, and declination are included.—*S. T. V.*

12530. Cardús, J. O. Sobre la ley de las fases en las corrientes telúricas [On the law of phases in telluric currents]: Rev. Geofís., v. 9, no. 35, pp. 215–233, 1950.

Studies of the effect of the moon on geomagnetic phenomena and telluric currents are reviewed. Records of the Observatorio del Ebro from 1910 to 1920 were analyzed and the conclusion is drawn that the so-called phase law is not a lunar phenomenon but a lunisolar effect.—*S. T. V.*

SEISMOLOGY

12531. Leet, L. D. Blasting vibrations' effects, Pt. 1: Explosives Engineer, v. 28, no. 6, pp. 176–178 and 190, 1950.

This is a review of the main types of elastic waves and the principles of seismographic recording.—*N. A. S.*

12532. Murnaghan, F. D. A revision of the theory of elasticity. Acad. Cien. Brasil Annales, v. 21, no. 4, pp. 329–336, 1949.

Some of the restrictive hypotheses made in the classical theory of elasticity are revised to obtain results which are in better accord with experimental data. The author assumes that the stress is not linearly related to the strain (that is, that the higher order components of strain are not necessarily neglected), and that the initial position from which the strain is measured may be under stress.

Using matrix notation the author deduces the fundamental result: $T=\rho^{(x)}/\rho^{(a)}J^*\phi_\eta J$ where $\rho^{(x)}$ is the density of the medium in the deformed state, $\rho^{(a)}$ is the density in the undeformed state, ϕ_η is the gradient of energy of deformation with respect to the strain matrix, η, the 3×3 matrix J is such that an element in any row or column is the derivative of the corresponding x with respect to the corresponding a, the matrix J^* is transpose of J, and T is the stress matrix. In the classical infinitestimal theory $T=\phi_\eta$.

The function, $\phi\eta$, is evaluated by developing it in a power series in the strain coordinates and using experimental data to determine the coefficients. By applying the revised formula to the deformation of isotropic medium under hydrostatic pressure, a formula is deduced expressing the pressure p as a function of $V(a)$, the initial volume of the medium and $V(x)$, the volume at pressure p and containing the constant coefficients α and β.

It is assumed that the medium is free from pressure in the initial state. In an example, pressures are evaluated by using the high pressure data for sodium obtained by Bridgman in his experimental work. Values of the ratio $V(x)/V(a)$ are tabulated for various values of p ranging from 2.5×10^4 to 10×10^4 atmospheres.

A pair of these values are used to compute the coefficients α and β. The other pressures are then calculated using the formula compared with the experimental data. The largest discrepancy is 1.2 per cent whereas Bridgman claims an accuracy of not more than 2 per cent.

The author points out that the revised theory shows the medium cannot be isotropic if the stress in the underformed state is not hydrostatic. Consequently modifications should be made to any theory of plasticity which is based entirely on the existence of an isotropic elastic medium. Mention is made of a hollow circular tube under internal and external pressure and to the torsion of a circular cylinder.—*I. Z.*

12533. Takahashi, Takehito, and Satō, Yasuo. On the theory of elastic waves in granular substance. I.: Tokyo Univ. Earthquake Research Inst. Bull., v. 27, pts. 1–4, pp. 11–16, 1949.

By means of simple structural models an attempt is made to explain the property that elastic waves are propagated in sand with only $1/\sqrt{3}$ times their velocity in rock. The one dimensional model consists of a large number of elastic spheres pressing against each other on a straight line. In the three dimensional model, the centers of spheres form a space lattice in equilibrium, and the pressures are the same at all contact points. The equation of motion for the nth sphere in each case is derived, and an expression for the velocity is presented. Treating the three dimensional model approximately as a continuous substance important formulas involving the apparent elastic constants are established. Further, by regarding an aggregate of aeolotropic bodies as if the whole were an isotrope, an expression for the tensor of elastic constants is obtained. This result together with the formulas for apparent elastic constants yields the desired relationship between velocities of elastic waves in sand and rocks. An example of the numerical calculation is given in a table.—*R. G. H.*

12534. Satō, Yasuo. Boundary conditions in the problem of generation of elastic waves: Tokyo Univ. Earthquake Research Inst. Bull., v. 27, pts. 1–4, pp. 1–9, 1949.

The problem of the generation of elastic waves has already been solved for the case where the known displacements on a given spherical surface are of a particular form. In this article expressions are derived for the displacements where the boundary conditions on the spherical surface are expressed in general terms. It is shown that the solution of this problem is theoretically equivalent to the case where the normal components of stress are given on a spherical surface.—*I. Z.*

12535. Poeverlein, Hermann. Über Wellen in anisotropen Ausbreitungsverhältnissen [Waves propagating under conditions of anisotropy]: Zeitschr. Naturf., Band 5a, Heft 9, pp. 492–499, 1950.

In anisotropic media, the direction of the ray does not coincide with the normal to the wave front. The direction of the ray is determined for an arbitrary point of the advancing wave by representing the displacement of the point as an exponential function with imaginary exponents and using the basic relations of vector analysis. An equation is obtained showing that the ray has at any point the direction of the normal to the index surface of the wave. The derived equation is valid for both homogeneous and inhomogeneous stratified anisotropic

media and for electromagnetic or mechanical waves. Two illustrations are given.—*S. T. V.*

12536. Sretenskiĭ, L. N. Refraction and reflection of plane waves propagating in a liquid medium at the transition from regions of different depths [in Russian]: Akad. Nauk SSSR Izv., otd. teknich. nauk, no. 11, pp. 1601–1614, 1950.

The behavior of elastic waves propagating through water is described with special attention to their refraction and reflection at boundaries separating regions of different depths. The treatment of the problem is purely theoretical. It is shown that if a plane wave is coming from a shallow region into a deeper one, and if the angle of incidence does not exceed a certain limiting value which varies with the wave length, the incoming wave will be partly reflected and will partly penetrate the deeper region. If the angle of incidence exceeds the limiting value, the wave will be totally reflected. The amplitudes and phases of the reflected and refracted waves are computed as functions of the parameters of the incoming wave. Similar phenomena occur when the wave is coming from a deeper to a shallower region.—*S. T. V.*

12537. Menzel, Heinz. Betrachtungen über die Theorie der von Love entdeckten seismischen Oberflächenwellen [Considerations on the theory of Love waves]: Gerlands Beit. Geophysik, Band 61, Heft 2, pp. 86–103, 1949.

Love's theory is extended to viscoelastic media. If the coefficient of viscosity is assumed to be very small, the velocity of a wave propagating in a viscoelastic medium is the same as that in an elastic medium, but the attenuation of the waves becomes a function of the frequency, resulting in a change of the spectrum of the waves with distance. As a new physical concept of the nature of Love waves, it is suggested that they are a result of the interference of two waves, one reflected from the earth's surface and the other from the plane boundary of the buried layer. Formulas are derived which can be used to determine the depth of this layer.—*S. T. V.*

12538. Antunes, M. T. Les sismographes électromagnétiques et l'enregistrement conforme des mouvements du sol: Soc. Portuguesa Ciên. Nat. Bol., v. 3, 2nd ser., fasc. 1, pp. 66–84, 1950.

Reference is made to Geophysical Abstract 10562 of a paper by D. P. Kirnos and N. V. Veshnîakov reporting construction of seismometers of the Galitzin type, which are able to reproduce ground movements with period between 0.2 sec and 5 sec without more than 5 percent amplitude and phase distortion. The possibility of obtaining almost constant dynamic magnifications and phase variations near zero is confirmed. To obtain this result, it is enough that the instruments be able to satisfy the following three conditions: that

$$\tfrac{1}{4}h_1^2\,(T_s/T_1 - T_1/T_s)^2 \ll 1;\ \text{that}\ T_s^2/T^2 \ll 1;\ \text{and that}\ (1-2h^2)(T_s^2/T^2) \gg 1;$$

where T and T_1 are the undamped periods of pendulum and of galvanometer, T_s the period of the ground movement, and h and h_1 are the damping constants of pendulum and galvanometer.

For magnification as constant as possible of ground movements of periods between 0.2 sec and 5 sec, it is necessary to use galvanometers on one-second period,

and damping constant $\geqq 10$, to use a damping constant of pendulum less than $1\sqrt{2}$ but not much less than this value, and to make the period of pendulum as great as possible. The phase difference is near zero when the first two conditions are fulfilled. The amplification of the seismometer and the phase difference in four particular cases are calculated.—*M. C. R.*

12539. Ivanov, A. G. A method of studying seismoelectrical phenomena [in Russian]: Akad. Nauk SSSR. Izv., Ser. geog. i geofiz., tom 14, no. 6, pp. 542–546, 1950.

Electrical potential differences in the ground from the propagation of elastic waves have been studied on a limited scale, measuring the potential and its derivatives at different points as the result of explosives. It is suggested that measurements of the second derivative may be used to determine mechanical stresses in geologic structures which lead to earthquakes when the stress exceeds a certain limit.—*S. T. V.*

12540. Inglada Garcia-Serrano, Vicente. Métodos macrosismicos de determinación de la profundidad focal [Macroseismic methods of determining the focal depth]: Rev. Geofís., v. 9, no. 34, pp. 123–146, 1950.

The Kövesligethy method for determining focal depth, the modification of Janosi, and the formulas of Inglada Ors and of Gutenberg and Richter are analyzed. A modification of the Janosi method is suggested. In this modification the system of simultaneous equations with three unknowns, derived from the Kövesligethy and Cancani formulas, is solved by the method of least squares without any previous elimination of the unknowns, and the computations are repeated with different assumed depth values. As an example, the earthquake of December 17, 1896 at Hereford, Great Britain, is studied and its epicentral depth computed by the proposed procedure.—*S. T. V.*

12541. Monakhov, F. I. Questions on the polarization of transverse seismic waves: Akad. Nauk SSSR Izv., Ser. geog. i geofiz., tom 14, no. 6, pp. 501–513, 1950.

In a previous study the formula $\tan \beta = k/2 \tan (\alpha_S - \alpha_P)$ was derived, where β is the angle formed by the plane of oscillations with the vertical plane through the ray, α_S and α_P are the azimuths of the displacement of the ground at the observation point by *S* and *P*, the phases, and k is determined by geometric relations. From use of this formula with more than 160 earthquakes recorded at different stations, it is concluded that the angle β is primarily determined by conditions at the focus of the earthquake and remains constant along the ray path.—*S. T. V.*

12542. Mooney, H. M. A study of the energy content of the seismic waves *P* and *pP:* Seismol. Soc. America Bull., v. 41, no. 1, pp. 13–30, 1951.

The energy in *P* and *pP* has been calculated from the observed amplitude and periods on many seismograms and compared with the expected energy computed from the standard equation. The ratio of energy in *pP* to that in *P* in the distance range of 60° to 90° decreases with depth by 0.5 on a logarithmic scale of energy between 100 and 600 km depth of focus. The effect is apparently about equally due to an increase in *P* energy and a decrease of *pP* energy with depth.

This variation with depth cannot be explained by physically permissible changes in the quantities involved in the calculation of theoretical energies. No clear trends of variation with distance are indicated. The energy ratio of *pP* to *P* compared to the theoretical ratio is significantly too large in shallow shocks in the Aleutian region, the discrepancy being attributable to *pP*. The ratio is too small for shallow shocks in the New Hebrides region and very deep shocks in the southwest Pacific.—*M. C. R.*

12543. Ewing, Maurice and Press, Frank. Crustal structure and surface-wave dispersion: Seismol. Soc. America Bull., v. 40, no. 4, pp. 271–280, 1950.

The observed dispersion of Rayleigh waves across the Atlantic and Pacific can be explained by considering the propagation of such waves through a system consisting of water and unconsolidated sediments over a thick layer of ultrabasic rock. The depth of the water-sediment layer and the speed of shear waves in the underlying layer have been calculated for several Atlantic and Pacific paths. Atlantic results are in good agreement with data obtained from a seismic refraction profile northwest of Bermuda. (See Geophys. Abstract 12187). The shear-wave velocity in both the Atlantic and Pacific was calculated as 4.45 km per sec, suggesting previously reported differences in Rayleigh wave velocities may be attributed to differences in the depth of water plus sediment in the two oceans.—*M. C. R.*

12544. Hayakawa, Masami. The variation of the seismic wave velocity (Preliminary report): Geol. Survey Japan Rept., Special no., pp. 7–24, 1950.

Experiments have shown that Young's modulus of any rock varies with the applied stress. Therefore, if an earthquake changes the stress in the crust in a certain region, the velocity of propagation of seismic waves will also be modified and thus cause changes in the travel time curve.

Similar changes in velocity were observed in the summer of 1945 when repeated explosions were produced with the same arrangement of shot points and geophone positions before and after drawing of oil from an area in Yawagata.

The travel time curves of several earthquakes from the same or very near foci were compared and measurable differences in the arrival times at different points along the same profiles were observed. These differences are as much as four seconds and are closely connected with mechanism of corresponding earthquakes.—*S. T. V.*

12545. Aliverti, Guiseppina, and Solaini, Luigi. Sulla velocità di propagazione delle onde sismiche su brevi percorsi. [The velocity of propagation of seismic waves at short distances]: Annali Geofis., v. 3, no. 4, pp. 485–487, 1950.

Records of several air raid explosions registered at the Geophysical observatory of Pavia during World War II indicated unexpectedly low velocities of propagation of seismic waves. A single profile 1600 m long provided with seventeen geophones and precise chronographs was run near the observatory to indicate study of wave propagation through the upper layer of the earth's crust. The velocity of the longitudinal refracted wave was found to be 1569 m per sec and that of the transverse wave 456 m per sec. The depth of the penetration of the refracted wave was about 150 meters. The velocity of the longitudinal wave through the upper layer alone was only 550 m per sec.—*S. T. V.*

12546. Gutenberg, Beno. Travel times from blasts in southern California: Seismol. Soc. America Bull., v. 41, no. 1, pp. 5–12, 1951.

Analysis of seismograms of a 70-ton blast at Corona recorded at the Pasadena group and the Lake Mead stations indicate a velocity of between 5.7 and 6.0 km per sec in the upper 6 km. At a depth of 10 km the velocity is about 6½ km per sec, and below the Mohorovičič discontinuity at about 40 km, the velocity is 8.1 to 8.2 km per sec. *S*-wave amplitudes are much smaller than those in earthquakes with comparable *P*-waves. A velocity of about 3¾ km per sec is indicated for a depth of about 10 km.—*M. C. R.*

12547. Richter, C. F. Velocities of *P* at short distances: Seismol. Soc. America Bull., v. 40, no. 4, pp. 281–289, 1950.

Recording of *P* and *S* at six or more stations within 160 km of the epicenter makes it possible to calculate velocities directly, assuming only that they are constant. Installation of stations at Perris, Pomona, Crestline, and China Lake have supplied appropriate data for southern California. For 6 or 8 well-recorded shocks the calculated velocity of *P* is about 6.4 km per sec.—*M. C. R.*

12548. Rothé, J. P., and Peterschmitt, Elie. Étude séismique des explosions d'Haslach [Seismic study of the Haslach explosions]: Annales Inst. Physique du Globe, tome 5, pt. 3, pp. 13–38, 1950.

Analysis of the seismographic records of the Haslach explosions indicates the existence of the following four layers in southern Germany: granite gneiss—2.4 km thick with velocity of 5.63 km per sec; deep granite—17.7 km thick with velocity of 5.97 km per sec; gabbro-basalt—10.1 km thick with velocity of 6.54 km per sec; and peridotite with velocity of 8.15 km per sec. The basaltic layer is very well defined, the *P* impulses and the reflections from the upper surface of the intermediate layer being very clearly shown on the seismograms.

An extensive bibliography is included.—*S. T. V.*

12549. Keilis-Borok, V. I. Dynamic characteristics of the focus determined from seismic observations [in Russian]: Akad. Nauk SSSR Doklady, tom 70, no. 6, pp. 995–998, 1950.

