Geophysical Abstracts 163 October-December 1955

GEOLOGICAL SURVEY BULLETIN 1033-D

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By MARY C. RABBITT, DOROTHY B. VITALIANO, S. T. VESSELOWSKY, *and others*

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Abstracts of current literature pertaining to the physics of the solid earth and to geophysical exploration

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GEOPHYSICAL ABSTRACTS 163, OCTOBER-DECEMBER 1955

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GENERAL INFORMATION

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

The form of the bibliographic reference is believed to be self-explanatory. List of abbreviations of journal titles were given in Geophysical Abstracts 160, 161, and 162. Additions to that list are given below. Unless specifically indicated otherwise, the language in which the article is written is the same as that given in the title. The system of transliteration used by the United States Board on Geographic Names is employed for transliteration of Slavic names and titles. Translations of author's abstracts are indicated as "Author's abstract" followed by the initials of the translator.

ABSTRACTORS

Abstracts have been prepared by J. R. Balsley, P. E. Byerly, G. V. Keller, V. S. Neuschel, and L. C. Pakiser as well as by the principal authors.

LIST OF JOURNALS

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

Abbreviation	*Publication*
Accad. Gioenia Boll	Bolletino delle Sedute della Accademia Gioenia di Scienze naturale in Catania. Sicily.
Advances in Physics	Advances in Physics. Quarterly supplement to the Philosophical Magazine. Taylor and Francis, Ltd. London.

Abbreviation	*Publication*
Akad. Nauk Armyanskoy SSR Doklady	Doklady Akademii Nauk Armyanskoy SSR. Erivan, Armenia.
Canadian Jour. Chemistry	Canadian Journal of Chemistry. National Research Council of Canada. Ottawa.
Endeavour	Endeavour. Imperial Chemical Industries, Ltd. London.
Inst. Civil Engineers [London] Proc	Proceedings of the Institution of Civil Engineers. London.
Inst. Égypte Bull	Bulletin de l'Institut d'Égypte. Institut Français d'Archéologie Orientale. Cairo.
Jour. Chem. Education	Journal of Chemical Education. Division of Chemical Education, American Chemical Society. La Jolla, Calif.
Naturw	Die Naturwissenschaften. Organ der Max-Planck-Gesellschaft zur Forderung der Wissenschaften. Berlin.
Pacific Science	Pacific Science. University of Hawaii Press. Honolulu, T. H.
Rev. Étude Calamités	Revue pour l'Étude des Calamités. Union Internationale de Secours. Genève, Switzerland.
Rev. Modern Physics	Reviews of Modern Physics. American Institute of Physics. New York.
Tokyo Univ. Education, Geol., and Mineralog. Inst. Studies.	Studies of the Education, Geological, and Mineralogical Institute, Tokyo University. Tokyo.
Wisconsin Geol. Survey Bull	Bulletin of the Wisconsin Geological Survey. Madison, Wis.

GRAVITY

GENERAL AND THEORETICAL PAPERS

163–1. Subbotin, S. I. O svyazi anomaliy sily tyazhesti s vertical'nymi dvizheniyami zemnoy kory [On the correlation between gravitational anomalies and the vertical movements of the earth's crust]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 332–338, 1955.

Undulatory deformations of the crust are usually attributed to vertical movements of subcrustal material. As a result of withdrawal of peridotite from beneath the crust, the surface of the earth is lowered, and there is a change in the gravitational intensity at the surface resulting in negative anomalies. When there is an influx of subcrustal material under a certain region, there must be a positive gravitational anomaly at the surface simultaneously with the rise of level. In reality there is an inverse relationship between changes in level and the sign of gravity anomalies is a region. The lowering of the surface of the earth is caused by changes in the physicochemical composition of subcrustal material such as an increase of density and decrease of volume, which would produce simultaneously positive anomalies and a lowering of the surface. Such a correlation is observed over the southern plain of the U. S. S. R. from the Carpathian Mountains in the west to the Donetz River in the east. Horizontal movements of crustal masses are, in Subbotin's opinion, of only secondary importance.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

163–2. Brown, William Fuller, Jr. Minimum variance in gravity analysis, Part I: One-dimensional: Geophysics, v. 20, no. 4, p. 807–828, 1955.

In calculation of second vertical derivatives or other quantities from measured field intensities, experimental errors in the data may produce large errors. Least-squares adjustments and smoothing formulas have been used to improve precision. The minimum-variance principle may also be used, according to which the $n-k$ arbitrary constants of a polynomial formula are adjusted to minimize the mean square error of the estimated quantity. Direct application of this principle leads to "best" estimation formulas of specified degree k. "Best" formulas are also obtained by a least-squares method that gives the same results as the minimum-variance method. Examples of the use of the method are given.—*M. C. R.*

163–3. Balavadze, B. K. K voprosu o vychislenii vertikal'nogo gradienta sily tyazhesti [On the problem of the numerical evaluation of the vertical gradient of gravity]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 425–434, 1955.

Formulas derived by A. K. Maloviczko and N. Hoffmann for the evaluation of the vertical gradient of the gravity force do not take into account the effect of the central zone, and precise results can be obtained only if the disturbing masses are buried deeply enough. The errors in the enumeration grow rapidly when the depth of these masses decrease.—*S. T. V.*

163–4. Bollo, R[obert], and Goguel, J[ean]. Un integrateur pour le calcul des corrections topographiques [An integrator for the calculation of topographic corrections]: Geophys. Prosp., v. 3, no. 3, p. 228–233, 1955.

To speed up calculation of topographic corrections, a polar integrator may be used. Contour lines of a map can be followed between two fixed radii, with the pole at the position of the station. Two integrator roulettes give the values of the first two terms of the expansion in terms of the quotient of the height divided by distance, the second of the terms resulting from the curvature of the earth; these two terms are sufficient unless there are escarpments near the station. The integration is carried out successively for different contours, and a subsidiary graph is plotted giving the value of each of the integrals in terms of height. The corrections are obtained from this graph by use of a planimeter and a moment integrator.—*M. C. R.*

163–5. Kapitsa, S. P. Pribor dlya vychisleniya integrala Poissona i nekotoryye yego primeneniya [Instrument for computing Poisson's integral and some of its applications]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 369–376, 1955.

In both magnetic and gravimetric surveying it is often necessary to recalculate the observed data from one level to another, which involves computation of Poisson's integral, satisfying the Laplace equation controlling the related field pattern. To reduce the numerical work required an instrument was designed and built in the Geophysical Institute of the Academy of Sciences of the U. S. S. R. The instrument is similar in appearance and handling to Amsler's planimeter, and it determines the numerical value of the integral with an error smaller than that admitted in the initial measurements. The theory of the operation of the instrument is discussed and its use illustrated on several examples.—*S. T. V.*

163–6. Miller, A. H., and Innes, M. J. S. Application of gravimeter observations to the determination of the mean density of the earth and of rock densities in mines: Dominion Observatory Ottawa Pubs., v. 16, no. 4, p. 3–17, 1953.

Accuracy of Airy's method to determine the mean density of the earth depends primarily on the accuracy of the gravity measurements and of the value used for the mean density of rocks lying between the upper and lower gravity stations. If the mean density is to be determined with an error not greater than 1/500 part, the gravity measurements must be correct to 1 milligal and the density within 0.005 grams per cm^3. Observations at Lake Shore and Noranda mines in Ontario yield values of the mean density reasonably close to the accepted value of 5.52. In addition, a density profile deduced from gravimeter observations at Noranda shows a direct relation between the density and occurrence of ore, and suggests that, in a mine not fully explored, gravimeter observations may be used to indicate levels at which ore is most likely to be found.—*M. C. R.*

163–7. Domzalski, W. Relative determination of the density of surface rocks and the mean density of the earth from vertical gravity measurements: Geophys. Prosp., v. 3, no. 3, p. 212–227, 1955.

The gravity difference between two stations, one at the surface and the other underground vertically below the surface station, depends on the mean density of the earth and the density of the rock between the two stations. When one density is known, the other can be computed from the difference with a reliability that depends on the relative accuracy of the determinations. The mean density

of the earth has been determined with an accuracy of about 0.01 grams per cm^3, but the accuracy of the determination of the density of a layer of rock depends on the method of averaging densities of samples and the uniformity of the geology.

From observations in the Godstone Quarries where the rocks dip gently and are fairly uniform and structurally undisturbed, the mean density of the earth was computed from observations at stations 100 feet apart as 5.52 grams per cm^3, but a different density could have been obtained if different or fewer samples had been chosen. Observations were made in the Florence mines in Cumberland both parallel to and across a fault. The rock layer between the surface and underground stations was approximately 1,000 feet thick. Calculated mean densities were 5.58 and 5.69 grams per cm^3.

The gravity difference may also be used to determine the average density of a layer of rock in place by using the standard value for the mean density of the earth.—*M. C. R.*

OBSERVATIONS OF GRAVITY AND GRAVITY SURVEYS

163–8. Cook, Alan Hugh, and Thirlaway, Henry Ivison Shipley. The geological results of measurements of gravity in the Welsh Borders: Geol. Soc. London Quart. Jour., v. 111, pt. 1, p. 47–70, 1955.

Gravity measurements in the Welsh Borders are presented as a Bouguer anomaly map. A rapid change at the Malvern Hills from about −25 milligals on the east to about +5 milligals on the west is interpreted as a deep fault basin east of the Malverns, filled with Triassic rock, to a depth of nearly 10,000 feet near Worcester. Large variations of anomaly which seem to have no relation to the known geology are probably due to heavy Precambrian masses, particularly in the Black Mountains and near Leominster. The Church Stretton disturbance is marked only by a slight maximum anomaly.—*D. B. V.*

163–9. Bemmelen, R. W. van. Gravity field and orogenesis in the west-Mediterranean region: Geologie en Mijnbouw, jaarg. 14, no. 8, p. 306–315, 1952.

The inductive approach from gravimetry to geology, such as that used by Harrison, Cooper, and Hey in Cyprus [see Geophys. Abs. 162–25], starts with an infinite number of mass distributions and selects the one which best fits the observed geology; it provides no proof for the correctness of that particular geological interpretation. On the other hand, if the geological data are taken as the point of departure, the gravity values calculated for a possible mass distribution can be checked against observed gravity data and thus verified.

Van Bemmelen has constructed a series of genetic cross sections, based on his undation theory, through the Tello-Betic mountain system of North Africa. The gravity field for his interpretation of present structure has been computed by Hofman in a companion paper [see Geophys. Abs. 152–14209] and compared with the gravity map of the west Mediterranean region. The prognosis based on the undation theory has been found to agree perfectly with the observed values, whereas Kraus's undercurrent theory [see Geophys. Abs. 155–15004] led to misfits of several hundred milligals.—*D. B. V.*

163–10. Allen, W. E., Caillouet, H. J., and Stanley, L. Gravity investigations in the Hockley salt dome, Harris County, Texas: Geophysics, v. 20, no. 4, p. 829–840, 1955.

Gravity measurements at the surface, in the shaft, and in the drifts of the United Salt Co. mine at the Hockley salt dome have been analyzed to determine densities of sediments, cap rock, and salt rock. The curve derived from the

gravity changes indicates the presence of lithologic breaks that correspond with the known geology of the shaft. The density values computed from this curve correspond closely with accepted values for near-surface clastic sediments, limestone, gypsum rock, anhydrite rocks, and salt rock.—*M. C. R.*

163–11. Stackler, W. F. Structural prospecting with the gravity meter: Oil in Canada, v. 7, no. 39, p. 52–62, 1955.

A demonstration of progress that has been made in structural prospecting with a gravity meter, illustrated by theoretical experiment and actual field results over the Erskine and Turner Valley oilfields in Alberta, Canada.—*V. S. N.*

163–12. Cantos Figuerola, José. Investigación gravimétrica en Carmona (Sevilla) [Gravimetric investigation in Carmona (Seville)]: Inst. geol. min. España notas y comunicaciones, no. 38, p. 97–120, 1955.

Gravity investigations were begun in Carmona in the search for coal-bearing synclines in the Paleozoic but have also been directed toward the petroleum possibilities of the region. As a strong regional gradient masked local anomalies on the Bouguer map, residual anomalies and second derivatives were calculated according to the Griffin and Saxov methods, respectively. These reveal that the basement forms a great structural trough whose unequally downthrown component blocks have been affected first by Hercynian movements transverse to the Guadalquivir, then by Alpine movements which produced the great Guadalquivir fault. This structure could have oil possibilities but should be further investigated by seismic reflection before exploratory drilling is attempted.—*D. B. V.*

163–13. Morelli, Carlo. Rilievo gravimetrico nel mare Adriatico 1954 [Gravimetric survey in the Adriatic Sea, 1954]: La Ricerca Sci., anno 25, no. 10, p. 2845–2872, 1955.

The gravity survey of the Adriatic begun in 1953 was continued in 1954; 23 check stations in two areas north of the mouths of the Po fully confirmed the anomalies mapped the previous year, and 223 new stations comprised the first-order network between the latitudes of the Po and Ancona. Stations at sea were located by means of an improved radar network whose "chainwise" distribution from the Yugoslavian to the Italian coast permitted compensation of errors. The results are presented in detailed tables and as a Bouguer map. The anomalies indicate details of the Istrian basement and the axis of the Po syncline, and also the presence of possible petroleum structures in the coastal region of the Marche.—*D. B. V.*

163–14. Castet, Jean, and Lagrula, Jean. Sur la comparaison d'anomalies gravimétriques et magnétiques an Sahara [On the comparison of gravimetric and magnetic anomalies in the Sahara]: Acad. Sci. Paris Comptes Rendus, tome 241, no. 1, p. 84–86, 1955.

Comparison between isostatic anomalies for depth of compensation of 20 km and vertical magnetic anomalies shows the agreement is marked in some places, but of opposite sign with the positive gravity anomaly corresponding to a negative magnetic anomaly.—*M. C. R.*

163–15. Tsuboi, Chuji. Gravity survey along the lines of precise levels throughout Japan by means of Worden gravimeter. Part 4. Map of Bouguer anomaly distribution in Japan based on approximately 4,500 measurements: Tokyo Univ. Earthquake Research Inst. Bull., supp. v. 4, pt. 3, 1954.

A map, scale 1:2,000,000, based on 3,500 measurements in Honshu, Kyūshū, and Shikoku by the Earthquake Research Institute and 1,000 measurements in Hokkaido by the Geographical Survey Institute. Bouguer anomalies have been computed on the basis of the International formula.—*M. C. R.*

163–16. Tsuboi, Chuji; Jitsukawa, Akira; Tajima, Hirokazu; and Okada, Atsushi. Gravity survey along the lines of precise levels throughout Japan by means of a Worden gravimeter. Part 1. Shikoku district: Tokyo Univ. Earthquake Research Inst. Bull., supp. v. 4, pt. 1, p. 1–45, 1953: Tsuboi, Chuji. Part 3. Supplement to the previous report of the gravity survey in Shikoku: ibid., pt. 2, p. 117–123, 1954.

A preliminary report on this survey has been published in the Proceedings of the Japan Academy [see Geophys. Abs. 158–26]. The complete report contains detailed station data, observations, and calculations. Bouguer anomalies calculated on the basis of the Helmert formula of 1901 are given in part 1, those on the basis of the International formula in the supplement. Maps on the scale of 1:500,000 are included.—*M. C. R.*

163–17. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity survey along the lines of precise levels throughout Japan by means of a Worden gravimeter. Part 2. Chugoku district: Tokyo Univ. Earthquake Research Inst. Bull., supp. v. 4, pt. 2, p. 47–116, 1954.

This is the complete report, the preliminary version of which was published in the Proceedings of the Japan Academy [see Geophys. Abs. 158–27]. A map on the scale of 1:500,000 showing Bouguer anomalies based on the International formula, as well as station data and observations, are included.—*M. C. R.*

163–18. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity survey along the lines of precise levels throughout Japan by means of a Worden gravimeter. Part 5. Kinki district: Tokyo Univ. Earthquake Research Inst. Bull., supp. v. 4, pt. 2, p. 47–116, 1954.

This is the complete report, the preliminary version of which was published in the Proceedings of the Japan Academy [see Geophys. Abs. 158–28]. A map on the scale of 1:500,000, showing Bouguer anomalies based on the International formula, and station data and observations are included.—*M. C. R.*

163–19. Matsuda, Takeo. Gravity survey at "Hichiku-Plain", northern Kyūshū [In Japanese with English summary]: Geol. Survey Japan Bull., v. 6, no. 1, p. 45–50, 1955.

A gravity survey of the Hichiku Plain, northern Kyushu, indicated the presence of three sedimentary basins: the western area from Saga-Line; the area between Saga-Line and Kagoshima-Line; and the eastern area of Kurume City. Remarkable gravity lows were found along the Chikugo River.—*V. S. N.*

163–20. Sawata, Hideho. Notes on the results of gravimetric survey in Hichiku Plain, northern Kyūshū [In Japanese with English summary]: Geol. Survey Japan Bull., v. 6, no. 1, p. 51–56, 1955.

A gravimetric survey of the Hichiku Plain was conducted by the Geological Survey of Japan in the spring of 1954. The isogal map confirmed the presence of three basins and two saddles, trending ENE.–WSW., indicated by earlier seismic surveys, borings, and surface geology studies. The north and south sides of the depressed zones are characterized by a zone of high gravity. These zones seem to represent structural units common to northern Kyūshū.—*V. S. N.*

163–21. Grant, C. Kerr. Gravity survey—Cape Jaffa area: South Australia Dept. Mines Min. Rev., no. 96, p. 72–74, 1954.

A detailed gravity survey in the Cape Jaffa area has been used to delineate the pattern of faulting.—*M. C. R.*

MAGNETISM

MAGNETIC FIELD OF THE EARTH

163–22. Inglis, D. R. Theories of the earth's magnetism: Rev. Modern Physics, v. 27, no. 2, p. 212–247, 1955.

The earth's core may be assumed to consist of fluid metal surrounding a solid inner core containing a source of heat to drive convection currents. Convective motions in the fluid core are characterized by radial flow streams and a tendency for the fluid to rotate, on the average, more rapidly near the axis to conserve angular momentum. Proposed mechanisms for generating a terrestrial magnetic field are considered as simplified flow patterns in an attempt to indicate what features of the flow may provide the most important possibilities for generation. These suggest that without a field to absorb the energy, the flow would be accelerated indefinitely and would evolve through a succession of flow patterns, some of which would have the properties of generating a field capable of preventing further acceleration and prolonging the status quo.

The induction theories of the generating mechanisms considered are the dynamo theory of Elsasser and Bullard and the "twisted-kink" theory of Alfvén, each of which depends on amplifying an initial stray magnetic field until it dissipates all of the available energy; and mechanisms depending on the thermoelectric effect with junctions at the core-mantle interface, or on a combination of thermoelectric and Hall effects in the core and mantle.

Two explanations of the observed slow westward drift of the field are given. If the convective flow is rather irregular, it may be attributed to the vanishing of the total torque on the core by the magnetic field threading through the core and mantle, as a result of an eastward drag on the outer part of the core rotating more slowly in space and a westward drag on the more rapidly rotating part of the core near the axis. The observed magnetic pattern is presumed to be characteristic of the westward-drifting outer part. If the flow involves a jet stream, the flow in the jet may be eastward for reasons comparable to temperate-zone meteorology, so the magnetic field should exert a westward drag on it, then leading to the westward drift of the flow pattern.—*M. C. R.*

163–23. Madwar, M. R. Magnetic observations in the Soudan January to February 1952: Inst. Égypte Bull., tome 36, fasc. 1, p. 5–16, 1955.

Magnetic observations were made nearly along the 30th meridian from Juba to Khartoum, and in Waw and at a point where the magnetic equator passed the

path of totality of the eclipse of Feb. 25, 1952. A La Cour quartz horizontal magnetometer was used with a theodolite in the base so declination could also be determined. There is apparently a slight displacement of the maximum of the daily variation toward the geographic equator; the maximum range occurs at the magnetic equator along the 30th meridian.—*M. C. R.*

163–24. Ferraro, Vincent C. A. Théories des orages magnétiques et des aurores [Theories of magnetic storms and aurorae]: Ciel et Terre, 70e année, fasc. 9–10, 1954.

This is a review of theories concerning the origin of magnetic storms and aurorae, with particular emphasis on the corpuscular concept of Chapman and Ferraro.—*D. B. V.*

163–25. Miguel y Gonzales Miranda, Luis de. Saltos bruscos en corrientes telúricas y su relación con los impulsos bruscos del campo magnético terrestre [Abrupt changes in the intensity of telluric currents and their relation to sudden impulses of geomagnetic field]: Rev. Geofísica, año 13, no. 50, p. 155–167, 1954.

Comparative analysis of magnetograms and records of telluric currents at the Toledo observatory indicates that many sudden changes in the intensity of the geomagnetic field are more clearly shown and can be better studied on the graphs of telluric currents than on the magnetograms. Telluric current installations are especially useful in detecting magnetic micropulsations and chromospheric disturbances. Several magnetic and telluric current records are included as illustrations.—*S. T. V.*

163–26. Fleischer, Ulrich. Ein Erdstrom im tieferen Untergrund Norddeutschlands während erdmagnetischer Baystörungen [An earth current deep in the crust in North Germany during geomagnetic bay disturbances]: Naturw., Jahrg. 41, Heft 5, p. 114–115, 1954.

Records of the magnetic bay disturbance of Dec. 5, 1952 from 6 observatories in north Germany, Holland, and Denmark show an anomaly in the vertical component, which changes from positive to negative from north to south. The reversal occurs between Witteveen and Scheessel, and coincides with the maximum H variation. The origin is ascribed to a local anomaly in conductivity deep underground, which influenced the earth current induced by the magnetic disturbance.—*D. B. V.*

163–27. Rikitake, T[suneji], and Yokoyama, I[zumi]. Anomale erdmagnetischen Variationen von kurzer Periods in Japan [Anomalous short-period geomagnetic variations in Japan]: Naturw., Jahrg. 41, Heft 18, p. 420–421, 1954.

This describes a phenomenon in Japan similar to that noted by Fleischer [see preceding abstract] in northern Germany, and likewise attributes it to the deep crystal structure. In Japan, it is probably temperature differences in seismic or volcanic zones which cause the anomalous distribution of conductivity in the crust.—*D. B. V.*

163–28. Egedal, J., and Ambolt, N. The effect on geomagnetism of the solar eclipse of 30 June 1954: Jour. Atmos. Terrest. Physics, v. 7, nn. 1/2, p. 40–48, 1955.

Observations of magnetic declination at 11 observatories during the solar eclipse indicate that the maximum effect is closely related to the passage of the eclipse.

On the assumption that the effect is a diminution of the departure of the daily variation, the diminution is of the order of that calculated by Chapman from theoretical considerations.—*M. C. R.*

MAGNETIC PROPERTIES OF ROCKS AND MINERALS

163–29. Nicholls, G. D. The mineralogy of rock magnetism: Advances in Physics, v. 4, no. 14, p. 113–190, 1955.

A comprehensive review. Bibliography of more than a hundred papers.—*M. C. R.*

163–30. Néel, Louis. Some theoretical aspects of rock magnetism: Advances in Physics, v. 4, no. 14, p. 191–243, 1955.

Brief theoretical studies of most typical magnetic properties of rocks, in particular on ferrimagnetism, single domain particles, and large multidomain particles. Bibliography of 54 papers.—*M. C. R.*

163–31. Runcorn, S. K. Rock magnetism—geophysical aspects: Advances in Physics, v. 4, no. 14, p. 244–291, 1955.

A review of "the application of rock magnetism to the extension of our knowledge of the physical properties of the earth throughout geological time."—*M. C. R.*

163–32. Creer, K. M., Irving, E., and Runcorn, S. K. The direction of the geomagnetic field in remote epochs in Great Britain: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 163–168, 1954.

The remanent magnetizations of samples of sediments and lava from Great Britain, representative of widely different geological epochs, have been studied. Evidence for the stability of these magnetizations from times soon after the formation of the rocks has beer found. These results seem most easily interpreted in terms of a dipole field, the polarity of which frequently reverses. In Pre-Tertiary times the axis of this dipole field diverges considerably from the present geographical axis and this is tentatively interpreted as a slow change in the axis of rotation of the earth with respect to its surface.—*Authors' abstract*

163–33. Roche, A[lexandre]. Exposé sommaire des etudes relatives à l'aimantation de matériaux volcaniques [Summary of studies on the magnetization of volcanic materials]: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 169–171, 1954.

Studies of the volcanic rocks of Auvergne in Velay, France have shown that the direction of magnetization is characteristic for a particular volcanic unit and that the direction is related to the age of the material and not to its petrography. These observations tend to support the hypothesis that the magnetic field of the earth has reversed several times during the Tertiary period.—*J. R. B.*

163–34. Hospers, J. Summary of studies on rock magnetism: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 172–175, 1954.

A series of abstracts is given of recent papers by Hospers on the magnetization of Miocene and younger lavas and sediments in Iceland, and a paper on the summarizing of rock magnetism data as far back as the Eocene. The main conclusions reached are that the earth's magnetic pole has been within 5° to 10° of its present position since Eocene time, but that it has reversed 180° at least four times since Miocene.—*J. R. B.*

163–35. Balsley, J. R., and Buddington, A. F. Correlation of reverse remanent magnetism and negative anomalies with certain minerals: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 176–181, 1954.

Chemical and magnetic analysis of 200 specimens of igneous and metamorphic rocks from the Adirondack Mountains, New York has shown that the direction of magnetization is related to the composition of the iron-titanium oxide minerals they contain. Rocks containing "magnetic" minerals of the magnetite-ilmenite-ulvöspinel series have directions of magnetization the same as that of the present earth's field, whereas rocks containing only minerals of the hematite-ilmenite-rutile series show magnetization opposite to that of the earth's field. Rocks containing mixtures of minerals of these two series show intermediate directions of magnetization. It is concluded that the reverse magnetization in these rocks is the result of the action of the normal earth's field on the inherent properties of the grains of intimately mixed hematite and ilmenite which they contain. The mechanism by which the mineral grains become magnetized has not yet been demonstrated, but it is suggested that it is similar to one of the methods proposed by Néel that involves a compact mixture of two materials with different Curie points.—*J. R. B.*

163–36. Nagata, T[akesi], Akimoto, [Syun-iti], Uyeda, S[eiya], Momose, K., and Asami, E[izo]. Reverse magnetization of rocks and its connection with the geomagnetic field: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 182–190, 1954.

From the present knowledge on the magnetism of rocks, palaeomagnetic study by means of the natural remanent magnetization of igneous rocks is reliable when and only when the natural remanent magnetization is ascertained to be the thermoremanent magnetization acquired at the time of the rocks' formation. The authors propose, in this paper, several experimental methods for examining whether a given natural remanent magnetization can have difinite palaeomagnetic significance or not, under the above mentioned criterion.

In short, the proposed set of testing methods comprises: thermomagnetic, crystallographic and chemical analyses of the ferromagnetic minerals contained in the rock, and the comparison of the stabilities of the natural remanent magnetization and of the thermoremanent magnetization, produced in laboratory, against the demagnetizing processes by heating in non-magnetic space and by applying an alternating magnetic field.

These proposed tests were actually carried out on several naturally adversely magnetized rocks found mainly in Japan. For three of them, including Dr. Hospers' Icelandic rock, it was concluded that their reverse natural remanence must have been brought about by the reversed earth's magnetic field at the times of their formation.

As to the Haruna type of the self-reversal of the thermoremanent magnetization, the two-constituent mechanism was investigated in detail with the aid of electron-microscopic observation on the intergrowth of the two constituents.—*Authors' abstract*

163–37. Clegg, J. A., Almond, Mary, and Stubbs, P. H. S. Some recent studies of the pre-history of the earth's magnetic field: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 194–199, 1954.

Magnetic measurements on fine red sandstones in the Triassic Keuper Marl series and Carboniferous Pennant Sandstone and Old Red Sandstone show that the magnetic material in these rocks contains a "hard" component with high

magnetic stability and a "soft" component with very low stability. The Triassic rocks show a direction of magnetization about 34° east of the present magnetic direction and it is assumed "the most likely possibility appears to be that the whole land mass of Britain has rotated through 34° relative to the earth's geographical axis." Approximately half the sites examined showed a direction of magnetization essentially opposite to the earth's field; this may be produced by a reversal of the earth's field or may be related to the composition and properties of the magnetic constituents present in the rocks.—*J. R. B.*

163–38. Roquet, Juliette. Sur les aimantations thermoremanente et remanente isotherme du sesquioxyde de fer et de la magnetite [On the thermoremanent and isothermal remanent magnetization of the sesquioxide of iron and of magnetite]: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 200–205, 1954.

