

# Geophysical Abstracts 161 April-June 1955

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GEOLOGICAL SURVEY BULLETIN 1033-B





# Geophysical Abstracts 161 April-June 1955

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

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G E O L O G I C A L   S U R V E Y   B U L L E T I N   1 0 3 3 - B

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



**UNITED STATES DEPARTMENT OF THE INTERIOR**

**Douglas McKay, *Secretary***

**GEOLOGICAL SURVEY**

**W. E. Wrather, *Director***

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For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. - Price 25 cents (single copy). Subscription price: \$1.00 a year; 35 cents additional for foreign mailing. The printing of this publication has been approved by the Director of the Bureau of the Budget, May 20, 1954.

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# GEOPHYSICAL ABSTRACTS 161, APRIL-JUNE 1955

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

## 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. A list of abbreviations of journal titles was given in Geophysical Abstracts 160. 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, Henry Faul, R. G. Henderson, D. R. Mabey, 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.

<i>Abbreviation</i>	<i>Publication</i>
Acta Chem. Scandinavica.....	Acta Chemica Scandinavica. Published by chemical societies in Denmark, Finland, Norway, and Sweden.
Am. Soc. Civil Engineers Proc.....	Proceedings of the American Society of Civil Engineers. New York.

<i>Abbreviation</i>	<i>Publication</i>
Australian Jour. Physics-----	Australian Journal of Physics. Melbourne, Australia.
Bol. informaciones cient. nac. Ecuador-	Boletin de Informaciones cientificas nacionales. Quito, Ecuador.
Colonial Geology and Mineral Resources.	Colonial Geology and Mineral Resources. Mineral Resources Division, Colonial Geological Survey. London.
Denmark Geod. Inst. Skr-----	Denmark Geodaetisk Instituts Skrifter. København.
Dyna -----	Dyna. Facultad de Minas. Medellin, Colombia.
Geog. Annaler-----	Geografiske Annaler. Svenska sällskapet för antropologi och geografi. Stockholm.
Inst. Mining and Metallurgy London Bull.	Bulletin of the Institute of Mining and Metallurgy. London.
Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus.	Comptes Rendus of the 19th session of the International Geological Congress. Algiers.
Naturwiss. Rundschau-----	Naturwissenschaftliche Rundschau. Stuttgart, Germany.
Promyslovaya geofizika-----	Promyslovaya geofizika. Moskovskiy Neftyanoy Institut. Moskva.
Przeglad geol-----	Przeglad geologiczny. Wydawnictwa geologiczne. Warszawa.
Royal Soc. New Zealand Trans-----	Transactions of the Royal Society of New Zealand. Wellington.
Soc. geol. italiana Boll-----	Bollettino della Societa geologica italiana. Roma.
South Africa Dept. Mines Geol. Survey Bull.	Union of South Africa Department of Mines Geological Survey Bulletin. Pretoria.
Survey of India Tech. Paper-----	Survey of India Technical Paper. Dehra Dun.
Tulsa Geophys. Soc. Proc-----	Proceedings of the Geophysical Society of Tulsa. Tulsa, Oklahoma.
Zürich Naturf. Gesellschaft Vierteljahrsschr.	Vierteljahrsschrift der naturforschenden Gesellschaft in Zürich. Zürich, Switzerland.

## GRAVITY

### GENERAL AND THEORETICAL PAPERS INCLUDING THOSE ON ISOSTASY

- 161-1. Lagrula, Jean. Sur l'eustatisme et l'isostasie [Eustasy and isostasy]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9, p. 45-50, 1954.

The variation of sea level as a function of the variations in the volume of continental icecaps is considered for the limiting cases of instantaneous melting of the ice and slow isostatic readjustment, and slow melting so that isostatic equilibrium is always maintained. The actual situation is somewhere between these two extremes. In a zone where the volume of ice has not varied (as, for example, Africa) a maximum stationary level, which may be represented by a beach, could have been at +9 to +23 meters but nearer to +9. The level which corresponds to total absence of continental ice and isostatic equilibrium is calculated to be at +24 meters. The exchange of material between continents and oceans and isostatic readjustments cause complicated movements, and these mathematical considerations based on a simple hypothesis are a contribution to setting up the equations of the problem.—*M. C. R.*

- 161-2. Halicki, Bronislaw, and Olczak, Tadeusz. Les glaciations quaternaires et les anomalies gravimétriques sur la plaine européenne [Quaternary glaciations and gravity anomalies in the European plain]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9, p. 9-20, 1954.