The problem of the determination of the dynamic properties of the initial shock from the seismic waves observed in different points of the earth's surface around the epicenter is analyzed. It is assumed that there are no tectonic discontinuities in the part of the earth's crust involved. A system of mutually independent differential equations for the displacements at the points of observation can be established in accordance with the assumed type of seismic shock. By comparing the resulting displacements at different points with the recorded seismograms, certain conclusions can be drawn as to the dynamic characteristics of the movement at the focus. In practice, seven to eight seismic stations surrounding the epicenter and at 150 to 180 km from it would provide sufficient information for a reasonable conclusion about the nature of the initial shock.—*S. T. V.*

12550. Di Filippo, Domenico. Sulla rappresentazione in superficie della natura dinamica di una scossa all'ipocentro [Representation at the surface of the earth of the dynamic nature of a shock at the focus]: Annali Geofis., v. 3, no. 2, pp. 263–279, 1950.

A method is given for determining the motion at the focus and delineating zones of compression and dilatation from analysis of the initial movements

recorded at stations around the epicenter. The method is based on the work by Byerly and the graphical method proposed by Koning for deep focus shocks.

Records of the strong earthquake of November 25, 1941, at 46 observatories were analyzed and the trace of the fault plane determined as either N. 3° W. or N. 87° E. The former is chosen because of the trend of the Atlantic basin in the area.—*M. C. R.*

12551. Di Filippo, Domenico. Sulla rappresentazione in superficie della natura dinamica di una scossa con ipocentro profondo [The representation at the surface of the dynamic nature of a deep-focus shock] : Annali Geofis., v. 3, no. 3, pp. 379–391, 1950.

The method of determining motion at the focus from the distribution of first motion around the epicenter has been applied to the intermediate earthquake of March 16, 1941, in Sicily. The azimuth of the fault thus determined is N. 67°45′ E., and angle of dip is 31°.—*M. C. R.*

12552. Di Filippo, Domenico, and Marcelli, L. Sul movimento iniziale delle onde sismiche registrate a Roma durante il periodo 1938–1943 [The first motion of seismic waves recorded at Rome between 1938 and 1943] : Annali Geofis., v. 2, no. 4, pp. 589–606, 1949.

A statistical compilation has been made of the nature of the first motion from distant earthquakes recorded at Rome between 1938 and 1943 and from a group of Italian earthquakes with epicenters within 1,000 km of Rome. Results are given in 14 tables and two maps.—*M. C. R.*

12553. Byerly, Perry and Evernden, J. F. First motion in earthquakes recorded at Berkeley: Seismol. Soc. America Bull., v. 40, no. 4, pp. 291–298, 1950.

The first motions from shocks in the Pacific area as recorded at the Berkeley station from 1938 to 1948 have been tabulated and plotted on a map. It was found that depth of focus must be considered if a definite pattern is to be established.—*M. C. R.*

12554. Di Filippo, Domenico and Marcelli, L. Magnitudo ed energia dei terremoti in Italia [Magnitude and energy of earthquakes in Italy]: Annali Geofis., v. 3, no. 3, pp. 337–348, 1950.

A magnitude scale based on records of the 200-kg Wiechert seismograph rather than the Wood-Anderson instrument has been established for Rome and other stations in central and southern Italy. A partly empirical relationship between this magnitude and the energy ($\log E=9.154+2.147M$) permits calculation of the energy in local earthquakes.—*M. C. R.*

12555. Mukherjee, S. M. Remarks on two Hindukush earthquake shocks: Indian Jour. Meteorology and Geophysics, v. 1, no. 4, pp. 297–302, 1950.

Results of Coulson's studies of the Hindu Kush earthquakes of February 1, 1929, and November 21, 1939, have been analyzed. Both shocks apparently occurred at or near the same epicenter (36.5° N. lat., 70.5° E. long.) and depth of focus (220 km). Additional data are used to complete the isoseismal map of the 1929 shock, and indicate that the earthquake was felt over an area of about 782,000 square miles. This is about eight times the felt area of the 1935 Quetta shock and nearly half that of Assam earthquake of 1897.—*M. C. R.*

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12556. Finch, R. H. Earthquakes accompanying the 1949 eruption of Mauna Loa: Seismol. Soc. America Bull., v. 40, no. 4, pp. 263–266, 1950.

The eruption of Mauna Loa which began in January 1949 had its source in a fissure which opened halfway across Mokuaweoweo and about 1.7 miles down the southwest rift. There was no striking seismic activity prior to this eruption as there was with the 1942 eruption. The number of shocks accompanying the eruption was also less than during flank eruptions.—*M. C. R.*

12557. Caloi, Pietro, and Peronaci, Francesco. Il batisismo del 28 agosto 1946 e la profondità del nucleo terrestre [The deep-focus earthquake of August 28, 1946, and the depth of the core]: Annali Geofis., v. 2, no. 4, pp. 493–502, 1949.

The epicenter was located at 24°56.05′ S. lat., 62°59.5′ W. long., the depth of focus 643±29 km, and the time of origin $22^h\ 28^m\ 32.8\pm4.2^s$. The depth to the core was calculated from the travel times of *ScS* as 2920 km.—*M. C. R.*

12558. Hodgson, E. A. The Saint Lawrence earthquake, March 1, 1925: Dominion Observatory Ottawa Pubs., v. 7, no. 10, pp. 367–436, 1950.

The St. Lawrence earthquake at $9^h\ 19^m\ 20^s$ p. m., e. s. t., February 28, 1925, caused wide-spread damage east of the city of Quebec. The epicenter has been located on the basis of instrumental and field data at 47.6° N. lat., 70.1° W. long. Detailed observations of effects of the earthquake are given, as well as a summary of historical records of previous shocks in the area.—*M. C. R.*

12559. Goller, Herbert. El terremoto del 1° de Noviembre de 1947 en Satipo [The earthquake of Nov. 1, 1947, in Satipo]: Soc. Geol. Perú, v. 25, pt. 2, fasc. 22, pp. 1–4, 1949.

The Huancayo records of the earthquake of November 1, 1947, in the Satipo region indicated an epicentral distance of 150 km if Gutenberg's southern California velocities are assumed. More than 3,600 aftershocks were recorded in the following twelve months. Some of these were unusually strong and from a slightly different epicenter.—*S. T. V.*

12560. Rey Pastor, Alfonso. Progresos de la geografiá sismológica, Pt. A, Evolución de esta ciencia e investigaciones mas destacadas [The progress of seismic geography. Development of the science and the more outstanding investigations]: Rev. Geofís., v. 9, no. 35, pp. 268–277, 1950.

This is a brief review of studies of the distribution of earthquakes.—*S. T. V.*

12561. Gutenberg, Beno, and Richter, C. F. Progresos de la geografiá sismológica, Pt. B, Sismicidad de la tierra y fenómenos asociados [The progress of seismic geography. Seismicity of the earth and related phenomena]: Rev. Geofís., v. 9, no. 35, pp. 278–295, 1950.

This is a summary of "Seismicity of the earth" by the same authors. *See* Geophys. Abstract 11517.—*S. T. V.*

12562. Gutenberg, Beno, and Richter, C. F. Géographie des tremblements de terre et dynamique de la croute terrestre [Geography of earthquakes and dynamics of the earth's crust]: Annales Inst. Physique du Globe, tome 5, pt. 3, pp. 3–11, 1950.

This is a summary of the authors' book Seismicity of the earth.—*N. A. S.*

12563. Merrell, R. H. The distribution and frequency of Alaskan earthquakes, 1939–1948: Seismol. Soc. America Bull., v. 40, no. 4, pp. 267–269, 1950.

Alaskan earthquakes during this period were frequent but lacked intensity. They were most numerous in the central and south-central parts of the Territory. The most widely felt shock was that of October 15, 1947, centering about forty miles south of Fairbanks.—*M. C. R.*

12564. Rey Pastor, Alfonso. Sismicidad de la comarca costera alicantina [Seismicity of the coastal region of Alicante]: Inst. Geog. y Catastral Mem., v. 19, no. 3, 24 pp., 1948.

The region studied by the author is the partly submerged portion of the Iberian Peninsula along the Alicante province of Spain, stretching from Cabo de Santa Pola to Cabo de la Nao. On the basis of data on local earthquakes from 1941 to 1946, including the strong earthquake of July 3, 1946, with epicenter at 38°27′ N. lat., 0°16′ W. long., under the Mediterranean Sea, a map has been compiled showing seismic lines or lines of least resistance of the crust.—*S. T. V.*

12565. Rothé, J. P. Les séismes de Kerrata et la séismicité de l'Algérie: Service carte géol. Algérie Bull., 4th ser., no. 3, pp. 1–40, 1950.

The seismicity of Algeria has been studied from data on the strong shocks of January and February 1949 near Kerrata and earlier quakes listed in earthquake catalogues. A total of 72 epicenters are shown on a map. In general, the epicenters fall along the principal anticlinal axes, and shocks are more frequent the more recent the folding.—*M. C. R.*

12566. Sassa, Kenzo, and Nishimura, Eiichi. On phenomena forerunning earthquakes: Am. Geophys. Union Trans., v. 32, no. 1, pp. 1–6, 1951.

A peculiar S-type tilting motion of the ground has been observed several hours before the occurrence of some destructive earthquakes at observatories near the epicenter. Observed tilts are of the order of magnitude of 0.1″ in angle at a distance of 100 km from the epicenter.—*S. T. V.*

12567. Giesicke, A. A. Algunos datos acerca de los microsismos [Certain data as to the nature of microseisms]: Soc. Geol. Perú, v. 25, pt. 2, fasc. 19, pp. 1–7, 1949.

A review of studies on the nature and origin of microseisms.—*S. T. V.*

12568. Benioff, Hugo. Earthquakes and rock creep (Part I: Creep characteristics of rocks and the origin of aftershocks): Seismol. Soc. America Bull., v. 41, no. 1, pp. 31–62, 1951.

The elastic characteristics of solids in general and rocks in particular depart greatly from the simple elastic theory in which strain is proportional to stress and independent of time. The purpose of this paper is to investigate the possible relationship of this departure to the origin of aftershocks. Concepts of creep phenomena (creep being that part of strain which varies with time) are described and a set of definitions suitable for use in geophysics is given. The creep behavior of rocks may be represented by circuit diagrams similar to those used to

describe electrical phenomena. A theory of aftershocks as part of creep phenomena is described in terms of such circuit diagrams, and several aftershock sequences are analyzed. The energy of the principal shock is derived from a quick-acting elastic element. The slowly acting creep element is responsible for aftershocks.

Creep which results in aftershocks may be purely compressional, purely shear, or a combination. The compressional phase occurs first in a combination, and is terminated abruptly by the onset of the shear phase at intervals which ranged from 0.01 to 2.4 days in the sequences investigated. The shear phases were apparently all produced by creep recovery, but there are not sufficient data to determine whether the compressional phases were creep recovery or forward creep.

Purely compressional creep sequences were observed for intervals of 70 to 640 days and apparently none showed a definite termination. Purely shear phases had fairly definite terminations at intervals ranging from 1.5 to 500 days.

The energy released in the creep mechanism as seismic waves and as heat was calculated roughly for each sequence. It ranged from about 0.5 to 2.0 times the energy released in the purely elastic elements as seismic waves. Only 1 to 5 percent of the energy released in aftershock sequences was in the form of elastic waves, the remainder being liberated as heat.—*M. C. R.*

12569. Muto, Katsuhiko, Okuda, Toyozo, and Harada, Yoshimichi. The land deformation accompanying the Fukui earthquake of June 28, 1948: Geog. Survey Inst. Japan Bull., v. 2, pt. 1, pp. 27–36, 1950.

A precise levelling and small scale 3rd order triangulation survey were made between August and December, 1948, to detect crustal deformation near Fukui from the destructive earthquake of June 28, 1948. The levelling route was from Higasa to Matsuda, along a line on which precise levels had been run three times previously. Triangulation nets covered an area of approximately 200 sq km north of the city. Conspicuous vertical and horizontal displacements were limited to an area of 50 sq km, the center of which coincides approximately with the epicenter. Displacements along the fault line are discontinuous, with a maximum vertical displacement of 90 cm. Distribution of horizontal displacements is like that caused by a quadruple source of strain with its center roughly on the epicenter, and is similar to that of the initial ground motions of the earthquake.—*S. T. V.*

12570. Inoue, Eiji, and Ono, Hideko. The horizontal displacements accompanying the great Kwanto earthquake 1923: Japanese Geog. Survey Inst. Bull., v. 2, pt. 1, pp. 61–72, 1950.

The horizontal displacements of about one thousand triangulation points were calculated by comparing the results of the surveys before and after the earthquake of 1923. From an analysis of these data it is concluded that the displacements are the superposition of two deformations. The more pronounced and systematic of these is related to the earthquake; the other, of minor importance, is irregular in character and related to minor geological features. The point of the greatest displacement was found by graphical extrapolation to lie in Sagami-Wan at the latitude 35.1° N. and longitude 139.5° E. If this point is assumed as the center of deformation, the displacement of other bench marks in a mean azimuth may be represented by the equation, $y=0.0038r^2-0.78r+4.35$, where r is measured in kilometers, y in decimeters. There seems to be a close relationship between this systematic deformation and the Fossa Magna. The

residual deformations are very small, distributed irregularly, and mainly influenced by the local topography.—*S. T. V.*

12571. Okuda, Toyozo. On the mode of the vertical land deformation accompanying the great Nankaido earthquake 1946: Geog. Survey Inst. Japan Bull., v. 2, pt. 1, pp. 37–59, 1950.

Modes of land deformations have been studied on the basis of several precise levelling surveys in Shikoku. It is concluded that crustal movement before the 1946 earthquake had the effect of a downwarping of coastal areas. The deformation accompanying the Nankaidō earthquake is almost an exact reverse and coincides in direction with that of the development of present coastal topography. The ratio R between these displacements at a point of the levelling route may be expressed as $R=-0.00805D+2.51$, D being the distance in kilometers from the epicenter of the earthquake of the point under consideration. Small local deviations from this general relation may be explained by the local topographic and geologic features. A secular crustal movement, which is independent of the rebound produced by the earthquake, seems to be going on toward the development of the present topography of Shikoku.—*S. T. V.*

12572. Roberts, D. L. Anti-earthquake damage operations: Petroleum Engineer, v. 22, no. 13, pp. B11–B14, 1950; Oil World, v. 43, no. 22, 2nd issue, pp. 3–7 and 122, 1950; and Petroleum World, v. 47, no. 12, pp. 4–6, 1950.

Horizontal earth movement along definite slippage planes in the shale beds at about 1500 and 1700 feet caused damage to wells in the Wilmington, Calif., oil field during two earthquakes in December, 1947, and November, 1949. Local concentrations of high velocity shock waves caused casing deformation within 10 feet of the slippage plane in the majority of the wells. The damage prevention program is based on the large diameter of the hole which must be maintained to permit earth slippage without transmittal of large localized stress concentrations.—*N. A. S.*

12573. Longuet-Higgins, M. S. A theory of the origin of microseisms: Royal Soc. London Philos. Trans., ser. A, v. 243, no. 857, pp. 1–35, 1950.

Miche has shown that in the second approximation to the standing wave there are second-order pressure variations which are not attenuated with depth. These variations are related to changes in the potential energy of the whole wave train. If there are groups of waves of the same wave length travelling in opposite directions, the pressure variations are proportional to the product of the wave amplitudes and of twice their frequency. In the ocean, waves of compression may be set up which are of sufficient amplitude to be recorded as microseisms. There is resonance between the bottom and the free surface when the depth of water is about $(\frac{1}{2}n+\frac{1}{4})$ times the length of a compression wave (n being an integer). An expression is derived for the vertical displacement of the ground in terms of the frequency characteristics of the waves, and the displacement from a storm area of 1,000 sq km is estimated to be of the order of 6.5μ at a distance of 2,000 km.