Measurements have shown that artificial magnetite and Fe_2O_3 have thermoremanent (A. T. R.) and isothermal remanent magnetiztion (A. R. I.) of very similar properties, but that although the A. T. R. and A. R. I. are similar in high magnetic fields, they are considerably different in weak magnetizing fields. The thermoremanent magnetization acquired by these minerals in magnetic fields approximately that of the earth is quite stable and to reduce it to zero requires a field of 905 oersteds for the sesquioxide of iron and 66 oersteds for magnetite. This thermoremanent magnetization is reduced only a little by heating the specimen to the temperature slightly less than the Curie point, but the isothermal remanent magnetization is reduced rapidly as temperature is raised. Experiments on clay rich in magnetite and on basalt have shown that the change in isothermal remanent magnetization is proportional to the logarithm of the time since the magnetizing field was applied. The magnetic properties of the two oxides depend on the size of the grains, and experiments show that the fine-grained materials possess stronger, more stable thermal remanent magnetization, and are less likely to acquire isothermal remanent magnetization from the earth's field.—*J. R. B.*

163–39. Kato, Y[oshio], and Takagi, A[kio]. Reverse remanent magnetism of dyke of basaltic andesite: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 206–207, 1954.

Measurements on a series of roughly parallel andesite dikes of late Miocene or Upper Pliocene age that cut Miocene green tuff show that the direction of magnetization of all dikes of basaltic andesite is nearly opposite to that of the present magnetic field. The direction of magnetization of the green tuff in contact with the dike is the same as that of the dike and opposite to the present magnetic field, and that of green tuff far from the contact coincides with the present field. The direction of the magnetization of the quartz-bearing andesite dikes is markedly different from that of both the basaltic andesite and the unaltered green tuff.—*J. R. B.*

163–40. Kawai, N[aoto]. Instability of natural remanent magnetism of rocks: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 208–209, 1954.

Studies of the stability of the natural remanent magnetization of Japanese rocks has shown that most of the Tertiary sedimentary rocks are unstable with the exception of a few volcanic sediments. The eruptive rocks on the other hand are stable or metastable, that is, intermediate between stable and unstable.—*J. R. B.*

163–41. Parry, J. H. The interpretation of reversed magnetization in igneous rocks: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 210–214, 1954.

Parry discusses the various hypotheses presented to explain the internal self-reversal of permanent magnetization and the laboratory experiments that have been conducted to investigate them. Whether the reversed magnetization is produced by a reversal of the geomagnetic field or by a internal effect among the magnetic constituents for rocks cannot be resolved until the properties of remanent magnetization are better known and better explained.—*J. R. B.*

163–42. Graham, J[ohn] W. Tracing the earth's magnetic field in geologic time: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 215, 1954.

Magnetizations observed in selected flat-lying sedimentary rocks in the eastern United States suggest that during Paleozoic time the earth's magnetic field retained approximately its present day orientation. In contrast, the magnetizations of sediments in the folded Appalachian belt present a pattern of great complexity that in part, at least, can be explained on the basis of deformation. Pebbles embedded in conglomerates that field evidence indicates were once deeply buried and hence presumably raised in temperature, show uniformly the same direction of magnetization, one that departs significantly, though slightly, from the direction of the earth's field today. Conglomerates that were never deeply buried have polarizations that, though more scattered, are not completely at random. Precambrian acid and basic rocks—presumably akin to the source material of these sediments—show complex patterns of polarizations that are difficult to relate to uniform magnetizing field. A conservative appraisal of these observations is that the stability in time of magnetizations varied from sample to sample within unknown limits according to environment and constitution. The need still exists for developing combined laboratory and field procedures for identifying in rocks the magnetization which can be relied upon as valid indicators of past directions of the earth's magnetic field.—*Author's abstract*

163–43. Thellier, É[mile], and Thellier, Odette. Nouveaux résultats sur la direction et l'intensité du champ magnétique terrestre dans le passé historique [New data on the direction and intensity of the geomagnetic field in the historic past]: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 217, 1954.

Although research on the paleomagnetic field on the basis of remanent magnetization of sedimentary and volcanic rocks continues to meet with considerable difficulties in principle, the research on thermoremanent magnetization of terra cotta is remarkably sure and precise; its limitation is only in the precision of the date and origin of the archeological material used. Since the Brussels assembly, we have been able to add to our previous results new data on the direction of the field in the Carolingian and Roman periods in Germany, England, and Belgium, and on the intensity in the Punic period in Carthage and the Roman period in Switzerland.—*Authors' résumé, M. C. R.*

163–44. Griffiths, D. H. The remanent magnetism of varved clays from Sweden: Jour. Geomagnetism and Geoelectricity, v. 6, no. 4, p. 217–220, 1954.

The direction of remanent magnetization has been measured on a series of Swedish varved clays covering approximately the periods A. D. 1000–"A. D. 0" and A. D. 500–500 B. C. There is a close agreement between measurements at

two places after they have been corrected for dip. The results from another series of samples covering a period of A. D. 1300 to A. D. 1900 agree reasonably well with the declination determined from observatory measurements. Both field and laboratory results indicate that if a varved clay is deposited under quiet conditions the horizontal polarization will be close to the direction of the geomagnetic field, but the inclination is less likely to be reliable; owing to compaction the inclination is always less than that of the geomagnetic field.—*J. R. B.*

163–45. Jaeger, J. C., and Joplin, Germaine. Rock magnetism and the differentiation of dolerite sill: Geol. Soc. Australia Jour., v. 2, p. 1–19, 1954.

Measurements of intensity of magnetization and susceptibility have been made at intervals of 5 ft on some bore cores from Tasmanian tholeiites of Jurassic age. In all cases the direction of magnetization was nearly vertical. One sill appears to have its upper 700 ft magnetized normally and its lower part reversed.

The magnetic properties vary very rapidly and show a structure in which narrow regions with high values are superposed on a general increase to a maximum at about 300 ft from the top of the sill. This coincides with a minimum of the density and a maximum of normative magnetite and total iron and also in the size of the areas of mesostasis.

It is suggested that this behaviour is due to differentiation and that magnetic measurements form an extremely sensitive tool for the study of this process. An attempt is made to show that differentiation by the settling of individual crystals through the sill is impossible in thick sills in which convection does not occur, and that the mechanism must be one of roof stoping in which large blocks of mixed crystals and residual magma fall from the roof to the floor of the sill. The regions with exceptionally high magnetic values which have been observed are regarded as composed of magma trapped between these blocks.—*Authors' abstract*

163–46. Runcorn, S. K. Palaeomagnetism of sediments from the Colorado Plateau: Nature, v. 176, no. 4480, p. 505–506, 1955.

Measurement of the direction of remanent magnetization of fine-grained red sandstones in the Precambrian Hakatai shale, the Carboniferous Naco sandstone, Permian Supai shales, Triassic Springdale sandstone, and Cretaceous Dakota sandstone in the western United States have verified a slow wandering of the magnetic pole deduced from similar measurements on British strata of similar age. These data indicate that the position of the magnetic pole moved in a regular path, but at a random rate from a position near Hawaii in the late Precambrian time toward the Pacific coast of Asia in Paleozoic times, reaching a high latitude in Triassic times and substantially the present pole position in Cretaceous times. The agreement between the results from Great Britain and from the Colorado Plateau seem to dispose of the possibility that since Precambrian times the continent of America has drifted any appreciable distance from the continents of Europe and Africa.—*J. R. B.*

163–47. DuBois, P. M. Palaeomagnetic measurements of the Keweenawan: Nature, v. 176, no. 4480, p. 506–507, 1955.

Measurements of the remanent magnetization in the Keweenawa Peninsula, Michigan were made of the late Precambrian Portage Lake lava series and, the overlying Copper Harbor formation of conglomerate and interbedded lava flows, the overlying Nonesuch shale, and the uppermost Freda sandstone. The direction

of magnetization of the Nonesuch and Freda formations is similar to that measured in the lower Cambrian in Wales. The direction of magnetization in the Copper Harbor sandstones is approximately 10° less than that in the lavas above and below them, but in the overlying Nonesuch and Freda formations the mean inclination is almost zero. "Thus it seems that the Copper Harbor sandstones have an inclination smaller than the lava because sedimentary rocks are unable to reproduce moderate inclinations, but that the mean inclination of the overlying Nonesuch and Freda formations is a true representation of the field at that time." There is a difference in inclination between the magnetizations of the Copper Harbor and Nonesuch formations of 40° and if the polar wandering was slow and continuous, quite a long period of nondeposition must be represented by the conformable contact of the two formations, but there may have been a sudden and quick change of the pole and continuous deposition.—*J. R. B.*

163–48. Kawai, Naoto. Magnetism of rocks and solid phase transformation in ferromagnetic minerals. III: Acad. Japan Proc., v. 31, no. 6, p. 346–351, 1955.

Measurements of the remanent magnetization of 76 specimens of upper Miocene rock, presumably basalt, from the Boso district, Japan during a period of 5 years have shown that those rocks whose original remanent magnetization was in a direction greatly different from that of the geomagnetic field have stable magnetization, and those whose original direction is the same as that of the geomagnetic field have unstable magnetization. Rocks with an intermediate direction revealed "time change in the manner intermediate between these extremities" and are designated metastable.

Thermomagnetic measurements have shown that the titanomagnetite of each of the rocks consists of three or more phases, each with a different Curie point, that those rocks whose titanomagnetite contains phases with Curie points above 130° are stable, and that those rocks containing titanomagnetites at least one of whose phases has a Curie point less than 100° are unstable or metastable.—*J. R. B.*

163–49. LeBorgne, Eugène. Sur la susceptibilité magnétique du sol [On the magnetic susceptibility of the soil]: Istanbul Univ. Fakultesi Mecmuasi, ser. C, tome 20, fasc. 2, p. 129–167, 1955.

The surface layer of the soil, rich in organic matter, often has a high magnetic susceptibility, clearly higher than that of the parent rock beneath; this fact is the more unexpected because the susceptibility of rocks in general tends to decrease during alteration. The magnetic properties of the soil are independent of the mineralogic character of the parent rock when the latter is only slightly magnetic; on the other hand, humidity plays a very important part, the weakest susceptibilities belonging to very humid soils. If a granulometric analysis of the soil is made, the most magnetic fraction is found, in general, to be the finest fraction, the clay fraction. The behavior of the magnetic constituent of this fraction indicates that it is the cubic oxide $\gamma = Fe_2O_3$. The formation of this oxide, related to phenomena of oxidation and reduction favored by the fermentation of organic matter, depends on the conditions of evolution of the soil. A systematic study of the susceptibility of soil could be of service to soil scientists.—*Author's abstract, M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

163–50. Birebent, Raymond. Appareil pour la mesure de l'intensité du champ magnétique terrestre [Apparatus for the measurement of the intensity of the geomagnetic field]: Acad. Sci. Paris Comptes Rendus, tome 241, no. 4, p. 368–369, 1955.

Description of an instrument for measuring the earth's magnetic field based on an alternating-current coil that imposes a torsion on a piezoelectric crystal inducing an alternating tension that can be amplified. The geomagnetic field is compensated by Helmholtz coils. Measurement is by regulating the current in the compensating coils so there is no tension in the crystal. Both vertical and horizontal components of the magnetic field can be measured.—*M. C. R.*

163–51. Waters, G. S. A measurement of the earth's magnetic field by nuclear induction: Nature, v. 176, no. 4484, p. 691, 1955.

The total magnetic field in the vicinity of Christchurch (near Southampton), has been experimentally determined using the free precession technique reported by Packard and Varian. Protons in a sample of water are initially polarized magnetically at right angles to the earth's field, the polarizing field switched off nonadiabatically, and the residual magnetic vector is free to precess about the earth's magnetic field F, inducing a signal voltage in a pickup coil. The frequency for the precession is related to the field by the equation $2\pi f = \gamma_p F$ where γ_p is the gyromagnetic ratio for the proton. The frequency was measured by beating the input signal with the second harmonic of a 1,000-cycle-per-second tuning fork, photographing the beat pattern from the cathode-ray oscilloscope display, and comparing with a crystal-derived 50-cycle-per-second trace.

For relative measurements where γ_p is not required, differences of the order of 1 microgauss should be just detectable.—*M. C. R.*

163–52. Agocs, W. B. The effect of line spacing illustrated by Marmora, Ontario airborne magnetometer control and the determination of optimum spacing: Geophysics, v. 20, no. 4, p. 871–885, 1955.

Data of the Marmora, Ontario airborne magnetometer data are used to illustrate how it is possible to miss an anomaly of economic significance through insufficiently close flight-line spacing. Equations are given for determining the probability of locating an anomaly of given dimension with a chosen line spacing or grid.—*M. C. R.*

MAGNETIC OBSERVATIONS AND SURVEYS

163–53. Rey Pastor, Alfonso. Contribución de la ciencia del magnetismo a la geología—Región NW de España [The contribution of the science of magnetism to geology—northwest region of Spain]: Rev. Geofísica, año 14, no. 53, p. 13–50, 1955.

Local anomalies have been determined from the isogonic lines of the declination chart for 1942.5 as departures from smooth curves representing the regional zone. These have been studied in relation to the geology and physiography of the Asturian and Golician massifs and the Duero plateau. Two strong axes of anomalies, one positive and the other negative, as well as several smaller anomalies are noted. Both axes are related to Hercynian trends, but no explanation is apparent for the difference in sign.—*M. C. R.*

163–54. Cattala, Louis. Quelques mesures de déclinaison magnétique a'Madagascar [Some measurements of magnetic declination at Madagascar]: Acad. Sci. Paris Competes Rendus, tome 241, no. 4, p. 435–436, 1955.

Record of a series of measurements of declination made during 1954–55, and comparison with those of Besairie in 1936–38.—*M. C. R.*

163–55. Sugiyama, Mitsusuke, and Takagi, Sinichiro. Geophysical prospecting at Yonago Mine, Kamitakai-gun, Nagano Prefecture [In Japanese with English summary]: Geol. Survey Japan Bull., v. 6, no. 1, p. 39–44, 1955.

The Yonago mine is in a massive sulfur deposit of impregnation-replacement type. Electrical resistivity and magnetic surveys were made. The magnetic survey showed the distribution of andesite and altered zone and indicated two types of altered zones: a clay-rich altered zone with negative self-potential and low resistivity, and a silicified zone with negative self-potential and high resistivity.—*V. S. N.*

163–56. Canada Geological Survey. Aeromagnetic maps of Nova Scotia: Dept. of Mines and Tech. Surveys, Geophysics Papers 226–228, 230–242, 1955.

Blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles: G. P. 226, Bras d'Or, in Cape Breton and Victoria Counties, Cape Breton Island; G. P. 227, Sydney, in Victoria and Cape Breton Counties, Cape Breton Island; G. P. 228, Glace Bay, in Cape Breton County, Cape Breton Island; G. P. 230, Cape George, in Antigonish and Inverness Counties; G. P. 231, Larrys River, in Guysborough County; G. P. 232, Louisburg, in Cape Breton County, Cape Breton Island; G. P. 233, Framboise, in Richmond and Cape Breton Counties, Cape Breton Island; G. P. 234, Mira, in Cape Breton and Richmond Counties, Cape Breton Island; G. P. 235, Grand Narrows, in Cape Breton, Richmond, Victoria, and Inverness Counties, Cape Breton Island; G. P. 236, St. Peters, in Richmond County, Cape Breton Island; G. P. 237, Chedabucto Bay, in Guysborough and Richmond Counties; G. P. 238, Port Hawkesbury, in Richmond, Guysborough, Inverness and Antigonish Counties; G. P. 239, Whycocomagh, in Inverness County, Cape Breton Island; G. P. 240, Antigonish, in Antigonish and Guysborough Counties; G. P. 241, Guysborough, in Guysborough and Antigonish Counties; and G. P. 242, Country Harbor, in Guysborough County.—*D. B. V.*

163–57. Canada Geological Survey. Aeromagnetic maps of Newfoundland: Dept. of Mines and Tech. Surveys, Geophysics Papers 205–206, 1954; 199–204, 207–208, 210–212, 229, 1955.

Blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles: G. P. 199, Eastport; G. P. 200, Gloverton; G. P. 201, Pudops Lake; G. P. 202, Mt. Sylvester; G. P. 203, Meta Pond; G. P. 204, Twillick Brook; G. P. 205 (advance edition), Burnt Pond; G. P. 206 (advance edition), Feeder Lake; G. P. 207, King George IV Lake, G. P. 208, Cold Spring Pond; G. P. 210, Bay de Verde; G. P. 211, Tug Pond; G. P. 212, Fandom Island; and G. P. 229, Port Blandford.—*D. B. V.*

163–58. Canada Geological Survey. Aeromagnetic maps of Northwest Territories: Dept. of Mines and Tech. Surveys, Geophysics Papers 252–267, 1955.

Advance editions of blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles in the District of Mackenzie: G. P. 252, Klokol Lake; G. P. 253, Barr Lake; G. P. 254, Latimer Lake; G. P. 255, White Partridge Island; G. P. 256, Gothe Island; G. P. 257, Simons Island; G. P. 258, Kakoot Lake; G. P. 259, Linklater Lake; G. P. 260, Mallet Lake; G. P. 261, Three Wives Lake; G. P. 262, Casimir Lake; G. P. 263, Taitna Lake; G. P. 264, Blue Island; G. P. 265, Kakarmik Lake; G. P. 266, Enekatcha Lake; and G. P. 267, Blue Lake.—*D. B. V.*

163–59. Canada Geological Survey. Aeromagnetic maps of the Province of Ontario: Dept. of Mines and Tech. Surveys, Geophysics Papers 197, 221, 222, 224, 1955.

Blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles: G. P. 197, Thurso, in Papineau, Russell, and Prescott Counties (Quebec-Ontario); G. P. 221, Quyon, in Pontiac, Gatineau, Carleton, and Renfrew Counties (Quebec-Ontario); G. P. 222, Cobden, in Renfrew and Pontiac Counties (Ontario-Quebec); and G. P. 224, Waltham Station, in Pontiac and Renfrew Counties (Quebec-Ontario).—*D. B. V.*

163–60. Canada Geological Survey. Aeromagnetic maps of the Province of Quebec: Dept. of Mines and Tech. Surveys, Geophysics Papers 164, 165, 196, 197, 1954; 215–217, 219–225, 1955.

Blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 500 or 1,000 feet above ground level have been published for the following quadrangles: G. P. 164, Aston, in Nicolet, Arthabaska, and Drummond Counties; G. P. 165, Drummondville, in Drummond, Arthabaska, Richmond, Yamaska, and Nicolet Counties; G. P. 196, Wakefield, in Gatineau and Papineau Counties; G. P. 197, Thurso, in Papineau, Russell, and Prescott Counties (Quebec-Ontario); G. P. 215, Low, in Gatineau, Papineau, and Labelle Counties; G. P. 216, Pythonga Lake, in Pontiac and Gatineau Counties; G. P. 217, Cheneville in Papineau and Labelle Counties; G. P. 219, Lac Duval, in Pontiac County; G. P. 220, Usborne Lake, in Pontiac County; G. P. 221, Quyon, in Pontiac, Gatineau, Carleton, and Renfrew Counties (Quebec-Ontario); G. P. 222, Gobden, in Renfrew and Pontiac Counties (Ontario-Quebec); G. P. 223, Danford Lake, in Pontiac and Gatineau Counties; G. P. 224, Waltham Station, in Pontiac and Renfrew Counties (Quebec-Ontario); and G. P. 225, Blue Sea Lake, in Pontiac and Gatineau Counties.—*D. B. V.*

163–61. Balsley, J. R., Hill, M. E., Hawkes, H. E., Buddington, A. F., and Leonard, B. F. Aeromagnetic survey and geologic map of Stark, Childwold, and part of Russell quadrangles, New York (GP 117); Aeromagnetic survey and geologic map of Cranberry Lake quadrangle, New York (GP 118): U. S. Geol. Survey Geophys. Inv. Maps GP 117, 118, 1955.

These maps, on a scale of 1 inch=about 1 mile and a contour interval of 100 gammas, show the results of an aeromagnetic survey made in 1945 and 1946, primarily to guide a program of exploration for magnetite, combined with generalized geologic maps of the area.—*M. C. R.*

ELECTRICITY

GENERAL AND THEORETICAL STUDIES

163–62. Pritchett, William C. A low frequency electrical earth model: Geophysics, v. 20, no. 4, p. 860–870, 1955.

A general earth model is described, which simulates the earth when excited by currents either conductively coupled to the earth by electrodes, or inductively coupled to the earth by loops. Consideration of model equations showed that a material with resistivity of approximately 10^{-4} ohm-meters was desired for use in the model. Although suitable materials with this resistivity were not known, it was found that fine bronze wheel grindings held together by wax did have the required macroscopic resistivity. Using this model, surface measurements were made employing a modified Wenner spread "one mile" in length. Only minor anomalies resulted from a simulated salt dome "three-quarters of a mile" in diameter and "one-half mile" below the surface.—*Author's abstract*

163–63. Bhattacharyya, Bismal Krishna. Electromagnetic induction in a two layer earth: Jour. Geophys. Research, v. 60, no. 3, p. 279–288, 1955.

A mathematical treatment is presented of the problem of determining the induced field components outside a horizontal two-layer earth. The general expressions have been applied to determine the induced field when an oscillating magnetic dipole is placed on the surface of the earth. Two cases have been considered: two layers of nearly equal conductivities; and a conducting layer over an insulating medium. The formulas have been obtained in a form that is suitable for numerical integration.—*P. E. B.*

ELECTRICAL PROPERTIES OF ROCKS AND MINERALS

163–64. Fritsch, V[olker]. Gibt es "Blitznester"? [Are there "lightning nests"?]: Umschau, Jahrg. 55, Heft 15, p. 452–454, 1955.

Fritsch examines the idea that certain areas attract lightning to an unusual degree and finds that such "lightning nests" are not merely superstition. Lightning nests depend on the electrical properties of the earth's surface and may be found where layers of very different conductivity occur in sharp contact with each other under a very thin cover, and furthermore over strongly cleft bedrock of old formations and particularly well-conducting soils such as moors and swamps.—*D. B. V.*

163–65. Löwy, H. Thermal hysteresis of electric rock constants: Inst. Égypte Bull., tome 36, fasc. 1, p. 33–35, 1955.

In measurements of resistivity and dielectric constant made during cycles of temperature change from 30° to 140° C and back, hysteresis has been observed for granites and basalts and for feldspars, hornblende, olivine, and hematite. The dielectric constant of mica was independent of temperature, and no hysteresis effect was observed for quartz. Of the sedimentary rocks, only shale showed hysteresis. The dielectric constants and resistivities of Nubian sandstones and calcite did not vary in the temperature range involved.—*M. C. R.*

163–66. Hughes, Harry. The pressure effect on the electrical conductivity of peridot: Jour. Geophys. Research, v. 60, no. 2, p. 187–191, 1955.

The ionic conductivity of a specimen of peridot (gem olivine) from the Red Sea was measured at pressures of 1,000, 2,500, 4,000, 5,500, 7,000, and 8,500 kg per cm^2 in an ascending and descending cycle. Runs were made with the

temperature held constant at 1330°, 1429°, and 1513°K. The measurements indicate that the average percentage change of conductivity $(\delta \log \sigma/\delta p)_T$, for the intervals measured, is about 4×10^{-5} bar $^{-1}$.

The increase of conductivity of about 1 percent per km in the upper part of the earth's mantle suggests that the total temperature gradient required is about 1.7°C per km. Extrapolations of the data obtained, alsough admittedly very great, suggest that the temperature at the base of the mantle may be about 10,000°K.—*P. E. B.*

163–67. Noritomi, Kazuo. Studies on the change of electrical conductivity with temperature of a few silicate minerals: Tōhoku Univ. Sci. Repts., 5th ser., v. 6, no. 2, p. 119–126, 1955.

The change with temperature of the electrical conductivity of quartz, anorthite, and perthite were measured in the temperature range from 300° to 1200°C. The presence of impurities in quartz affects the conductivity noticeably below 400°, but not appreciably at higher temperatures, where the conductivity increases regularly in proportion to temperature. Abnormal changes in conductivity seem to begin in the 300°–500° range and continue for at least 100° above the 573° inversion point. The 870° inversion point is strongly marked, whereas above that the rate of change is again regular but greater than at lower temperatures.

Anorthite and perthite behave similarly, in general, with abnormal changes in the 900°–1000° range. Cooling phenomena are generally irreversible, but some reverses noted in certain higher temperature ranges should be investigated further.—*D. B. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

163–68. Dakhnov, V. N., and Ryapolova, V. A. Method soprotivleniya ekranirovannogo zazemleniya [The guard-electrode method]: Promyslovaya geofizika, p. 83–103, 1952.

The guard-electrode method is a development of the single-electrode resistivity logging method in which two additional electrodes, termed the guard electrodes, are placed above and below a relatively narrow main electrode. These are kept at the same potential as the main electrode and restrict the current flowing from it to a horizontal plane, forcing the current deeper into the wall of the well. The resistance to current flowing from the main section of the electrode is measured. The guard-electrode system is much more sensitive to vertical changes in resistivity in a well than the single-electrode system, making it possible to differentiate strata only 2 to 4 inches thick. All three electrodes are mounted on a common block of impregnated wood having a diameter slightly smaller than that of the drill hole; this decreases the influence of the mud resistivity on the resistance. The theory of the method is treated in detail. Resistivity measurements by this arrangement can easily be combined with measurements of induced polarization. Graphs obtained in actual cases are presented and interpreted.—*S. T. V., G. V. K.*

METHODS OF ANALYSIS AND INTERPRETATION

163–69. Flathe, H. A practical method of calculating geoelectrical model graphs for horizontally stratified media: Geophys. Prosp., v. 3, no. 3, p. 268–294, 1955.

For the quantitative interpretation of field resistivity curves it is necessary to possess theoretically calculated standard graphs. The problem of calculating such graphs for certain parallel stratified media has been solved long ago. The

methods developed so far, however, require facilities, which are not normally available to the geophysicist in the field. It has been shown by experience, that the catalogues of graphs, which have been made available for practical use, are inadequate, when the number of layers exceeds three. For this reason endeavours are made to find a method, to allow the geophysicist to calculate model graphs suited to any given special geological situation, with ordinary field facilities and without too great an expenditure of time. The principle of equivalence implies that such a model graph be known with a high accuracy.

To this end, a method for the calculation of model graphs for a series of parallel beds is described. This method is sufficiently simple—no series need to be summed up—to be applied by the geophysicist in practice, even during field work. The study of the kernel function in Stefanescu's integral representation of the "apparent" resistivity leads to a basis for the set of graphs. The prime elements of this basis form a one-parametric curve-system, by means of which the graph for any multi-layer sequence of strata can be obtained to any degree of approximation by linear combination.

The importance of this method in practice is demonstrated with the help of examples.—*Author's abstract*

163–70. Koefoed, O. Resistivity curves for a conducting layer of finite thickness embedded in an otherwise homogeneous and less conducting earth: Geophys. Prosp., v. 3, no. 3, p. 258–267, 1955.

A modification of the method of Ehrenburg and Watson has been used to compute 31 master resistivity curves for the three-layer case in which $\rho_3=\rho_1$, and $\rho_2/\rho_1=2/3$, 3/7, 1/4, 3/17, and 1/9. Computations are for the Wenner electrode configuration.—*M. O. R.*

163–71. Gorelik, A. M. Ob interpretatsii krivykh elektricheskogo zondirovaniya pri poiskakh vody na nebol'skikh glubinakh [The interpretation of the graphs obtained by electric sounding when prospecting for water at shallow depths]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 364–368, 1955.

When prospecting for drinking water for small settlements, the depth of the wells necessary to satisfy the needs of the community is often very small so that the usual classification of the strata and their electric properties cannot be used in the evaluation of the resistivity curves. Gorelik introduces as typical the following classification, taking into account as the most important factor the moisture content of the layers: upper layer—loam, dry or only slightly moist, with electrical resistivity of 100–60 ohm-meters, moist loam—resistivity 40-20 ohm-meters, water-saturated loam—13-11 ohm-meters, limestone (anhydrous)—400–1200 ohm-meters, disintegrated limestone—120–150 ohm-meters. Master charts constructed from resistivity measurements over layers so classified have been sucessfully used in several practical cases.—*S. T. V.*

163–72. Tarkhov, A. G. Volnovodnyye svoystva gornykh vyrabotok [Mining galleries as wave guides]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 358–363, 1955.