Ocean waves may therefore be the cause of microseisms if there is interference between groups of waves of the same frequency travelling in opposite directions. Such conditions may exist at the center of a cyclonic depression, particularly if the depression is moving rapidly, or if there is wave reflection from a coast. Microseisms from the latter source are likely to be smaller, except perhaps locally.—*M. O. R.*

12574. Mukherjee, S. M. Microseisms and sea waves: Seismol. Soc. America Bull., v. 41, no. 1, pp. 1–4, 1951.

Variations of the microseism periods during the period of the southwest monsoon in 1947 (June to August) recorded at Poona and Bombay are identical to variations of swell activity in the Arabian Sea and generally similar to variation of the state of the sea near the coast.—*M. C. R.*

12575. Savarenskiĭ, E. F. Problems facing the seismological institutions of the U. S. S. R. [in Russian]: Akad. Nauk SSSR Vestnik, no. 12, pp. 48–53, 1950.

To determine the seismotectonic characteristics of different localities where in the near future vast engineering structures may be started, many new seismological stations must be established and some automatic stations, analogous to existing meteorologic observatories, will be needed. The accuracy of time measurement must be increased to ± 0.1–0.2 second. Data from these stations will make possible precise location of the epicenters and provide information on amplitudes and frequency needed in designing earthquake-resistant structures.—*S. T. V.*

RADIOACTIVITY

12576. Marble, J. P. Report of the Committee on the Measurement of Geologic Time, 1949–1950, 118 pp. Washington, National Research Council, 1950.

A review and annotated bibliography of work on radioactivity and the measurement of geologic time.—*M. C. R.*

12577. Houtermans, F. G., Haxel, O., and Heintze, J. Die Halbwertszeit des K^{40} [The half life of K^{40}]: Zeitschr. Physik, Band 128, Heft 5, pp. 547–557, 1950.

Using a specially designed sensitive counter, making it possible to embrace a total solid angle of 4π, the number of beta particles emitted by potassium was determined as 27.1 ± 1.5 per gram per second. The gamma activity was found equal to 3.1 ± 0.3. From these values the half life of K^{40} was determined as $(1.33 \pm 0.18) \times 10^9$ years.—*S. T. V.*

12578. Festa, Camilla, Sulla abbondanza originaria del K^{40} [The initial abundance of K^{40}]: Annali Geofis., v. 3, no. 4, pp. 489–499, 1950.

Established relations between the abundance of atomic nuclei in the universe and their principal nuclear characteristics make possible an evaluation of the initial abundance of potassium in the earth independently of knowledge of the decay constant of K^{40} or the time of formation of the elements. By comparing the approximate value of the initial abundance of potassium with the result obtained from the law of radioactive decay, a decay constant of 1.97×10^{-9} per year, it is possible to derive the time of formation of the elements as about 3×10^9 years. This order of magnitude indicates that the contribution of potassium to the production of terrestrial heat at the time of the formation of the crust and immediately thereafter did not have the decisive importance formerly attributed to it.—*S. T. V.*

12579. Festa, Camilla and Santangelo, M. Un metodo per la determinazione dell'età della terra [A method for determining the age of the earth]: Annali Geofis., v. 3, no. 2, pp. 251–261, 1950.

A method for determining the age of the earth based on the radioactive disintegration of potassium is given. Using analytical data on the isotopic abundance in crustal material and in stony meteorites, and assuming the initial isotopic distribution to be the same in the crust and in meteorites and the time since formation of the crust and of the meteorites to be the same, an age of 3.16×10^9 years was found. This figure is said to be accurate to ±19 percent. A bibliography of 62 references is included.—*M. C. R.*

12580. Jung, Karl. Der Temperaturgradient an der Erdoberfläche und die radioactive Wärmeerzeugung in der Erdkrüste bei Berücksichtigung der Halbwertszeiten [The thermal gradient at the earth's surface and heat generation of the crust by radioactive bodies, as determined by the half-life values] : Geofis. Pura e Appl., v. 17, pp. 1–12, 1950.

The generally assumed value of the thickness of the upper layer of the crust in which radioactive processes are or were taking place is considered too low. Calculations first made by Jeffreys are repeated, taking into account the half-lives of the radioactive elements and modifying the boundary and the initial conditions in the differential equation of heat flow. The thickness is then calculated as 23 km. Variation with increasing depth Z of the heat generated in this layer was found to be proportional to the function $e^{-1/20z}$. Uranium, thorium, potassium, and their derivatives were counted. Recent experimental data on the disintegration of radioactive substances and refinement of the calculations may result in values of the thickness as high as 50 km. The calculations are shown on graphs.—*S. T. V.*

12581. Voitkevich, G. V. Radioactivity of potassium and the thermal balance of the earth [in Russian] : Akad. Nauk SSSR Doklady, tom. 74, no. 4, pp. 771–773, 1950.

From recent experimental data, the decay constant of postassium has been found to be greater than previously reported. The amount of heat produced by this reaction is now 26×10^{-6} calories per year per gram of potassium, making the total heat developed by potassium in the earth 4.7×10^{16} calories per hour. This is about 10 percent of the total heat produced at the present time by radioactive processes, placing potassium in third place behind uranium and thorium. The situation was quite different in the past. For instance, three billion years ago, potassium produced about 30 percent of the total radioactive heat, which was 2½ times the present amount. This should be considered in evaluating physicochemical processes of the past geologic history and the age of different minerals.—*S. T. V.*

12582. McKellar, A. Isotopic variations of geophysical significance: Dominion Observatory Ottawa Pubs., v. 7, no. 26, pp. 395–414, 1949.

A historical résumé is given of investigations of the abundance ratio C^{12} to C^{13}. In terrestrial and meteoric carbon this ratio is about 90. Observations at Victoria of 21 R-type stars show little, if any, C^{13} in three stars, and an unexpected and remarkably constant ratio of 3.4 in 12 others. Two possible explanations are outlined, one based on recent work by Klein, Beskow, and Treffenberg on the origin of chemical elements and the other in terms of the C–N cycle initiation.—*M. C. R.*

12583. Ingham, W. N. and Keevil, N. B. Radioactivity of the Bourlamaque, Elzevir, and Cheddar batholiths, Canada: Geol. Soc. America Bull., v. 62, no. 2, pp. 131–148, 1951.

Detailed investigations were made of the Bourlamaque granodiorite in the Val-d'Or mining district of western Quebec, the Elzevir batholith at the southern edge of the pre-Cambrian shield in southeastern Ontario, and the Cheddar batholith west of the Elzevir. Radioactivity determinations from the alpha-ray emission of prepared hand specimens indicate a concentration of radioactivity toward the outer margin and a central core of lower-than-average radioactivity. In the composite Elzevir intrusion an increase in specific radioactivity was found in the change from basic to later acidic rocks, culminating in the pegmatitic stage, but an intermediate, gray-granite phase accounted for two-thirds of the original activity of the batholith as a whole. A difference in radiogenic heat-producing power of the Elzevir and Cheddar rocks (2.9 cal per gm per million years) and those of the Bourlamaque area (0.8 cal per gm per million years) suggests the geothermal gradient in southeastern Ontario should be steeper than that in western Quebec.—*M. C. R.*

12584. Slack, H. A., and Whitham, K. A further investigation of the radioactivity of the Round Lake and Elzevir batholiths: Am. Geophys. Union Trans., v. 32, no. 1, pp. 44–48, 1951.

Distribution of radioactivity over two batholiths in the pre-Cambrian shield was investigated, using a field gamma-ray counter designed for measuring weak radioactive sources. Ninety determinations on the Round Lake batholith show good overall agreement with previous investigations by the alpha counting method. Results in and around the Elzevir batholith show a significant decrease in radioactivity from both the eastern and western edges.—*M. C. R.*

12585. Holland, H. D., and Kulp, J. L. Low level alpha counting of solids by the scintillation method: Columbia Univ. Lamont Geol. Observatory, Tech. Rept. 1, 50 pp., 1950.

This paper describes a type of scintillation counter for the measurement of the alpha activity of solids. An important feature of the apparatus is a lucite cone which collimates the light impulses from the phosphor located on the bottom of the cone and thus gathers light flashes from a much larger surface area of sample than is possible with a photo-multiplier tube alone. Two commercially produced silver activated zinc sulfide phosphors have been used. An RCA 5819 photo-multiplier tube was found to be suitable. Details of the construction and calibration are given, and the results are compared with those predicted theoretically from thick and thin sources.—*S. T. V.*

HEAT [1]

12586. Verhoogen, Jean. The adiabatic gradient in the mantle: Am. Geophys. Union Trans., v. 32, no. 1, pp. 41–43, 1951.

A method is given by which the adiabatic gradient at any depth in the mantle can be determined from the velocities of longitudinal and transverse waves. The average gradient from 200 to 2600 km depth is found to be approximately $1.7\times10^{-4}T_{200}$ deg per km, where T_{200} is the temperature at the depth of 200 km, in good agreement with Benfield's recent estimate.—*M. C. R.*

[1] *See also* Geophys. Abstracts 12580–12581.

12587. Misener, A. D., and Thompson, L. G. D. Temperature gradients in Ontario and Quebec: Canadian Min. Met. Bull., v. 43, no. 462, pp. 542–545, 1950.

In the Malartic gold fields temperature determinations at 34 points to a maximum depth of 1,500 feet indicated isothermal levels with a slight upward trend from east to west and with an average gradient of 1 F per 188 feet and 1 F per 170 feet in No. 1 and No. 2 mines respectively. In the Delnite mines 80 temperature readings to a maximum depth of 3,000 feet indicated an average gradient of 1 F per 197 feet. Local gradients of 1 F per 260 feet in a 200-foot hole at the 1,750-foot level and 1 F per 255 feet between the 1,500- and 2,010-foot levels were noted. An average of 1 F per 116 feet was obtained from 14 readings in the King asbestos mines of the Thetford mines. Isothermal levels in the Kerr-Addison gold mine were considerably distorted in both north-south and east-west directions, but a gradient of 1 F per 187 feet in the lower levels was obtained from 112 determinations. In the New Calumet mines, 16 readings to a depth of 1,350 feet indicated a gradient of 1 F per 117 feet. Gradients of 1 F per 136 feet in the Lake Shore mine and 1 F per 114 feet in a demonstration well on the Canadian National Exhibition grounds in Toronto were obtained.

Gradients determined in this and previous work fall into two groups with the Kirkland Lake area an intermediate group. The group with high gradients lies in the Grenville province, that with the lowest in the Superior province. As conductivities so far measured indicate variations of less than 20 percent between regions of high and low gradients while the gradients vary by more than 40 percent, it is probable that the heat flowing to the surface in the Grenville province is greater than in the Superior.—*M. C. R.*

12588. Wijffels, F. C. M. Les rapports entre le degré géothermique et l'aerage dans les mines [Correlation between the geothermic gradient and the ventilation of mines]: Soc. géol. beligique Bull., tome 72, pp. 521–530. 1949.

The geothermal gradient has been found to vary between 41 and 46 meters per degree in the overburden and between 22 and 30 meters in the carbon layer.—*S. T. V.*

12589. Hagen, Werner. Bergbau in sehr grösser Teufe in Südafrika und Indien [Mining at very great depths in South Africa and India]: Glückauf, 87 Jahrg., Heft 3/4, pp. 63–70, 1951.

In describing the mining conditions found in the deepest mines of the world, the gold mines of South Africa and India, reference is made to the rapid increase of the geothermal gradient with depth. Near the earth's surface in South Africa the geothermic step is about 127 m; at depth this decreases to 60 to 70 m or less. At 2,600 m the rock temperature has been measured at 40.5 C. In gold mines in Mysore province, India, the geothermic step at the earth's surface is about 110 m, but drops to 42 to 46 m at a depth of 2,400 m where the rock temperature is 56.6 C.—*S. T. V.*

TECTONOPHYSICS

12590. Jardetzky, W. S. The problem of mountain chains: Am. Geophys. Union Trans., v. 31, no. 6, pp. 901–913, 1950.

There is not as yet a theory of the formation of mountain ranges which explains all known facts. Systematic analysis requires solution of the three funda-

mental problems: the mechanism of folding; the distribution of forces in the crust at a given geologic period producing ranges in different parts of the crust; and changes of such a field of forces during geologic time. Four types of folding are recognized: pre-Cambrian, coastal, intercontinental, and Himalayan. The hypothesis of zonal rotation of the earth leads to a distribution of forces in the crust which could have produced the Tertiary mountain building.—*M. C. R.*

12591. Chertkova, E. I. Some of the results obtained on models of tectonic breaks [in Russian]: Akad. Nauk USSR Izv., Serg. geog. i geofiz., tom 14, no. 5, pp. 415–420, 1950.

Experiments at the Geophysical Institute of the Akademiîa Nauk [Russian Academy of Sciences] made to show how ruptures formed in salt domes are described. Through a small piston, pressure was exerted on a round plate of about 20 cm diameter prepared from a mixture of solidified petrolatum and paraffin. By using circular, oval, or rectangular shaped piston ends and varying the depth of penetration into the paraffin plate, cracks of different shape and distribution were produced over the area of the plate, imitating many of the patterns observed in the field. Six photographs illustrate the text.—*S. T. V.*

12592. West, S. S. Major shear fractures of Alaska and adjacent regions: Am. Geophys. Union Trans., v. 32, no. 1, pp. 81–86, 1951.

The Aleutian Islands consist of three almost linear groups, differing in orientation, depth of foredeep, and depth of sea to the north. Stream direction and shore lines in Alaska, Siberia, and Canada suggest the existence of three major pairs of shear fractures which correspond to forces originating in the Beaufort Sea, in the bay of the Arctic Ocean near 80° N. lat., 123° E. long., and from a direction a few degrees east of north from Bering Strait. These have been tentatively dated as between Lower and Upper Cretaceous, between Upper Triassic and Lower Jurassic, and in late Carboniferous or earlier. The first and third of these correspond roughly to shear nets calculated by Vening Meinesz for shifts of the pole. An alternative history postulates existence of a land mass where the Arctic Ocean is now which became unstable, probably in late Carboniferous, and began to subside, thrusting southward and initiating an overthrust shear fault in the Aleutian region. Subsidence of a large block north of Siberia between Upper Triassic and Jurassic times increased the overthrust toward the southeast and made it asymmetrical, and subsidence of a third block between Lower and Upper Cretaceous times to form the Beaufort Sea created a thrust toward the southwest and completed the arcuate shape of the fault system. Important dimensions of the Aleutian Islands have been compared with theoretical predictions from Gunn's overthrust theory. There is reasonable agreement for depth of foredeep and distance from greatest depth of water to volcanoes, but there are certain discrepancies, the most serious being the existence and magnitude of the backdeep.—*M. C. R.*

12593. Lászlo, Bendefy. Die Rolle der Urmarken des Präzisiousnivellements des früheren Militärgeographischen Instituts zu Wein bei der Feststellung Aktueller Krusten bewegrengen [Possible use of geodetic bench marks made by the former Military-Geographic Institution of Vienna for determination of movements of the crust]: Földtani Közlöny, v. 79, no. 9–12, pp. 361–393, 1949.

Since 1873 numerous precise geodetic surveys of high precision have been made in the territory of the former Austria-Hungary. The stability of bench marks erected on these surveys is discussed on the basis of more recent surveys. Some were established on granitic massives, and could be displaced only by regional deformation of the crust. A plan is suggested for using these stable bench marks of the Military-Geographic Institute and of the adjoining geodetic networks for the determination of the crustal movements in the basin bordering the Carpathian Mountains. Such a survey would necessitate the cooperation of eight countries. The level of the mareographic station at Trieste could be taken as the base.—*S. T. V.*

12594. Birch, Francis. A simple technique for the study of the elasticity of crystals: Am. Mineralogist, v. 35, pp. 644–650, 1950.

If properly oriented small samples of a single crystal are cemented to piezoelectric crystals whose natural resonant frequencies are known, it is possible to determine the elastic constants of the sample material by measuring with a simple electrical circuit the frequency of the composite crystal oscillator. A brief bibliography, a discussion of theory, a description of experimental technique, and a listing of experimental results are included. The results agree closely with those obtained by more laborious methods or those suitable only for large samples.—*J. R. B.*

12595. Fairbairn, H. W. Hydrothermal-differential pressure equipment for experimental studies in low-grade rock metamorphism: Geol. Soc. America Bull., v. 62, pp. 39–44, 1951.

Modifications have been made to prolong the life of the hydrothermal-differential pressure equipment developed by D. T. Griggs (Am. Geophys. Union Trans., p. 526, 1941). By means of weights at the end of a long bar a piston is pressed against a specimen in a stainless steel cylinder. Confining pressure is applied to the specimen by means of an external pressure source and temperature by a coil surrounding the cylinder. Drawings, photographs, and specifications of the assembly and associated equipment are included. Confining pressure up to 30,000 pounds per square inch, compressive loads up to 100,000 pounds per square inch and temperatures up to 450 C have been used successfully, demonstrating the applicability of the equipment for performing experiments within the range corresponding to that of low grade metamorphism.—*J. R. B.*

12596. Yoder, H. S., Jr. High-low quartz inversion up to 10,000 bars: Am. Geophys. Union Trans., v. 31, no. 6, pp. 827–835, 1950.

Sixty determinations of the high-low quartz inversion temperature under pressures up to 10,000 bars have been made. The data may be represented by $T = -1.6 + 2.871 \times 10^{-2} P - 4.824 \times 10^{-7} P^2$. The relation of the change of inversion temperature with pressure to problems of earth structure is discussed with particular reference to ideas of Daly, Gutenberg, and Birch.—*M. C. R.*

12597. Gurevich, L. E., and Lebedinskiĭ, A. I. Gravitational condensation of a dust cloud [in Russian]: Akad. Nauk SSSR Doklady, tom 74, no. 4, pp. 673–676, 1950.

One of the fundamental problems of cosmogony is the process of formation of planets from a cloud of diffuse matter which originally surrounded the sun. If this cloud was composed of rigid particles, then the evolution of the cloud was

as follows. The energy of moving particles was transformed into heat through collision and was lost by radiation. If the integrated moment of the momenta of the particles remained constant, the initially spherical cloud was gradually flattened and finally transformed into a plane system, such as Saturn. At a certain degree of flattening the process was changed to one of gravitational condensation. Gravitational condensation began when the gravitational energy of a unit mass became twice as great as the kinetic energy of the relative motion and of the tidal forces. After that time, numerous separate coagulated masses formed beginning with the exterior planets. Bodies moving over intersecting orbits inevitably collide, forming new larger masses. These collisions decrease the number of bodies and increase the size of those remaining to the present conditions of the solar planetary system. The asteroids are thus postulated to be not fragments of a disintegrated planet, but a number of such clots which have not yet gone through this second phase of condensation.—*S. T. V.*

12598. Gurevich, L. E., and Lebedinskiĭ, A. I. Properties of the cloud from which the planets of the solar system were generated [in Russian]: Akad. Nauk SSSR Doklady, tom 74, no. 5, pp. 905–907, 1950.

The generation of our planetary system by gravitational condensation from a cloud of diffuse matter, initially forming a corona around the sun, has been proposed. (*See* Geophys. Abstract 12597). As gravitational condensation is a natural process in a dust cloud, but impossible in a gaseous nebula, a dust cloud state, therefore, must have immediately preceded the period of gravitational condensation. It is assumed that the mass of the cloud and the total momentum of its particles moving at random was the same as that of the present planetary system. If the initial chemical composition of the cloud was similar to that of stars, it was completely opaque because components of high melting point, such as metals, were in the solid state as ultramicroscopic suspended particles. Collision of these particles caused a decrease of the total energy amount of the solid phase of the cloud and as a result it became more and more flattened, whereas the gaseous component remained almost spherical. Continuous cooling of the dust particles finally caused the condensation of the gaseous components. Gases were transformed into the liquid or partly solid phase, thus transforming the initially gaseous cloud into a dust cloud. Further evolution of the process resulted in formation of planets.—*S. T. V.*

12599. Dungen, F. H. Van den, Cox, J. F., and Mieghem, J. Van. Sur les fluctuations saisonnières de la rotation du globe terrestre [On seasonal fluctuations in the rotation of the earth]; Acad. royale Belgique Bull., Cl. Sci., 5th ser., tome 36, pp. 388–402, 1950.

The distribution of atmospheric pressure over the surface of the earth has been found to be contributory to seasonal variations of the angular velocity of rotation. Analysis of the influence of the periodic displacement of air masses confirms and completes the previous conclusion.—*S. T. V.*

12600. Munk, W. H., and Miller, R. L. Variation in the earth's angular velocity resulting from fluctuations in atmospheric and oceanic circulations: Tellus, v. 2, no. 2, pp. 93–101, 1950.

The seasonal component of these fluctuations, computed from weather maps, agrees, with respect to magnitude and phase, with anomalies reported on the basis of astronomic observations, but it accounts for only about 15 percent of the

observed effect. The detection of shorter period fluctuations would be of great interest, but is presently limited by the accuracy of astronomic time determination. The developments of atomic clocks and of photographic zenith tube recording open the possibility of determining angular anomalies of shorter duration.—*S. T. V.*

12601. Nersesova, Z. A. Variation of the ice content of the ground as a function of its temperature [in Russian]: Akad. Nauk SSSR Doklady, tom 75, no. 6, pp. 845–846, 1950.

When the ground freezes or thaws, important changes in its volume and its carrying strength take place. Usually these phenomena are observed not at 0 C but at a temperature which is the function of the physicochemical composition of the ground. The state of the ground at any temperature may be characterized by the percentage of its water content transformed into ice. Three samples were tested, sand, argillaceous soil, and clay. At —1 C, 97 percent of the total water content in the sand became frozen, but only 55 percent of the water in the argillaceous soil. At —11 C, 75 percent of the water content of argillaceous soil was frozen, while in clay samples, at the same temperature only 70 percent of the water was frozen.—*S. T. V.*

12602. Woollard, G. P., Chairman. Report of the Special Committee on the Geophysical and Geological Study of the Continents, 1949–1950: Am. Geophys. Union Trans., v. 32, no. 1, pp. 96–105, 1951.

Gravity, magnetic, seismic, and tectonic investigations, chiefly in North America, are reviewed.—*M. C. R.*

MISCELLANEOUS

12603. Fleming, J. A. Geology and geophysics: Soc. Geol. Perú, v. 25, pt. 2, fasc. 9, pp. 1–6, 1949.

This is the text of an address prepared for presentation at the meeting of the Sociedad Geológica del Perú. The importance of international cooperation in geophysical investigations, the work of the Instituto Geofísico de Huancayo, and the practical value of many investigations of the physics of the earth are discussed. Several examples illustrating the importance of geophysical studies to the problems of geology are cited.—*S. T. V.*

12604. Hardtwig, Erwin. Mathematische Probleme der Geophysik [Mathematical problems of geophysics]: Annali Geofis., v. 3, no. 3, pp. 315–335, 1950.

A discussion of the use of mathematics in the solution of geophysical problems.—*S. T. V.*

EXPLORATION GEOPHYSICS

GENERAL

12605. Abramovich, M. V. Poiski i razvedka zalezheĭ nefti i gaza [Prospecting for and exploration of petroleum and gas deposits], 396 pp., Gostoptekhizdat, Moscow, 1948.

This is the third edition of the author's textbook on geophysical prospecting for oil and gas. A description of geophysical methods, their procedure and instrumentation are omitted but the organization, program, and extent of

geophysical prospecting and interpretation of the results are discussed in detail.—*S. T. V.*

12606. Cagniard, Louis. La prospection géophysique [Geophysical prospecting] : 204 pp., Presses universitaires, Paris, 1950.

Application of the laws, theories, and methods of physics to the exploration of ore deposits and petroleum sources and the attainable results are discussed in this textbook in a manner understandable to the layman.—*S. T. V.*

12607. Sorokin, L. V. Editor. General course of geophysical prospecting [in Russian], 408 pp., Gostoptekhizdat, Moscow, 1949.

This is a textbook on geophysical prospecting by a group of scientists—*S. T. V.*

12608. Nettleton, L. L. On the use of geophysical tools: Mines Mag., v. 40, no. 10, pp. 49–52, 1950.

The principles of magnetic, gravitational, and seismic methods are reviewed primarily for "those geologists who have had geophysics more or less thrust on them."—*M. C. R.*

12609. Whetton, J. T., and Myers, J. O. Geophysical surveying. Practical application to general problems: Mine and Quarry Eng., v. 16, no. 10, pp. 307–313; no. 11, pp. 341–346, 1950.

A review, fully illustrated, of the use of modern geophysical instruments and methods in prospecting for oil, minerals, and ground water.—*M. C. R.*

12610. Bourgin, A. Technique des sondages sous-glaciaires [Technique of exploring glaciers] : Rev. Géographie Alpine, tome 38, fasc. 4, pp. 623–632, 1950.

The uses and limitations of methods for determining the thickness of glacial ice are discussed. Included are mechanical drilling, which is seldom practical because of the difficulties in transporting heavy equipment, the absence of water for flushing the hole, and the fluidity of the mass of the ice resulting in jamming or even breakage of the drill column; and the seismic method, the greatest limitation of which is the complicated subsurface topography. Ultrasonic elastic waves have been tried, but the heterogeneous and crevassed mass of glaciers contained air bubbles making it opaque for short waves. In certain places the depth of glaciers has been determined by melting a hole in the ice with an electrical soldering bit.—*S. T. V.*

12611. Herzog, Gerhard. Petroleum exploration and production research: Helvetica Physica Acta, v. 22, fasc. 1–2, pp. 171–177, 1950.

This is a brief review of research problems facing the exploration division of an oil company.—*S. T. V.*

12612. Hollister, J. C. Geophysics grows at "Mines": Mines Mag., v. 40, no. 10, pp. 53–59, 1950.

The development of and present status of training in the geophysics at the Colorado School of Mines is described.—*M. C. R.*

12613. Brasil Conselho nacional do petróleo. Relatório de 1949 [Annual report for 1949], 222 pp., Rio de Janeiro, 1950.

This is the annual report on petroleum exploration and production in Brazil. In several areas geophysical exploration has been carried on with good results. The results of the surveys are presented in numerous maps, but no details of technical nature are given.—*S. T. V.*

12614. Gassmann, Fritz. Recent geophysical research work: Ver. Schweizer. Petrol. Geol. u. Ing. Bull., v. 16, no. 53, pp. 5–14, 1950.

This is a short report on recent work at the Department of Geophysics of the Swiss Federal Institute of Technology. A bibliography is included.—*M. C. R.*

12615. South African Council for Scientific and Industrial Research. Fourth annual report, 69 pp., Pretoria, 1950.

The Applied Geophysics Section of the Council conducted a gravity survey of the Union of South Africa, South-West Africa, Bechuanaland, and Southern Rhodesia in collaboration with the Geological and Trigonometrical Surveys. Gravimeter determinations were made at 53 stations, in a series of loops linking base stations in Cape Town and Johannesburg. These base stations have been accurately tied to Cambridge, England, and to the international absolute stations of Teddington, Washington, and Potsdam by means of absolute determinations made with two sets of three invar steel pendulums and a quartz crystal clock. Seismic prospecting was also in progress in the Vryburg area and in the Kalahari.—*S. T. V.*

12616. Nickle, C. O. and Rowland, L. O., editors. Exploration and refining lead rush of technical advances in all branches: Oil in Canada, v. 3, no. 2, pp. 18–26, 1951.

Advances in the design and use of portable geophysical equipment and the use of new types of vehicles made possible year-round operations of seismograph crews in 1950 in the muskeg country. Two versions of super-light shot-hole drilling rigs, portable recording equipment, and the development of the PSU–11 unit as a set of miniature seismic instruments are described. Use of helicopters and the airborne magnetometer are also described. Radioactivity logging had its first full year of operation in Canadian oil fields in 1950. Conclusions from available data indicate the neutron curve is a highly accurate quantitative method of porosity evaluation and that in a limestone or dolomite bed in a known field with core analysis available from one well the evaluation may be applied satisfactorily to any well in the field.—*N. A. S.*

12617. Rowland, L. O. Exploration at new heights in activity and methods: Oil in Canada, November 6, pp. 30–34, 1950.

Exploration for oil in Canada is concentrated in Alberta, Saskatchewan, and Manitoba. The number of exploration crews in Alberta is exceeded only by that in Texas. New type vehicles, light drilling rigs, and specially built trailers that made possible in 1949, the first full summer geophysical work in muskeg country are described. Aerial magnetometer surveys have given significant data on basement depths, structures, and other aspects of rocks underlying the sediments. The accuracy of magnetic data is estimated as about two gammas.—*S. T. V.*

GRAVITY METHODS

12618. Hammer, Sigmund. Recent developments in gravity prospecting: Colorado School of Mines Quart., v. 45, no. 4A, pp. 87–103, 1950.

Recent instrumental developments are reviewed. The interpretation of gravimetric data is discussed and several examples are used to illustrate procedures and attainable results in prospecting for ore and oil deposits.—*S. T. V.*

12619. Garland, G. D. Combined analysis of gravity and magnetic anomalies: Geophysics, v. 16, no. 1, pp. 51–62, 1951.

As the anomaly produced by a body in a field of force is a function of both the material and the potential factor determined by the form of the body, a unique interpretation is not possible. If the anomalies produced by the same body in two different force fields are measured, the unknown potential factor can be eliminated, and a relationship, independent of the form and position of the body between the two different properties, can be determined. By using tables of the properties of the rocks in the region surveyed, it is possible, therefore, to make a more reliable determination of the material causing the anomalies.

A typical formula is derived relating the vertical magnetic anomaly and the gradient of the gravity anomaly by means of a factor which is the ratio between magnetic susceptibility and density. The method is applied to a magnetic and gravimetric survey near Bauxite, Arkansas, and the results show marked agreement with those obtained independently.—*J. R. B.*

12620. Elkins, T. A. The second derivative method of gravity interpretation: Geophysics, v. 16, no. 1, pp. 29–50, 1951.

The mathematical theory of the computation of the second vertical derivative of gravity is presented for both two-dimensional and three-dimensional anomalies. The graphical solution is outlined and studies of averages of gravity values on concentric circles of radius, r, for both the sphere and cylinder are given. Sources of error inherent in the graphical method are also discussed. The numerical method of calculation is given by three different formulas, each of which employs the gravity value at the origin and average values at circles r, $r\sqrt{2}$ and $r\sqrt{5}$ units from the origin. The various formulas are obtained as a consequence of weighting the averages differently. Comparisons are made for the derivative using two of the formulas and the theoretical value for the case of the sphere and cylinder. A method is devised of applying second vertical derivatives to simple geometric structures to determine the unknown parameters.

Several observed gravimetric maps are presented together with the second derivative maps to illustrate the higher resolving power of the latter.—*I. Z.*

12621. Gabriel, V. G. Geological considerations in evaluation of residual gravities: Mines Mag., v. 40, no. 10, pp. 104–106, 1950.

Regional gravity corrections are investigated with special attention being given to geological implications. The regional structures treated are essentially evenly dipping formations of very large extent, with physical properties differing perceptibly from those of the overlying strata. For such structures, the depth at a central point is the average of the depths for points on a circle of radius r about the center. If there is a break, or change in dip, smaller radii must be taken if the averaging process is to hold.