In the exploration by radio wave methods, three types of propagation are to be distinguished: exclusively through formations; almost exclusively through the air, cables, and pipes along the walls of mining galleries, or drill holes; or along both paths. Using formulas derived in Russian studies on the theory of waveguides, Tarkhov gives the limiting value of the wavelength separating the regions

of very small losses of energy from that of longer waves which propagate with great losses and therefore are rapidly damped. The effect of the changes of the cross section of the mining gallery on the propagation of the waves is also analyzed. The formulas given make it possible to determine the electric or magnetic properties of the surrounding formations and to localize anomalies, indicating changes in geologic structure. In Tarkhov's opinion, the limit of this range of radio waves through the ground is only 200–250 meters.—*S. T. V.*

ELECTRICAL SURVEYS

163–73. Tarass, Nasser. Geoelektrische Bestimung von Schichtgrenzen eines tertiaren Plateaus mit Quartör-decking [Geoelectric determination of layer boundaries of a Tertiary plateau with Quaternary cover]: Eclogae geol. Helvetiae, v. 47, no. 2, p. 269–303, 1954 (1955).

Geoelectrical measurements were carried out on the Stadlerberg plateau in order to determine the boundary between the Tertiary (molasse) and Quaternary (gravels, moraines) sediments.

The results are presented in a map and series of profiles. Besides yielding data on the resistivity of the Stadlerberg rocks and on the thickness of the moraines, they show that the surface of the molasse below the Quaternary forms an east-west trending valley. Much of this paper consists of presentation of the theory of standard d-c methods with certain adaptations to local conditions.—*D. B. V.*

163–74. Mazzoni, A., and Breusse, J. J. Application de la prospection électrique à la tectonique pour la recherche de vapeur naturelle à Larderello (Italie) [Application of electrical exploration to the structure in the search for natural steam at Larderello (Italy)]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 15, fasc. 17, p. 161–168, 1954.

Electrical resistivity surveys in the Larderello region of Italy have been successful in determining subsurface structure in the exploitation of natural steam for geothermal power. It was desirable to locate borings on horsts, preferably in the vicinity of major faults. The electrical measurements, though not completely resolving the structure, differentiated clearly between cover and basement rocks; the productive Larderello-Castelnuevo horst was always clearly defined in spite of chaotic composition of the cover, affording basis for the hope that electrical methods may permit direct determination of hot zones.—*D. B. V.*

163–75. McKellar, I. [C.], and Collins, B. W. The use of earth resistivity tests in the location of underground water in Canterbury: Pacific Sci. Assoc., 7th Cong., Proc., v. 2, p. 129, 1949 (1953).

Electrical resistivity tests in the Methven district, Canterbury Plains, New Zealand, with the Gish-Rooney milliameter-potentiometer apparatus and Wenner electrode configuration, have given very encouraging results in determining depth to the water table. Since wells in Canterbury generally produce adequate supplies from depths only a few feet below the water table, it is concluded that drilling is worthwhile wherever ground water may be reached within reasonable depth.—*D. B. V.*

SEISMOLOGY

GENERAL

163–76. Tillotson, Ernest. British seismology during 1954–55: Nature, v. 176, no. 4484, p. 679–680, 1955.

This is a summary of the 60th annual report of the Committee for Seismological Investigations appointed by the British Association. M. N. Hill has found the depth to the Paleozoic floor beneath the Channel from the Greenwich meridian to the longitude of Weymouth is only 2,400 to 3,500 feet. In an investigation of the propagation of surface waves in a medium with cubic symmetry, the free surface of which is a principal plane, Stoneley has found propagation of Rayleigh waves is not possible for all values of density and elastic constants, and where possible the velocity depends on direction of propagation. A station is being established at the University of Durham. The epicenter of the shock of Oct. 23, 1954 was at 53°36′ N. lat., 1°19′ W long. Darbyshire has calculated refraction diagrams for microseismic waves approaching Bermuda on the assumption that they are surface waves between the ocean and seabed of the type described by Stoneley. The diagrams show that the refraction of energy away from the island is very marked for waves approaching from the northeast and southwest, thus explaining some of the anomalies in observations of microseisms at Bermuda.—*M. C. R.*

ELASTIC WAVES

163–77. Erceville, I. d′ Etude théorique de la vitesse des ondes de compression dans les vases [Theoretical study of the velocity of compressional waves in mud]: Geophys. Prosp., v. 3, no. 3, p. 240–245, 1955.

A medium consisting of identical solid spheres piled one upon the other in a regular array with fluid filling the interstices is used to represent the mud. Velocity is calculated first for the system of solid particles and then for the solid-fluid system. For the latter, two solutions are possible, one greater and one less than the velocity in the system without fluid. For example, in a medium in which the velocity is 3,000 meters per second in the spheres and 1,500 meters per second in the liquid, the velocity is 400 meters per second in the system of solid particles without fluid, and 247 meters per second or 2,090 meters per second when the interstices are filled.—*M. C. R.*

163–78. Skuridin, G. A. Po povodu stat'i Yu. V. Riznichenko "Opredeleniye poley intensivnosti seismicheskikh voln" [Apropos of the article by Yu. V. Riznichenko "The determination of the intensity fields of seismic waves"]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 391–392, 1955.

Results of Riznichenko's study can be found or readily derived from N. A. Umov's more general treatment of the subject.—*S. T. V.*

163–79. Kanai, Kiyoshi, and Yoshizawa, Shizuyo. Relation between the amplitude of earthquake motions and the nature of surface layer III: Tokyo Univ. Earthquake Research Inst. Bull., v. 31, pt. 4, p. 275–279, 1953.

This is a mathematical study of motion at the surface from primary seismic waves incident upward, normal to a three-layer medium on a semi-infinite body. Displacements are shown graphically for different ratios of velocities and layer thicknesses. In combination with previous results, these indicate that differences in the amplitude on the free surface with respect to the period of incident waves

decrease with increase in number of layers, and that the maximum amplitude decreases with number of layers when the ratio of velocity in the surface medium to that in the bottom medium is constant. Observational studies show that when the surface layers consist of two or more strata, the relation of frequency to period of ground movements caused by earthquakes is flat, but when there is a single layer, the relation has a sharp peak.—*M. C. R.*

163–80. Matumoto, Tosimatu. Transmission and reflection of seismic waves through multilayered elastic medium: Tokyo, Univ. Earthquake Research Inst. Bull., v. 31, pt. 4, p. 261–273, 1953.

Expressions are obtained for the amplitude of transmitted and reflected waves for incident dilatational and distortional waves using matrix methods. Numerical examples are included.—*M. C. R.*

163–81. Postma, G. W. Wave propagation in a stratified medium: Geophysics, v. 20, no. 4, p. 780–806, 1955.

A periodic structure consisting of alternating plane, parallel, isotropic, and homogeneous elastic layers can be replaced by a homogeneous, transversely isotropic medium as far as its gross-scale elastic behavior is concerned. The five elastic moduli of the equivalent transversely isotropic medium are accordingly expressed in terms of the elastic properties and the ratio of the thicknesses of the individual isotropic layers. Imposing the condition that the Lamé constants in the isotropic layers are positive, a number of inequalities are derived, showing limitations of the values the five elastic constants of the anisotropic medium can assume. The wave equation is derived from the stress-strain relations and the equation of motion. It is shown that there are in general three characteristic velocities, all functions of the direction of the propagation. A graphical procedure is given for the derivation of these characteristic velocities from the five elastic moduli and the average density of the medium. A few numerical examples are presented in which the graphical procedure is applied. Examples are given of cases which are likely to be encountered in nature, as well as of cases which emphasize the peculiarities which may occur for a physically possible, but less likely, choice of properties of the constituent isotropic layers. The concept of a wave surface is briefly discussed. It is indicated that one branch of a wave surface may have cusps. Finally, a few remarks are made on the possible application of this theory to actual field problems.—*Author's abstract.*

163–82. Uhrig, L. F., and Van Melle, F. A. Velocity anisotropy in stratified media: Geophysics, v. 20, no. 4, p. 774–779, 1955.

The effect of velocity anisotropy in stratified media has been observed in Texas, Oklahoma, Canada, and Colorado. The anisotropy factor A for relatively homogeneous rock members of surface outcrops varies between 1.17 and 1.40, and for 7,000 to 8,000 feet of clastic and carbonate sediments below the surface varies between 1.10 and 1.19. Velocity anisotropy is probably the result of three effects: homogeneous anisotropy in individual rock layers; transversely isotropic rock layers; and, for the oblique paths, quasi-anisotropy caused by time differences between straight line and minimum-time paths assuming a sequence of isotropic formations of different speeds.

The available data suggest that velocity anisotropy is large enough to be a factor of importance in seismic computations. At the present time, the amount of information is limited; it is suggested that measurements of velocity anisotropy be made when vertical velocity surveys are conducted. This can be done simply by recording the oblique times to a seismometer in a well from shots spaced

at distances comparable to the depth of the seismometer in the well. Shot-points at 2,000-foot intervals on both sides of the well up to a distance equal to the depth in the well should be sufficient. Such a program may be restricted by limiting it to distances from the well about equal to the depth of the most important reflecting or refracting levels.—*Authors' summary*

163–83. Clay, C. S., and McNeil, Halcyon. An amplitude study on a seismic model: Geophysics, v. 20, no. 4, p. 766–773, 1955

A study has been made of the amplitude of a dilatational "event" and a dilatational-to-shear conversion "event" on a two-layer seismic model used by Levin and Hubbard [see Geophys. Abs. 160–87]. Comparison of the measured amplitudes with those calculated from plane-wave reflection and transmission theory shows reasonably good agreement.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

163–84. Benioff, Hugo. Earthquake seismographs and associated instruments: Advances in Geophysics, v. 2, p. 219–275, 1955.

A review of development in seismographic instruments during the last quarter century, with 47 illustrations and a bibliography of 27 papers.—*M. C. R.*

163–85. Nishimura, Genrokuro; Suzuki, Masazi; Furukawa, Eiichi; Kotaki, Tomio; and Takahashi, Koichi. A new-designed prospecting apparatus: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 4, p. 317–334, 1953.

A description, with circuit diagrams, of a seismic prospecting apparatus in which time intervals between impulses at different seismometers are measured electronically.—*M. C. R.*

163–86. Taylor, J. B. C., and Harrison, L. W. An electronic strong-motion seismograph: Seismol. Soc. America Bull., v. 45, no. 3, p. 179–186, 1955.

A detailed description is given of the "strong-motion seismograph type EB" designed at the Dominion Physical Laboratory of New Zealand. The seismograph records horizontal accelerations in two perpendicular directions, and has a range of approximately 0 to 0.5 *g*, with two channels per accelerometer, one of which is 0 to 0.1 *g*, and the other 0 to 0.5 *g*. Recording is by means of a 4-channel pen recorder using dry electrolytic paper. Sensitivity curves for the accelerometer and channel are presented for the range 2.0 to 10 cycles per second.—*P. E. B.*

163–87. Forester, R. D. Calibrating seismometers by means of earthquake data: Am. Geophys. Union Trans., v. 36, no. 5, p. 855–860, 1955.

Recordings of earthquakes were used to calculate the magnification of ground motion produced by various seismometers. The calculations were based upon the "A" values (energy parameters) listed by Gutenberg for seismic waves *P*, *PP*, and *S*. Results of the calibration procedure indicate that the energy content of *P*, *PP*, and *S* waves recorded on Benioff instruments increases with increasing wave period. In order to calibrate the horizontal seismometers by use of recorded longitudinal waves, it is necessary to correct for the fact that the amplitudes recorded transverse to the direction of wave propagation are appreciable. The resultant calibrations were accurate enough to be used for a subsequent study of the energy content of seismic waves.—*Author's abstract*

163–88. World Oil. New logging technique speeds seismic surveys: World Oil, v. 141, no. 1, p. 101, 1955.

This is a description of the continuous velocity logger which measures interval velocities over short distances in a drill hole. An ultrasonic signal generator and receiver are used.—*L. C. P.*

163–89. Jones, Hal J., Morrison, John A., Sarrafian, G. P., and Spieker, L. J. Magnetic delay line filtering techniques: Geophysics, v. 20, no. 4, p. 745–765, 1955.

Modern communications theory and information theory have placed considerable emphasis upon the problem of detection and extraction of signals in noise backgrounds. Some of the methods and equipment developed have possible geophysical applications. This paper presents a discussion of the delay line method of filter approximation. Magnetic recording delay line equipment which permits approximation of a wide variety of linear filtering and correlation operations is described. The fundamental theory of linear operator filtering by delay line techniques is outlined and some possible applications to processing seismic data are briefly discussed.—*Authors' abstract*

163–90. Schoeffler, J., and Diemer, E. Rapporteur pour la construction rapide du rayon refracte [Protractor for the rapid construction of refracted rays]: Geophys. Prosp., v. 3, no. 3, p. 234–239, 1955.

Description, construction, and method of using a simple protractor for constructing refracted rays in a vertical plane.—*M. C. R.*

163–91. Selem, A. M. Reflection survey in rough topography: Geophys. Prosp., v. 3, no. 3, p. 246–257, 1955.

Rough topography has been a limiting factor to reflection surveys because of the difficulty of maneuvering heavy equipment and because of problems associated with sharp differences in elevation and the near-surface corrections. In southern Italy, jeep-mounted portable seismic and drilling equipment has been used. Special 2-ton army trucks have also been successfully used. Because of the youthful topography and the variations in near-surface materials, careful analysis is needed to determine the thickness of the correction zone. The reference datum was chosen to follow gently and with segments of constant slopes, the general features of the rough topographic relief at a depth ranging from 30 to 60 meters from the surface. Routine checks of velocity variations in the correction zones were based on analyses of uphole time and plots of refraction "first breaks", with deeper shotholes at constant intervals. Where unsatisfactory results necessitated longer spreads for low-velocity tests and uphole shooting from deeper holes, the reference datum was deepened for that particular area.—*M. C. R.*

163–92. Gamburtsev, G. A., and Berzon, I. S. Vysokochastotnaya seysmicheskaya razvedka [High-frequency seismic surveying]: Akad. Nauk SSSR Doklady, tom 101, no. 5, p. 841–844, 1955.

Several experiments in high-frequency seismic prospecting from 1946 to 1954 have shown that by using high-frequency seismic waves it is possible to obtain refracted waves from depths of 1 to 500 meters; that reflected waves can be clearly recorded from depths as great as 2,000 meters; that high-frequency waves result in seismograms free from microseismic or industrial disturbances, or disturbances caused by the wind; and that high-frequency waves have a greater resolving

power and make it possible to determine structures only 5 meters thick. For the generation of high-frequency waves it is necessary to use somewhat greater amount of explosives, and, to bury them more deeply in dense rock. This produces waves of 70–400 cycles per second in contrast to the usual 25–70 cycles. High-sensitivity instruments are required.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

163–93. Gurevich, G. I. O dline i forme volny, vzonikayushchey pri razryve [On the length and shape of the wave produced by rupture]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 261–264, 1955.

The probable cause of tectonic earthquakes lies in relative displacements along the boundary planes between adjoining blocks. These produce deformation of the edges with accumulation of mechanical energy in the deformed parts. In the simplest assumption the break along the fault plane occurs instantly so that the deformed part is instantly released, thus producing vibrations. No forces between the parts separated by the break are ordinarily assumed to act during the shock. At the moment of breakage the continuity is destroyed. In reality the break is not instantaneous, but, as can be assumed from experiments, continues with increasing velocity to a certain maximum velocity and then decreases to zero. Also, aftershocks occur when the process of breaking is repeated. Moreover, the relative movements of the initially deformed portions are affected by friction, which is usually neglected. Gurevich emphasizes the necessity of investigating the process of breaking on models in laboratories as well as by observations in the field. A new type of instrument to measure the real (static) deformation of the ground along the breaks must be designed. Only then will it be possible to discuss the initial dynamic processes in the focus of an earthquake.—*S. T. V.*

163–94. Yepinat'yeva, A. M. O prelomlennykh volnakh v sredakh so slaboy skorostnoy differentsiatsiey [Refracted waves in media characterized by small velocity differences]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 303–322, 1955.

If the different subsurface formations of a region have only slightly different seismic velocities, then the traveltime curves are almost parallel, and the times of arrival of refracted and reflected waves are almost the same, so that the separation of waves by their kinematic properties becomes impossible. An analytical study of the dynamic characteristics of such waves, using the acoustic method developed by L. M. Brekhovskikh [see Geophys. Abs. 10282] leads to formulas and graphs for the changes in amplitudes taking place on the refracting boundary, and a determination of the length of the interference of both waves over the seismic profile, as well as the influence of differences in the damping capacity of the formation on the shape of the waves. The screening effect of such a boundary which can be considerable under unfavorable conditions is also discussed. The analytical results are in satisfactory agreement with the experimental data previously obtained by Yepinat'yeva [see Geophys. Abs. 161–93].—*S. T. V.*

163–95. Berzon, I. S. Effektivnyye skorosti v sluchaye nepreryvnogo izmeneniya s glubinoy istinnykh skorostey seysmicheskikh voln [Effective velocities in the case of continuous variation with depth of the true velocities of seismic waves]: Akak. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 299–302, 1955.

The effective seismic velocity Ve of a wave reflected from a horizontal layer at depth H, when the actual seismic velocity $V(z)$ varies continuously with the

depth Z and its relation to the average velocity Vm, is given by the formula

$$Ve=\frac{Vm}{H}\sqrt{\int_0^H V(z)dz\times\int_0^{H'}\frac{dz}{V(z)}}$$

When the velocity varies linearly so that $V_z=V_o(1+\beta z)$, where V_o is the velocity at the surface, and β is a constant coefficient, V_e and V_m differ by only 1–2 percent; when the law of variation is parabolic so that $V_z=V_o(1+\beta H)^2$, the difference between the effective and the average velocities may be, in unfavorable cases, as much as 5 percent or more, though in many cases it will not be greater than about 2 percent; when $V(z)$ varies exponentially so that $V(z)=V_oe^{\beta z}$, the difference between Ve and Vm may be much greater, so that when Vm is used in computations, corresponding corrections which are given graphically must be applied.—*S. T. V.*

OBSERVATIONS OF SEISMIC WAVES

163–96. Forester, R. D. Calculated travel times of seismic core waves: Seismol. Soc. America Bull., v. 45, no. 3, p. 187–195, 1955.

Traveltimes for the seismic core waves, *PKP*, *PKS*, and *SKS*, were computed by integration along the travel paths. Mantle and core velocities given by Gutenberg and Richter were fitted over pertinent intervals by the formula $V=V_O-Kr^2$, where V_O and K are constants over the intervals, and r is the radial distance from the center of the earth. Formulas are presented for the central angle subtended by a ray-path segment and for the traveltime along a segment for the above law. Except for rays of grazing incidence to the outer core, the times calculated for *PKP* and *PKS* are intermediate between the smoothed times given by Jeffreys and times based upon recent observed data. The times calculated for *SKS* are in fair agreement with the smoothed times given by Jeffreys. Graphs of the calculated curves and those of Jeffreys are presented.—*P. E. B.*

163–97. De Bremaecker, J. Cl. Use of amplitudes, Part I: P_n from 3° to 23°: Seismol. Soc. America Bull., v. 45, no. 3, p. 219–244, 1955.

Ten earthquakes with epicentral distances between 3° and 23° are studied. Application of Gutenberg's method to find the variation of P_n amplitudes with distance results in observations too scattered to permit any conclusion. By using a combination of earthquakes, each observed in a limited range, to determine the variation of the amplitudes, a minimum is found around 7° and a maximum around 13.5°. The essence of the proposed theoretical explanation is the coexistence of "head-waves" (refracted along a discontinuity) and "direct-waves" (refracted into the faster medium along least time paths) and the existence of head-waves along the boundary of two media, in one of which the velocity increases with depth. The results are well explained by comparing the amplitudes due to these two waves.

The following structure of the earth's crust best explains the results: speed above the Mohorovičić discontinuity 6.3 kmps; speed immediately below it, 8.1 kmps; speed at 80 km depth, between 8.10 and 8.128 kmps; around 80 km, decrease in the rate of increase of speed with depth, or decrease of speed with depth <0.001293 kmps per km; depth of the discontinuity, 35 km; $\sigma_1=\sigma_2=0.25$; and density ratio $=1.103$.—*P. E. B.*

163–98. Evernden, Jack F. Tripartite results for the Kamchatka earthquake of November 1, 1952: Seismol. Soc. America Bull., v. 45, no. 3, p. 167–178, 1955.

The tripartite technique (using stations at Berkeley, Palo Alto, and San Francisco) was applied to all parts of the record following initial *S*. The results of this study indicate: that the *SV* motion, extending from initial *S* to *G*, was a cohesive whole, not random motion, and is the result of continuous arrival of energy along paths of decreasing mantle penetration; and that the *SV*-, Rayleigh-, and Love-wave arrivals were all deflected from the great circle path toward the Pacific. This is in contrast with previous results obtained by Evernden [see Geophys. Abs. 158–139] for earthquakes with an unbroken Pacific route to Berkeley. For these earthquakes, the periods of greater than approximately 15 seconds in the Rayleigh waves did not show a significant departure from the station-to-epicenter azimuth. The deflection observed in this study is tentatively explained by a general downwarping of the equal-velocity surfaces in the mantle in the vicintiy of the Aleutian tectonic welt.—*P. E. B.*

163–99. Båth, Markus. The elastic waves *Lg* and *Rg* along Euroasiatic paths: Arkiv Geofysik, Band 2, Häfte 4, (no. 13), p. 295–342, 1954.

Lg and *Rg* waves along Euroasiatic paths have been studied on about 400 seismograms at Uppsala, Kiruna, and Bergen. The frequency distribution of group velocities indicates that *Lg* consists of at least two distinct waves with velocities of 3.54 kmps (Lg_1) and 3.37 kmps (Lg_2). The latter may be a combination of two waves. The velocity of *Rg* is about 3.07 kmps. The energy is greater in the Lg_2 group and is at a maximum for focal depths slightly below normal. Periods of Lg_2 are somewhat longer than Lg_1 and the periods of *Rg* distinctly longer than both. The wave motion in both Lg_1 and Lg_2 is transverse horizontal, in *Rg* retrograde elliptic in the plane of propagation. The waves are propagated only along continental paths, in a low-velocity layer in the crust that acts as a channel or waveguide. Records at Uppsala indicate that much of the Arctic Ocean basin is continental in structure.—*M. C. R.*

EARTHQUAKE OCCURRENCES AND EFFECTS

163–100. Rothé, J[ean]–P[ierre]. Tableau de la séismicité du globe pendant les années 1951–1952 [Table of the seismicity of the globe during the years 1951–52]: Rev. Étude Calamités, tome 14, no. 32, p. 83–116, 1954.

During 1951–52 more than 2,000 epicenters were determined by the Bureau Central International de Strasbourg in collaboration with numerous seismological surveys, particularly the U. S. Coast and Geodetic Survey and the Pasadena Seismological Laboratory. When plotted, the new epicenters rarely coincide with earlier ones, but tend to fill in voids on the map; the great seismic zones appear more and more to be narrow, almost continuous bands.

Destructive earthquakes are tabulated regionally, with magnitude and other data; then each broad geographic division is discussed in more detail, with further tables for some areas listing all shocks and giving time, location of epicenter, magnitude, and focal depth (if determined).—*D. B. V.*

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163–101. Montandon, Frédéric. Les grandes catastrophes causées par les forces de la nature dans l'année 1953 [The great catastrophes caused by the forces of nature in 1953]: Rev. Étude Calamités, tome 14, no. 32, p. 117–119, 1954.

The number of major disasters caused by the forces of nature in 1953 was 26, 4 less than the average for the 5 preceding years. Admittedly it is difficult to draw the line between major and minor catastrophes. Most of these calamities were floods or windstorms or combinations of both.

One of the most destructive earthquakes ever experienced in Greece occurred in the Ionian Islands on August 9–13. The most violent shock was on August 12. The first shock was probably caused by movement on a submarine fault between Ithaca and Cephalonia; the later shocks can definitely be attributed to the great submarine fault parallel to and near the west coast of the Ionian Archipelago. Four large earthquake-proof buildings in Zante and Cephalonia were undamaged.—*D. B. V.*

163–102. Monakhov, F. T., and Tarakanov, R. Z. Kharakteristika Kurilo-Kamchatskikh zemletryaseniy po nablyudeniyam blizkikh stantsiy za 1952–1954 g [The character of the Kurile-Kamchatka earthquakes from observations at near stations during 1952–54]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 401–415, 1955.

In 1952 five seismological stations were put in operation at different places in Kamchatka, the Kurile Islands, and Sakhalin. From 1952 to 1954 several hundred earthquakes occurred in the area. Analysis of the earthquakes indicates that the area is tectonically separated into four seismically independent blocks, that the boundary of the Kurile-Kamchatka earthquake zone is in the Pacific Ocean along the trench, and that the depth of foci is about 60 km in the eastern part of the region increasing toward the continent to as deep as 600 km.—*S. T. V.*

163–103. Rothé, J[ean]–P[ierre]. Les tremblements de terre d'Orleansville (septembre–octobre 1954) [The Orleansville earthquakes (September–October 1954)]: Rev. Étude Calamités, tome 14, no. 32, p. 77–82, 1954.

The strongest earthquake felt in North Africa for a century occurred on Sept. 9, 1954 at 1:04 a. m. with its epicenter near Orleansville, 150 km west of Algiers. More than 1,200 people were killed and 5,000 injured, and property damage ran to tens of billions of francs. The first and strongest shock had a magnitude of 6.7 (Richter scale); the energy has been calculated as 10^{24} ergs. Another violent shock occurred the next day, with a magnitude of 6.2×10^{23} ergs, with its epicenter 40 km farther north. The shocks continued for several weeks, with particularly strong ones on October 12, 19, and 21. These earthquakes resulted from orogenic movement (Alpine folding) in the Dahra Range, one of the most active of the coast ranges of Algeria. The Orleansville earthquake underlined the necessity for earthquake-resistant construction in Algeria.—*D. B. V.*

163–104. Cumin, Gustavo. Il terremoto di Codavolpe (versante orientale del 'Etna) dell' 8 aprile 1950 [The earthquake at Codavolpe (eastern slope of Etna) of April 8, 1950]: Accad. Gioenia Boll., ser. 4, v. 2, fasc. 8, p. 474–483, 1954.

At 8:50 a. m. on Apr. 8, 1950, a strong earthquake shook a narrow strip at the eastern base of Etna. The felt area was limited, the maximum intensity (Mercalli

7) was confined to an elliptical area of about 2.1 km², and the whole macroseismic area covered only about 86 km². Almost exactly the same area was shaken in September 1920, but on that occasion there occurred a succession of shocks over a brief seismic period rather than the one strong shock. The cause is believed to be slipping along one of the numerous superficial stepfaults (gradini) locally called "timpe." Imbo believes the ultimate cause lies in magmatic reactions whose surface manifestations are controlled by the structure of the region, but Cumin believes it unnecessary to seek a deeper source of energy because the superficial movement is quite adequate to produce the necessary energy.—*D. B. V.*

163–105. Housner, George W. Properties of strong ground motion earthquakes; Seismol. Soc. America Bull., v. 45, no. 3, p. 197–218, 1955.

The analysis given here considers that an earthquake fault is formed by the superposition of a large number of incremental shear dislocations, the sudden release of which produces the earthquake. It is postulated that, during an earthquake, the incremental dislocations are released in such a way that the average slip is proportional to the square root of the area slip, and that the probability of release of individual incremental dislocations is such that the probability of a total slip area A is inversely proportional to A. With these two postulates a frequency distribution of earthquakes is derived that agrees with observed data; the Richter magnitude is shown to be essentially a logarithmic measure of the average slip on a fault; and an expression is derived for the energy released by an earthquake that agrees with that derived from consideration of the energy carried in a wave train. Expressions are derived also for the areas of slip, and the average annual over-all shearing distortion of the state of California, and these are in satisfactory agreement with observed behavior. It is assumed that an accelerogram is formed by the superposition of pulses random in time. It is shown that this agrees with recorded accelerograms, and an accelerogram composed in this fashion is shown to have the characteristics of actual recorded accelerograms. It is also shown that the maximum ground accelerations in the vicinity of the center of the fault, so far as they are dependent upon the size of slip area, have essentially reached their upper limits for shocks with areas of slip approximately equal to that associated with the El Centro earthquake of 1940.—*Author's summary*

163–106. Suzuki, Ziro. A statistical study on the occurrence of small earthquakes, II: Tohoku Univ. Sci. Repts, 5th ser., v. 6, no. 2, p. 105–118, 1955.