It is shown that the value of gravity at the central point is likewise the average of gravity values at points on a circle of radius r about the center. However, when there is a local anomaly near the central point, the difference between the observed gravity value at that point and the average value yields the gravity component of the local anomaly. The number of points and the magnitudes of the radii for proper evaluation of residual gravity depend upon the magnitude and character of the variations existing in the regional structure.—*R. G. H.*

12622. Fitzpatrick, M. M. A gravitational study of the Clare River syncline area, Ontario: Royal Soc. Canada Trans., 3rd. series, v. 44, sec. 4, pp. 21–34, 1950.

A survey of an area of approximately 600 sq mi north of Belleville, Ontario, has shown the usefulness of the gravimetric method in studying Pre-Cambrian structures such as the Clare River syncline. Readings were made at 150 stations, reduced to Bouguer anomalies, and contoured at 2½-milligal intervals. As the syncline rocks were for the most part denser than the surrounding granite gneiss, the anomaly outlined the structure very well, the contours paralleling the structure almost exactly along the edges and western end. Calculations of the subsurface configuration of the syncline and of an area of volcanic rocks in Elzevir township associated with a gravitational high demonstrated the importance of accurate knowledge of the densities involved.—*M. C. R.*

12623. Boaga, Giovanni, Tribalto, G., and Faccara, G. Misure gravimetriche nelle grotte di Castellana [Gravimetric measurements in the caverns of Castellana]: Annali Geofis., v. 3, no. 4, p. 439–449, 1950.

Gravity measurements were made in caverns over 1.6 km long near Castellana, Italy, using a Western GC gravimeter. Twenty two stations, occupied inside and outside of the caverns, were adjusted to form pairs on the same vertical, the difference in the level between corresponding stations varying from about 40 to 70 meters. Sajgey's formula, $\Delta g = 4\pi c(2/3e - b/h)$, in which Δg is the variation in gravity, c is the universal gravitational constant, e the average density of the earth, b the density of the overburden, and h the difference in level between stations, was used to compute the density of the overburden. The values of b ranging from 2.09 to 2.39 were found.—*S. T. V.*

12624. Williams, L. W. Gravity survey in the Leigh Creek area: South Australia Dept. Mines, Mining Rev., no. 89, pp. 80–89, 1950.

Further gravity surveys to investigate the possibility of coal basins north of the Leigh Creek [Copley] coalfield were made from May to September 1948. The instrument used was a Heiland GSC2 gravimeter with a sensitivity of 1 part in 50 million. A grid of stations at approximately half-mile intervals was laid out over the area surveyed. Elevation correction factors were determined by running a "density profile" over a topographic irregularity, and by the method of J. A. Sharpe. This latter method consists of statistically examining groups of three stations in lines, which are scattered over the area. The best value of the elevation correction factor minimizes the sum of the square of the difference between the central station reduced gravity and reduced gravity linearly interpolated between the first and third stations.

Results of the survey are presented on several gravity contour maps and gravity profiles. In certain places where the geologic structure is relatively

well known a gravity profile was computed using the known values of density of various strata. This method gave a curve closely agreeing with that measured by the gravimeter. Two gravity minima were found in the Lyndhurst area, but drilling established that these minima are caused by low density pre-Cambrian rock.—*S. T. V.*

12625. Fenner, W. G. Gravity survey-north of the Leigh Creek coalfields: South Australia Dept. Mines, Mining Rev., no. 89, pp. 122–125, 1950.

An area of about 40 square miles north and east of Lyndhurst siding was surveyed during November and December 1948. The instrument used was the North-American gravity meter. During a period of 26 days 170 stations were occupied. The looping field technique, with every station repeated twice, was used throughout the survey. The results of the survey are presented on a contour map of corrected gravity values. The most striking feature is the general trend toward lower gravity values toward the north. Three small lows were discovered and four sites have been recommended for drilling.—*S. T. V.*

12626. van Erkelens, C. H. Gravity survey in the Leigh Creek area: South Australia Dept. Mines, Mining Rev., no. 89, pp. 90–95, 1950.

This report covers gravity surveys in the Leigh Creek [Copley] area in May and June, 1949. The results are presented in three gravity maps, contoured at one-milligal intervals. The survey failed to reveal any anomalies which might be attributed to a coal basin.—*S. T. V.*

12627. Cornejo Toledo, Alfonso, and Hernandez Osuna, Alfonso. Las anomalias gravimetricas en la cuenca salina del Istmo, planicie costera de Tabasco, Campeche y Penisula de Yucatan [Gravitational anomalies in the saline basin of the Isthmus, in the coastal plain of Tabasco, Campeche and the Yucatan Peninsula]: Petroleos Mexicanos, no. 87, pp. 60–69, 1950.

Gravitational exploration of the part of Mexico north of the Isthmus of Tehuantepec began in 1923 with the torsion balance, and was continued in most places by gravimeter. The aggregate results of these investigations are given in three gravimetric maps with geologic interpretation in the light of later seismic exploration and industrial development in the same areas. Frequently occurring salt domes make geologic interpretation difficult because they may be associated with either gravitational maxima or minima, depending on the composition and the thickness of the overburden.—*S. T. V.*

MAGNETIC METHODS [2]

12628. Tsubokawa, Ietsune. A new type magnetometer: Geog. Survey Inst. Japan Bull., v. 2, pt. 1, pp. 73–76, 1950.

The magnetometer developed by the Institute is described (*See* Geophys. Abstract 12359). A similar instrument is described in which the rotating coil is set perpendicular to the Helmholtz coil which is fixed on the horizontal axis of the theodolite, and its rotating axis is perpendicular to one of the latter.—*W. J. D.*

12629. Groves, A. W. Results of magnetometric survey at Benallt manganese mine, Caernarvonshire: Inst. Min. Met., Trans., London, v. 56, pp. 475–513, 1950.

[2] *See also* Abstract 12619.

Exploratory work was done in the vicinity of the Benallt mine in search for additional deposits of manganese ore, using the magnetic method because the manganese ores of this deposit contain highly magnetic jacobsite. Watts vertical force variometers adjusted to about 32 gammas per scale division in a field of 0.43 gauss, and requiring no correction for temperature, were used. Several profiles were surveyed with station intervals reduced to 10 ft or 5 ft in especially interesting parts. The results of the survey, presented in the form of magnetometric curves, were later checked by drilling, which confirmed the findings of the geophysical work. Discussion of the paper at the Institution meeting is included.—*S. T. V.*

12630. Trueman, A. E., Chairman. Report of the Geological Survey Board [Great Britain] for the year 1949, 18 pp., 1950.

Geophysical work of the Geological Survey and Museum included a magnetic survey in the Coalisland district of County Tyrone, Northern Ireland, and gravimetric surveys in working or potential coal areas in southeast Kent, Somerset, and west of Bath. In the Coalisland district the exposed coal field is bounded by faults east of which lie sediments and Antrim basalts which have a high magnetic susceptibility. The magnetic survey was made to supplement boring information on the possible eastward extension of the Coal Measures. Vertical anomalies were plotted over an 11-square mile area and reached a magnitude of 1,000 gammas. Isoanomaly lines were alined with faults whose position and strike could be defined if the basalts were present at moderate depth on one side of the displacement. The anomalies showed that the upper surface of the basalt group is strongly magnetized with north-seeking polarity. No results of the gravimetric surveys are given.—*M. C. R.*

12631. Holmes, C. R. Magnetic fields associated with igneous pipes in the central Ozarks: Min. Eng., v. 187, no. 11, pp. 1143–1146, 1950.

A vertical and horizontal magnetometer survey was made over one of approximately 70 intrusions in southwestern Ste. Genevieve County and southeastern St. Francois County, Mo. These intrusions occupy diatremes or explosion tubes and are post-Devonian and probably Cretaceous in age. The intrusion studied is an "augite-free alnoite" containing about 2 percent magnetite and having a susceptibility of from 0.001 to 0.008 cgs units. The enclosing Bonneterre dolomite has a susceptibility of 0.0002.

Detailed surveys, to an accuracy of 10 gammas, of both the horizontal and vertical components were made and isoanomalic maps prepared. Analysis of the magnetic data indicates the intrusion is vertical, has an elliptical plan of about 140 by 160 feet with the long axis oriented north-south. Susceptibility determinations and the character of the isoanomaly maps show that there are local concentrations of magnetite within the igneous rock. This, together with the near surface effects of flux concentrations on edges and corners of the intrusion, greatly affect the character and magnitude of points of maximum magnetic variations.—*W. J. D.*

12632. O'Malley, Thomas. Exploration speeded in Peace River by aeromagnetic survey: Petroleum Engineer, v. 22, no. 11, pp. B36–B42, 1950.

An airborne magnetometer survey of a 16-million acre tract in northwestern Alberta, Canada, to guide exploration for petroleum, is described. The survey was flown at an altitude of 1,000 ft along a series of parallel flight lines spaced at

1½-mile intervals. A control pattern was followed with the area divided into 30- by 50-mile rectangles; along the periphery of each rectangle an overlapping series of loops were flown. In the interior areas, a series of tie lines was flown at six-mile intervals, perpendicular to the original 1½-mile flight lines. This means that no magnetic reading is more than 3 miles or 1⅛ min from a control point. Magnetic records are stated to be accurate to one or two gammas. Maps were to be ready by January 1, 1951.—*N. A. S.*

12633. U. S. Geological Survey. Total intensity aeromagnetic maps of New Mexico. Geophysical Investigations Maps GP15 to 18, Scale 1 inch=1 mile, contour interval=10 gammas, 1950.

Four maps of approximately 2,000 square miles in Guadalupe, De Baca and San Miguel Counties, N. Mex., have been issued based on an aeromagnetic survey by the U. S. Geological Survey. Two maps show parts of De Baca and Guadalupe Counties and two show parts of San Miguel and Guadalupe Counties. The total magnetic intensity at about 1,000 feet above the ground is shown by contour lines. The survey was made to obtain information on the configuration, composition, and approximate depth of the crystalline rocks underlying the sedimentary rocks in the area. Such information may aid in deciphering the structure of the sedimentary rocks and consequently in exploration for petroleum.—*W. J. D.*

12634. U. S. Geological Survey. Total intensity aeromagnetic maps of Indiana. Geophysical Investigations Maps GP30 to 45, Scale 1 inch=1 mile, contour interval=10 gammas, 1950.

A continuation of the series first listed in Abstract 11816. Maps of Boone, Clinton, Gibson, Hendricks, Montgomery, Perry, Putnam, Tippecanoe, Vanderburgh, Vermillion, and Warren Counties, an area of 4,000 square miles in west-central and southwestern Indiana have been prepared by J. R. Henderson, J. L. Meuschke, and W. J. Dempsey.—*W. J. D.*

SEISMIC METHODS

12635. Clewell, D. H. Recent developments in seismic research: Colorado School of Mines Quart., v. 45, no. 44, pp. 79–86, 1950.

Recent developments in seismic prospecting are described, including the Poulter method, the use of composite reflections and instrumental development.—*S. T. V.*

12636. Berson, I. S., and Epinat'eva, A. M. Screening effect in seismic prospecting [in Russian]: Akad. Nauk SSSR Izv., Ser. geog. i geofiz., tom 14, no. 6, pp. 473–500, 1950.

According to the laws of geometric seismology a refracted wave can exist only in a layer with a greater velocity than any of the overlying strata. However, in seismic surveys over plane parallel strata, it has been established that refracted waves with lower velocities than those in the overlying formation were registered. This phenomenon has been investigated both theoretically and experimentally. It is concluded that the screening effect of a layer is determined by the ratio d/l of the depth of the layer to the wave length, and by the number of screening formations. If the subsurface has two to four high velocity layers, deeper layers with lower or equal velocities were observed with values of d/l ranging from 0.06 to 0.50. Increase of this ratio causes the disappearance of slower waves. With $d/l=1$ the screening effect for such waves was com-

plete. The characteristic value of d/l, producing the screening effect, is determined by the ratio of velocities $V_1/V_2=n$, and densities $S_1/S_2=K$. By analogy with optical and acoustical phenomena, it seems possible to predict that with appropriate values of n and K, the screening effect will be reversed so that waves with higher velocities will disappear. Such a result, while paradoxical in seismology, is in good agreement with experimental acoustic data.—*S. T. V.*

12637. Goguel, J. M. Seismic refraction with variable velocity: Geophysics, v. 16, no. 1, pp. 81–101, 1951.

Methods of interpreting and calculating the propogation of seismic waves with variable velocity have been investigated. The purpose of the investigation was to establish a method that can be applied to existing types of alluvium and similar geologic formations found in shallow seismic refraction work. Necessary tables and graphs for such computations are given, and two examples from actual field experience are presented.—*H. R. J.*

12638. de Castro, Honorato. Determinacion de las constantes k and v_o que intervienen en la formula seismologica $t=2/k$ Sinh^{-1} $kx/2v_o$, [Determination of the constants k and v_o in the seismological formula $t=2/k$ Sinh^{-1} $kx/2v_o$]: Ciencia, v. 10, no. 7–8, pp. 221–222, 1950.

In the formula for the travel time $t=2/k$ Sinh^{-1} $kx/2v_o$, often used in seismic investigations, there are two unknowns, k the rate of increase of seismic velocity with depth x, and v the velocity at the surface. They are also related by the formula $v=v_o+kx$. These two unknowns may be determined by developing the hyperbolic sine into a series and omitting members beyond the fifth power. This is admissible for all practical purposes as long as t does not exceed three seconds. The equation then obtained is $t-x/v_o+k^2t^2/24+k^4t^4/1920=0$. At least three determinations of t are made in the field and then normal equations are derived, from which the most probable values of the unknowns may be obtained.—*S. T. V.*

12639. Dobrin, M. B. Dispersion in seismic surface waves: Geophysics, v. 16, no. 1, pp. 63–80, 1951.

Published theories and observations on dispersion in surface waves from earthquakes and in water-borne waves from shallow-water explosions are summarized nonmathematically. Dispersion similar to that in Rayleigh waves from distant earthquakes has been observed on ground roll from explosions in shot holes. This may be attributed to the low-speed weathered zone. In order of magnitude the ground roll data agree with theoretical curves of Sezawa and Jeffreys for solid layers and of Press and Ewing for a liquid layer overlying a solid, but there are certain quantitative differences because of the departure of the weathered layer from both simplifying assumptions.—*M. C. R.*

12640. Herdström, H., and Kollert, R. Seismic sounding of shallow depth: Tellus, v. 1, no. 4, pp. 24–36, 1949.

Shallow seismic surveying procedures used by the authors in their work in Sweden are described. The equipment consists of a set of six amplifiers, a recorder with oscillographs, timing device, and accessories. Geophones are placed along the profile at 5-meter intervals. After the shot, geophones 1 to 5 are moved to points between 30 and 55 meters, the last geophone remaining in

place and becoming number 1 in the new set-up. The double record obtained at this station provides the correction to be applied to the travel times if the conditions in a shot point change between successive shots. A seismic crew of one observer and six helpers covers, on the average, a profile length of about 150 meters per day, recording 25 to 30 shots. Under favorable conditions, as much as 400 meters can be covered in a day. Interpretation of the results is discussed and data on velocities in different kinds of media are given. Special problems such as investigation of glaciers and determination of the ice thickness, are also described. The reflection method has been successfully used even for ice thicknesses of less than 100 meters.—*S. T. V.*

12641. Hodgson, J. H. The implications of the Poulter method to the problem of seismic prospecting in southwestern Ontario: Canadian Min. Met. Bull., v. 43, no. 461, p. 486, 1950.

Previous failure of seismic prospecting in the Paleozoic area of southwestern Ontario has been caused by the lack of many reflecting horizons in the geologic column and the effect of the drift-cover which absorbs seismic energy and gives rise to groups of refracted phases. The high reflection velocities which make small surface errors into large ones in structural interpretation, and the relative shortness of the Paleozoic section further complicate the situation. Many of the structures are small in area. Most of the known accumulations are controlled by porosity rather than structure rendering the seismic method useless for detecting them. Though Dr. Poulter's techniques were designed to overcome many such difficulties, it is deemed improbable that any great benefit could be expected from their further application to this area. The explosion of dynamite is hardly possible in the highly developed areas of southwestern Ontario.—*N. A. S.*

12642. Mercanton, P. L. Le sondage des glaciers. Methodes et resultats [The sounding of glaciers, methods and results]: Le Globe, tome 89, pp. 9–10, 1950.

This is an address by the president of the Swiss Committee on Glaciers (Commission Helvétique des glaciers) on the recent geophysical investigations of glaciers. Thicknesses up to 440 meters were determined by a seismic survey of the Upper Aar Glacier [Oberaargletscher]. Precise observation of reflected waves made possible the construction of an accurate map of the bottom surface of this glacier.—*S. T. V.*

12643. Valerius, C. N., and Von Croy, Stefan. Case history of Benton Field, Bossier Parish, Louisiana: Geophysics, v. 16, no. 1, pp. 14–28, 1951.

The two producing horizons in the Benton field are members of the upper part of the Cotton Valley formation of Jurassic age. The structure is an elongate anticline on the flanks of the Sabine uplift, approximately seven miles long with an average width of 2¼ miles. Both producing sands have developed their greatest thickness on the crest because the fold was steadily rising during the time of deposition. The structure was discovered by a regional gravity-meter survey in 1943 and outlined by a moderate amount of seismograph work.—*M. C. R.*

12644. Clayton, Neal. Geology and geophysics of the North Snyder area Scurry County, Texas: Geophysics, v. 16, no. 1, pp. 1–13, 1951.

Discovery of the North Snyder reef in November 1948 was based on a reflection seismic survey. This reef is unique in that reflected energy is obtained from the reef-shale contact in some parts of the field. Magnetic and gravity surveys of the area are also described.—*M. C. R.*

12645. Rummerfield, B. F. Some problems in seismic exploration in Mexico: Mines Mag., v. 40, no. 10, pp. 120–22, 129, 1950.

See Geophys. Abstract 12456.—*M. C. R.*

12646. Swan, B. G. Index of wells shot for velocity (third supplement): Geophysics, v. 16, no. 1, pp. 140–152, 1951.

Information is listed on 498 additional well velocity surveys, mostly new surveys shot since the fall of 1948.—*M. C. R.*

ELECTRICAL METHODS

12647. Al'pin, L. M. The theory of dipole sounding [in Russian]; 88 pp., Moscow, Gostoptekhizdat, 1950.

In dipole sounding only two electrodes are used, corresponding to middle points of the usual four feeding and measuring electrodes. The physical foundations of this method of exploration are analyzed, the controlling differential equations are derived and their solution given in the form of graphs and charts, and the methods of interpretation are presented. Dipole sounding has been applied in field work in several regions of the U. S. S. R. but it is indicated that full effectiveness can be attained only by sufficient practical experience.—*S. T. V.*

12648. Tuman, V. S. The telluric method of prospecting and its limitations under certain geologic conditions: Geophysics, v. 16, no. 1, pp. 102–114, 1951.

In prospecting by the telluric method, the time variation of the potential gradient is recorded simultaneously at a base station B and field stations S. A linear relation exists between components of the telluric field vectors at B and the components of the corresponding vectors at S. While a unit vector at the base rotates in all directions over a period of time producing a circle, the corresponding or homologous vector at S produces an ellipse whose shape and area yield information about subsurface current flow. Contour maps of equal area ellipses are drawn, as well as maps of current flow in two perpendicular directions.

Theoretical aspects of the application of telluric surveys to one, two, and three conductive layers overlying a resistive layer are discussed. When the thickness, h, of a homogeneous bed is a function of one coordinate, y, it is shown that the potential gradient along y varies inversely with h. If h is a function of two variables x and y, the inverse variation of the potential gradient along y must be modified by a tectonic factor φ. The dimensions and shape of the ellipse at a field station can provide estimates of φ. In the two and three layer problems the inverse variation of potential gradient and thickness must be further modified by a factor ψ which depends generally upon the thickness of the layers and their resistivities.

The factors φ and ψ limit the interpretation of surface measurements in a telluric survey. Under certain conditions it can give a clearer picture than magnetic or gravity surveys.—*H. R. J.* and *R. G. H.*

12649. Mukhina, G. V. The screening effect of conductive layers located over a vertical vein [in Russian] : Akad. Nauk. SSSR Izv., Ser. geog. i geofiz., tom 14, no. 5, pp. 392–402, 1950.

Studies on the screening effect of a conductive layer (*see* Geophys. Abstract 12460) are extended to the problem of a subsurface vertical vein which is either covered by a conductive alluvium or projects to the surface. The upper layer and the vertical vein are assumed to be replaced by conductive films. The potential created by a point source is recorded for all portions of the medium. Conditions of continuity across the separating films and conditions at the boundaries are derived and analyzed in detail with the final solution given as an integral equation. From the formulas obtained, numerical values for specific electrical and geometric conditions are computed. The results are given graphically.—*S. T. V.*

12650. Nakabayashi, Kazutaka, and Fujiwara, Takayo. Generating mechanism of the spontaneous polarization. Classification of the generating mechanism. Single electrode potential of ores [in Japanese, with English summary] : Tokyo Research Inst. Nat. Resources, Rept. 13, p. 16, 1949, and Rept. 15, pp. 6–16, 1950.

To determine the expected potential difference produced by the presence underground of certain ores, specimens of pyrite, chalcopyrite, pyrrhotite, galena, magnetite, graphite, sulfur, and coal were acted upon by a weak solution of sulfuric acid and sodium hydroxide. The results of the experiments are presented in the form of graphs giving the potential difference in millivolts against pH-value of the solution. Hydrochloric acid and potassium hydroxide were also tried but did not produce significant variation of the measured potential difference. The effect of SH-ions in the solution on the pyrite electrode was investigated by introducing hydrogen sulfide into the solution. This resulted in significantly lower potential compared with the initial solution. Analysis of the experimental results shows that the mechanisms of spontaneous polarization cannot be attributed to a single factor, but is more complicated —*S. T. V.*

12651. Abelès, Florin. Recherches sur la propagation des ondes électromagnétiques sinusuoidales dans les mileux stratifiés. Application aux couches minces [Studies of the propagation of sinusoidal electromagnetic waves in stratified media. Application to thin layers]: Annales physique, tome 5, pp. 706–784, 1950.

The problem of the oblique incidence of an electromagnetic wave on a transparent layer overlying transparent semispace is analyzed. Using the method of matrices, the theory is extended to transparent layer over an absorbent medium and of an absorbent layer over a transparent medium. Formulas are derived giving the changes in amplitude and phase of the incoming, reflected and refracted waves as functions of the physical properties of the layer and its thickness. The theory is also extended to the case of several thin strata. Comparison of these results, obtained theoretically, with experimental evidence published by other scientists shows certain discrepancies between the data, but quantitative agreement. For earlier work, *see* Geophys. Abstract 12461.—*S. T. V.*

12652. Fritsch, Volker. Einige funkgeologische Untersuchungen nach der Ersatzkapazitäts-und Ausbreitungsmethode mit nahem Sender und die Möglichkeit einer indirekten Anzeige tiefer elektrischer Discontinuitäten

[Some geophysical investigations by radio-methods using the procedure of substituted capacity and the determination of the direction of propagation in the vicinity of a transmitter. Possibility of indirect determination of deep electrical discontinuities]: Archiv für Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 2, Heft 1, pp. 127–143, 1950.

During World War II, several investigations by radio methods were interpreted as providing data on very deep formations. Certain predictions made on the basis of these investigations were confirmed by the mining industry. In the present article the method of substituted capacity and the method of determination of the field components on the earth's surface are described, and their possible range computed as a function of the characteristics of the measuring instruments and of the properties of the formations surveyed. The results of the analysis do not give a clear picture of the physical phenomena taking place. The author emphasizes the necessity of further experiments.—*S. T. V.*

12653. Lundberg, Hans. Airborne electrical surveys for regional studies in oil and ore prospecting: Canadian Min. Met. Bull. v. 43, no. 456, pp. 190–192, 1950.

See Geophys. Abstract 12471.—*W. J. D.*

RADIOACTIVE METHODS

12654. Magnée, Ivan de. Geiger-Müller counters. Some aspects of their use in prospecting [translated and abbreviated by Maj. A. Graves]: Mine and Quarry Eng., v. 16, no. 7, pp. 217–224, 1950.

This is a discussion of the use of Geiger-Müller counters in geologic work, including surveys of uranium and thorium veins by direct measurement of surface radioactivity; stratigraphic and tectonic studies based on the different radioactivity of different rock types; exploration of bore holes, pits, underground workings, or quarry faces ("gamma intensity charting") and laboratory assays of minerals.—*M. C. R.*

THERMAL METHODS

12655. Vialov, S. S. Determination of the pattern of thermal field around buried bodies [in Russian]: Akad. Nauk SSSR Izv., Ser. geog. i geofiz., tom 14, no. 6, pp. 553–561, 1950.

For geophysical investigations by thermal methods, it is important to know the intensity of the heat flow from buried bodies under certain conditions of observation. Similar problems are found in tunneling and mining engineering. The problem is discussed analytically for bodies of simple geometrical shape and the results are given as analytical equations and graphs. The method of electric models is more useful. This method is based on the identity of differential relations for heat flow and the flow of electrical current under similar conditions. Solutions for unsteady conditions of flow for any body shape and boundary conditions may be found. Graphs are presented of the temperature distribution under selected conditions of experiment.—*S. T. V.*

WELL LOGGING

12656. Doll, H. G., and Martin, Maurice. Recent developments in electrical logging and auxiliary methods: Colorado School Mines Quart., v. 45, no. 4A, pp. 49–78, 1950.

The principles of electrical well logging and the history of its development are briefly outlined. Modern operating techniques are described.—*S. T. V.*

12657. Doll, H. G. Selective SP logging: Jour. Petroleum Technology, v. 2, no. 5, pp. 129–141, 1950.

Selective self-potential logging gives an accurate determination of the permeable beds, except when the salinity of the mud is extremely high, and it allows a close approximation of the static self-potential to be obtained. A description of the measuring device and its use in bore holes is presented. The difference in the two recorded curves, one equal to the static self-potential of the shales and the other to that of the permeable beds, locates the permeable and impervious beds. A method of computing the static self-potential log from the curves of selective self-potential is outlined. The static self-potential is related to the resistivity of the connate water which is a factor used in computing oil saturations.—*N. A. S.*

12658. Patnode, H. W., and Wyllie, M. R. J. The presence of conductive solids in reservoir rocks as a factor in electric log interpretation: Jour. Petroleum Technology, v. 2, no. 2, pp. 47–52, 1950.

In the quantitative interpretation of electric log data it is essential to know the formation factor, which is defined as the ratio of the resistivity of the formation 100 percent saturated with brine to the resistivity of the brine. Laboratory tests on permeable cores showed that the calculated formation factor of the core decreased as the resistivity of the saturating solution was increased. Total conductance of the core appeared to equal the sum of the conductances of the solids and the saturating solution. Errors may be made in the determination of formation factor and resistivity index from electric log data if the effects of conductive solids are not considered. A method of determining the approximate quantity of conductive solids present in reservoir rocks when basic data can be obtained from the electric log is proposed and an example given.—*N. A. S.*

12659. Williams, Milton. Estimation of interstitial water from the electric log: Jour. Petroleum Technology, v. 2, no. 10, pp. 295–308, 1950.

Agreement between the amount of interstitial water determined by analysis in cores and estimated from the resistivity curve of the electric log may be due to a fortuitous compensation of errors. From studies of two wells in the Hawkins Field in east Texas and additional data from the Charlotte Field in southwest Texas, it was concluded that the apparent resistivities of high-resistivity beds read from electric logs made in ordinary mud were generally much lower than the true resistivities as revealed by the core resistivities; that methods for deriving true resistivities from the apparent resistivities of logs made in ordinary mud were ineffectual; and that the proposed square root relation between interstitial water saturation and true resistivity did not hold. Variations in salinity of interstitial water and in the texture of reservoir sands complicated the estimation of interstitial water from the electric log but these factors alone probably contribute only minor errors to the average values of water saturation computed from the electric log. A discussion by G. E. Archie and rebuttal are included.—*M. C. R.*

12660. Jones, P. H., and Buford, T. B. Electric logging applied to ground water exploration: Geophysics, v. 16, no. 1, pp. 115–139, 1951.

A method is described for determining the quality of ground water in terms of hypothetical chemical analyses, and the porosities of granular aquifers in situ, from electric logs of drill holes penetrating aquifers, from laboratory tests of drill cuttings, and from ground-water temperatures. Three examples are given to illustrate the use of the method in the Gulf Coast region.—*H. R. J.*

12661. Bush, R. E., and Mardock, E. S. Some preliminary investigations of quantitative interpretations of radioactivity logs: Jour. Petroleum Technology, v. 2, no. 1, pp. 19–34, 1950.

The basic theories of the gamma ray and neutron logs are briefly discussed. The gamma-ray log measures the intensity of gamma rays emitted naturally by the rock strata and so is used mainly to locate strata. The neutron log measures the radiation resulting from the bombardment of the formation with neutrons emitted from a radium-beryllium source attached to the ionization chamber. A physical basis is presented for the assumption that the neutron curve may be calibrated in terms of porosity. A quantitative calibration of the neutron log is given in terms of liquid-filled porosity for certain areas based on core information available. Specific examples show the application of the relative methods of interpretation to logs of several areas.—*N. A. S.*

12662. Simonato, I. B. Primeras aplicaciones del perfolaje radioactive en Comodore Rivadavia [The first applications of the radioactive method in Comodore Rivadavia]: Bol. inf. petroleras, v. 27, no. 300, pp. 26–35, 1950.

Results of radioactive well logging in Comodore Rivadavia oil field in northern Argentina are reviewed and compared with electrical logging. Layers were studied to a depth of almost 1500 meters. The graphs of the discussed logs and their detailed analyses are included.—*S. T. V.*

TECHNICAL AIDS

12663. Brownscombe, E. R., Slobod, R. L., and Caudle, B. H. Laboratory determinations of relative permeability: Pt. 1, Oil and Gas Jour., v. 48, no. 40, pp. 68–69 and 81–82, 1950; Pt. 2, v. 48, no. 41, pp. 98–102 and 123, 1950.

The spatial distribution of the phases within the porous system are said to largely determine the ability of a particular phase to flow. The authors suggest that the method used to introduce a second phase into a core specimen may have an appreciable effect on the observed relative permeability of the resulting system at a given saturation. Discussion of the capillary-pressure method of displacing one fluid by another, the dynamic displacement, and the solution-gas displacement are given in detail.

The second part describes the equipment used in determining relative permeability by the capillary pressure method, its operation, and the reproducibility of the results. Such results obtained on natural and synthetic cores and on unconsolidated sands are presented and discussed.—*N. A. S.*

12664. Bernasconi, Carlo. Sull' analisi periodale dei diagrammi [The periodic analysis of diagrams]: Geofis, Pura e Appl., v. 14, fasc. 3–4, pp. 181–187, 1950.

The periodic or harmonic analysis of a diagram is its decomposition into sinusoidal components of determined amplitudes, periods and relative phase

sequence. The mathematical counterpart is the development of a function in a Fourier series. In working out observations on any natural phenomenon, it is often essential to establish a relationship to physical factors of given periodicity. The mechanical procedures of Labrouste, Vercelli, Lovera, and a modification of the last method are described. Mathematical bases of each method and the operation of instruments for the analysis are described.—*S. T. V.*

12665. Caloi, Pietro. Il pendolo orizzontale come clinometro [The horizontal pendulum as a clinometer]: Annali Geofis., v. 3, no. 4, pp. 451–457, 1950.