This continues the mathematical study of the distribution of small earthquakes [see Geophys. Abs. 158–143] by testing the validity of the previous conclusions with respect to earthquakes in one seismic region; namely, the aftershocks of the Tango, Nankai, and Fukui earthquakes. The Ishmioto-Iida relation holds fairly well at every station. The numerical value of m is identical at all stations, so it is concluded that the magnitude distribution can be estimated from observations at any single station.—*D. B. V.*

163–107. Shebalin, N. V. O suyazi mezhdy energiey, ball'nost'yu i glubinoyu ochaga zemletryaseniy [Correlation between the energy, magnitude, and the depth of focus of an earthquake]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 377–380, 1955.

Using empirical curves derived from analysis of the total energy and intensity of waves at the surface from 56 earthquakes with different epicenters and focal depths, Shebalin concludes that for the earthquakes caused by tectonic processes

within the crust, the intensity of surface waves at the epicenter is independent of the depth of the focus. It follows also that the magnitude of the earthquake decreases by 1 unit if the depth of the focus increases 1.8 times. According to Shebalin's curves there must be a layer of decreased velocity between 80 and 100 km.—*S. T. V.*

163–108. Båth, Markus. The relation between magnitude and energy of earthquakes: Am. Geophys. Union Trans., v. 36, no. 5, p. 861–865, 1955.

Complete energy computation of the whole train of Rayleigh waves, including the coda, have been made for 25 shallow-focus earthquakes of magnitude 5.3 to 7.8 recorded by the Galitzin instruments at Kiruna during 1952–53. The relation between magnitude and energy is found to be given by the formula $\log E = (7.2 \pm 0.5) + (2.0 \pm 0.07)\ M + \log x/2$. The last term is a correction factor for the ratio of total energy to energy of Rayleigh waves, which is assumed to be 2 in this report.—*M. C. R.*

163–109. Gutenberg, B[eno], and Richter, C. F. Magnitude and energy of earthquakes: Nature, v. 176, no. 4486, p. 795, 1955.

The relations between magnitude and energy are being revised in the light of new data. For a given shock, energy is much lower than previously estimated. For further research the magnitude based on the amplitude and period ratio in body waves (M_B) is being used as a standard, and tentatively $\log E = 5.8 + 2.4 M_B$.—*M. C. R.*

163–110. Bonelli Rubio, Juan, and Esteban Carrasco, Luis. La magnetud de los sismos en Toledo [The magnitude of earthquakes at Toledo]: Rev. Geofísica, año 14, no. 53, p. 1–12, 1955.

The magnitude equation for Toledo has been determined from data of 137 earthquakes by least squares as $M = \log A + 1.916\Delta + 1.357$. Differences between magnitudes determined at Pasadena and at Toledo show a systematic tendency with negative values in the western Pacific and positive in the eastern Pacific and the Antilles. Peterschmitt has suggested such variations are due to the mechanism at the focus. The differences at Toledo seem to be related to differences in continental and oceanic paths.—*M. C. R.*

163–111. Vorhis, Robert C. Interpretation of hydrologic data resulting from earthquakes: Geol. Rundschau, Band 43, Heft 1, p. 47–52, 1955.

Quantitative hydrologic data resulting from earthquakes now being recorded in the United States include data on flow of springs and streams in a large area in southern California, and numerous data on well-level fluctuations. Rigorous interpretation of the latter may have to await determination of the rate of energy release of earthquakes. Lacking such information, one can only suggest that seismic water-level fluctuations in wells may be controlled both by the magnitude and by the rate of energy release, which are in turn controlled by the type of tectonic action involved. It is hoped that eventually it might be possible to calculate from such studies the approximate hydrologic coefficients for many aquifers on which pumping tests have not been made.—*D. B. V.*

163–112. Mügge, R. Registrierung von Erdbeben und Gezeiten durch unterirdisches Wasser [Registration of earthquakes and tides by means of ground water]: Umschau, Jahrg. 55, Heft 11, p. 328–330, 1955.

Records of well-level fluctuations at the Inheiden waterworks have been compared with records from the Mainka north-south horizontal seismographs at the

Taunus Observatory for the earthquake of Nov. 25, 1953 in Japan. Although the focal distance was 9,400 km the well-level records are in excellent agreement with those of the observatory. Correspondence is better for long-period waves than for the short-period preliminary waves. The ground water at Inheiden magnified the ground motion about 32 times, owing either to resonance, or, more probably, to the difference between compressibility of the solid earth and of the water locally replacing it.

Ground-water fluctuations recorded in a flooded mine near Sontra reveal a rise and fall of 5–10 cm twice daily with biweekly maximums and minimums; superposed on this semidiurnal cycle is a longer period variation which was found to correspond to atmospheric pressure changes. The former is definitely a tidal effect, but the mechanism is not clear. Earth tides are too slight to have any influence; difference in compressibility is again suggested as a possible cause.—*D. B. V.*

163–113. Gershanik, Simón. Improvements on the estimate of seismic charges: Annali Geofisica, v. 8, no. 2, p. 181–188, 1955.

Deformation of buildings due to the accelerations of earthquakes, whether the result of shear or bending, may be expressed by a uniformly convergent series of eigen functions. Except for a variable factor, the Fourier coefficients of these series are the same as the "*X* values" obtained by Housner, Martel, and Alford by means of an electrical analog computer. Using mean values of the spectrum of earthquakes, it is found that the seismic charge is constant on buildings less than 30 meters high, and with higher buildings the charge decreases with increasing height.—*M. C. R.*

163–114. Kanai, Kiyoshi, and Suzuki, Tomisaburo. Relation between the property of building vibration and the nature of the ground (Observation of earthquake motion of actual building): Tokyo Univ. Earthquake Research Inst. Bull., v. 31, pt. 4, p. 305–316, 1953.

Vibrations from earthquakes were simultaneously observed on the ground floor and roof level of two combinations of buildings of the same structure on ground of different properties. These studies indicate that the largest amplitudes are obtained from periods near the resonance period of the building, and differences from different types of ground are not great.—*M. C. R.*

SEISMIC SURVEYS

163–115. Ninagawa, Shinji. Seismic prospecting of Naie District, Hokkaido [In Japanese with English summary]: Geol. Survey Japan Bull., v. 6, no. 2, p. 63–68, 1955.

A seismic refraction survey of the northern part of the Ishikari plain, in the Naie District, Hokkaido, Japan, indicates the presence of a buried anticline or fault zone separating the Ishikari and Kabato coalfields. Exploratory borings along the Ishikari River are recommended to clarify the seismic data and facilitate future development of these coalfields.—*D. B. V.*

163–116. Eiby, G. A. New Zealand crustal structure: Nature, v. 176, no. 4470, p. 32, 1955.

A seismic refraction profile 170 km long in Wellington Province indicates presence of four layers with thicknesses of 0.6, 1.7, 7.2, and 8.8 km in which the longitudinal velocities are 3.5, 5.5, 6.0, and 6.2 kmps. The Mohorovičić discontinuity is at a depth of a little more than 18 km, and the velocity below it is 8.0 kmps. No reverse shot was made, and gravity data indicate the discontinuity may be slightly deeper at the northern end.—*M. C. R.*

MICROSEISMS

163–117. Carder, Dean S. Transmission of microseisms across North America and the western North Atlantic: Am. Geophys. Union Trans., v. 36, no. 5, p. 838–842, 1955.

A comparison of microseisms recorded at Bermuda and North American stations indicates that the North Atlantic between the continent and Bermuda has a relatively high absorption rate for microseisms having periods of ten seconds or less, if the source area is on the margin of the continent and the period on the continent is 6.5 to 9 seconds, energy absorption over a 1000-km oceanic path is probably at least an order greater than over an equal continental path, and absorption rates of the longer periods are relatively less. The oceanic passage is accompanied by a slight increase in period. All four- to five-second microseisms recognizable on the Bermuda Milne-Shaw records are believed to have local sources.—*Author's abstract*

163–118. Carder, Dean S. Microseisms at Bermuda: Am. Geophys. Union Trans., v. 36, no. 5, p. 843–854, 1955.

From an examination of above normal microseisms recorded on the Bermuda Milne-Shaw seismograph over several hurricane and winter seasons, it was found that in all cases, if the periods were 4 to 5 seconds or if the microseisms were strong, they could be attributed indirectly to local weather conditions. Occasionally weak 7 to 10 second microseisms could be traced to storm conditions from as far away as the coast of Alaska, but absorption of all microseisms across the northwest Atlantic is relatively high. Strong microseisms may be generated when local storm conditions are not apparent but when the wind is favorable for the production of opposing swells.—*Author's abstract*

ISOTOPE STUDIES AND AGE DETERMINATIONS

163–119. Rankama, Kalervo. Isotope geology: 535 p., London, Pergamon Press, Ltd., 1954.

Isotope geology is defined by Rankama as "investigation of geological phenomena by means of stable and unstable isotopes of elements and of changes in their abundance." This book is a review and compilation of the subject covering published information to about 1954. The physics and chemistry of nuclides are covered in part 1, the natural science of nuclides (their manner of occurrence in nature) in part 2. The bibliography contains several hundred items.—*M. C. R.*

163–120. Proceedings of the Conference on nuclear processes in geologic settings, Williams Bay, Wisconsin, Sept. 21–23, 1953. Co-sponsored by the University of Chicago, the National Research Council, and the National Science Foundation: 82 p., no date or place of publication given.

This volume contains summaries of papers presented at the conference together with compilations of the important points of controversy which arose during the discussions. More complete versions of many of the papers have been published elsewhere. The following are included in this volume:

MacGregor, Malcolm H. and Wiedenbeck, M. L. The decay of rubidium 87.—The half-life has been measured as $6.4 \pm 0.3 \times 10^{10}$ years for a sample of natural RbCl and $6.2 \pm 0.3 \times 10^{10}$ years for a sample enriched in Rb^{87}. Experiments indicate Rb^{87} decays directly to the ground state of Sr^{87}.

Farquhar, R. M. The branching ratio of K^{40}.—The A^{40}/K^{40} content of five

potassium minerals along with lead ages for uraninites from pegmatites nearby. Ages plotted against the A^{40}/K^{40} ratio fit within the limit of error on the curve for a branching ratio of 0.06.

Kohman, Truman P. Possible geological significance of bound beta decay.—The higher ages found by the Sr^{87}/Rb^{87} ratios than by lead isotopes may be due to a shorter half-life of Rb^{87} than currently used. The shorter half-life may be due to "bound beta decay", a process in which beta decay takes place with no loss of matter from the decaying atom.

Kohman, Truman P. Search for new natural radioactivities.—Known or possible weak activities with very long lives are being investigated. That of La^{138} has been proved. Others possible are Nd^{144}, V^{50}, Te^{130}, W^{180}, and Bi^{209}.

Kohman, Truman P. Extinct natural radioactivity.—See Geophys. Abs. 158–166.

Peppard, D. F. Consequences of a natural neutron flux: Occurrence of Pu^{239} and the $(4n+1)$ series in nature.—The amount of Pu^{239} contained in some Belgian Congo pitchblende is too large to be accounted for by the natural fission of uranium. An important source of neutrons for its production may be in the interaction of high energy particles with light elements in the ore body.

Thode, H. G., and Fleming, W. H. Neutron and spontaneous fission in uranium ores.—Studies of the isotopes of xenon and krypton resulting from the natural fission of uranium in pitchblende and uraninite indicate that the principal fission process is the natural fission of U^{238} but that there is also some neutron-induced fission of U^{235}. [See also Phys. Rev. v. 92, p. 378–382, 1953.]

Wetherill, G. W., and Inghram, M. G. Spontaneous fission in uranium and thorium ores.—Spontaneous fission yields of krypton and xenon from old euxenites were compared with those from pitchblendes and slow-neutron irradiated uranium. They are believed to be true spontaneous fission yields of U^{238}. Results on thorium are inconclusive.

Wetherill, G. W., and Inghram, M. G. Neutron production in rocks: Variations in isotopic abundances in nature due to (α, n) and (α, p) reactions.—Large excesses of Ne^{21}, Ne^{22}, and A^{38} in uranium and thorium minerals are ascribed to (α, n) and (α, p) reactions resulting from the alpha particles from simple alpha decay. The magnitude of the effect in neon is sufficient to affect the isotopic abundances of Ne^{21} in the atmosphere.

Patterson, C. C. The isotopic composition of meteoric, basaltic, and ocean leads, and the age of the earth.—See Geophys. Abs. 160–144.

Craig, Harmon. The composition and origin of the meterorites.—Available data on stony-iron and iron meteorites support the bimodal distribution of chondrites and strengthen the proposed model of derivation via collision between two small parent asteroids.

Boato, G. The primeval cosmic abundances of deuterium.—A deuterium-hydrogen ratio of the order of 1/6,500, or probably 1/20,000, is the best present guess for the primeval cosmic abundance of deuterium.

Edwards, George. Hydrogen and deuterium in iron meteorites.—Present results indicate the deuterium-hydrogen ratio in space cannot be strikingly different from that on earth.

Faul, Henry; Gott, G. B.; Manger, G. E.; Mytton, J. W.; and Sakakura, A. Y. Radon and helium in natural gas.—See Geophys. Abs. 161–148.

Suess, Hans. E. Natural radiocarbon and the rate of exchange of carbon dioxide between the atmosphere and the sea.—See Geophys. Abs. 162–181.

Thode, H. G., Wanless, R. K., and Wallouch, R. The origin of Texas and Louisiana sulfur deposits from isotope fractionation studies.—See Geophys. Abs. 161–129 and 163–122.

Reynolds, John H. Natural variations in the isotopic constitution of silicon.—See Geophys. Abs. 154–14724 and 157–128.

Aldrich, L. T. Variations in isotopic abundances of strontium in minerals.—See Geophys. Abs. 152–14330.

Cameron, A. E. Variations in the isotopic abundances of lithium and bromine in natural materials.—The Br^{79}/Br^{81} ratio in West Virginia brines is lower than other natural sources. The difference may be significant. A significant variation in lithium isotopic abundances was found between a Mallinckrodt standard reagent and samples of spodume. [See also Geophys. Abs. 160–139.]

Urey, Harold C. The measurement of paleotemperatures.—A brief review.

Jensen, Mead LeRoy. Isotopic study of fluid inclusions.—This is an outline of a program of research on the isotpoic composition of material in fluid inclusions and the possible geologic applications.

Craig, Harmon. Application of natural isotopic trace and dilution techniques to geologic problems.—A summary of the work in Chicago on the natural variations of hydrogen, carbon, oxygen, and nitrogen.

Borst, L. B. Noble gases in the earth's atmosphere.—A brief summary of theoretical studies of abundance ratios of A^{40}, He^3, and He^4 and possible geologic applications.—*M. C. R.*

163–121. Lopez de Azcona, Juan Manuel. Las variaciones isotópicas naturales de los elementos químicos [The natural isotopic variations of the chemical elements]: Rev. Cienc. Apl., no. 44, año 9, fasc. 3, p. 193–207, 1955.

This is a supplement to a previous paper on natural isotopic variations [see Geophys. Abs. 155–14942], and includes new information which has become available since that publication. Data on 20 elements are summarized in tables giving type of radiation, proportion of nuclides, and period. The elements considered are hydrogen, helium, beryllium, carbon, oxygen, neon, silicon, sulfur, argon, potassium, germanium, krypton, strontium, tellurium, xenon, neodymium, tungsten, platinum, lead, and bismuth. For hydrogen, carbon, and sulfur the isotope ratios in natural substances are also tabulated.—*D. B. V.*

163–122. Thode, H. G. Sulfur isotope fractionation studies and their relation to geological problems: Canadian Inst. Min. Metallurgy Trans., v. 57, p. 283–285, 1954.

The S^{34} content of sulfur varies by approximately 8 percent depending on the origin of the sulfur. In general, sulfates are enriched, and sedimentary sulfides and native sulfur are depleted. The S^{34} content of meteorites is remarkably constant, and it may be assumed that when the earth was formed sulfur isotope abundances were about the same as in meteorites today.

In the sulfur cycle in the sea, the sulfur isotopes are fractionated by the bacterial reduction of sulfate. A remarkable correlation has been found between isotopic ratio and geologic age of the S^{34} content of sulfides and sulfates in shales and limestones. The fractionation of sulfur isotopes in the sea began about 800 million years ago, probably when living organisms which support life from oxidation of H_2S and S came into existence.

Isotope abundance data shows that the large native sulfur deposits of Louisiana and Texas have been formed by means of living organisms. Investigations of sea-water sulfate show a large reservoir of sulfur in the oceans with a constant S^{34} content, about 2 percent more than that present in meteoritic sulfur. Isotope fractionation which occurs in sea-water sulfate can therefore be measured from this base level.

Not all processes involving oxidation or reduction of sulfur lead to isotope fractionation. Organically bound sulfur in plants is not appreciably different in its isotopic ratio from that of the sulfate nutrient from which it originates.—*V. S. N.*

163–123. Asimov, Isaac. Naturally occurring radioisoptoes: Jour. Chem. Education, v. 30, no. 8, p. 398, 1953.

If the age of the earth is assumed to be 3.35×10^9 years, the percentage of the original quantity of natural radioactive isotopes surviving today (S) can be calculated from the equation $S=\text{antilog}\,[2-(1.0008\times10^9)\,\tau^{1/2}]$, where $\tau^{1/2}$ is the half-life. The results for 10 long-lived radioactive isotopes are tabulated, ranging from 7.38 percent for U^{235} to 99.92 percent for Re^{187}.

Only elements whose half-lives are greater than 20 million years can have existed continuously since formation of the earth. Isotopes of shorter half-life have been formed long after the origin of the earth in one of three ways: through decay of a long-lived precursor—39 isotopes with half-lives ranging from 230,000 years (U^{234}) to 2.6×10^{-7} seconds (Po^{212}) belong in this group, whose most famous member is radium (Ra^{226}); through natural transmutative processes continually occurring in the earth—for instance, C^{14}, with a half-life of only 5,700 years but continually formed from N^{14} by cosmic-ray bombardment; and through completely artificial controlled nuclear reactions in the laboratory, as plutonium.—*D. B. V.*

163–124. Asimov, Isaac. The natural occurrence of short-lived radioisotopes: Jour. Chem. Education, v. 30, no. 12, p. 616–618, 1953.

Seven elements—polonium, astatine, radon, francium, radium, actinium, and protactinium—occur naturally although their half-lives are so short that none can reasonably be expected to have survived over the period of the earth's existence. They exist because they are continually regenerated by decay of certain long-lived precursors such as U^{238} and Th^{232}.

Weights of the most frequently occurring isotopes of each of the seven elements are tabulated. Except for astatine the predominant naturally occurring isotope is also the most stable; the most stable isotope of astatine, At^{210}, is completely artificial.

Radium is the most common of the seven, with more than 18 billion kg in the limited portion of the crust under consideration; if uniformly distributed throughout, it would be a trace element, but if concentrated could occur in sizeable quantities. Astatine and francium, on the other hand, would be trace elements even if the total amount were concentrated in a single spot; both occur only in heavily unfavored sides of branched portions of the three natural decay chains.—*D. B. V.*

163–125. Alperovitch, Edward A., and Miller, J. M. Occurrence of technetium-98 in nature: Nature, v. 176, no. 4476, p. 299–301, 1955.

A systematic search for Tc^{98} has been undertaken, using neutron activation analysis. Samples containing Tc^{98} will yield, on exposure to slow neutrons, Tc^{99m}, which can be readily identified by its 6-hour half-life and 140-Kev gamma ray. The formation of 99m may be regarded as proof of the presence of Tc^{98} if its production by three alternative processes from molybdenum, ruthenium, and 2×10^5 year Tc^{99} can be ruled out. Of 12 samples of columbite, yttrotantalite, thortveitite, and chromite studied, 6 gave positive results, 2 negative, and in 4 identification was uncertain.—*M. C. R.*

163–126. Bate, George L., and Kulp, J. L[aurence]. Isotopic composition of common lead from southern Africa: Science, v. 122, no. 3177, p. 970–971, 1955.

Isotopic analyses are given for 16 samples of Precambrian rocks of southern Africa. Ages have been determined by the common lead method. Six samples from Southern Rhodesia are of great age, indicating a major period of mineralization 2.2 to 2.5×10^9 years ago. The seventh sample probably indicates a later period of mineralization. Some samples from South Africa apparently contain abnormal amounts of radiogenic lead.—*M. C. R.*

163–127. Kulp, J. Laurence. Geological chronometry by radioactive methods: Advances in Geophysics, v. 2, p. 179–217, 1955.

A review of the principles and results of the lead, C^{14}, strontium, and potassium methods of age determinations and a discussion of potential methods such as the helium, ionium, metamict mineral, thermoluminescence, common-lead, tritium, and spontaneous fission methods. A bibliography of 74 items is included.—*M. C. R.*

163–128. Shillibeer, H. A., and Russell, R. D. The argon-40 content of the atmosphere and the age of the earth: Geochim. et Cosmochim. Acta, v. 8, no. 1/2, p. 16–21, 1955.

The age of the earth is calculated from the A^{40} content of the atmosphere, assuming that the continents have been formed by addition of volcanic material from depth during geologic time and that this material released all of its radiogenic A^{40} while in the molten state. The figure obtained, using current estimates of the potassium content of crustal rocks, volume of continents, and A^{40} content of the atmosphere, is 5,300 million years.

This is compatible with estimates based on other methods. As this calculation determines the time at which the earth contained essentially no A^{40}, its results need not equal those of the lead method, which determines the time at which the earth's mantle could first maintain permanent heterogeneities in its uranium and lead content.

It is concluded therefore that the bulk of the earth's argon can be explained by the release of radiogenic argon by crustal rocks as they are built into the continental masses.—*D. B. V.*

163–129. Kulp, J. Laurence. Isotopic dating and the geologic time scale: Geol. Soc. America Special Paper 62, p. 609–630, 1955.

This is a review of recent developments in methods and techniques, and of results of isotopic age determinations, with particular reference to their effect on the geologic time scale. The age of the planet now seems to be about 4.5 billion years, of the oldest rocks about 3.5 billion. A large number of measurements on Precambrian rocks provide a basis for interregional correlation. In general the post-Cambrian time scale remains unchanged, but new determinations corroborate older ones and reduce the errors involved. The major problem of correlating isotopic dates with the sedimentary column remains; the most promising leads in this direction lie in absolute age determinations on intercalated volcanic rocks and carbonaceous shales.

Ages obtained from the various uranium-lead isotope ratios on pegmatite uraninite or samarskite are generally concordant, provided a correction for radon leakage is applied and the proper common lead correction is made. Where the apparent ages derived from these ratios do not agree, recrystallization with

consequent lead loss is indicated. With pitchblende, the ease of recrystallization, transportation, and redeposition complicates the interpretation of the apparent age derived from the measurements. Rubidium-strontium ages have been reported which seem too high, probably because the assumed half-life of Rb is too high; this method promises to be the most reliable for very ancient rocks. The potassium-argon method, particularly the K^{40}–A^{40} branch, has been shown to be feasible during the past year, and is potentially the most useful of all isotopic chronometers.—*D. B. V.*

163–130. Ahrens, Louis H. Oldest rocks exposed: Geol. Soc. America Special Paper 62, p. 155–168, 1955.

The ages of the oldest rocks are of interest not only to geologists but in certain aspects of nuclear physics, biology, cosmochemistry, and astronomy. Several radioactivity methods combine to confirm that pegmatites from Southern Rhodesia and southeastern Manitoba are at least $2{,}700\times10^6$ years old. Two lines of evidence suggest that rocks of substantially greater age (300–500 million years older) must exist: the difference (~700–1600×10^5 years) between the Rhodesia-Manitoba age and most recent estimates of the age of the earth; and indications from a few radioactivity measurements. On the other hand, statistical examination of the bulk of available data leads to the prediction that the chance of finding a substantially older pegmatite is very slight.

Concretionary structures in Southern Rhodesian limestones older than the dated pegmatites suggest algal growth, which would be the oldest fossils yet reported and would allow some $2{,}700\times10^6$ years or so for organisms to have evolved to their present state.

The magnitude of the age of the oldest rocks, though somewhat smaller, is similar to most recent estimates of the ages of the earth, meteorites, elements, and universe, all of which are in remarkable agreement.—*D. B. V.*

163-131. Ahrens, L. H. Implications of the Rhodesia age patterns: Geochim. et Cosmochim. Acta, v. 8, no. 1/2, p. 1–15, 1955.

Assuming that most published lead age distributions—in which $Pb^{207}/Pb^{206} > Pb^{207}/U^{235} > Pb^{206}/U^{238}$ generally—are members of age patterns of the Rhodesia type, the majority of all recommended lead ages, including Pb^{207}/Pb^{206} estimates, are underestimates. The extent of underestimation should depend on degree of internal disagreement and on which ratio has been used. The net effect is a distinct expansion of the lead age scale as a whole.

In the Rhodesia pattern, $\log t(206/238) = a\, t(207/235) + b$, where t = age, and a and b are constants. For atomic ratios other than calculated ages, the relationship $N_{207/238} = a' N_{206/235} - b'$ (where N – number of atoms) appears to hold.

Varying lead deficiency has been suggested as the cause of the Rhodesia pattern, and the negative sign of b' in the above equation and in one involving N_{208}/N_{232} indicates a lead isotope deficiency order of $208 > 207 > 206$. The deficiency $207 > 206$ is the reverse of that indicated by the age relationship of $t(207/235) > t(206/238)$; the apparent anomaly is due to the nature of the age equation itself and because the half-life of U^{235} is much less than that of U^{238} and the deficiency of 207 is not very much greater than that of 206.—*D. B. V.*

163–132. Schnurmann, H. M. E., Bot, A. C. W. C., Niggli, E., Houtermans, F. G., and Geiss, J. Preliminary note on age determinations of magmatic rocks by means of radioactivity: Geologie en Mijnbouw, jaarg. 17, no. 9, p. 217–223, 1955.

The lead isotope ratios of monazite from three granites (from Singkep, Indonesia; Lausitz, Germany; and Nigeria) were determined using both macro- and microanalytic methods. Preliminary results give chemical ages (RaG/U^{238}) of 140, 220, and 350 million years, respectively, and check with the respective field datings as Mesozoic, Paleozoic, and Precambrian.

An age determination on zircon from the Lausitz granite is in progress, to check the results obtained with monazite. The RaD and ThB methods will also be used to check the "chemical age" results.—*D. B. V.*

163–133. Macgregor, Alex. Miers. Precambrian formations of tropical southern Africa: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 1, fasc. 1, p. 39–50, 1954.

A chronology for the formations and orogenies of Southern and Northern Rhodesia, based on radioactive age determinations. The nature and structure of the formations and the stratigraphic setting of the dated specimens are described briefly.—*D. B. V.*

163–134. Cahen, Lucien. Le Précambrien du Congo belge et sa corrélation avec celui d'autres parties du monde [The Precambrian of the Belgian Congo and its correlation with that of other parts of the world]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 1, fasc. 1, p. 21–38, 1954.

The author establishes a chronology for the formations of the Precambrian subbasement of the Belgian Congo, discusses the possible bases of correlation between the African shield and other shields, and proposes a provisional correlation based essentially on radioactive age determinations.—*Author's summary, D. B. V.*

163–135. Wasserstein, B. Ages of pitchblendes by X-ray diffraction: Nature, v. 176, no. 4473, p. 159–160, 1955.

Although β-uraninites (pitchblendes) have been considered unsuitable for age determinations based on progressive shrinking of the unit cell, experiments have shown that heating in hydrogen removes the characteristic excess of oxygen to give α-uraninites, the parameter of which serves as the criterion of age. Results are better with older pitchblendes than with relatively young specimens.—*M. C. R.*

163–136. Hiemstra, S. A., and Wasserstein, B. Age of uraninites from dimensions of their unit cells: Nature, v. 176, no. 4478, p. 405–406, 1955.

Heimstra raises eight points of question with regard to Wasserstein's method of age determination and is answered by Wasserstein.—*M. C. R.*

163–137. Giletti, Bruno J., and Kulp, J. Laurence. Radon leakage from radioactive minerals: Am. Mineralogist, v. 40, no. 5–6, p. 481–496, 1954.

The leakage of radon from a variety of primary and secondary uranium minerals has been measured. At room temperature, pitchblende shows a radon loss of 0.064 to 16.6 percent; uraninite, 0.58 to 0.80 percent; samarskite, about 0.03

percent; carnotite, 17 to 27 percent; and zircon, 1.6 to 6.2 percent. Radon leakage increases with temperature so that at 150°C it is about twice that at room temperature. Between 200° and 300°C recrystallization ensues, reducing internal surface areas and radon leakage.

Radon leakage measurements are necessary in order to estimate the correction to be applied to the 206/238 ages. If this is done as a function of temperature, if the average temperature at which the mineral has existed for its history can be approximated, and if no leaching has occurred, the 207/206 age agrees with the corrected 206/238 and 207/235 ages for a considerable variety of specimens. If leaching is absent, the 207/235 age seems to be most reliable; conversely, if the three isotopic ages agree after correction for radon leakage, leaching of uranium and lead has probably not occurred.—*D. B. V.*

163–138. Gast, Paul W. Abundance of Sr^{87} during geologic time: Geol. Soc. America Bull., v. 66, no. 11, p. 1449–1454, 1955.

Contrary to expectations on theoretical grounds, it has been found experimentally that the abundance of Sr^{87} in marine carbonates and shells does not increase appreciably with time, hence cannot be used as a method of absolute age determination. The great difference between the observed and predicted abundance presents a problem that cannot be resolved until more work has been done on rubidium and strontium.—*D. B. V.*

163–139. Aldrich, L. T., Herzog, L. F., Pinson, W. H., Jr., and Davis, G. L. Radiogenic Sr^{87} in micas from granites: Am. Geophys. Union Trans., v. 36, no. 5, p. 875–876, 1955.

Additional samples of mica have been analyzed for radiogenic Sr^{87} by the method of isotope dilution. The proportion of radiogenic Sr^{87} in the Sr in each of these micas is much greater than that found previously. Three biotite samples have been reanalyzed using improved procedures, and in every case, greater proportions of radiogenic Sr^{87} were also found. As a result, biotite appears to be much more favorable as a mineral to be used for Rb–Sr age measurements. Since the source and isotopic composition of the Sr contamination in the earlier group of samples are not known, the Sr^{86}/Sr^{88} isotope variations reported by us at that time are of questionable value.—*Authors' abstract*

163–140. Tomlinson, R. H., and Das Gupta, A. K. The use of isotope dilution in determination of geologic age of minerals: Canadian Jour. Chemistry, v. 31, no. 10, p. 909–914, 1953.

The mass spectrometer has been used for the estimation of trace quantities of rubidium and strontium. The isotope dilution technique developed by Aldrich has been extended so that 0.01 percent of Rb and 0.0001 percent of Sr have been analyzed with 100 mg of material. The use of small quantities for mass spectrometric determination allows the use of easily available fission strontium and rubidium. The radioactivity of the fission strontium also simplifies the chemical manipulation. No chemical separation from the mineral was required for the rubidium, but the strontium was concentrated by ion exchange methods.

The age of a lepidolite was determined to be 1.39×10^9 yrs, agreeing with Ahrens' determination of lepidolite from the same area [see Geophys. Abs. 140–11759]. A biotite separated from uraninite gave a much higher age (3.23×10^9 yrs) than the lead determination for the uraninite (1.9×10^9 yrs). Even when the possible effect of weathering was experimentally and drastically taken into account, these ages were not appreciably altered. Determination on another

biotite (0.57×10^9 yrs) was also found to be high in comparison to the lead isotope limits for ores of its area ($0.25–0.40\times10^9$ yrs). It is concluded that since weathering does not affect the determination, the ages found by this method are essentially correct apart from possible error in the half-life of Rb.—*D. B. V.*

163–141. Cahen, L[ucien], Macgregor, A[lex.] M[iers], and Nel, L. T. Provisional table of radioactive ages in Africa, south of the Sahara: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 1, fasc. 1, p. 51–52, 1954.

A table summarizing all known radioactive age determinations for east, central, southern, and west Africa.—*D. B. V.*

163–142. Gentner, W., Jensen, F., and Mehnert, K. R. Zur geologischen Alterbestimmung von Kalifeldspat nach der Kalium-Argon-Methode [On the geologic age determination for potassium feldspar by the potassium-argon method]: Zeitschr. Naturforschung, Band 9a, Heft 2, p. 176, 1954.

An absolute age of 223×10^6 (±20 percent) years was found for potassium feldspar from a pegmatite from Waldkirch in the Black Forest. The pegmatite belongs to a Variscan series most probably differentiated some time between upper Kulm and Upper Carboniferous time. The age obtained here is thus in very good agreement with Holmes' determination of the duration of that interval as 250–200 $\times$ 10^6 yrs.—*D. B. V.*

163–143. Wetherill, G. W., Aldrich, L. T., and Davis, G. L. A^{40}/K^{40} ratios of feldspars and micas from the same rock: Geochim. et Cosmochim. Acta, v. 8, no. 3, p. 171–172, 1955.

A^{40}/K^{40} ratios have been determined for feldspar and mica from the same rock from seven geological settings. In every case the ratio for mica is higher than that for the feldspar. Comparison with strontium age determinations on the same samples and with uranium and thorium determinations on other minerals from the same rocks indicates that the argon age calculated for the mica is more accurate than that based on the feldspar. The cause of the discrepancy is being sought. Wasserburg and Hayden's calculations of the branching ratio of K^{40}, made by comparing A^{40}/K^{40} ratios in feldspar with ages of uraninite [see Geophys. Abs. 161–132], must be reconsidered; if feldspar is unable to retain argon as completely as mica, their value of 0.085 for the branching ratio is probably too low.—*D. B. V.*

163–144. Holmes, Arthur, Shillibeer, H. A., and Wilson, J. T[uzo]. Potassium-argon ages of some Lewisian and Fennoscandian pegmatites: Nature, v. 176, no. 4478, p. 390–392, 1955.

Apparent ages have been determined by the potassium-argon method for 10 samples collected from pegmatites in the Outer Hebrides, northwest Sutherland, southern Norway, and southwest Finland. Loss of radon is suspected from three samples with low ages. The average age of the other five samples of Lewisian pegmatites is 1,090± 70 million years. The age of a microcline from the Arendal district of southern Norway agrees within the limits of error with the Lewisian ages and with ages determined by the lead method for cleveite from the same district. Grenville pegmatites in Canada are also of about the same age. The age of a Svecofennian pegmatite in Finland is about 1,800 million years. This coupled with results by Parwel and Wickman [see Geophys. Abs. 160–150] suggests

the Svecofennian pegmatites are much older than those in the Arendal, Lewisian, and Grenville provinces.—*M. C. R.*

163–145. Libby, W. F. Radiocarbon dating: Endeavour, v. 13, no. 49, p. 5–16, 1954.

A discussion of the basic principles of radiocarbon dating, techniques, and types of materials suitable. A list of more than 50 dates is included.—*D. B. V.*

163–146. Chesterman, Charles W. Age of the obsidian flow at Glass Mountain, Siskiyou County, California: Am. Jour. Sci., v. 253, no. 7, p. 418–424, 1955.

The age of a pumice bed at Glass Mountain in eastern Siskiyou County, Calif., has been determined by radiocarbon dating of trunks of trees buried standing in the pumice; the maximum age is $1,660 \pm 300$ years, minimum $1,107 \pm 380$, and average $1,360 \pm 240$. The overlying rhyolite obsidian and composite flows thus cannot be older than this maximum and are more probably only 750 to 1,000 years old.—*D. B. V.*

163–147. Antevs, Ernst. Varve and radiocarbon chronologies appraised by pollen data: Jour. Geology, v. 63, no. 5, p. 495–499, 1955.

Natural correlation with climatic ages of Canadian postglacial forest types, deduced by Potzger and Courtemanche, confirms the well suggested view that the ice border oscillations at Cochrane antedated the Altithermal which culminated ca. 6,000 years ago. The postglacial crustal rise of the James Bay country required 8,000–10,000 years according to Gutenberg. The Cochrane must be the correlative of the European Salpausselkä stage and be some 10,000–11,000 years old. Since ice retreat from Milwaukee to Cochrane comprised at least 7,000 years, the radiocarbon age of the Two Creek forest bed of 11,400 years must be much too low.—*Author's abstract*

163–148. Preston, Richard S., Person, Elaine, and Deevey, E[dward] S., Jr. Yale natural radiocarbon measurements II: Science, v. 122, no. 3177, p. 954–960, 1955.

Radiocarbon dates are reported for 78 samples, chiefly related to three projects: North American geology, the Alaskan Little Ice Age, and Caribbean archeology. Some dates are also given for Iceland, New Zealand, and Washington Island. Libby's solid-carbon counting method has been abandoned because of difficulties resulting from nuclear weapons tests, and Suess's acetylene method is now being used.—*M. C. R.*

163–149. Zeller, Edward J. Thermoluminescence as a radiation damage method of geologic age determination in carbonate sediments: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 12, fasc. 12, p. 365–373, 1954.

Thermoluminescence of carbonate sediments seems to be the result of damage to the crystal lattice by radiation from included radioactive elements, and a function of the age of the crystal lattice and the natural rate of alpha-particle radiation. Thermoluminescence glow-curves can be measured quantitatively by means of a photomultiplier tube and α-radiation by means of a scintillometer, so thermoluminescence affords a potentially simple method of determining the age of a geologic event that caused a rock to be heated above 200° C. Periods of folding, faulting, or igneous intrusion, or any structural or igneous activity sufficiently

intense to cause recrystallization of limestone or dolomite, may be dated. The principal advantage of such a method is that it can be applied directly to the sedimentary sequence.

Every sample has a characteristic saturation level beyond which further radiation will not increase the thermoluminescence; therefore, before an age determination can be attempted it is necessary to determine the shape of the saturation curve and the level of ultimate saturation for each sample; this can be done by exposure to alpha-bombardment from polonium. If a sample has reached saturation under natural conditions only its minimum age can be determined. Fortunately, many Paleozoic and some Precambrian rocks apparently have not been saturated.—*D. B. V.*

163–150. Wasserburg, G. J., and Hayden, R. J. Time interval between nucleogenesis and the formation of meteorites: Nature, v. 176, no. 4472, p. 130–131, 1955.

Mass spectrometric determination of xenon in the Beardsley meteorite showed a normal isotopic composition. If the meteorites had formed soon after the formation of the elements, there would be an excess of Xe^{129} from the decay of I^{129}. A lower limit for the time interval between the formation of the elements and the last crystallization of the meteorites, calculated by assuming that I^{129} and I^{127} were originally made in equal abundance and that there has been no loss of xenon by diffusion, is $\geqq 0.41 \times 10^9$ years. As the A^{40}/K^{40} age of the meteorite is $4.8 \pm 0.2 \times 10^9$ years, a lower limit of 5.0×10^9 years for the time since the formation of the elements is obtained. Thus if the earth and meteorites are cogenetic, all radioactive elements with half-lives short compared to 4×10^8 years would have decayed in the time interval between nucleogenesis and the formation of the earth and would not contribute to the heating of the primeval earth.—*M. C. R.*

163–151. Paneth, F. A. Das Alter von Eisenmeteoriten [The age of iron meteorites]: Naturw., Jahrg. 41, Heft 5, p. 99–101, 1954.

Results of helium age determinations on iron meteorites are chiefly in two groups: those of the order of a few hundred million years old, and a very few no older than 4 million years. One sample falls between, with an age of 30 million years. The iron meteorites thus are much younger than the solar system and the oldest terrestrial rocks. Nevertheless many show signs of a long and complicated geologic development. The few very young meteorites may represent those which approached the sun closely enough to have remelted, but it is possible that their ages are the true geologic ages; if so they are remnants of a vanished member of the solar system.—*D. B. V.*

RADIOACTIVITY

RADIOACTIVITY CONSTANTS

163–152. Porschen, W., and Riezler, W. Naturliche Radioaktivität von Platin und Neodym [Natural radioactivity of platinum and neodymium]: Zeitschr. Naturforschung, Band 9a, Heft 8, p. 701–703, 1954.

In investigation of very weak α-activity in the natural elements by means of nuclear emulsion plates [see Geophys. Abs. 158–179], a positive effect was found for platinum and neodymium. For platinum, the range of α-particles was between 11 and 13μ, indicating α-particle energy of 3.3 ± 0.2 Mev. The decay constant was calculated as 8.5×10^{-17} years, and the half-life, $\alpha \times 8 \times 10^{15}$ years, where α is the abundance of active isotopes. Thus, if Pt^{190} ($\alpha = 0.006$ percent) is the active isotope, the half-life would be 5×10^{11} years.

For neodymium B, the average range of particles was $6.27 \pm 0.15\mu$, α-particle energy 1.8 ± 0.1 Mev, decay constant 3.5×10^{17} years, and half-life $\alpha \times 2 \times 10^{16}$ years. Assuming the active isotope to be Nd^{144} ($\alpha = 23.9$ percent), the half-life becomes 5×10^{15}.

For both Pt and Nd, calculations of the theoretical half-life from Gamow's formula agree within the limits of experimental error.—*D. B. V.*

163–153. Heintze, Joachim. Zur Frage der naturlichen Radioaktivität des V^{50}, In^{113}, und Te^{123} [On the question of the natural radioactivity of V^{50}, In^{113}, and Te^{123}]: Zeitschr. Naturforschung, Band 10a, Heft 1, p. 77, 1955.

V^{50} must be radioactive because it is heavier than its neighbors Ti^{50} and Cr^{50}. Investigations of γ-ray emission by means of a Geiger counter and of K-capture and α-particle emission by means of a proportional counter point to the conclusion that in the transformation $V^{50} \rightarrow Ti^{50}$, Ti-$K$ radiation has a minimum half-life of 3×10^{14} years; γ-radiation (1.58 Mev) of 3×10^{15} years, and β-radiation (2.4 Mev) of 10^{15} years; the transformation $V^{50} \rightarrow Cr^{50}$ is accomplished by β-ray emission (1.2 Mev) with a half-life of 3×10^{14} years.

Similarly, it was found that the transformation of In^{113} to Cd^{113} by Cd-K radiation has a half-life of 10^{16} years, by Cd-L radiation of 10^{14} years; and the decay of $Te^{123} \rightarrow Sb^{123}$ by K-capture has a half-life of 10^{15} years, by L-capture of 10^{13} years.—*D. B. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

163–154. Dyad'kin, I. G. K teorii gamma-gamma-karottazha burovykh skvazhin [On the theory of the gamma-gamma well logging]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 323–331, 1955.

With the aid of radioactive gamma-gamma well logging it is possible to determine the density of the formations penetrated by the drill hole; this density is related to lithologic composition of rocks and their porosity. This type of well logging is characterized by the following properties: in drill holes bigger than 15–20 cm the intensity of scattered radiation decreases with the increasing density, and this decrease is more pronounced in large holes; the intensity of radiation decreases exponentially with the increasing diameter of the hole; and in holes of large diameters intensity is only slightly dependent on the density of rocks, particularly if the density is high as compared with the density of the mud filling the hole.—*Author's summary, S. T. V.*

163–155. Hradil, Guido. Zur Messung des Emanationsgehaltes der Bodenluft über Strukturlinien [On the measurement of the emanation content of soil air over structural lines]: Berg- u. Hüttenmänn. Monatsh., Jahrg. 100, Heft 4, p. 145–147, 1955.

The presence of fault lines of joints can be revealed by measurement of the emanation content of the overlying soil. An average value of 35×10^{-14} curies per cm^3 was established from measurement at a depth of 1 meter in a garden at Innsbruck, carried on over a 7-month period. The field measurements were made over structural lines previously determined by Fritsch by his diffusion method, and also at a distance of 20 meters from each station for comparison. Over any crack, the Curie value was found to be consistently higher than at the corresponding control point, and at intersections the increase was even greater; the average increase was about 70 percent. The findings appear to be reproducible, and independent of outside influences.

Applied to the Karwendel range, the method reveals numerous structural lines which are considered to be breaks due to subsidence of the base of the terraces under the thick glacial cover; the surface effect of such structure is unrecognizable.—*D. B. V.*

163–156. Broding, R. A., and Rummerfield, Ben F. Simultaneous gamma ray and resistance logging as applied to uranium exploration: Geophysics, v. 20, no. 4, p. 841–859, 1955.

The transferring of petroleum exploration thinking and methods to uranium exploration has greatly facilitated the search for radioactive ores. Radioactivity and resistance logs obviate the need and expense of taking continuous cores to locate mineralized zones in shallow core holes. Specialized instrumentation, field equipment, and interpretive techniques are required in applying the logging methods to uranium exploration. Radiometric analysis from logs is possible, but must be carefully controlled, calculated, and qualified. Results are presented of actual uranium exploration in the field. The impact of atomic energy on world economics makes it necessary to scrutinize the applicability of all geophysical methods to uranium exploration.—*Authors' abstract*

163–157. Merritt, John W. How to avoid costly errors in gamma ray surveying: World Oil, v. 141, no. 2, p. 84–90, 1955.

This is a discussion of precautions that should be taken in gamma-ray surveying to obtain the full benefit from the method in oil prospecting.—*L. C. P.*

RADIOACTIVITY OF ROCKS, WATERS, AND AIR

163–158. Asimov, Isaac. The relative contributions of various elements to the earth's radioactivity: Jour. Chem. Education, v. 31, no. 1, p. 24–25, 1954.

The contribution of the long-lived radioactive isotopes to the earth's radioactivity can be calculated quantitatively from the equation $-dN/dt=(4.8\times10^{23})/\tau^{1/2}$, where $-dN/dt$ is number of atoms decaying per second, and $\tau^{1/2}$ is the half-life. Uranium accounts for 90.1 percent of the total radioactivity of the crust, thorium 5.0 percent, potassium 4.9 percent, and all other elements <0.1 percent. The overall contribution of the lighter elements, generally overlooked, is thus quite appreciable. Calculations also show that every second the crust loses 9.5 kg of uranium, 0.74 kg of thorium, and 1.3 kg of potassium; on the credit side it gains 8.9 kg of lead, 1.3 kg of helium (56 liters), 1.2 kg of calcium, and 0.1 kg of argon (7,200 liters).—*D. B. V.*

163–159. Whittle, A. W. G. The radioactive minerals of South Australia and their petrogenetic significance: Geol. Soc. Australia Jour., v. 2, p. 21–45, 1954.

Radioactive minerals of South Australia show a preference toward deposition in the acidic rocks of Archean provinces. Those usually characterized by richness in uranium are mostly related to metosomatic rocks rich in sodic plagioclase, and thorium-rich minerals are found in primary acid igneous intrusive rocks characterized by dominant potash feldspar. There is evidence for a genetic relationship between uranium, sodium, and titanium.—*M. C. R.*

163–160. Breger, Irving A. Radioactive equilibrium in ancient marine sediments: Geochim. et Cosmochim. Acta, v. 8, no. 1/2, p. 63–73, 1955.

Radioactive equilibrium in eight marine sedimentary formations has been studied by means of direct determinations of uranium, radium, and thorium. Alpha-particle counting has also been carried out in order to cross calibrate thick-source counting techniques. The ratio of radium found to the radium equivalent of the uranium in the composites is in each case practically unity. The maximum deviation from equilibrium conditions that has been noted is 11 percent; the maximum standard deviation in a suite of measurements is 12 percent. It would seem therefore that there is probably radioactive equilibrium in all the formations analyzed.—*D. B. V.*

163–161. Arrhenius, Gustaf, and Goldberg, Edward D. Distribution of radioactivity in pelagic clays: Tellus, v. 7, no. 2, p. 226–231, 1955.

Results so far obtained in a study of the localization of radioelements in different mineral phases of pelagic clay sediments indicate that the ionium (Th^{230}) supported radium is redistributed by diffusion through the interstitial solution and that the authigenic zeolite phillipsite plays an important role as a scavenger of radioelements within the deposit. A discussion of points of uncertainty in the interpretation of the distribution of gross beta–activity is included for the phillipsite study.

The contribution of initial radioactivity of the detrital mineral grains seems generally to be relatively unimportant in the pelagic sediments of the Pacific. This is indicated by the fact that most of the ionium is not uranium supported. The accumulation of ionic ionium and radium in hydrogenous oxide, clay, and zeolite minerals seems to be quantitatively the most important mechanism of transfer of radioelements to the pelagic sediments of the Pacific Ocean. The contribution of radioelements by the accumulation of shell material and the like in the sediments is apparently of less importance than the hydrogenous contribution.—*P. E. B.*

163–162. Graudé, Ch., and Rodier, J. Contribution à l'étude des eaux thermominerales de Moulay Yacoub (composition, vieillissement et radioactivité) [Contribution to the study of the hot mineral waters of Moulay Yacoub (composition, aging, and radioactivity)]: Soc. sci. nat. phys. Maroc, Comptes Rendus, no. 4, p. 78–81, 1955.

The hot mineral spring of Moulay Yacoub, about 20 km northwest of Fez in Morocco, discharges about 16 liters per second of clear water accompanied by about 1 cm^3 per second of gases. Radioactivity was measured by a goldleaf electroscope as 4.55 millimicrocuries of radon per liter (of gas) and 16.4 millimicrocuries per hour for the free gaseous emanations; 1.24 millimicrocuries of radon per liter (of water) and 71,000 millimicrocuries per hour for the dissolved gas, and practically no radioactivity for the water itself. The resistivity of the water was found to be 26.4 ohm-centimeters at 18°C, and remained constant during a 4-week period of observation.—*D. B. V.*

163–163. Reed, George W., and Turkevich, Anthony. Uranium content of two meteorites: Nature, v. 176, no. 4486, p. 794–795, 1955.

The uranium content of two iron meteorites was determined by neutron activation analysis at the Argonne heavy-water pile. A mock meteorite spiked with a known amount of uranium was simultaneously analyzed for control. Uranium

if present is in much smaller amounts than indicated by Dalton and others.—*M. C. R.*

163–164. Moxham, R. M., Walker, G. W., and Baumgardner, L. H. Geologic and airborne radioactivity studies in the Rock Corral area, San Bernardino County, California: U. S. Geol. Survey Bull. 1021–C, p. 109–125 and 2 maps, 1955.

The investigation in the Rock Corral area was undertaken to determine the relation between the anomalously high radioactivity recorded during an airborne survey and the distribution and mode of occurrence of radioactive material. Thorium-bearing minerals occur in relatively small, highly radioactive biotite-rich inclusions in a porphyritic quartz monzonite. Radioactive accessory minerals are also disseminated in the porphyritic quartz monzonite and in detritus derived from the porphyritic quartz monzonite. The configuration and amplitude of the major radioactivity anomalies detected from the air indicate that they have resulted chiefly from the large masses of porphyritic quartz monzonite rather than the biotite-rich inclusions. An analysis of the recorded radioactivity anomalies in the Rock Corral area and the equivalent-uranium content of the source rocks indicates that the lower limit of sensitivity of the airborne equipment, with respect to gross geologic features, is probably 0.001 percent.—*Authors' abstract*

163–165. Cotton, E. S. Diurnal variation in natural atmosphere radioactivity: Jour. Atmos. Terrest. Physics, v. 7, no. 1/2, p. 90–98, 1955.

The equation of the diffusion of radium emanation in the atmosphere has been solved by using several simplifying assumptions to determine the order of magnitude of variations as a result of changes in atmospheric exchange conditions, such as nocturnal inversions. Night-to-day ratios were calculated for various daytime concentrations and found to be variable, even for constant exhalation, and the value of the daytime content was found to determine the ratio even under the same exchange conditions. Observations near Bedford, Mass., in 1952 and 1953 are in reasonable agreement with the calculations. Thus individual diurnal variations may be explained on the basis of meteorological conditions, such as wind speed and temperature.—*M. C. R.*

163–166. Tanaevsky, Olga, and Vassy, Étienne. Variations de la radioactivité naturelle et artificielle de l'atmosphere [Variations of the natural and artificial radioactivity of the atmosphere]: Acad. Sci. Paris Comptes Rendus, tome 241, no. 1, p. 38–40, 1955.

Continuous registration of radioactivity 4 meters above the ground shows that when the air is calm radon accumulates but it is dissipated with the slightest wind. Radioactivity, with long half-life indicating artificial origin, was observed in rainwater.—*M. C. R.*

RADIOACTIVITY SURVEYS

163–167. Gross, W. H. Airborne scintillometer reconnaissance survey of the Radium Hill area, South Australia: South Australia Dept. Mines Min. Rev., no. 94, p. 15–20, 1953.

An area of 2,000 square miles was surveyed by flying north-south traverses at 500-yard intervals at an altitude of 250 feet. Several areas of higher-than-normal radioactivity to be checked by ground surveys were found. The survey

was also of value in indicating large areas of lower-than-normal radioactivity which could be dismissed from further prospecting. The contact between the Archean (higher-than-normal radioactivity) and Proterozoic rocks (lower-than-normal radioactivity) was outlined in a general way.—*M. C. R.*

163–168. Knapman, W. H. Jeep-mounted scintillometer survey for copper lodes—Wallaroo-Moonta area—with results of follow-up work on radioactive anomalies obtained: South Australia Dept. Mines Min. Rev., no. 96, p. 75–83, 1954.

Because of the association of radioactive material with the copper lodes in the district, a radioactivity survey, using a jeep-mounted scintillometer, was made in 1951 and 1952 in an attempt to revive mining. Magnetic, self-potential, and gravity surveys were made as a followup study of anomalies, and an airborne radioactivity survey was also made. No new lodes were discovered.—*M. C. R.*

163–169. Knapman. W. H. Scintillometer survey of the Houghton-Inglewood area: South Australia Dept. Mines Min. Rev., no. 96, p. 83–86, 1954.

A radioactive high discovered on the slope of a hill may have resulted from a zone of primary radioactive material on the upper slope with secondarily derived material creating the effect downslope. By inserting the probe of a scintillometer in post holes about 18 inches deep, it would presumably be possible to distinguish radioactive bedrock from secondary material as the source. The technique is promising though still in the experimental stage.—*M. C. R.*

HEAT

163–170. Allan, D. W. Heat in the Earth: Adv. Sci., v. 12, no. 45, p. 89–96, 1955.

In this Endeavour prize essay on the thermal history of the earth cooling by conduction, Allan discusses evidence based on known facts concerning the present state and past history of the earth; a mathematical solution for a radioactive, spherically symmetric earth; and a mathematical solution for a non-radioactive earth. The results of the mathematical solution for a radioactive earth are applied to calculate temperatures and heat flows due to radioactive heating at six depths in the earth and six times in the past for two earth models. The results show that the earth has probably been heating up at great depths throughout its history, and that near-surface thermal conditions were very different 4 billion years ago from what they are today.—*V. S. N.*

163–171. Saull, Vincent A. Chemical energy and metamorphism: Geochim. et Cosmochim. Acta, v. 8, no. 1/2, p. 86–106, 1955.

Data on heats of reaction indicate that metamorphic chemical changes may develop temperature rises of several hundred degrees centigrade. A multitude of temperature-space-time relations are possible in the interplay of reaction heat and heat transfer; one of the most important geologically is that in which heat production exceeds heat transfer for some time interval, for in such exothermic reactions, thermal autocatalysis (the process in which a reaction alters the temperature of its own environment and hence the velocity of subsequent reaction) must always be considered a possible accelerating device. Values obtained from experimental work on single interfaces between solids and on mixtures of powders, and from geologic data, suggest that thermal autocatalysis will be a borderline case which may occur depending on local conditions; this is compatible with geologic observations.—*D. B. V.*

163–172. Ingerson, Earl. Geologic thermometry: Geol. Soc. America Special Paper 62, p. 465–488, 1955.

Methods of measuring and estimating temperatures of geologic processes are examined critically, with data for some of the more accurate methods of wide geologic application summarized in tables and graphs. The most accurate and satisfactory method is direct measurement, which however, is obviously of limited applicability. The most accurate indirect method, calculation from isotope ratios, is limited to compounds of light elements formed at low temperatures. Liquid inclusions can give results accurate within a few degrees if formation pressures are known, but most commonly there is uncertainty of some tens of degrees.