The theory of the horizontal pendulum, especially of the bifilar type as constructed by M. Ishimoto, is developed. An instrument similar to Ishimoto's with certain modifications to make it less fragile has been constructed. The instrument is especially adapted for determination of slow movements of the crust.—*S. T. V.*

12666. Freise, Heinrich. Dämpfungseinrichtungen für Schwingungsmessgeräte [Damping devices for vibrometers]: Archiv tech. Messen, Lief. 159, pp. T72, 1949.

Two types of damping arrangements are discussed, one by eddy currents, and the other by frictional losses in liquids. The former has the great advantage of being almost independent of temperature but is not well adapted to measuring high frequencies. Typical applications of both kinds of damping are described. —*S. T. V.*

PATENTS

MAGNETIC METHODS

12667. Method of magnetographic surveying. Maunu Puranen and Aarno Assar Kahma, Helsinki, Finland: U. S. patent 2,539,270, issued Jan. 23, 1951.

A method of magnetic surveying comprising flying an airplane carrying an automatic magnetograph over the surface of the earth to be surveyed, controlling the course of said airplane from an airplane flying at a higher level, photographing said magnetograph carrying airplane relative to said surface at frequent time intervals from said airplane at a higher level and recording the moments of the photographic exposures on the magnetogram produced by said magnetograph by radio impulses transmitted from said airplane at a higher level thereby fixing the magnetogram with relation to said surface. Claims allowed, 2.

12668. Magnetic testing device. Marion V. Long, Berkeley, Calif., assignor to Shell Devel. Co., San Francisco, Calif., a corporation of Delaware: U. S. patent 2,540,588, issued Feb. 6, 1951.

For use with a measuring bridge circuit, a probing device comprising a core of magnetic material adapted for insertion and movement in a passageway in a metallic object to be tested, and two longitudinally spaced co-axial coil means wound on said core, each of said coil means having a different number of turns. Claims allowed, 10.

12669. Magnetic testing recording system for metallic bodies. Marion V. Long, Berkeley, Calif., assignor to Shell Devel. Co., San Francisco, Calif., a corporation of Delaware: U. S. patent 2,540,589, issued Feb. 6, 1951.

A system for magnetically testing an elongated metallic member, comprising two coaxial coils longitudinally spaced in fixed relationship with each other and adapted to be moved along said metallic member adjacent thereto, a compound measuring bridge circuit comprising a main and an auxiliary bridge, means for supplying an alternating current to said bridge circuit, each of said two coils being connected to form an arm of said main bridge, said main bridge being grounded at a point intermediate said two coils, resistance means connected to form the other two arms of said main bridge, first and second impedance means connected across an intermediate portion of said resistance means to form two arms of the auxiliary bridge, said intermediate portion of said resistance means forming the two other arms of said auxiliary bridge, variable means for adjusting said impedance means to balance said bridge circuit, means for amplifying the unbalance voltage appearing between the grounded point in said main bridge intermediate said two coils and a point in said auxiliary bridge intermediate said first and second impedance means when said coils are moved into the proximity of a variation in the cross-section of said metallic member, means responsive to said amplified unbalance voltage for readjusting said impedance means to rebalance said bridge circuit, and means synchronized with said rebalancing means for recording the unbalance of the measuring bridge circuit. Claims allowed, 6.

12670. Magnetometer. Cecil Stanley Davidson, Sudbury, Ontario, Canada: U. S. patent 2,541,213, issued Feb. 13, 1951.

In a vertical magnetometer, the combination with a scaled dial and a magnetic needle mounted to swing in a vertical plane, of a counterbalance slidably mounted on said needle, an Invar stud extending downwardly from said slidable counterbalance below the needle, and an aluminum stud extending upwardly from said slidable counterbalance in opposed relation to said Invar stud. Claims allowed, 3.

12671. Method of and apparatus for making magnetic measurements. Kenneth L. Scott, Western Electric Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,541,618, issued Feb. 13, 1951.

A method of determining the coercive force of magnetic materials comprising subjecting a specimen of magnetic material to a magnetizing force sufficient to saturate the material, removing said specimen from the influence of said magnetizing force at a predetermined slow rate of speed, and measuring the remanence of said specimen. Claims allowed, 12.

12672. Magnetic field measuring device. Alex Frosch, Houston, Tex., assignor, by mesne assignments, to Standard Oil Devel. Co., Elizabeth, N. J., a corporation of Delaware: U. S. patent 2,543,843, issued March 6, 1951.

In a magnetometer, a transformer having an elongated straight core of magnetizable material with a coaxial secondary coil thereon, a first source of alternating current connected to said transformer to set up flux in said core transverse to its longitudinal axis, a second source of alternating current connected to said secondary coil for causing the flux in said core periodically to pass completely through its hysteresis loop and a measuring circuit connected to said secondary coil responsive to differences in output voltage of said transformer during the passages of flux in said core through its hysteresis loop. Claims allowed, 4.

SEISMIC METHODS

12673. Accelerometer. Robert O. Fehr, Augustus H. Fiske, Jr., and Richard J. Wells, Schenectady, N. Y., assignors to General Electric Co., a corporation of New York: U. S. patent 2,536,802, issued Jan. 2, 1951.

An accelerometer comprising a base, a post rigidly attached at one of its ends to the base so that the post deflects as a cantilever beam responsive to acceleration normal to its axis, said post having a substantially uniform square cross section throughout its length, a coaxial cable, the post and base having a cylindrical bore extending along the axis of the post into which the coaxial cable fits, thin piezoelectric crystals respectively attached to opposite sides of said post near the base, each such crystal having two relatively large opposite faces one of which is rigidly attached to a side of the post, electrodes in contact with and substantially covering the large faces of the crystals, an insulating sheath about the post to electrically insulate it from the crystals and their electrodes, and electrical connections between electrodes and the coaxial cable such that crystals on opposite sides of the post are connected with opposed polarities. Claims allowed, 1.

12674. Vibrograph. John G. Burist, Philadelphia, Pa.: U. S. patent 2,536,870, issued Jan. 2, 1951.

In a vibrograph, an oscillatory system comprising a seismographic mass, a flat resilient member to which said mass is secured at one end, and additional resilient members, in combination with a base, a support for said flat resilient member secured to said base and to which the other end of the flat resilient member is rigidly secured for determining the plane of movement of the mass, a fixedly mounted abutment member secured to said base and intersecting the plane of movement of said mass, an adjustable supporting rod in screw threaded engagement with said abutment member and disposed in the plane of movement of said mass, said rod being movable along its longitudinal axis in said abutment member and extending through an opening in said mass, spaced holding members in threaded engagement with said supporting rod on opposite sides of said mass, said additional resilient members being mounted on said supporting rod in engagement with said holding members and with opposite sides of said mass, the natural period of oscillation of said oscillatory system being determined by the mass and by the spring constants of said resilient members. Claims allowed, 1.

12675. Seismographic record correlation system. Lawrence F. Athy and Harold R. Prescott, Ponca City, Okla., assignors to Continental Oil Co., Ponca City, Okla., a corporation of Delaware: U. S. patent 2,539,220, issued Jan. 23, 1951.

In a method of seismographic survey by creating at a localized source a disturbance in the earth to form artificial seismic waves, producing dual simultaneous variable amplitude records with respect to time, side by side on record strip means, of the vibrations resulting from said disturbance at a plurality of points differently located relative to said source, the improvement comprising reversing the arrangement of one of the records relative to the other while forming the portions of the record aligned transversely of the strip. Claims allowed, 8.

12676. Apparatus for marine seismic prospecting. John J. Babb, Laurel, Miss., and Neal J. Smith, New Orleans, La.; said Babb assignor to Geophysical Service, Inc., Dallas, Tex., a corporation of Delaware, and said Smith assignor to The California Co., New Orleans, La., a corporation of California: U. S. patent 2,544,819, issued March 13, 1951.

A seismometer spread for submarine prospecting that comprises a plurality of seismometer units each including a seismometer for converting seismic signals into electrical signals and flotation means which taken with the seismometer will make the seismometer unit have an apparent specific gravity less than that of water in which it is to be used, a flexible electro-conductive cable attached to each seismometer unit for carrying the electrical signals from the seismometer in the unit and positioning the seismometer unit, and a main electroconductive cable to which the first-mentioned cables are connected at spaced positions, said main seismometer cable serving to conduct the signals from the seismometers to the surface of the water and being sufficiently heavier than the water it displaces so that it will sink to the bottom of the water and drag the seismometer units down to fixed positions above it, which positions will be determined by the lengths of the first-mentioned seismometer cables. Claims allowed 3.

12677. Seismic exploration employing elevated charges. Thomas C. Poulter, Palo Alto, Calif., assignor to Inst. of Inventive Research, San Antonio, Tex., a trust estate: U. S. patent 2,545,380, issued March 13, 1951.

The method of seismic exploration which includes the steps of supporting a plurality of charges above the surface of the ground laterally spaced from one another to define an area and at substantially the same height, each of said charges being free of substantial obstruction to the passage of a supersonic wave downwardly therefrom, said charges being located at such height as to apply supersonic waves to the ground below the respective charges and said charges being laterally spaced from one another at such distance that the seismic waves resulting from the supersonic waves form a composite seismic wave front upon passage through the earth, exploding said charges simultaneously to project said composite wave toward a reflecting horizon, and detecting the seismic wave after reflection of the same from said horizon. Claims allowed, 7.

ELECTRICAL METHODS

12678. Surface wave cancellation electrical prospecting. Charles I. Beard, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,542,462, issued Feb. 20, 1951.

The method of detecting resistance inhomogeneities in an electrically conducting body which comprises applying to said body at a sending station a pulse of electrical energy, some of which travels downwardly through the body and some of which travels along the body-air interface as a boundary wave whose shape depends upon the resistivity of that portion of the body through which it travels, at a detecting station spaced from the point of application of said pulse detecting a signal comprising the sum of the boundary wave and an upwardly reflected energy wave resulting from reflection of downwardly traveling energy from electrically contrasting subsurface interfaces, in a zone electrically isolated from the region of said sending and detecting stations generating a boundary-

cancellation wave having the same shape said detected signal would have if the body were homogeneous in terms of electrical resistivity, applying said cancellation wave in opposition to the detected signal to leave a remaining signal due substantially entirely to reflected energy, and measuring said remaining signal for location of said interfaces. Claims allowed, 21.

RADIOACTIVE METHODS

12679. Measuring apparatus. Gerhard Herzog, Arthur H. Lord, Jr., Leon M. Evans, and Robert B. Heath, Houston, Tex., assignors to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,536,131, issued Jan. 2, 1951.

A device for measuring the thickness of a tube wall from the inner side thereof comprising an elongated cylindrical casing, a source of penetrative radiation within said casing, a cylindrical radiation detector disposed substantially concentrically within said casing and spaced from said source, a vacuum tube preamplifier contained within said casing and connected to said detector, means within said casing for shielding the detector from direct radiation from said source, means for indicating the amount of radiation from said source scattered within a section of the tube wall and thence impressed on said detector, a flexible conductor cable connecting the output of said preamplifier with said indicating means, and means for clamping said casing to the inner surface of said tube wall, said clamping means comprising an elongated frame having a front side and a back side and adapted to releasably engage said casing, the ends of said frame being provided with cylinders disposed laterally of the frame, pistons in said cylinders, a contact member attached to each of said pistons, and means for supplying fluid under pressure to said cylinders to force said pistons outwardly in a lateral direction so that said contact members will engage the inner surface of said tube at the back side of the frame to force the front side of the frame against the opposite inner surface portion of said tube to be measured. Claims allowed, 3.

12680. Radiation detector. Serge A. Scherbatskoy, Tulsa, Okla.: U. S. patent 2,536,314, issued Jan. 2, 1951.

A radiation detecting device comprising a wire electrode, an undulated ribbon electrode in the neighborhood of said wire electrode, said undulated ribbon electrode consisting of a plurality of parallel plate segments arranged one above the other substantially transversally to said wire electrode and a plurality of connecting plate segments substantially parallel to said wire electrode, said connecting segments interposed between said plate segments to form the undulations, an ionizable medium between said electrodes, and an ionization responsive circuit between said electrodes. Claims allowed, 5.

12681. Radiation detector. Ernest O. Wollan and Louis A. Pardue, Oak Ridge, Tenn., assignors to the United States of America as represented by the U. S. Atomic Energy Commission: U. S. patent 2,536,991, issued Jan. 2, 1951.

An ionization chamber comprising at least two mutually insulated electrodes having an ionizing medium therebetween, means for hermetically sealing said ionizing medium, an insulated charging pin supported upon said means for hermetically sealing the ionizing medium by resilient means which normally

holds said pin out of contact with one of said electrodes, but which permits said pin to be moved into temporary contact with said electrode during the charging of said ion chamber. Claims allowed, 13.

12682. Combination beta and gamma chamber. Edward R. Tompkins, Oak Ridge, Tenn., assignor to the United States of America as represented by the U. S. Atomic Energy Commission: U. S. patent 2,538,632, issued Jan. 16, 1951.

A monitoring device for measuring radioactivity of fluids comprising a housing, a tubular element passing through the housing to provide a passage for the continuous flow of fluids, said element being transparent throughout to the passage of gamma radiation while retarding beta radiation, said element also having only an intermediate portion transparent to beta radiation, and means selectively responsive to the gamma and the beta radiation from the fluids for providing a measure of the intensity thereof, said means including chambers within the housing. Claims allowed, 9.

12683. Radiation detector. Fitz-Hugh B. Marshall, Glenshaw, Pa., assignor to Westinghouse Electric Corp., East Pittsburgh, Pa., a corporation of Pennsylvania: U. S. patent 2,539,196, issued Jan. 23, 1951.

In combination with means for producing an exciting radiation distributed with varying intensity over an area normal to the direction of propagation thereof, a substance having the property of storing energy with a distribution corresponding point-by-point with the intensity of radiation incident thereon and of reradiating said energy under incidence of a stimulating radiation, said substance being interposed in the path of said exciting radiation, means for scanning said substance point-by-point with a narrow beam of said stimulating radiation and recording means producing an electric current corresponding to the intensity of said reradiated energy positioned to be energized thereby. Claims allowed, 12.

12684. Method of locating leaks in wells and well fittings. Howard H. Hinson, Ponca City, Okla., assignor to Continental Oil Co., Ponca City, Okla., a corporation of Delaware; U. S. patent 2,540,049, issued Jan. 30, 1951.

The method for locating the point of confusion of the materials in a system of first and second laterally contiguous streams which comprises introducing radioactive material into the first of such streams, determining the presence of such material in the second of such streams at a fixed point in the system and determining the point of confusion by moving a radioactivity sensitive instrument longitudinally of said second stream. Claims allowed, 5.

12685. Measurement of thickness. Gerhard Herzog, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,540,261, issued Feb. 6, 1951.

A device for measuring the wall thickness of a curved object comprising an elongated supporting member, a holder containing a source of gamma-ray radiation mounted on the side of said supporting member, an elongated detector of said radiation mounted longitudinally on the same side of the supporting member as said source and separated from the source so as to provide a space therebetween, the object to be measured being adapted to be placed in said space against the supporting member and source and at right angles to the supporting

member so that radiation from the source will pass tangentially through the object to said detector, the mounting means by which the detector is attached to the source being adjustable so as to control the length of said space whereby objects of different sizes can be accommodated and their wall thicknesses measured, a meter connected to the detector for indicating the intensity of the radiation transmitted through the object to the detector, and means for calibrating the device comprising a plurality of radiation absorbing members of different thicknesses, said absorbing members when inserted singly or collectively between the source and detector serving to reduce the intensity of transmitted radiation by a known amount. Claims allowed, 1.

12686. Integration device for radioactivity measurements. Alexander Wolf, Houston, Tex., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,540,310, issued Feb. 6, 1951.