Unless the relation between the temperature and composition of exsolved phases is known, exsolution phenomena merely give a minimum temperature above which an original homogeneous phase must have formed, or a range over which exsolution probably took place. Mineral assemblages likewise indicate only ranges of temperature except in the ideal case of an assemblage formed at or very near a boundary curve. Other methods—melting points, inversions, eutectics, crystallography, conductivity, thermoluminescence and dissipation of radiation coloring, metamictization, effects of intrusions on xenoliths and wall rocks or on coal—give only maximum, minimum, or ranges of temperature, but the limits may be narrowed considerably by use of any two or more methods in conjunction.—*D. B. V.*

163–173. Verhoogen, John. Thermal expansion of solids and the temperature at the boundary of the earth's core: Am. Geophys. Union Trans., v. 36, no. 5, p. 866–874, 1955.

The empirical relation $\alpha T = b(T/\Theta)^{1.5}$, where b is a constant and Θ the Debye temperature, represents satisfactorily the variation with temperature T of the coefficient of thermal expansion α at ordinary pressure. The dimensionless constant b is found to have the same value $(24.7 \pm 4.5) \times 10^{-3}$ for a large number of substances, including oxides, silicates, and diamond. Limits can be set to the variation of b with pressure. Taking values of α and Θ at the core's boundary from seismic data, and solving the above relation for T, it is found that the temperature at that depth is not likely to exceed 2700°K.—*Author's abstract*

163–174. Carte, A. E. Thermal conductivity and mineral composition of some Transvaal rocks: Am. Jour. Sci., v. 253, no. 8, p. 482–490, 1955.

The thermal conductivity and mineral composition of 42 samples of different rocks from the Transvaal are given; correlation between thermal behavior and composition is qualitative rather than quantitative, owing to the complexity and degree of alteration of the rocks. In some of the igneous rocks, porosity is a dominating factor influencing conductivity.

A study of less complex, specially selected rocks, for instance the Bushveld complex, is advisable. More information is needed on single crystals and monomineralic aggregates, particularly the feldspars, which are the poorest conductors of heat and which, contrary to other crystalline aggregates, show increase of conductivity with temperature.—*D. B. V.*

163–175. Stenz, Edward. Deep-well temperatures and geothermal gradient at Ciechocinek [In English with Polish summary]: Acta Geophys. Polonica, v. 2, no. 4, p. 159–168, 1954.

Temperature measurements in deep wells drilled for hot brine for the local health resort at Ciechocinek, Poland, are tabulated. The mean value of the geothermal (reciprocal) gradient computed for the 1300-meter layer is 42.9 meters per 1°C. Using this value and an approximate value of 5.3×10^{-3} cal per cm^2 per second for the mean conductivity of the rock (limestone, sandstone, and shale), the heat flow is calculated to be 1.23×10^{-6} cal cm^{-2} $second^{-1}$.—*D. B. V.*

163–176. Dakhnov, V. N., and Dyakonov, D. I. Termicheskiye issledovaniya skvazhin [Thermal investigation in drill holes]: 252 p., Moscow, Gostoptekhizdat, 1952.

This is a discussion of the physical basis and methods of investigation of thermal fields, both natural and artificial. A detailed description is given of the instruments, many of which were designed by the authors, and of the methods of measurements.—*S. T. V.*

VOLCANOLOGY

163–177. Aslanyan, A. T. Svyaz' vulkanicheskoy deyatel 'nosti s deformatsiyami zemnoy kory [Correlation between volcanic activity and the deformation of the crust of the earth]: Akad. Nauk Armyanskoy SSR Doklady, tom 18, no. 1, p. 19–24, 1954.

Using the methods of the theory of elasticity, Aslanyan evaluates the approximate stresses to which material just beneath the crust would be exposed as the result of various tectonic processes, such as undulatory movements of the crust or rising of subcrustal mass caused by deep convection current movements, and concludes that in many cases the initial solid will be transformed into a liquid of varying viscosity and of high temperature. Therefore, volcanic phenomena in the form of an eruption of liquid material can be the result of such deformations of the crust. Correlation between gravitational anomalies and volcanic activity as, for example, in the Antilles island arc are also cited.—*S. T. V.*

163–178. Rikitake, Tsuneji, and Yokoyama, Izumi. Volcanic activity and changes in geomagnetism: Jour. Geophys. Research, v. 60, no. 2, p. 165–172, 1955.

Geomagnetic studies have been conducted on the volcano Mihara since its great eruption in 1950. Repeated magnetic surveys have demonstrated marked changes in the geomagnetic field. Continuous recording also proves the occurrence of anomalous changes in magnetic declination with the development and subsidence of volcanic activity. It seems likely that most of the changes are caused by demagnetization and magnetization within the volcano, which is composed of basaltic rocks containing considerable magnetite. The apparent demagnetization and magnetization possibly is due to heating and cooling within the volcano. The heating may be explained by injection of high temperature gas, but cooling at the rate observed would not be possible by conduction through rocks alone.

Geomagnetic studies will be useful for inferring the internal state of certain volcanoes and sometimes even for the prediction of their eruptions.—*P. E. B.*

163–179. Krejci-Graf, Karl. Beobachtungen an "Salsen" zur Lösung der Probleme des Vulkanismus [Observations of mud volcanoes for the solution of the problems of volcanism]: Umschau, Jahrg. 54, Heft 18, p. 562–563, 566–567, 1954

The development of very few volcanoes—only seven to be exact—has been directly observable from their earliest stages. Much light, however, can be thrown on the problem by the study of mud volcanoes—vents from which gas, mud, and water are erupted—such as the group near Buzeu, Romania, and of the outlets of explosively gushing oil wells. These features in effect constitute small-scale models of the growth and decline of real volcanoes, including such phenomena as the formation of calderas and explosion craters, and offer confirmation of the theory that the conduits of a given crater are interconnected. Certain observed cones recall the craters of the moon.—*D. B. V.*

163–180. Rittmann, A[lfred]. Remarks on the eruptive mechanism of the Tertiary volcanoes of Egypt: Bull. volcanolog., sér. 2, tome 15, p. 109–117, 1954.

The various cases of eruptive mechanism are treated in principle, with specific examples, then summarized in a table showing the conditions, processes, and results of Tertiary volcanism in Egypt. Factors considered include tectonic and stratigraphic conditions, limit of ascent and extent of degasification of the magma, metamorphism of roof rock, and relations of various pressures (vapor, hydrostatic, and mechanical resistance of roof rock). The types of eruption and volcanic edifices resulting from various combinations of these factors are presented.—*D. B. V.*

163–181. Cumin, Gustavo. L'eruzione laterale etnea del novembre 1950–dicembre 1951 [The flank eruption of Etna of November 1950–December 1951]: Bull. volcanolog., sér. 2, tome 15, p. 3–70, 1954.

This describes in detail the 1950–51 flank eruption of Etna, including not only the phases of activity but also its geomorphologic effects and petrography of the lava. The eruption occurred with little warning after almost a year of quiescence, at the site of an earlier (1811) eruption. Predominant activity was the extrusion of lava extending over an unusually long period. The lava emitted was identical mineralogically with previous lavas in that sector and slightly more femic chemically. Posteruptive seismic activity was noteworthy but for the most part appeared to be only indirectly related to posteruptive phenomena.—*D. B. V.*

163–182. Fisher, N. H. Report of the sub-committee on vulcanology of the Australian National Committee on Geodesy and Geophysics 1951: Bull. volcanolog., tome 15, sér. 2, p. 71–80, 1954.

This report includes a description of observations at Rabaul in 1951, and the disastrous peléean eruption of Mt. Lamington which began on January 21 of that year. Data on volcanic centers of New Guinea are summarized in a table giving the name of each crater, elevation, type of activity, and population of adjacent area.—*D. B. V.*

163–183. Taylor, G. A. Vulcanological observations, Mount Lamington 29th May, 1952: Bull. volcanolog., tome 15, sér. 2, p. 81–89, 1954.

Comparison of the sequence of activity of the 1951 eruption of Mt. Lamington with the history of Mt. Pelée seems to indicate that the New Guinea volcano is well into the effusive dome-building phase which is an aspect of volcanic de-

generacy. Because major tectonic movements are not common in the area, regional reactivation of volcanism appears unlikely. The reappearance of incandescent lava in the crater in January 1952, accompanied by persistent earth tremors, is therefore no cause for alarm, but merely a phenomenon characteristic of periodicity within a general decline of activity.—*D. B. V.*

163–184. Bullard, Fred M. Activity of Stromboli in June and December, 1952: Bull. volcanolog., tome 15, sér. 2, p. 91–98, 1954.

This is a brief report on the activity of Stromboli as observed on three visits in 1952, in June, early December, and mid-December respectively. At the time of the first visit, about two weeks after the June 6 outflow of lava, the lack of red glare over the crater and absence of incandescent scoria indicated that the lava column stood at low level. The peculiar "exhaust" noise may be attributed to the echoing of gas explosions in a narrow channel at some depth. On the last visit, when incandescent scoria were being erupted, no such noise was present; apparently the lava column stood high enough that explosions hurled the thin crust into the air instead of producing reverberations in a restricted channel.

The remarkable persistence of the vents at Stromboli has been noted by many authors.—*D. B. V.*

163–185. Macdonald, Gordon A. Activity of Hawaiian volcanoes during the years 1940–1950: Bull. volcanolog., tome 15, sér 2, p. 119–179, 1954.

Summit eruptions of Mauna Loa occurred in 1940 and 1949, flank eruptions in 1942 and 1950. About 76 million cubic meters of lava were extruded in 1940 and 1942, about 59 million cubic meters in 1949, and about 459 million cubic meters in 1950. The 1950 eruption was one of the largest on record, with five large and several smaller flows. Gas content of the 1940 lavas was calculated to be about 1 percent by weight, viscosity of fluid Hawaiian lavas to be between 10^3 and 10^5 poises. Temperature readings on the 1950 lava ranged from 1090° to 900°C.

At Kilauea, outward tilting of the mountain flanks and a series of earthquakes progressing toward the surface indicated an increase of magmatic pressure in 1944; subsidence of the summit in December 1950 was accompanied by a series of earthquakes.—*D. B. V.*

163–186. Hantke, Gustav. Übersicht über die vulkanische Tätigkeit 1951–1953 [Review of volcanic activity in 1951–53]: Bull. volcanolog., tome 16, sér. 2, p. 71–113, 1955.

Altogether, 40 volcanoes were active in 1951, compared to 31 in 1950; 13 of them erupted. In 1952, 25 were active, of which 11 erupted. In 1953, there were 36 active, with 13 eruptions. The volcanoes active during the period under consideration are listed geographically and their activity summed up briefly.—*D. B. V.*

163–187. Morimoto, Ryôhei. The 1952–1953 eruption of Myôjin reef with special reference to the volcanic rock fragments embedded into the wreckage of "No. 5 Kaiyô-maru": Tokyo Univ. Education, Geol., and Mineralog. Inst. Studies (Kawada Memorial Volume), no. 3, p. 5–14, 1954.

The submarine eruption near Bayonnaise rock, 420 km south of Tokyo, was first observed by the fishing boat No. 11 Myôjin-maru on Sept. 17, 1952. Between September 1952 and October 1953, dacite domes or spines were formed and

collapsed in successive eruptions. Volcanic rock fragments found embedded in the wreckage on the No. 5 Kaiyô-maru destroyed by a sudden explosion on Sept. 24, 1952, were compact dacites, some with patches of basalt or andesite included, and similar to the material in the domes and spines of Myôjin reef.—*V. S. N.*

163–188. Macdonald, Gordon A., and Eaton, Jerry P. Hawaiian Volcano Observatory report for April–June 1955: Volcano Letter, no. 528, p. 4–6, 1955.

Volcanic activity along the east rift zone of Kilauea continued intermittently until May 26, with quiet release of volcanic fumes and steam through June. There were numerous earthquakes in April but in May seismic activity was at a low level in the East Puna area, Kilauea caldera, and at Mauna Loa; in June seismic activity was the lowest since February 1953. Southward tilting continued through June well beyond the normal seasonal reversal to northward tilting. Reversal from westward to eastward tilting occurred in June. This reversal, which usually follows the reversal of tilting from south to north, may indicate increase of pressure beneath the Mauna Loa area or a decrease of pressure beneath the Puna area.—*V. S. N.*

TECTONOPHYSICS

163–189. Birch, Francis. Physics of the crust: Geol. Soc. America Special Paper 62, p. 101–118, 1955.

This is a review of two aspects of the physics of the crust, the physical measurements of properties of geological materials required for the interpretation of field observations in terms of composition, and the physical conditions of temperature and pressure which influence these properties. Much more work has been done on the properties of igneous rocks than on sedimentary and metamorphic rocks. Data from several sources have been compiled into a number of graphs showing such physical properties as thermal conductivity, transverse and shear wave velocities, incompressibility, density, and the effect of temperature and pressure on certain of these properties.

After discussing problems involved in determination of temperature and pressures in the crust, Birch concludes with the remark that as the average values of temperature and stress within the crust can be reproduced in the modern high-pressure laboratory, we ought eventually to be able to measure the necessary physical properties for the crust, except for time-dependent properties, under fairly realistic conditions.—*D. B. V.*

163–190. Robertson, Eugene C. Experimental study of the strength of rocks: Geol. Soc. America Bull., v. 66, no. 10, p. 1275–1314, 1955.

Experiments were made on a number of rocks and minerals to determine their strengths under moderate hydrostatic pressures at room temperature. All rocks showed a range of elastic linearity of stress with strain. Carbonate rocks flowed plastically, whereas silicate rocks exhibited no plasticity. Plasticity of limestone increased with heating. The maximum shear-stress criterion was found to be reliable in predicting the yield point for the limestones and was an approximate guide to failure of limestone by rupture.

The silicate rocks failed by rupture, and their rupture strength was increased by hydrostatic pressure. As a rough empirical criterion of failure, the maximum shear stress was found to be linear with mean stress —*D. B V.*

163–191. Belousov, V. V. Tektonicheskiye razryvy, ikh tipy i mekhanism obrazovaniya [Tectonic ruptures, their types, and the mechanism of formation]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 17 (144), p. 1–147, 1952.

This is a compendium of results of experiments in the Tectonophysics Laboratory of the Geophysical Institute of the Academy of Sciences of the U. S. S. R. on models prepared from different plastic materials and exposed to the combined action of different forces and moments. The strength of the materials used and the combined mechanical loading were selected to correspond as nearly as possible to conditions in nature. The results of the experiments are only qualitative, but suggest the relationship between the acting forces and the resulting destruction, and provide explanation for many tectonic processes. Many pictures of the tested specimen in different phases of destruction are included.—*S. T. V.*

163–192. Sakuma, Shūzō. Elastic and viscous properties of volcanic rocks at high temperatures. Part 3. Oosima lava: Tokyo Univ. Earthquake Research Inst. Bull., v. 31, pt. 4, p. 291–303, 1953.

Three specimens of lava from the 1950–51 flows of Oosima were studied by the "bending or sagging method" [see Geophys. Abs. 162–215 and 216], a glassy lava, a highly crystalline lava, and an intermediate lava. An increase in elasticity with rising temperature to a critical temperature above which elasticity decreases, and a decrease in viscosity with rising temperature, especially abrupt above 1,100°C, were noted.—*M. C. R.*

163–193. Müller, Erich. Eine neue Messmethode zur Bestimmung des Wellengechwindigkeiten in Gesteinsproben [A new method of measurement for the determination of wave velocities in rock samples]: Naturw., Jahrg. 41, Heft 4, p. 85, 1954.

A small rod-shaped sample (3 cm long and a few millimeters thick) is immersed in fluid in a cuvette, and high-frequency head waves propagated in the fluid are photographed by means of a lightning spark, according to the schlieren method. The angle between the rectilinear head waves and the plane surface of the sample is measured. As the wavelengths are small compared to the thickness, the longitudinal and transverse wave velocities for an infinite medium can be calculated directly; the elastic constants are then calculated from the values of V_l and V_t. The results of measurements on 10 rock types are presented and show good agreement with field observations.—*D. B. V.*

163–194. Petrascheck, Walther Emil, Jr. Die absolute Grösse des Faltungsdruckes [The absolute magnitude of folding pressure]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 3, fasc. 3, p. 197–209, 1954.

Until now, estimates of folding pressure have been based on experiments on plastic rock deformation and theoretical calculations on the bending of sheets; they are uncertain because they neglect the time factor. But nature itself has made experiments excluding this uncertainty. Some rocks change with increasing depth due to load pressure and also horizontally toward areas of folding. The specific gravity of overburden being known, the change with depth gives a quantitative relation between pressure and variation of character; this measure applied horizontally indicates the amount of folding pressure.

The volatile content of coal decreases 1.4 percent for 100 meters depth; thus a 1 percent reduction signifies 18 kg per cm^2 pressure. Tectonic devolitalization

of coal seams in Silesia, the Ruhr, and South Wales amounts to 5 to 20 percent; so pressure must have been a few hundred kilograms per cm². Seismic velocities show linear increase with depth by compaction; velocity increase of 1 meter per second indicates determinable load pressure. The difference of velocities in folded and unfolded beds of the same formation has been established in Utah and in the Alpine foreland. Again, a pressure of several hundred kilograms per cm² is indicated. The same order of magnitude can be concluded from comparison of the porosity of Tertiary sediments in Bavaria and the density of clays in Austria. This corresponds with the theoretical-mechanical calculations of Kienow for the Jura Mountains and Elkins for the Appalachians.—*D. B. V.*

163–195. Schmidt, Walter J. Zur Berechnung des maximalen Gebirgsdruckes [On the calculation of the maximum mountain pressure]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 3, fasc. 3, p. 211–212, 1954.

"Gebirgsdruck", consisting of load pressure plus tectonic pressure, can be calculated by comparing the amount and size distribution of fractured pieces with experimental data. The method is naturally limited to pulverized rocks such as mylonite, crush zones, and the like, and consists of subjecting an unfractured piece of the same formation, if obtainable, to different pressures until the product obtained resembles the naturally broken rock. The pressure applied to achieve this result should be that which was applied in nature. If unfractured portions of the formation are lacking, one can determine the pressure at which the size distribution of particles is altered. The following experimental conditions must be taken into account: rate of application of pressure, temperature, water content and dimensions of the sample, and experimental setup.—*D. B. V.*

163–196. Belousov, V. V. Mekhanizm obrozovaniya skladchatosti [The mechanism of formation of folds]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 3, fasc. 3, p. 181–190, 1954.

There are two types of folds, interrupted and complete. The former, represented by domes and short folds, are generally developed on continental platforms; the latter, long linear folds, are characteristic of geosynclines. The interrupted folds result from local and extremely slow elevations of the crust, generally in places previously affected by subsidence. The linear folds do not result from contraction but instead arise, without shortening of the total surface of the folded area, by plasticity of the constituent materials within each stratum in the interior of the folded zone, with expulsion of these materials at certain points and displacement at others. This new distribution of matter is provoked by tensions developed in the crust in the course of its vertical oscillatory movements.—*D. B. V.*

163–197. Goguel, Jean. Importance des facteurs physico-chimiques dans la déformation des roches [Importance of physicochemical factors in the deformation of rocks]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 3, fasc. 3, p. 133–142, 1954.

Any strictly mechanical concept is inadequate to explain deformation of rocks. Given sufficient temperature and suitable nature of the aqueous solution which impregnates all rocks, the minerals will recrystallize. From this moment, according to Riecke's principle, the rocks are capable of slow plastic deformation. This plasticity in no way resembles fusion, for it may be coupled with high rigidity toward instantaneous stimulations.

These considerations are very important in understanding, among other things, the deformation of metamorphic axial zones of the Alps. At the moment of recrystallization this deformation could have taken place in response to rather low pressures, then later the same zones could have behaved as rigid. The same type of deformation might also explain isostatic readjustment.—*D. B. V.*

163–198. Benioff, Hugo. Seismic evidence for crustal structure and tectonic activity: Geol. Soc. America Special Paper 62, p. 61–74, 1955.

The availability of precise epicenters in the Kern County, Calif., earthquake sequence of July 21, 1952, showed that the two components of the elastic strain-rebound characteristic are derived separately from the two sides of the fault. Aftershocks producing the compressional-creep strain release occurred on the southeast side of the fault, while those which generated the shearing-creep strain occurred on the northwest side with a delay in onset of 37 hours.

A sequence of shallow earthquakes originating under the Indian Ocean was interrupted for a number of years following the shock of Oct. 24, 1933; by extrapolating the original curve it was possible to predict the magnitude of the accumulated strain available at any subsequent date. Thus in 1948 there was sufficient strain to produce an earthquake of magnitude 7.5. On Dec. 8, 1951 there was a shock of magnitude 7.6, which brought the observed curve to coincide with the extrapolated curve within the limits of observational error. The rate of increase of strain in this region is now so low that it will require another 60 years to produce an earthquake of magnitude 7.5.

Further study of the regional earthquake sequences along the Pacific arc suggests that the principal orogenic structure responsible for each of the great linear and curvilinear mountain ranges and oceanic trenches is one of two types of complex reverse faults, designated oceanic and marginal. The oceanic faults, situated within the oceanic domain, extend from the surface down to about 700 km with an average dip of 61°. The marginal faults, along continental margins, occur in dual or triple forms; the dual faults have a shallow member extending from the surface down to about 60 km and an intermediate member extending down to about 300 km with average dip of 33°, and the triple forms have a third component extending down to about 650 km with a dip of 60°. In the continental domain the 300-km level seems to represent a tectonic discontinuity that may be the lower boundary of the continents.

Elastic-strain rebound characteristics of all world shallow earthquakes of magnitude 8 and over indicate that the great Assam earthquake of 1950 marked the close of a cycle of activity which began before 1904, when precise observations first became available. On the basis of the small segment of the new cycle now perceptible, it seems that the rate of world-strain generation has increased.—*D. B. V.*

163–199. Byerly, Perry. Nature of faulting as deduced from seismograms: Geol. Soc. America Special Paper 62, p. 75–86, 1955.

This is a discussion of the development of techniques for determining fault motion at the source of earthquakes from study of initial motion on seismograms. The stereographic method is described and an example of its use for the Montana earthquake of June 28, 1925, is given. The results indicate that the earthquake occurred along a fault striking N. 26° E. and dipping 87° SE. Motion was almost horizontal with the southeast block moving southwestward. Hodgson and others have calculated the fault motion for many earthquakes in different parts of the world. Gutenberg has been able to use the first motion in *S* to resolve the am-

biguity of the *P*-wave results. All studies to date indicate a remarkable preponderance of transcurrent faulting.—*D. B. V.*

163–200. Gignoux, Maurice. Sur les nouvelles théories de la tectonique d'écoulement [On the new theories of flow tectonics]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendes, sec. 3, fasc. 3, p. 193–196, 1954.

Gignoux criticizes some current tectonic theories involving convection currents and attempts to demonstrate the reality of gravity flow tectonics from analysis of present geologic sections. Scale models demonstrating deformation on which much tectonic reasoning is based are perforce made of viscous fluids rather than plastic solids deformable only under great pressures. To prove the reality and determine the mechanism of deep currents, geologists are turning to geophysical data in order to impart a mathematical precision to their theories; but actually the geophysicists' theories are more daring than the geologists'.—*D. B. V.*

163–201. Carey, S. Warren. The orocline concept in geotectonics. Part 1: Royal Soc. Tasmania Papers and Proc., v. 89, p. 255–288, 1955.

The face of the globe shows many areas where orogenic belts wheel in trend through large angles, sometimes as much as 180°. Such a form could have one of two origins. Either the orogenic zone had that shape from the beginning, or the bend represents an impressed strain (here defined as an orocline). Classical geology has always made the first assumption, explicitly or implicitly, using the concept of cratons around which the orogens were moulded. However, logical scientific analysis demands that we should also examine the consequences of making the second assumption. Twenty-five such cases occur on the face of the globe. In every case the major structures of the region not only agree with the assumption, but lesser compressional and tensional structures fall where they would be predicted by the impressed strain theory, and quite unexpected solutions of other major tectonic problems result. Six of these oroclines are worked out in detail in this paper. Six more are presented more briefly. When all such oroclines, together with other identifiable strains, are reversed, there appears a Laurasia substantially identical with that deduced by Du Toit on wholly different grounds.—*Author's abstract*

163–202. Rutten, M. G. Orogénèse et édification des montagnes [Orogenesis and mountain-building]: Rev. géomorphologie dynamique, 6e année, no. 2, p. 49–53, 1955.

In present usage, the term orogenesis has become restricted to the designation of folding movements, involving predominantly tangential pressures, whereas mountain building implies vertical, epeirogenic uplift. The two are not contemporaneous, but are difficult to distinguish for older periods of diastrophism. Mountain ranges do not necessarily attain their elevation during the period of folding, but rather in the ensuing period of uplift. Erosion is then rapid and many ranges may disappear entirely; hence, direct evidence for the mountain-building period as distinct from the orogenetic is scarce. Arguments for its separate existence must be sought in the sedimentary record, and in the evidence from mountains forming today.

The interval between the two stages may be as long as 50 million years. Often the late period has been termed "orogenic rejuvenation", but the only feature the two movements really have in common is their geographic extent. True rejuvenation is a renewal of the vertical uplift; it does not imply any renewal of tangential forces nor any reestablishment of the sial root, but merely a continuation of the positive vertical movement after a period of relative calm.

Rutten's arguments are illustrated by examples from the ranges of Europe and North Africa.—*D. B. V.*

163–203. King, Philip B. Orogeny and epeirogeny through time: Geol. Soc. America Special Paper 62, p. 723–740, 1955.

Theories of the time relations of orogeny and epeirogeny are only as strong as the available evidence; this evidence leaves much to be desired. The sedimentary record—occurrence of unconformities and of varous types of clastics—remains the chief evidence, but in many places is available only in the marginal zones of mobile belts, as in the Southern Appalachians, and may not reflect orogenic history in the interior of the belt. Even where evidence is available for the interior, as in the Maritime Provinces, it is less complete for the main orogeny than for minor succeeding episodes. Lack of precise regional correlations increases the difficulty.

In King's opinion, it seems clear that the major orogenic and epeirogenic structures have not been created during relatively short periods of movement, but were built up slowly by episodic movements extending over a long period. Individual orogenic periods seem to have affected relatively small areas; their synchroneity with movements elsewhere is difficult to prove by available methods. Simultaneous epeirogenic movements may affect wider areas, but some of the prominent unconformities and transgressions produced by epeirogeny may express a combination of more than one pulsation. The presumption is strong that orogenic movements in one part of a continent are nearly simultaneous with epeirogenic movements and growth of tensional fracture belts elsewhere, as though all were manifestations of the same ultimate forces.—*D. B. V.*

163–204. Paige, Sidney. Sources of energy responsible for the transformation and deformation of the earth's crust: Geol. Soc. America Special Paper 62, p. 331–342, 1955.

Relatively light, sialic continental segments of the earth's crust, essentially sedimentary in origin, have grown from small centers of lineaments to their present size throughout geologic time. The physicochemical instability, stemming from the sun's radiation, of an original simatic crust beneath an atmosphere and hydrosphere results in weathering, physical and chemical sorting, sedimentation, loading and depression of the ocean floors, unloading and uplift of the continents with deep burial of sediments, their deformation, metamorphism, and finally ultrametamorphism with the formation of the diorite-granite suite of plutonic intrusives, largely derived from sediments, but receiving accessions of simatic invasions through geologic time. Isostasy is a dominating link in this evolution.

Thus, the most important discontinuity within the gravitational field of the earth is that between the atmosphere and hydrosphere above and the lithosphere below. The density distribution within the earth indicates gravitational adjustment during the early stages of the earth's evolution when temperatures were higher and the subsurface more mobile. The figure of the earth fits the observed density distribution of an earth wherein stress distribution from the center outward almost to the surface is essentially hydrostatic. This stable figure has been maintained for billions of years and is being maintained today, against disturbing forces, in the region of the Mohorovičić discontinuity.

The imbalance between sialic continental segments buoyed up dynamically by the heavier simatic oceanic segments results in stresses directed toward the ocean basins, in spreading of the continental segments, and in their invasion by simatic magma. Creep from beneath the ocean floors toward and beneath continental segments, together with depression of ocean floors or continental borders by geo-

synclinal loading, results in stresses partly directed toward the continents. This directed stress is opposed by the continental creep toward the ocean basins. The resulting stress couple initiates thrust faulting, gravitational sliding, extended deformation of geosynclinal depressions, and also invites volcanism.

Many island arcs thus are linked in origin with geosynclines and illustrate progressive capture of ocean basins by continental segments as the geosynclines are folded, metamorphosed, and progressively uplifted. Volcanism is linked to the potential energy of the earth's residual heat, to gravitation, to the effects of the temperature-pressure gradient on melting of rocks, and to imbalance between continental and oceanic segments. Volcanism on the ocean floors implies subsidence of those floors. Concentration of ores is linked to evolution of continents, likewise concentration of radioactive minerals in sedimentary rocks and sialic intrusive rocks. The processes of continental evolution imply continuous deformation of the earth's surface in time but not in place.—*D. B. V.*

163–205. Vening Meinesz, F. A. Plastic buckling of the earth's crust: the origin of geosynclines: Geol. Soc. America Special Paper 62, p. 319–330, 1955.

Formulas are derived for plastic buckling. It is shown that development of geosynclines requires 20–40 million years of relatively quiet evolution until, with continuing compressive stress, the catastrophic stage is reached bringing about folding and overthrusting of less-competent surface layers. During this entire process the plastic part of the crust is thickening. As this phenomenon takes place more rapidly in the ocean than in the continents, a border geosyncline must be asymmetrical, the continent appearing to override the ocean floor.

When compressive stress vanishes, relaxation and the beginning of isostatic readjustment take place. If the relaxation occurs before the catastrophic stage is reached, a high mountain range comes into being without much folding, such as the Atlas Mountains; if relaxation occurs afterward, it leads to a high folded range such as the Alps.

The gravity field that must accompany the development of a geosyncline is calculated from the equations for plastic buckling and found to explain conditions in Indonesia, with its belt of strong negative anomalies and overall positive anomaly of 30 milligals.

The high mountain range of a continental geosyncline eventually disappears not only because of erosion at the surface, but also because of melting and flattening of the root and a spreading under the foreland. This results in sinking of the mountain range itself and rising of the foreland—the rising of the French and German Mittelgebirge can be explained in this way, a rising which is still spreading northward under Belgium and Holland. The low submarine ridges arising from oceanic geosynclines are more stable than continental mountain ranges as they cannot be eroded and as the sial layer is too thin and hence too high to be melted even after thickening.—*D. B. V.*

163–206. Bucher, Walter H. Deformation in orogenic belts: Geol. Soc. America Special Paper 62, p. 343–368, 1955.

The deformation within the zones destined to become orogenic belts begins with the crust bending down over constrictions in an actively shrinking subcrustal shell beneath which lie the zones of deep-focus earthquakes. Sedimentation in the deepening geosyncline may accentuate the process. Sooner or later the state of all-sided compression will cause the crust to fail by one side shearing across in low-angle thrusts. Simultaneously superheated water and volatiles escaping

from the subcrust produce regional metamorphism and plutonic rock bodies. Compression of the zone thus weakened drives out yielding blocks of the geosynclinal zone as crustal folds which, lengthening upward, become recumbent folds or thrust blocks. Piling up, generally but not necessarily, on one side and advancing under the combined action of the pressure behind them and gravity acting on them, these advancing recumbent folds or thrust masses cause the sedimentary cover to "peel off" far beyond the borders of the active zones, producing the phenomena of marginal deformation.

Pre-existing fracture zones help or interfere in this process, depending on their position with reference to the direction of mountain movement, from details of basin formation within the original geosynclines to local interference in the outermost skin folds.

The actual structure in cross section and ground plan will look very different at different stages in this development. Even greater differences result when vast quantities of magma are extruded as the orogenic belt develops. In such cases liquid is pushed out in place of major anticlines or thrust blocks, and the basic simplicity and the normal structural configuration of the "typical orogenic belt" may be lost, at least in part.

Throughout its development, the orogenic belts are thus dynamically and geochemically set apart from the rest of the earth's surface which fractures, warps, and emits volcanic products without evidence of regional metamorphism or the tectonic features characteristic of orogenic belts.—*Author's conclusions.*

163–207. Stille, Hans. Recent deformations of the earth's crust in the light of those of earlier epochs: Geol. Soc. America Special Paper 62, p. 171–192, 1955.

The Pacific border has been undergoing orogeny since mid-Pleistocene time. Block faulting of large dimensions rather than Alpine folding is involved. A better understanding of recent geotectonics is gained by a discussion of the concept of progressive consolidation of the earth's crust. This process is expressed in the regionally progressive reduction in size of crustal portions subject to folding (orthogeosynclines), in their replacement by consolidated, "cratonic" basements, and in the development of geomagmatic phenomena. Retrogressive phases (regenerations) may interrupt this orderly progression, but are on the whole compensated for relatively rapidly by renewed consolidation.

The present climax of consolidation of the crust is indicated by the evidence that true orthogeosynclines no longer seem to exist and that mountain building is at best of the German type that produces only minor compressive effects in the crust. Thus present conditions represent a late phase or even a sequel to earlier geologic history characterized by mountain building of Alpine type with its accompanying magmatic phenomena. Stille points out that following the Algoman orogeny at the close of Huronian time, the crust had achieved complete or nearly complete consolidation when it was unable to accommodate any further Alpine compressions. Such conditions seem to exist again at the present time. This erstwhile complete consolidation was followed by a major regeneration, "Algonkischer Umbruch", which initiated a great new system of orthogeosynclines. Just as the "Algonkischer Umbruch" followed crustal consolidation of a high degree at the end of the Protogean, a comparably large regenerative event may again be impending at this time.—*D. B. V.*

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163–208. Thom, W. T., Jr. Wedge uplifts and their tectonic significance: Geol. Soc. America Special Paper 62, p. 369–376, 1955.

Wedge (or cone) uplifts occur at the third and fourth tectonic orders of magnitude and owe their elevation to the development of a vertical component in tangentially directed orogenic compressional movements. The kite-shaped Beartooth massif of Montana–Wyoming, the Owl Creek Range of Wyoming, and the northern segment of the Bighorn Mountain uplift are typical of the deformational pattern characterizing "heterogeneous mobile belts." The Phillipsburg intrusion-and-wedge complex west of Butte, Mont., lying between two batholiths, partially demonstrates the causal relation between volcanism and orogeny in time and space.

It is shown that fourth-order tectonic features stem from third-order frames of deformation; similarly that third-order features of differing character owe their differences to corresponding differences in the nature, arrangement, or segmentation of second-order regional crustal segments, which are in turn subunits of first-order continental or oceanic shields or mobile belts. Such second- and third-order orogenic units owe their position with respect to sea level to regional, not local, isostatic adjustment. Their long-period magmatic and compressional activities are due to a slow ebb and flow of heat generation far below the earth's surface, presumably at a depth corresponding to the lower depth limit of deep-focus earthquakes. This maximum depth presumably marks the base of the principal crust, to be distinguished from the upper portion of the crust which recurrently is involved in thrust faulting over large areas which have become temporarily subtended by magmatic blisters developed at shallow depth.—*D. B. V.*

163–209. Read, H. H. Granite series in mobile belts: Geol. Soc. America Special Paper 62, p. 409–430, 1955.

This inquiry has two main themes, the mobility connected with the appearance of granitic axes in basements, and the appearance of granitic rocks connected with mobility in geosynclines. Worldwide studies have shown how the types of deformation in a basement give information about its state. During orogeny, the basement acquires a new structure and locally becomes plastic. The development of this state is associated with the appearance of diffuse granitic material of a definite quality. The most granitized parts are found to be the most mobile, and two general characteristic patterns of deformation can be established—those with linear strikes and those with erratic strikes.

In the geosynclines, preorogenic sediments are often regionally metamorphosed, migmatized, and granitized; the synorogenic sediments are less often so affected but are the places of granitic intrusion; and the postorogenic sediments are never migmatized and enclose small granites with a special mode of emplacement. The granitic rocks produced vary in form and composition with time and place, passing from early diffuse granitization granites, dominantly sodic, to late circumscribed and intrusive granites, dominantly potassic—this variation is related to evolution of the orogenic belt.

It seems reasonable to hold that all these phenomena—granitization, the appearance of granites, regional metamorphism, and crustal instability—are related, and that all depend on events deep in the simatic layer. In Read's opinion, concepts which suppose downbuckling of sial into the sima seem to be most compatible with the orogenic and granitic phenomena.—*D. B. V.*

163–210. Ramberg, Hans. Thermodynamics and kinetics of petrogenesis: Geol. Soc. America Special Paper 62, p. 431–448, 1955.

Application of thermodynamic reasoning to geology is important in order to insure that we do not postulate processes impossible in the sense that they would lead the earth away from the state of ultimate stability and maximum entropy. Five basically different types of processes and their corresponding states of equilibrium should be distinguished when dealing with petrogenesis and evolution of the crust: mechanical transport, involving motion of matter in bulk caused by mechanical instabilities in the earth and leading to stable mechanical equilibrium characterized by uniform and minimum values of mechanical potentials throughout the earth; chemical processes, comprising changes brought about by individual motion and rearrangement of atoms, ions, and molecules and aiming toward stable chemical equilibrium characterized by uniform chemical potentials of minimum values throughout; thermal transport, characterized by heat flow down temperature gradients which become smooth at thermal equilibrium; electric transport, comprising unidirected currents of ions or electrons down electric potential gradients and prevailing when the electric potential is uniform throughout; and nuclear processes, including all types of nuclear reactions in the earth and leading ultimately to a state of equilibrium among the various nuclei and their products.—*D. B. V.*

163–211. Hess, H. H. Serpentines, orogeny, and epeirogeny: Geol. Soc. America Special Paper 62, p. 391–408, 1955.

Serpentinized peridotites are probably intruded only during the first great deformation of a mountain belt. They are typically found in two belts about 120 miles apart, one on either side of the axis of most intense deformation, but may also occur irregularly through this zone. Orogenies may be dated by dating the serpentines, and the axes of an ancient orogenic belt may be followed in some cases for thousands of miles. Hess maintains his stand, not as yet well accepted, that geosynclines are not present in island arcs (which represent an early stage in alpine mountain building) before the first deformation, but normally develop later because of that deformation.

Hess also believes that field evidence for fluid-state intrusion of peridotite takes precedence over laboratory evidence which seems to prove such magmas are not possible, and rejects the hypothesis of emplacement of serpentines as solids, except possibly for special cases.

Peridotites exposed in fault scarps of the Mid-Atlantic Ridge are interpreted as exposures of the peridotitic substratum, not as evidence of an alpine-type structure for the ridge. In the oldest rocks, serpentinized peridotites occur throughout the whole terrane rather than in belts. These seem to represent something similar to the present oceanic crust strongly deformed.

Finally, it is suggested that many features of suboceanic topography might be the result of uplift caused by serpentinization of peridotite below the Mohorovičić discontinuity, brought about by water leaking from the interior of the earth. Increase in temperature could cause deserpentinization. Uplift and subsequent subsidence could thus be accounted for by this reversible reaction.—*D. B. V.*

163–212. Stille, Hans. Unterschiebungs-Palingenese [Underthrusting palingenesis]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 15, fasc. 17, p. 127–137, 1954.

Folding leads to zonal thickening of the sialic upper crust and therefore results, according to the principles of isostasy, in a marked depression of the base

of the sial. When the sial reaches depths so hot that it can no longer remain in the solid state, it melts and a "palingenic" (lithogene) magma is formed. Thickening of the sialic portion of the crust can also be caused by underthrusting processes, and thus new sialic magmas can be formed in the region of thrust mountains (Deckengebirge). An outstanding example of this is the 800-km long Inner Carpathian volcanic ring.—*D. B. V.*

163–213. Kay, Marshall. Sediments and subsidence through time: Geol. Soc. America Special Paper 62, p. 665–684, 1955.

Superficial sediments and volcanic rocks are not distributed uniformly through time. The masses lying between restored surfaces have been classified in several ways. Long, laterally lenticular bodies in "mobile" or "orthogeosynclinal" belts contrast with areally more equidimensional forms of "stable" regions and cratons. The forms of these great surficial masses change with time.

Conclusions as to rates of subsidence are drawn from, and affected by inaccuracies in, measurements of thickness from surface outcrops or wells or by geophysical methods, and estimates of spans of time. Few estimates of maximum subsidence rates have been compiled, and very few of average thickness of surficial rocks for parts of the whole of continents. Most estimates in geosynclinal belts are for younger systems, because older rocks are buried or deformed or metamorphosed, if preserved at all.

For spans as long as a period, deformation at rates of more than 500 feet (150 meters) in 1 million years is uncommon; for shorter spans, parts of periods or epochs, rates occasionally exceed 1,000 feet (300 meters) but the probable error is greater. Maximum recorded rates are 2,000 feet (600 meters) and more, represented in fault-bounded geosynclines and foredeeps in the margins of stable cratons. Subsidence in basin form within cratons tends not be be long or extensive; it occasionally approaches 500 feet (150 meters) for spans of a few million years.

It is not conclusively shown that rates of maximum subsidence have increased through time. Estimates of average thickness of surficial rocks for continents are strongly influenced by interpretations of continental genesis.—*D. B. V.*

163–214. Kuenen, Ph. H. Sea level and crustal warping: Geol. Soc. America Special Paper 62, p. 193–204, 1955.

The reliability of sea level as a datum in geodesy and geology is affected locally by climatic influences and universally by variation in glacier volume. As a datum for the geologic past, many problems are involved. The nick just below sea level is evidently due to the action of external processes. It is not yet known whether cyclothems are of eustatic nature. The flat tops of guyots are erosional and indicate sinking at a rate of about 20 meters per million years. The lowest level during glacial times was roughly 100 meters minus, as shown by the riverbed on the Sunda shelf which has not been warped since the peak of the last ice age. Raised beaches prove the recent rise of island arcs facing deep-sea trenches and the intermittent nature of the movement, each jump adding about 1 milligal or less to the local value of gravity. There is a deplorable lack of data on tilting, warping, and dating of these terraces, which could tell so much of crustal movements. The amount and dating of the rise of the Daly terraces, ascribed by Daly to eustatism, is still debated; in some areas there is a singular absence of evidence on a recent drop in sea level. The postglacial updoming of the Canadian and Fennoscandian shields is recorded in countless raised beaches. Fieldwork seems to indicate the establishment of hinge lines, with updoming on the inside and permanent stability on the outside; the hinge line has migrated from south to

north in several jumps. Interglacial terraces have been widely studied outside glaciated areas, but not all can agree to their eustatic nature. The origin of the older terraces that lie far above sea level for an ice-free world is a vexing problem.—*D. B. V.*

163–215. Kuenen, Ph. H. Eustatic changes of sea-level: Geologie en Mijnbouw, jaarg. 16, no. 6, p. 148–155, 1954.

Three geologic processes that can influence sea level are the addition of water from the interior of the earth, changes in shape and capacity of the ocean basins, and changes in amount of ice on the land. The amount of juvenile water added to the oceans may have been great in the earliest history of the crust, but has not influenced sea level in the Quaternary. There have been more or less rhythmic changes during pre-Quaternary times that are probably due to internal deformations, but even with minor, more rapid superposed oscillations, it is highly improbable that eustatic shifts caused by nonclimatic conditions ever exceeded 1 cm per century. Glacial eustatism on the other hand has shown a range of 150 meters.—*D. B. V.*

163–216. Cotton, C. A. Aspects géomorphologiques de la flexure continentale [Geomorphic aspects of the continental flexure]: Soc. géol. Belgique Bull., tome 8–10, p. 403–418, 1955.

Marginal flexure of the continents, and perhaps also of large islands, seems to be a fact in some parts of stable regions and may obviously be present locally in mobile regions, but the extent to which such warping has been active in very recent times is undetermined. Confirmation of the hypothesis of flexure may be sought in assemblages of coastal landscape forms. Such traces as are found, however, will nearly always be complicated by assemblages of forms due to eustatic changes of sea level, especially the Flandrian transgression.—*D. B. V.*

163–217. Graham, John W. Evidence of polar shift since Triassic time: Jour. Geophys. Research, v. 60, no. 3, p. 329–347, 1955.

The magnetizations of 343 samples of Permian and Triassic sediments from the United States are compared with magnetizations that have been reported for sediments of approximately the corresponding age in England. It is demonstrated that an impressive number of the observations are in essential agreement simply on the basis of assuming that the rocks were magnetized by a geomagnetic field about like the one today, the essential difference being that this field was in a significantly different orientation. It is believed that, taken together, the observations reported earlier from England and those reported here provide a basis for believing that the geographic axis in Permian and Triassic time, or possibly somewhat after, appeared at about 50° W. long, and 45° S. lat (130° E. and 45° N.). A polar shift evidently implies the slipping of an outer shell of the earth relative to the axis of revolution. The problem is how much of the outer part of the earth behaves as a coherent unit and how much of the inner part reacts so as to conserve angular momentum.—*P. E. B.*

163–218. Day, A. A., and Runcorn, S. K. Polar wandering. Some geological, dynamical and palaeomagnetic aspects: Nature, v. 176, no. 4479, p. 422–426, 1955.

A report on a colloquium at the University of Cambridge. J. W. Durham spoke on paleontological evidence and stated that "Tertiary marine faunas clearly militate against any position of the continents and poles markedly different from

that now existing and the available evidence for the Paleozoic is much more in accord with the present positions than those postulated for continental drift." W. J. Arkell speaking on faunal evidence from the Jurassic concluded that the weight of the evidence is in favor of the North Pole being at about its present position, but that the climate was warmer and more even. T. Gold discussed the dynamics of the problem of polar wandering. Plasticity suggested by the free nutation of the poles is such as to cause the figure of the earth to be distorted toward the shape appropriate to the new axis at the rate of 10 percent per year, thus being responsible for a secular effect. Movement of the poles also causes some redistribution of mass, the largest being a change in polar glaciation and hence sea level, which may either help or hinder polar wandering. The effect of melting of the Greenland icecap is the correct order of magnitude within the uncertainties of the data to account for the present drift of the pole. S. K. Runcorn discussed inferences from studies of direction of magnetization. Paleomagnetic evidence suggests many reversals of the polarity of the geomagnetic field and a slow change in mean direction. The movement of the pole of rotation from the mid-Pacific to the present position may be the result of a lack of symmetry in convection currents in the mantle.—*M. C. R.*

163–219. Pariyskiy, N. N. Izmeneniye skorosti vrashcheniya zemli v techenii goda [The variation of the rotational velocity of the earth in the course of the year]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 19 (146), p. 53–102, 1953.

Changes in the rate of the deviation of astronomical clocks indicate there are irregularities in the rotational movement of the earth with annual and semi-annual periods. The velocity of rotation is greatest in August and the least in March. Pariyskiy is critical of related studies by Belgian scientists [see Geophys Abs. 12599, 14312, 14313, 14363] which attribute this irregularity to seasonal displacements of the air over the earth's surface that affect the moment of inertia. Pariyskiy's calculations indicate these displacements of air masses produce an effect about 3,000 times smaller than that observed.

Other seasonal phenomena of a meteorological nature such as vertical displacements of the air, changes in the snow cover, and humidity of the atmosphere cannot produce noticeable variations of the rotation of the earth.

The situation is different with seasonal changes in atmospheric circulation. The effect of the interchange of moments of momentum related to different wind masses varying with the seasons of the year can produce the observed effects on terrestrial rotation. However, calculations can not be sufficiently accurate because the absence of necessary meteorological observations in many parts of the earth.—*S. T. V.*

163–220. Pariyskiy, N. N. Neravnomernost' vrashcheniya zemli [Irregularity of the rotation of the earth]: Akad. Nauk SSSR Geofiz. Inst. Trudy no. 26 (153), p. 131–152, 1955.

A review of studies of secular, periodic, and irregular variations of the rotation of the earth. Pariyskiy finds that during the last 2,500 years, in addition to the secular deceleration caused by tidal friction, there has been a smaller secular acceleration, producing a relative change of angular velocity of $+1.4\times10^{-8}$. This acceleration can be explained either by an accumulation of changes in the moment of inertia of the earth caused by the displacement of masses in the interior of the earth or, less probably, by an increase of the Antarctic icecap (64 meters during 2,000 years) and a corresponding lowering of sea level (about 2.5

meters). Computations of the effect of tidal friction by Jeffreys are incomplete; those of Heiskanen are underestimated by a factor of 3. Secular tidal retardation is possibly affected by the phase displacement of tides in the solid body of the earth. Irregular changes of the angular velocity of the earth are correlated with the processes in the earth's interior.—*S. T. V.*

163–221. Goodhart, C. B. Instability of the earth's axis: Nature, v. 176, no. 4477, p. 349, 1955.

In a "Letter to the Editors", Goodhart suggests that evidence of major changes in latitude should be sought in plant fossils. If plant fossils showing continuous growth without well-defined annual rings are found at higher latitudes, it would be good evidence of past latitude changes, as continuous growth without an annual winter check can never have been possible far outside tropical latitudes.—*M. C. R.*

163–222. Thomas, H. Hamshaw. Instability of the earth's axis: Nature, v. 176, no. 4477, p. 349, 1955.

A "Letter to the Editors" points out that both rocks and fossils provide evidence of climatic changes of great importance in relation to the evolution of plants and to the past history of terrestrial animals. If geophysical research can establish how these changes came about, an important contribution to biology will be made.—*M. C. R.*

163–223. Wegmann, E. Lebendige Tektonik—Eine Übersicht [Active tectonics—A review]: Geol. Rundschau, Band 43, Heft 1, p. 4–34, 1955. (Also in French, p. 273–306).

This review of recent deformation covers the other papers appearing in the same issue (which is entirely devoted to the subject) as well as numerous earlier references; it includes discussion of methods of determining recent deformations and measuring their rate of development, and their geographic distribution.

Structural evolution of a region is worked out from the superposition of various types of deformation. Geophysical methods show us the present state of the earth's crust but in themselves do not yield information as to its evolution, most methods having been in use for only about 50 years at most.—*D. B. V.*

163–224. Fisk, H. N., and McFarlan, E., Jr. Late Quaternary deltaic deposits of the Mississippi River (Local sedimentation and basin tectonics): Geol. Soc. America Special Paper 62, p. 279–302, 1955.

Surface and borehole information on the delta sediments of the Mississippi River shows that over 8,000 cubic miles of sediment have been deposited during the late Quaternary within a 44,000-square-mile area comprising the deltaic plain and adjacent continental shelf and slope. Resulting localized subsidence of the continental margin has been over 350 feet near the present shoreline and over 500 feet offshore. Major and minor features both seem to have been controlled by the same tectonic forces.

From radiocarbon dating of younger parts of the delta it is deduced that sea level was rising about 20,000 years ago and filling the subsiding trench, and about 10,000 years ago stood within 100 feet of its present level.—*D. B. V.*

163–225. Suter, H. H. Indications of recent tectonic activity in Canada: Geol. Rundschau, Band 43, Heft 1, p. 263–264, 1955.

Very little tectonic activity in recent times is reported from Canada. There are active earthquake zones along the British Columbia coast, and some earth-

quakes have been correlated with known faults. Alluvial gravels in the Ghost River valley have been displaced along a fault parallel to the Front Range. Earthquake lines in east-central Canada are suspected to be related to movements along the Ottawa Bonnechere graben. The Canadian shield has been remarkably stable for a long period of time. There are indications of recent or subrecent faulting near the rim of the shield in central Quebec.—*D. B. V.*

163–226. Suter, H. H. Present tectonic activity in Trinidad, B. W. I.: Geol. Rundschau, Band 43, Heft 1, p. 264–265, 1955.

Present activity consists mainly of sporadic paroxysms of mud volcanoes, which are one surface expression of diapirs. Material erupted comes, in some places, from depths of more than 2,000 meters. In one place on the south coast, mud volcanic activity has raised parts of young beach terraces from tidal level to an elevation of 10 feet. The alinement of the four rows of mud volcanoes, averaging N. 85° E., is more easterly than that of fold trends, which run N. 60°–70° E. It is concluded that the active tectonic lines are deeper seated and probably related to the trend of the Northern Range, in which the oldest (Cretaceous-Jurassic) beds cropping out in Trinidad occur. Other tectonic activity consists of minor earthquakes, particularly along the transcurrent Los Bajos fault.—*D. B. V.*

163–227. Edelman, T. Tectonic movements as resulting from the comparison of two precision levelings: Geologie en Mijnbouw, jaarg. 16, no. 6, p. 209–213, 1954.

Results of precision leveling of the Netherlands between 1926 and 1940 show appreciable differences from those of leveling carried on from 1875 to 1887. An important point is the general northward tilting of the country as a whole, which has amounted to about 8 cm over a distance of 300 km in the 50–60 years between surveys. In the southeastern part of the country, lines of tilt are parallel to the great faults (NNW.–SSE.).—*D. B. V.*

163–228. Pannekoek, A. J. Einige Beispiele quartärer Tektonik in den Niederlanden [Some examples of Quaternary tectonics in the Netherlands]: Geol. Rundschau, Band 43, Heft 1, p. 52–56, 1955.

The Netherlands as a whole are part of the subsiding North Sea Basin; movements along faults in the southwestern part of the country have produced a continuation of the Lower Rhine horst and graben structure. Recent levelings show that the general tilting and differential movements are still going on. Whether true folding occurred in the Quaternary cannot yet be determined.—*D. B. V.*

163–229. Pannekoek, A. J. Final address to the symposium on Quaternary changes of sea level in the Netherlands: Geologie en Mijnbouw, jaarg. 16, no. 6, p. 265–267, 1954.

This is a summary of the symposium on sea level changes in the Netherlands [see Geophys. Abs. 158–168, 158–209; and others in this issue]. Since a meeting on the same subject 15 years ago, many more facts have become known regarding the relative height of sea level, the tectonic element of subsidence, and the role of compaction, but it is still not possible to estimate the present rate of relative subsidence any more accurately than in 1939. The probable figure may be anything between 5 and 30 cm per century. The crux of the problem lies in the glaciated polar regions and ultimately in variations of solar radiation; further research into these problems is indispensable.—*D. B. V.*

163–230. Schmidt-Thomé, P. Zur Frage quartärer Krustenbewegungen im Alpen und Voralpengebiet des Isartalbereichs [On the question of Quaternary crustal movements in the Alps and pre-Alps region of the Isar Valley area]: Geol. Rundschau, Band 43, Heft 1, p. 144–158, 1955.

Deep borings and geophysical investigations show there are more than 200 meters of Pleistocene gravels and marine clay covering a preglacial surface. Indications of Quaternary uparching cannot be accepted as established; rather the movement since later interglacial time is of widespread epeirogenic proportions.—*D. B. V.*

163–231. Küpper, H. Art und Ausmase der jüngsten Bewegungen im wiener Becken [Type and amount of the very recent movements in the Vienna basin]: Geol. Rundschau, Band 43, Heft 1, p. 176–178, 1955.

The recent tectonic phase in the Vienna basin, which began in the uppermost Pliocene, is characterized by new trends with respect to older structures and is related to the seismicity of the region. Subsidence has amounted to about 200 meters during the last 700,000 years, a rate of about 1 meter in 3,000 years.—*D. B. V.*

163–232. Trevisan, Livio. Les mouvements tectoniques recēnts en Sicile. Hypothéses et problémes [Recent tectonic movements in Sicily. Hypotheses and problems]: Geol. Rundschau, Band 43, Heft 1, p. 207–221, 1955.

Quaternary tectonic movements in Sicily (mainly faulting and tilting) are discussed here in some detail; they appear to be a continuation of Pliocene movements. Sections most recently uplifted are least active seismically, and those recently depressed most active. The existence of post-Sicilian or post-Tyrrhenian deformation might be determined if more exact altitude determinations of old shorelines in Sicily and elsewhere were available.—*D. B. V.*

163–233. Glangeaud, Louis. Les deformations plio-quaternaires de l'Afrique du Nord [The Plio-Quaternary deformations of North Africa]: Geol. Rundschau, Band 43, Heft 1, p. 181–196, 1955.

Evidence on the Pliocene-Quarternary deformation in French North Africa points to an interaction of eustatic and epeirogenic movements (affecting the whole peri-African region), migration of continental borders (local isostatic adjustment to erosion and sedimentation), and small-scale folding (due to local play of forces due to semiautonomous adjustments between individual segments).

The relations between the geophysical mechanisms and gravity are difficult to calculate exactly because of the superposition of phenomena of different scales of importance. Moreover, isostatic calculations are established by assuming that equilibrium is attained, but certain zones are still in process of readjustment. Zones in the course of uplift thus can have a negative anomaly whereas those in the course of subsiding show a positive anomaly.

Localization of earthquake zones depends both on present epeirogenic phenomena and on ancient local faults. Many earthquakes are related to the Pliocene-Quaternary flexures which are still being deformed, but locally, movement takes place along ancient dislocations dating from Upper Nummulitic and older times.—*D. B. V.*

163–234. Lees, G[eorge] M[artin] Recent earth movements in the Middle East: Geol. Rundschau, Band 43, Heft 1, p. 221–226, 1955.