An integration circuit comprising a resistor, a group of condensers of equal capacities, the resistor when in series with any one of the condensers forming an integration circuit having a time constant, means for charging one of said condensers through said resistor for a time period, means for removing said charged condenser from the charging portion of the circuit and replacing it with an uncharged condenser, means for simultaneously connecting the charged condenser in series with the previously charged condensers to form a group, said time period being equivalent to the same fraction of said time constant as one is to the number of condensers in said group, means for removing one of the condensers from said group and for simultaneously discharging said removed condenser, whereupon a voltage will be built up across the group of condensers connected in series during the said charging time, and a driving device for actuating all of said means in repeated sequence whereby the averaging effect of the integration circuit is extended over a time period which is several times as long as said charging time. Claims allowed, 6.

12687. Geiger tube. John A. Victoreen and Roger W. Barton, Cleveland, Ohio, assignors, by direct and mesne assignments, to The Victoreen Instrument Co.: U. S. patent 2,542,440, issued Feb. 20, 1951.

A tube of the class described comprising a spun copper chamber having a flange at one end, a connector sealed in the other end and including an insulating member, a hollow metal connector extending through said insulating member, a center electrode carried by said insulating member and extending into said chamber, window means for said flange and for closing the other end of said chamber comprising a mica disc, cushion means disposed on each side of the mica disc, a flanged cup embracing the cushion means and the mica disc, cement means for engagement with said flange and said cup and the edges of the mica disc and cushion means. Claims allowed, 3.

12688. Process for measuring permeability and porosity of borehole substrata. James M. Bird, Bradford, Pa.: U. S. patent 2,544,412, issued March 6, 1951.

The process of determining permeability of substrata in the bore of a well which consists in depositing in the bore of the well a colloidal dispersion of radioactive cobalt in liquid and permitting said liquid to permeate into the substrata formation, the radioactive cobalt colloids being of a size to filter out directly upon the natural bore surface of the well at the substrata thru which

the liquid penetrates without appreciable penetration of the colloids into the substrata beyond the bore. Claims allowed, 3.

12689. Radioactivity detector. John D. Lahmeyer, Tulsa, Okla., and John T. Callahan, La Feria, Tex., assignors to Industrial Nucleonic Devices, Tulsa, Okla., a corporation of Oklahoma: U. S. patent 2,544,928, issued March 13, 1951.

A radioactivity detector comprising a cylindrical wall and end plates therefor cooperating to define a closed ionization chamber, said cylindrical wall forming one electrode of the chamber, a thin diaphragm window in one of said end plates, an electronic tube having at least an anode, cathode and control grid mounted inside said chamber and centrally located with the other of said end plates, a slender inner electrode extending from said grid toward said diaphragm window with the end thereof substantially coaxial with the cylinder, and an input resistance mounted in said chamber and connected to the grid of said tube, whereby a directional radioactivity detector of high sensitivity may be obtained. Claims allowed, 4.

12690. Geiger-Müller tube mounting. Meyer Joseph Test, Kansas City, Mo., and Shelley Krasnow, Fairfax, Va., assignors to Schlumberger Well Surveying Corp., Houston, Tex., a corporation of Delaware: U. S. patent 2,546,048, issued March 20, 1951.

A mounting for a Geiger-Müller tube comprising a rigid insulating base with a plurality of rigid conducting prongs, a conducting enclosure having ray transmitting properties for the rays to be measured by the Geiger-Müller tube completely enclosing the Geiger-Müller counter tube, the terminals of the said counter tube being connected respectively to the prongs, the external conducting enclosure being connected to an additional prong and supported by said base, thereby providing a convenient and easily connectible mounting for the tube. Claims allowed, 13.

WELL LOGGING

12691. Apparatus for measuring interstitial water content, permeability, and electrical conductivity of well cores. Paul P. Reichertz, Dallas, Tex., assignor, by mesne assignments, to Socony-Vacuum Oil Co., Inc., New York, N. Y., a corporation of New York: U. S. patent 2,539,355, issued Jan. 23, 1951.

In an apparatus for the measurement of interstitial water content of a well-core sample, an annular member containing a recess adapted to receive in fluid-tight relationship one end of a core sample which has been coated on its surface except for two end faces with a fluid-impervious coating, a second annular member adapted to receive in fluid-tight relationship the other end of said core sample, a semipermeable membrane supported within the annulus of said second annular member one surface of which membrane is exposed for capillary relationship with the exposed face of said core sample, an annular plug member slidably and at least partially received within the annulus in fluid-tight relationship of said second annular member the annulus of said plug member being exposed to the opposite surface of said membrane, rigid support means connected to said annular members for adjustably holding said annular members in spaced relationship, rigid support means connected to said second annular member and said annular plug member for adjustably holding said annular plug

member at least partially within the annulus of said second annular member, means for imposing a fluid pressure through the annulus of said first annular member to the exposed face of said core sample, means for imposing the same fluid pressure to the other exposed face of said core sample exposed to the surface of said semipermeable membrane, and liquid volume measuring means operable at a pressure lower than said fluid pressure connected to the annulus of said plug member. Claims allowed, 9.

12692. Means for logging drilling rates. Daniel Silverman and Robert W. Stuart, Tulsa, Okla., assignors to Stanolind Oil and Gas Co., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,539,758, issued Jan. 30, 1951.

A system for logging a well during a rotary drilling operation comprising a first means for producing a signal which normally would be proportional to the actual drilling time rate, a second means responsive to variations in the weight on the drill bit, a third means actuated by said second means for determining variations in the drilling rate caused by variations in the weight on the drill bit, a fourth means for modifying the signal produced by said first means in accordance with the variations in the drilling rate determined by said third means, and a fifth means for exhibiting an indication of said modified signal. Claims allowed, 18.

12693. Well logging. Kenneth C. Crumrine, Tulsa, Okla., assignor to The Texas Co., New York, N. Y., a corporation of Delaware: U. S. patent 2,541,341, issued Feb. 13, 1951.

In a logging device, the combination which comprises a logging head containing a source of fast neutrons and gamma rays, a proportional counter sensitive to slow neutrons and gamma rays and capable of producing pulses of greater amplitude from slow neutrons than from gamma rays, an amplifier-discriminator circuit adapted to suppress pulses of the gamma ray amplitude and to leave unsuppressed pulses of neutron amplitude, a counter voltage supply, and an automatic volume control for controlling the amplitude-discriminator circuit, said automatic volume control being responsive to the gamma rays being detected by the proportional counter, but substantially unresponsive to the slow neutrons detected by the counter. Claims allowed, 5.

12694. Treatment of earth formations penetrated by a deep well bore. Paul H. Cardwell, Tulsa, Okla., assignor to The Dow Chemical Co., Midland, Mich., a corporation of Delaware: U. S. patent 2,541,688, issued Feb. 13, 1951.

In a method of equalizing the permeability of an earth stratum having a permeability, P_m, with that of another having a lesser permeability P_1, the permeabilities being measured in darcys, both strata being penetrated by the same well bore, the steps which comprise injecting through the well bore into the stratum having the permeability P_m a resinous liquid mixture while excluding the same from the stratum having the permeability P_1 said resinous liquid mixture consisting of two partially resinified phenolic-aldehydic resinous liquids, a catalyst promoting the further condensation of the phenolic-aldehydic constituents of the resinous liquid mixture into a solid resin in situ, and a diluent soluble in the liquid mixture but insoluble in the solid resin produced therefrom, one of said partially resinified phenolic-aldehydic resinous liquids being formed by par-

tially condensing phenol and an aldehyde selected from the group consisting of formaldehyde and paraformaldehyde in the proportion of 0.75 to 2 moles of HCHO per mole of phenol in the presence of an alkaline catalyst selected from the group consisting of alkali metal hydroxides and carbonates in the proportion of 0.015 to 0.6 moles of the alkali per mole of phenol, and water in amount not exceeding 20 moles per mole of phenol, the reaction being continued until upon acidification two liquid layers are formed; acidifying the resulting partially condensed reaction mass to a pH of 4 to 6, whereby two liquid layers form on standing; separating the lower liquid layer from the upper liquid layer; treating the lower layer by dissolving therein a polyhydroxybenzene selected from the group consisting of resorcinol and phlorglucinol in the amount of 0.67 to 1.8 moles per mole of phenol; the other said partially resinified phenolic-aldehydic resinous liquids being formed by partially condensing a nuclear alkylated phenol selected from the group consisting of meta-cresol, 3.5-dimethyl phenol, 3-methyl 5-ethyl phenol, and cresylic acid containing 25 to 35 percent of meta-phenolic compounds with an aldehyde selected from the group consisting of formaldehyde and paraformaldehyde in the proportions of 2.25 to 4.5 moles of the aldehyde calculated as HCHO per mole of the alkylated phenol in the presence of an alkali catalyst selected from the group consisting of the alkali metal hydroxides and carbonates in the proportion of 0.006 to 0.28 moles of alkali per mole of alkylated phenol, and water in amount not exceeding 20 moles per mole of alkylated phenol, the reaction being continued until the viscosity measured at 80 F reaches a value between 150 and 5000 cps.; acidifying the resulting reaction mass to a pH between 3.5 and 6, said resinous liquid mixture being diluted with an aliphatic alcohol selected from the group consisting of methyl alcohol, ethyl alcohol, and isopropyl alcohol in a proportion in parts by volume, D, per 100 parts of the diluted mixture according to the equation: $D=100R^{0.262}$ in which R is the ratio: P_1/P_m, the resulting diluted resin-forming liquid mixture having added to it an alkaline catalyst selected from the group consisting of the alkali metal hydroxides and carbonates in a proportion sufficient to produce deposition and hardening of solid resin in situ. Claims allowed, 3.

12695. Multiplex well logging system. Jacob Neufeld, Oak Ridge, Tenn., assignor to Well Surveys, Inc., a corporation of Delaware: U. S. patent 2,543,532, issued Feb. 27, 1951.

Apparatus useful in geophysical prospecting, comprising an exploring unit adapted to be lowered in a drill hole including a plurality of sensing instruments directly and individually responsive to different characteristics of geophysical formations adjoining said drill hole for individually producing electric currents representing said characteristics, an electrical cable for transmitting simultaneously all of said current to the surface of the earth, a plurality of switches interconnecting said cable with said sensing elements respectively, a controlling means for cyclically energizing said switches at mutually exclusive time intervals whereby each of said sensing elements transmits through said cable a train of elementary signals at mutually exclusive time intervals, means operated in a definite time relationship with said controlling means for producing synchronizing signals and for transmitting said synchronizing through said cable, means for producing signals representing depths to which the exploring unit is lowered, a recorder positioned at the surface of the earth and connected to said last means and to said cable for producing a phonographic record of said depth representing, elementary and synchronizing signals, a reproducer provided with three channels and adapted to be operated in conjunction with said record for reproducing said

elementary signals across the first of said channels, said synchronizing signals across the second channel, and said depths representing signals across the third channel, a plurality of switching elements and a plurality of indicators, said switching elements being individually adapted to connect said first channel to each of said indicators, means for deriving from said second channel said synchronizing signals and for utilizing said signals to cyclically energize said switching elements at mutually exclusive time intervals thereby individually transmitting said separate trains of signals to said indicators, and means connected to said third channel and responsive to said depth representing signals for controlling the operation of said indicators. Claims allowed, 2.

12696. Method and apparatus for adjusting spacing between neutron source and detector. Lawrence M. Swift, Tulsa, Okla., assignor to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. patent 2,543,675, issued Feb. 27, 1951.

A radioactivity well surveying apparatus adapted to traverse a well that comprises an elongated housing, a detector in said housing, means defining a cylindrical axial passageway in a portion of said housing that extends at one end to a point adjacent the detector, a source of primary radiation movably disposed in said passageway, a plurality of cylindrical slugs adapted to be inserted in said passageway above and below said source of radiation, whereby the space between the source and detector can be adjusted. Claims allowed, 5.

12697. Method and apparatus for neutron well logging. Jean M. Thayer and Robert E. Fearon, Tulsa, Okla., assignors to Well Surveys, Inc., Tulsa, Okla., a corporation of Delaware: U. S. Patent 2,543,676, issued Feb. 27, 1951.

A method of producing a well log that emphasizes a particular chemical element existing in certain of the formations penetrated by a well that comprises irradiating the formations adjacent to the well with fast neutrons, detecting neutrons which return to the well by producing proportionally related electrical signals, additionally selectively filtering neutrons returning to the well, said filtering action being characteristic of the chemical element that it is desired to emphasize, detecting said filtered neutrons by producing proportionally related electrical signals, subtracting the latter signals from the former signals, and recording the remainder versus the depth at which the detections occurred. Claims allowed, 6.

TECHNICAL AIDS

12698. Porosimeter and method of using same. Glen G. Hebard, Bartlesville, Okla., assignor to Phillips Petroleum Co., a corporation of Delaware: U. S. patent 2,537,668, issued Jan. 9, 1951.

An apparatus for testing porosity comprising in combination a first graduated chamber having a removable and replaceable wall portion for the insertion of a sample the porosity of which sample is to be tested, said first chamber having an orifice in its uppermost portion disposed and constructed so as to be visible from outside said apparatus whereby an operator can see when any liquid in said apparatus is brimming said orifice, a valve disposed to open and close said orifice without changing the total internal volume of said apparatus, fluid pressure responsive means indicating the gage pressure in said

first chamber, a second graduated chamber, a flexible conduit connected to said first and second chambers whereby an operator may quickly vary the relative elevations of said chambers and providing communication between said chambers, said second chamber having an air inlet and an air outlet, a valve disposed to open and close said air inlet, a valve disposed to open and close said air outlet, fluid pressure responsive means indicating the gage pressure in said second chamber and a liquid test medium in said chambers and said flexible conduit. Claims allowed, 10.

12699. Vibration translator. Austin N. Stanton, Garland, Tex.: U. S. patent 2,540,796, issued Feb. 6, 1951.

In a device for translating mechanical energy into electrical energy: a tubular magnet having a central axis, said magnet being magnetized parallel to said central axis; a first annular pole piece concentric with respect to said central axis extending inwardly from one end of said magnet; a second and a third annular pole pieces separated by an annular spacing block concentric with respect to said central axis extending inwardly from the other end of said magnet; and an armature resiliently mounted for movement along said central axis and having a central axis coincident with said central axis of said magnet, said armature comprising a central field piece having a central core provided at each end with a disk, a tubular field piece concentric with respect to said central axis mounted on said central field piece between said disk and separated from said disks by nonmagnetic annular washers, said tubular field piece having at its ends outwardly extending annular flanges abutting said washers, the peripheral edges of said disks, washers and flanges lying in the same cylindrical plane, one of said washers lying in the same plane normal to said central axis as said first annular pole piece when said armature is in its normal position, the other of said washers and its abutting flange and disk lying in planes parallel to and between the planes of said second and third annular pole pieces when said armature is in its normal position, and a tubular coil between said core and said tubular field piece having a central axis coincident with said central axis of said tubular magnet. Claims allowed, 10.

12700. Blasting device. Ferdinand De Witt Bickel, Wilmington, Del., Robert Allen, George Earich, Pittsburgh, Pa., and Harold Arthur Lewis, Wilmington, Del., assignors to E. I. du Pont de Nemours and Co., Wilmington, Del., a corporation of Delaware: U. S. patent 2,546,686, issued March 27, 1951.

A mechanically operated timing device for firing charges of explosives by power circuits in predetermined order and at precise time intervals, said device comprising a plurality of firing circuits, said circuits being initially and normally in short-circuited status; a shaft adapted to revolve and carrying a plurality of attachments adapted to cause successive closing of all of said circuits in predetermined order; an electric motor for driving said shaft; means for engaging said motor on application of the electric current; means for effecting automatic removal of short circuits from all circuits prior to the application of firing current; means whereby, after actuation and firing, a return is made in the assembly to a position in which all firing circuits are again short-circuited; and means for disengaging the motor after firing of the last explosive charge, while the electric current is still being applied, all of said operations taking place during less than the course of one complete revolution of the revolving shaft. Claims allowed, 6.

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