In the Mesopotamian plains, recent deformation can be measured by its effect on old canal systems and culture levels. As a whole the mountains (Alpine-Himalayan system) are being upwarped and the plains depressed, but there is also continued growth of individual anticlines. At Shaur, an old Sassanian canal has been folded anticlinally at a rate of 1 meter per century. Areas which were under irrigated cultivation perhaps as late as the 13th century have been depressed and are now inundated by the advancing head of the Persian Gulf.—*D. B. V.*

163–235. Zeuner, F. E. Recent movement on the western fault of the Dead Sea Rift: Geol. Rundschau, Band 43, Heft 1, p. 3, 1955.

Excavation of the ruins of the Khirbet Qumran monastery near the north end of the Dead Sea reveals a minor fault crossing a staircase, with the east side dropped about 30 cm. This faulting took place in an earthquake in 31 B. C. Fragments of the Dead Sea scrolls found nearby have been dated by the radiocarbon method as $1{,}917 \pm 200$ years old. The region, along the western fault of the Dead Sea rift, is tectonically active at the present time; earthquakes are so numerous that minor shocks receive little attention.—*D. B. V.*

163–236. Pinar, N[uriye], and Lahn, E. La position tectonique de l'Anatolie dans le systéme orogénique Méditerranéen [The tectonic position of Anatolia in the Mediterranean orogenic system]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 15, fasc. 17, p. 171–180, 1954.

Anatolia has undergone an orogenic and epeirogenic evolution analogous to that of the western Mediterranean, but the Anatolian Alpine zone differs from the European Alpine zone in the great intensity of its epeirogenic movements, as shown by the multitude and extent of young volcanic events and the frequency and intensity of earthquakes.—*D. B. V.*

163–237. Brock, Byron Britton. An approach to the Rift Valley problem: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec. 3, fasc. 3, p. 225–239, 1954.

Neither the keystone nor the compressional theory adequately explains the east African rift valleys. Rift faulting forms an integral part of the Gondwana type of structure with its block faulting, basins, and rims all interrelated. The difference between these features is largely one of pattern and scale; the tectonics are the same.

The dropping of fault blocks has a counterpart in uplift of adjacent blocks suggesting a limited magma reservoir below operating on the principle of a hydraulic jack. Extrusion of lava is an imperfection in the hydraulic device. Uplifted blocks within the rift axes are explained by this principle. Isostasy is irrelevant, and the gravity anomalies in the rift valleys have not the significance hitherto attached to them.—*D. B. V.*

163–238. Kobayashi, Teiichi. Up and down movements now in action in Japan: Geol. Rundschau, Band 43, Heft 1, p. 233–247, 1955.

Vertical movements now going on in Japan are of different spatiotemporal dimensions. Those caused by earthquakes and volcanic eruptions are quite large relative to their short time span. Secular movements are extensive and differ among the various tectonic provinces. In general, basins are still being

depressed and mountains rising. Levelings across the inner zone of west Japan indicate geanticlinal warping of 9 cm in 30–40 years, with the axis along the backbone of the Mesozic folded mountains.

Japan is a good example of the development and migration of a geosyncline (the Nakamura). The vertical movements now going on may be the aftereffects of a second phase, with a third phase still to come, of the Oyashima orogenic cycle.—*D. B. V.*

163–239. Rade, J. Geotectonics and volcanoes of Australian New Guinea: Australian Jour. Sci., v. 17, no. 3, p. 83–87, 1954.

The geotectonic features of Australian New Guinea and the Bismarck Archipelago are outlined briefly and interpreted according to Kraus' theory of "mobilismus" [see Geophys. Abs. 155–14997]. The broad structural outlines are similar to those of Indonesia and the Hawaiian Islands. The main bathyreal underflow has been responsible for the fragmentation of the northeastern portion into a number of blocks, separated along north-south fractures, which have undergone considerable horizontal and vertical movement. Volcanic centers in the Bismarck Archipelago and in the "tail" of New Guinea are migrating southeast and south along deep-seated crustal fractures. [See also Geophys. Abs. 154–14745].—*D. B. V.*

163–240. Wellman, H. W. New Zealand Quaternary tectonics: Geol. Rundschau, Band 43, Heft 1, p. 248–257, 1955.

The major faults in the New Zealand mobile belt are all transcurrent. The great majority strike northeastward and movement is clockwise. At the largest, the Alpine fault, the undermass on the southeast side seems to have been displaced 300 miles southwestward relative to the northwest side since the end of the Jurassic. The average rate since the Jurassic is 0.15 inches per year, about 1 inch per year since the last glaciation.

The direct relation at several places along the branches of the Alpine fault between transcurrent faulting and river downcutting suggests that both have continued at a uniform rate at least since the last glaciation. At two of the major branches the rate is about 0.25 inches per year. A rate of about an inch a year was determined from the differences observed in geodetic triangulation during a period of 50 years, but probably only part of the geodetic difference corresponds with faulting.—*D. B. V.*

INTERNAL CONSTITUTION OF THE EARTH

163–241. Kuiper, Gerard P. (editor). The earth as a planet: 751 p., Chicago, Univ. Chicago Press, 1954.

This is volume 2 of a planned 4-volume treatise on the solar system. It is intended "to cover those aspects of geophysics, geochemistry, and atmospheric physics as pertain to the earth as a whole and which incidentally, are able to assist and guide the astrophysical studies of the other planets." The fifteen chapters include: Dimensions and rotation, by Sir Harold Spencer Jones; Dynamics of the earth-moon system, by Sir Harold Jeffreys; The interior of the earth, by Sir Edward Bullard; The development and structure of the crust, by J. Tuzo Wilson; and The geochemistry of the crust, by Brian Mason.—*M. C. R.*

163–242. Poldervaart, Arie (editor). Crust of the earth (A symposium): Geol. Soc. America Special Paper 62, 770 p., 1955.

Papers presented at a symposium during the bicentennial celebration of Columbia University have been gathered in this volume. They are in four groups

on: the nature of the earth's crust; recent deformation and sedimentation; structural synthesis and petrogenesis; and historical development of the earth's crust. For geophysical contributions see abstracts in this issue.—*M. C. R.*

163–243. Ewing, Maurice, and Press, Frank. Geophysical contrasts between continents and ocean basins: Geol. Soc. America Special Paper 62, p. 1–6, 1955.

Geophysical studies have shown that the continental crust and mantle are uniform, and also the oceanic crust and mantle, if the three types of anomalous crust—mountain chains, island arcs and deep-sea trenches, and continental margins—are excluded. The continental crust is 35 km thick; compressional and shear velocities are 6.2 and 3.6 kmps near the top, increasing with depth to 7.0 and 3.8 kmps. In the mantle the velocities are 8.15 and 4.7 kmps. In the ocean areas, the Mohorovičić discontinuity is 10–11 km below the sea surface and is underlain by ultramafic rocks with compressional velocity of about 8.1 kmps. The crust is somewhat less than 5 km thick with a compressional velocity of 6.4 to 6.9 kmps, with some evidence that the lower velocities occur nearer continental margins. The margins and anomalous regions are now the most crucial and least known regions of the crust.—*M. C. R.*

163–244. Gilluly, James. Geologic contrasts between continents and ocean basins: Geol. Soc. America Special Paper 62, p. 7–18, 1955.

Isostasy implies gross lithologic contrasts between continents and ocean basins, but oceanic rocks collected from islands do not differ sharply from continental rocks. Most high ridges seem to be partly sial; probably the deeper oceanic basins are essentially free of it. The continents should be smaller or lower than in the past owing to secular loss of sialic material to the pelagic areas; the fact that they seem as large or larger than in early geologic history suggests addition of sial from the mantle.

If the continents have grown areally by accretion of shelf geosynclines to a central nucleus, pelagic sediments and simatic geosynclinal floors should be common. Their absence, however, is not conclusive argument against such growth, as metasomatism may have changed the original rock during orogeny, and furthermore many of the Pacific border mountains show no geosynclinal floors older than Paleozoic. A former simatic basement may have been folded downward and be now overlain by sial crowded over it, thus changing a former oceanic segment to a continental. In many areas there is evidence that former continental segments have been depressed at least 3,000 meters. Thinning and thickening of sial by subcrustal erosion or deposition could explain isostatically both this sort of depression and plateau uplift.

The visible processes now modifying continents and ocean basins do not account for the diversities between them. The shoreline is critical in dynamic geology. Sediment is being carried across this boundary at a rate which would erase all topography above sea level in less than 10 million years if compensating uplift did not occur. Subcrustal flow induced by isostatic response to unloading may influence both coastal structures and differentiation of sial, but such flow does not in any way explain the contrast between Pacific and Atlantic structures nor can it be the governing factor in orogeny. These must result from other movements deep within the mantle, perhaps led by the shallow movements.—*D. B. V.*

163–245. Knopf, Adolph. Bathyliths in time: Geol. Soc. America Special Paper 62, p. 685–702, 1955.

The oldest batholiths of Archean age have invariably been found to intrude Precambrian supracrustal rocks, and consequently no field evidence for a primordial granite shell has yet been found. The belief that granite intrusion was especially abundant in earliest geologic time because the crust was thin, hot, and mobile has been giving way to the conviction that batholithic intrusion has been determined by the same laws throughout geologic time.

Absolute age determinations show that Precambrian granites actually differ in age by as much as 1,000 million years (Lawson's "Laurentian," 2,000–2,500 million years; type Laurentian, 1,050 million; Killarnean, 800 million). At present six distinct periods of granitic intrusions have been recognized for the Canadian shield on the basis of absolute age determinations.

Most batholiths are of orogenic type, situated generally in the axes of folded geosynclines. According to Stille, foldable geosynclinal belts have been diminishing in total area during geological time and therefore batholithic intrusion should have followed the same course; on the other hand, Birch concluded from analysis of the few data available that the rate of intrusion or formation of granite was uniform. Knopf's planimeter measurements of the batholiths of North America seem to show that rate of intrusion was roughly the same during Precambrian as since Precambrian time. For shorter periods the rate was highly variable, reaching a maximum during late Mesozoic time. Evidence from shield areas indicates that the volume of granite intruded was small during earliest Precambrian, and increased to a maximum in the middle of the Cambrian.—*D. B. V.*

163–246. Worzel, J. Lamar, and Shurbet, G. Lynn. Gravity interpretations from standard oceanic and continental crustal sections: Geol. Soc. America Special Paper 62, p. 87–100, 1955.

From seven continental seismic profiles believed to be the best where gravity and elevation information is also available, and six oceanic seismic stations where gravity data are available, standard continental and sea sections have been determined. Densities of 1.03 for sea water, 2.30 for sediments, and 3.27 for the mantle have been used. The density 2.84 is chosen for crustal rock to make the land and sea columns of equal gravitational attraction from the layer thicknesses determined by these seismic data. The sections obtained are 33 km of crustal rock of density 2.84 overlying the mantle for the standard continental section, and 5 km of sea water, 1 km of sediments, 4½ km of crustal material overlying the mantle for the standard sea column.

Utilizing these standard columns, the Puerto Rico Trench, the great deeps such as the Mindanao Deep, the Gulf Coast geosyncline, and the Bahamas Platform are discussed and their probable structure deduced. It is concluded that the Puerto Rico Trench contains about 6 km of sediments over a standard oceanic crust, that the crustal thickness beneath Puerto Rico is about 25 km, and that the great deeps contain little sediments and probably have been formed by tensional processes. Assuming that the Gulf Coast geosyncline and the Bahamas Platform were formed on an oceanic crust, the base of the Gulf Coast sediments is approximately level at a depth of 12.5 to 15.7 km (41,000 to 51,000 feet) from the shore line to the 100-fathom curve, and the calcareous sediments in the Bahamas are 28.5 km (93,000 feet) thick, with the upper 4.9 km (16,000 feet), observed in the well on Andros Island, laid down in water depths of less than 0.6 km (2,000 feet).—*Author's abstract*

163–247. Tatel, Howard E., and Tuve, Merle A. Seismic exploration of a continental crust: Geol. Soc. America Special Paper 62, p. 35–50, 1955.

Field and model work indicate that a very large part of the ground undulations recorded on a typical seismogram may be attributed to waves converted and scattered at the earth's surface. These large motions mask the waves from the earth's interior and are therefore extraneous. Many seismograms, and many changes in shot point and observing position, are necessary to sort out the true earth waves.

With these precautions, it has been found that in a typical section the average velocity increases only slightly with depth for the upper two-thirds of the crust, but in the lower third increases more rapidly, and perhaps abruptly, to 8 kmps. Most of this increase either is concentrated in a special refracting-focusing zone of the lower few kilometers of the crust or is a discontinuous increase from 7 to 8 kmps within the lowest fraction of a kilometer of the crust.

Fluctuations in arrival times, with respect to uniform wave travel, are due to a combination of interior and near-surface inhomogeneities. Thus the data are considered to be averages, and the straight lines in the time-distance curves and velocity-depth curves are simple approximations to the actual complex earth structures.

Although some regional relations are found between surface heights and the depth of the velocity discontinuity, the old Pratt and Airy concepts are inadequate to describe the structure of a continent. From gravity and seismic data we can conclude only that a continent may be described as a large land mass over which there is approximate isostatic compensation. It may have a depth of compensation down to hundreds of kilometers. Such a continent is capped by a layer which is discontinuous, 30 or 40 km below surface, with respect to the material beneath it. The mean regional density of the upper layer, or crust, may vary. Thus the properties of a continental region may be determined by large sections of the outer mantle itself, with densities varying over a horizontal extent of continental dimensions. In this picture, continental elevation and subsidence would be controlled by small changes in a large vertical column. The old concept of a continental plate overlying the mantle may hold, but must allow for large variations in regional crustal densities; the average density is 7 or 8 percent less for the entire crustal column under the Colorado Plateau than for those under the Atlantic coastal plain or the Appalachians or the Mesabi. These regional differences are fundamental to our understanding of the structure of continents.—*D. B. V.*

163–248. Press, Frank, and Ewing, Maurice. Earthquake surface waves and crustal structure: Geol. Soc. America Special Paper 62, p. 51–60, 1955.

In order to check the reliability of methods of determining crustal structure involving use of surface waves, the best available data for Love and Rayleigh waves from earthquakes were compared with theoretical dispersion curves based on experimental seismic refraction studies. Both oceanic and continental regions were considered. It is concluded that the surface wave determinations are concordant with the principal results of refraction measurements and, as they give the average properties of the crust across continents or oceans, provide valuable supplementary data to the point-by-point refraction measurements. Furthermore, surface-wave methods may be applied to regions inaccessible for refraction experiments. The velocity of shear waves in the upper silicic crust

of continents deduced from study of the L_g phase is used in interpretation of surface-wave data. Three conditions must be fulfilled to insure successful application of the surface-wave method: careful separation of continental and oceanic paths; use of dispersion waves covering a large range of periods and, wherever possible, based on a single well-recorded earthquake; and proper allowance for all parameters that affect the dispersion.—*D. B. V.*

163–249. Treskov, A. A. Seysmicheskiye issledovaniya zemnoy kory [Seismic investigations of the crust of the earth]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 26(153), p. 92–99, 1955.

Existence of the crust was discovered by Mohorovičić from observations of differences in traveltimes that could be explained by a layer of abruptly increasing velocity. It is generally assumed that the velocity along the lower boundary surface of this crust is 7.8 kmps. The total thickness of the crust has been determined in many places. According to Rozova it is 50 km deep in Russian Turkestan, and Treskov indicates that in the middle of the Asiatic continent, near Lake Baikal, the thickness of the crust is about 60 km. The most convenient method of determining the thickness of the crust is by observation of the wave reflected from the lower surface of the crust.—*S. T. V.*

163–250. Sanders, P. La structure des bassins oceaniques d'apres les données seismologiques [The structure of the ocean basins from seismologic data]: Ciel et Terre, 71e année, fasc. 9–10, p. 298–314, 1955.

This is an explanation of seismological methods of determining crustal structure under ocean basins, the longitudinal wave dispersion method, and the seismic refraction technique which promises to resolve many fundamental problems of the Atlantic and Pacific basins. Present knowledge of the structure underlying these two oceans and prominent hypotheses accounting for their features are reviewed.—*D. B. V.*

163–251. Gutenberg, Beno. Wave velocities in the earth's crust: Geol. Soc. America Special Paper 62, p. 19–34, 1955.

The crust (here defined as the lithosphere) consists of sediments, a granitic (or sialic) layer which is absent in deep ocean basins, a basaltic (or gabbro) layer which is separated from the deeper ultrasima by the Mohorovičić discontinuity. The velocities of longitudinal and transverse waves in the sial are about 6 kmps and 3½ kmps, in the gabbro, 6½ to 7 kmps and 3¾ kmps, and in the ultrasima, 8.2 and 4¾ kmps. The depth of the Mohorovičić discontinuity varies between from about 10 km below sea level in deep ocean basins to 50 km or more under mountains. There are local differences in velocities and depths, some of which may be spurious and due to errors in calculations, misinterpretation, and incorrect assumptions about the structure, especially failure to consider effects of low-velocity layers, which may produce shadow zones for certain waves or at least very small amplitudes. The low-velocity layers at depths between 10 to 150 km are probably the effect of the preponderance of a decrease in wave velocity as a consequence of the temperature increase with depth over the increase by pressure. Such a decrease may occur in each of the crustal layers.—*M. C. R.*

163–252. Weaver, Paul. Gulf of Mexico: Geol. Soc. America Special Paper 62, p. 269–278, 1955.

Geologic and geophysical data on sediments underlying the gulf coast area indicate rather stable conditions on land, but irregularity in topography wherever the bottom of the gulf has been mapped. On the continental slope and even on the continental shelf and just inside the shoreline there is evidence of recent movement. Weaver believes that the "flexures" (zones where rate of thickening of sediments increases from about 1 percent per mile seaward to 10 times that amount) represent sharp steep continental slopes like that off the west coast of Florida today. Subsurface data suggest that steepening of the slope takes considerable time. The four flexures postulated are widely but not regularly spaced in time. In contrast, the regular thickening in all formations seaward might be due to compaction and (or) isostatic effects.

A positive magnetic anomaly is associated with the south Texas flexure, suggesting basement displacement corresponding to the Vicksburg displacement.—*D. B. V.*

163–253. Emery, K. O. Submarine topography south of Hawaii: Pacific Science, v. 9, no. 3, p. 286–291, 1955.

Geomorphic and structural evidence suggests that the center of volcanism in the Hawaiian Islands has migrated slowly from northwest to southeast. A younger center of volcanism may now be building one or more cones on the sea floor southeast of Hawaii, eventually to form new islands. Sounding traverses south and southeast of Hawaii in 1954 showed the presence of three main physiographic units: lower slopes of Hawaii, Hawaiian Deep, and Hawaiian Arch with five seamounts superimposed on these units. It is highly probable that the seamounts are of volcanic origin, but it is impossible to state that they constitute an extension of the center of volcanic activity without further study. Such a study is important in a geophysical sense because the submarine area of the island chain far exceeds the subaerial area and the effort expended to date has been dominantly on the land area.—*V. S. N.*

163–254. Westerveld, J. The Lucipara Islands ridge and a third arc in the Banda Sea: Geologie en Mijnbouw, jaarg. 17, no. 3, p. 84–88, 1955.

The geological evidence shows that the presumed third arc in the Banda Sea, as postulated by Vening Meinesz [see Geophys. Abs. 149–13675], connects island regions with very different geological records and structural positions; hence "a fair degree of scepticism regarding the realty of its existence seems justified."—*D. B. V.*

163–255. Revelle, R[oger], Bramlette, M., Arrhenius, G[ustaf], and Goldberg, E[dward] D. Pelagic sediments of the Pacific: Geol. Soc. America Special Paper 62, p. 221–236, 1955.

This paper is concerned mainly with the distribution and composition of sediments in the Pacific Ocean basin. The percentage of bottom area covered by clays is nearly twice that of the Atlantic, and the average carbonate content of the clays is smaller. Furthermore, the decrease of CO_2 with depth is more rapid in the Pacific than in the Atlantic sediments. Seismic refraction and reflection profiles suggest the sediments are about 200 meters thick in the clay areas and 400 meters thick beneath the equatorial calcareous zones. A radiocarbon measurement indicates for the last 14,000 years an average rate of deposition of 3 cm per 1,000 years in the area of maximum carbonate accumulation below the equa-

torial divergence. The corresponding rate of deposition of the nonbiogenous components would be about 0.26 cm per 1,000 years.—*D. B. V.*

163–256. Raitt, Russell W., Fisher, Robert L., and Mason, Ronald G. Tonga Trench: Geol. Soc. America Special Paper 62, p. 237–254, 1955.

Seismic refraction profiles parallel to the axis indicate that the foundation of the trench is rock, probably volcanic, of compressional wave velocity 5.2 ± 0.2 kmps. The sediment thickness is about 2 km in the Tofua Trough, very thin (<200 meters average) in the inner gorge of the trench, and about 400 meters on the east flank, 50 km from the trench axis. Beneath the 5.2-kmps basement the crustal velocity is 7 kmps in Tofua Trough, 6.5 kmps at the trench axis and on the east flank. The Mohorovičić discontinuity, characterized by a velocity of 8.1 ± 0.1 kmps, is estimated to be at a depth of 20 km below sea level at the trench axis, and 12 km below sea level on the east flank. Beneath Tofua Trough the highest velocity observed was 7.6 kmps, at about 12 km below sea level. Two profiles of total magnetic field strength recorded across the trench have been used to estimate profiles of sediment thickness. When the effects of basement topography are eliminated, a deep-seated asymmetry remains that could indicate either that the Curie point isothermal surface is deeper or that the magnetic susceptibility is greater on the west side than on the east side of the trench.

Comparison with the Puerto Rico Trench [see Geophys. Abs. 156–16, 156–17] shows a striking difference in the quantity of sediment, which is considerable in the Puerto Rican but nearly absent in the deepest part of the Tonga Trench. Basement velocity is somewhat higher in the Puerto Rican (5.5–6 kmps). These differences suggest that the Tonga Trench is younger. As volcanic eruption continues to build up the ridge, it will not only supply sediment to the trench but will also increase the basement velocity by the added weight of material. If during this process the forces producing the trench continue to widen and deepen it, it will become more like the Puerto Rico Trench.—*D. B. V.*

163–257. Ewing, Maurice, and Heezen, Bruce C. Puerto Rico Trench topographic and geophysical data: Geol. Soc. America Special Paper 62, p. 255–268, 1955.

The gravity anomalies across the Puerto Rico Trench can be most satisfactorily interpreted as being due to local thinning of the crust rather than to downbuckling; hence, tension rather than compression is probably the dominant force involved in the formation of deep oceanic trenches.

The many similarities shown between the Puerto Rico Trench and the Cayman Trench point to a similar origin of the two features. Both are the result of tension. Along the axes of the present trenches the crust has either fractured or thinned owing to tension. In order that equilibrium be reached, the thin crust will eventually be forced up, or the fissures partly filled, by upward flow of subcrustal material under the trench. It can be supposed that the viscosity of the subcrustal material is sufficiently great that a considerable timelag will occur between the time of the fracture and the time the subcrustal material has finished its upward flow. The sediments deposited in the trench during this interval will be uplifted and deformed. This provides a mechanism for the formation of the islands of the arcs and for the periodic extension of the continents. Parallel fractures occurring along nearly the same lines but somewhat offset each time would provide a continent-forming process without the necessity of downbuckling of the crust. The linearity of the feature strongly suggests a transcurrent component.—*D. B. V.*

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163–258. Valle, P. E. Una stima del punte di fusione del ferro sotto alte pressioni [An estimate of the melting point of iron under high pressure]: Annali Geofisica, v. 8, no. 2, p. 189–200, 1955.

Using the theory of solids the temperature and density of iron at melting as a function of pressure have been estimated. Iron has a maximum melting point of about 8,409°K which results at a density of 36.4 grams per cm^3. However in the range of pressure of the earth's interior the melting of iron cannot be achieved solely by reversible adiabatic compression. The density-pressure curve of iron at melting is very close to the isothermal curve calculated by Birch on the basis of the theory of finite strain. Bullen's densities for layer *E* of the earth's core are about 15 percent smaller than the values for iron at melting point.—*Author's abstract.*

163–259. Quiring, Heinrich. Schalenbau der Erde und sphärogene Erze [Shell structure of the earth and spherogene ores]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, sec, 13, fasc. 15, p. 431–438, 1954.

The concentric shells forming the solid earth, from outside in, are the rigid sial (granite) and sima (basalt); the amorphous-plastic gabbro-, pyroxenite-, dunite-, hortonolite-, and fayalite-magma shells; below these, which together constitute the lithosphere, is the siderosphere, composed of the amorphous-plastic chalcosphere or ore shell; the both solid and amorphous-plastic nickel-iron shell; and the dense gaseous core. According to Quiring, the ascent of magma from deep ultrabasic shells of the lithosphere sets up convection currents in the chalcosphere beneath; the release of pressure causes the sulfide to become liquified or even gaseous, and burst forth into the overlying layers to form at least a great part of ore deposits.—*D. B. V.*

163–260. Melik-Gaykazyan, I. Ya. O stroyenii zemnogo yadra [On the structure of the earth's core]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 26(153), p. 117–120, 1955.

From analysis of longitudinal waves reflected and refracted at the core boundary on seismograms of distant earthquakes recorded chiefly by Russian seismological observatories, Melik-Gaykazyan concludes that the boundary of the core is seismically sharp, probably one result of an abrupt change in physical composition.—*S. T. V.*

GEOPHYSICAL EXPLORATION

163–261. Robertshaw, Jack, and Brown, Philip Duncan. Geophysical methods of exploration and their application to civil engineering problems: Inst. Civil Engineers [London] Proc., v. 4, no. 5, p. 644–690, [text, 644–676, discussion, 676–690], 1955.

A review of the principles of the electrical resistivity and seismic refraction method and their application to site investigation. Resistivity surveys at a proposed dam site in the Fiji Islands, a cutoff wall in Cornwall, for gravel deposits in Northamptonshire, and along a proposed pipeline trench in Scotland, seismic surveys at sites of proposed dams in Eire and Pakistan and a proposed ironworks, and also to determine the depth of glacial drift over coal measures in Wigan are cited as examples. The necessity of geologic knowledge of the sites and the advisability of boreholes to aid and check interpretation are emphasized.—*M. C. R.*

163–262. Blum, C. J. Geophysical methods for uranium prospecting: Compass, v. 32, no. 1, p. 21–24, 1954.

A review of various geophysical methods for locating uranium. Aerial radioactivity surveys are considered the best methods for initial reconnaissance to be followed by detailed work on the ground.—*V. S. N.*

163–263. Oil in Canada. Hunting for oil: Oil in Canada, v. 7, no. 39, p. 44–50, 1955.

This is a composite abstract of the most significant papers on exploration delivered at the World Petroleum Congress in Rome, June 1955, with particular emphasis on geophysical methods of exploration.—*V. S. N.*

163–264. Goguel, Jean. De quelques sujétions de la géophysique minière [Some suggestions for mining geophysics]: Geophys. Prosp., v. 3, no. 3, p. 205–211, 1955.

Presidential address at the 4th annual meeting of the European Association of Exploration Geophysicists.—*M. C. R.*

163–265. Woollard, George P., and Hanson, George F. Geophysical methods applied to geologic problems in Wisconsin: Wisconsin Geol. Survey Bull., no. 78, 255 p., 1954.

A compilation of the results of 35 geophysical investigations in parts of the State of Wisconsin, including ground-water investigations, subsurface engineering studies, mineral exploration, and general geologic studies, carried out cooperatively by the Wisconsin Geological Survey and the University of Wisconsin. Methods used were gravity, magnetic, seismic, electrical, and electromagnetic. The basic principles of each method are given.—*S. T. V.*

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128–131, January–December 1947, Geological Survey Bulletin 957.
132–135, January–December 1948, Geological Survey Bulletin 959.
136–139, January–December 1949, Geological Survey Bulletin 966.
140–143, January–December 1950, Geological Survey Bulletin 976.
144–147, January–December 1951, Geological Survey Bulletin 981.
148–151, January–December 1952, Geological Survey Bulletin 991.
152–155, January–December 1953, Geological Survey Bulletin 1002.
156–159, January–December 1954, Geological Survey Bulletin 1022.