Examination of the gravity map and of the limits of advance and phases of retreat of Pleistocene glaciers shows a correlation, often close, between these limits and the present distribution of positive and negative gravity anomalies. The correlation is especially striking in regions where there is no apparent physiographic control for the movement of the ice masses. In the last glaciation and the Warta stage, lobes advanced toward the south in regions of negative anomalies and drew back or were deflected from positive areas. In several places a close correlation can be observed between the drainage pattern and the gravity distribution. One explanation is that there were vertical movements in the region invaded by the glacier, but if so they were anti-isostatic. Another possibility is the existence of an elastic differentiation resulting in increased lability as a characteristic of zones of gravity deficit and stability in regions of gravity surplus.—*M. C. R.*

- 161-3. Bott, M. H. P. Interpretation of the gravity field of the eastern Alps: Geol. Mag., v. 91, no. 5, p. 377-383, 1954.

One problem in interpreting the gravity field of the Alps is that the Bouguer gradients are often greater than would be expected from a simple crustal downwarp for which the top of the mass deficiency must be at a considerable depth. Using Bullard and Cooper's method for estimating the maximum depth of the masses causing an anomaly, Bott finds that the top surface of the mass deficiency responsible for the central negative anomaly on a profile from Venice to Passau is less than 10 km below the surface. This result can be verified by alternative methods of depth estimation assuming various geometric configurations as the source. The most satisfactory geologic interpretation seems to be that this belt is underlain by a large mass or masses of granite. As the position of part of

this mass deficiency cannot be reconciled with the Airy theory of isostasy, it is proposed that the isostatic compensation of this region is present in two forms: concentrated as downwarps at the bases of the crustal layers, mainly at the Mohorovičić discontinuity, and as less dense intrusive masses within the top 10 or 20 km of the crust. The mass deficiency developed first as crustal thickening accompanying the Alpine orogeny, entirely at the base of the crust, and then by the melting of the granitic layer during and shortly after the main movements, invasion of the overlying metasedimentary rocks as magma, and consolidation as a batholith.—*M. C. R.*

- 161-4. Scheffer, V[iktor]. Über den Zusammenhang zwischen isostatischen Anomalien und Vergenzen der Gebirgsbildung [On the relation between isostatic anomalies and the trends of mountain building]: *Acta Tech. Acad. Sci. Hungaricae*, tomus 10, fasc. 1-2, p. 19-29, 1955.

Comparison of the map of isostatic anomalies in Europe and the outlines of Mediterranean mountains shows a relationship between the two with the trends of orogenesis being displaced from zones of positive isostatic anomalies, denoting excess of mass, toward depressions, or parts representing deficits of mass. This correlation suggests that the earth's crust also trends toward isostatic equilibrium through horizontal crustal movements.—*S. T. V.*

- 161-5. Gourinard, Yves. Isostasie et deformations quaternaires dans le nord-ouest Algerien [Isostasy and Quaternary deformations in northwest Algeria]: *Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus*, Sec. 9, fasc. 9, p. 21-38, 1954.

Along the coastal region of the Department of Oran (Algeria) geological observation shows a fairly considerable number of Quaternary deformations. A study of the gravimetric data shows that certain of these deformations affect regions of isostatic disequilibrium whilst others correspond to massifs of compensated relief. The interpretation of the first category (in the light of earlier geological evolution) gives results which agree with already accepted ideas. The other deformations, on the contrary, lead us to admit a positive, vertical movement of the compensated reliefs, a movement whose amplitude is in proportion to the local thickness of the earth's crust. It would seem to follow that the fluctuations of sea-level are the combined effect of glacial eustasy and a general upward movement of the continent. Because this upward movement is not everywhere the same, the generally accepted levels seem to be valid only in zones of isostatic disequilibrium where, moreover, the earth's crust has a normal thickness.—*Author's abstract*

- 161-6. Fischer, Irene. The deflection of the vertical in the western and central Mediterranean area: *Bull. géod.*, no. 34, p. 343-353, 1954.

The deflection of the vertical was computed by gravimetric methods at 23 stations around the western Mediterranean in Spain, North Africa, Sardinia, and Sicily, and the results compared with the corresponding astrogeodetic deflection based on the European adjustment. The two sets of values are in fair agreement, indicating that doubts about the relative reliability of submarine gravity observations are not justified. A small systematic discrepancy in the meridian components of the deflection of the vertical could be accounted for by a translation of the international ellipsoid, or may be the effect of an unbalanced region.—*M. C. R.*

- 161-7. Kawabata, Y. A study on the deviation of the plumb-line in Japan: *Geophys. Mag.* v. 26, no. 3, p. 139-213, 1955.

The ellipsoid most suitably representing the surface of the earth in Japan, based on a study of the deviation of the vertical at 128 stations, closely resembles Bessel's ellipsoid. In general the plumb lines are strongly attracted to the arc of the Japanese islands. The geoid is highest in central Japan. The ridge bifurcates, one arm extending along the Fuji volcanic zone and the zone of deep focus earthquakes, and the other along the western side of the island. With a correction for the topography there is in general an attraction toward the Pacific, which indicates that the density of the subcrustal material under the Pacific is larger than that under the Sea of Japan. It therefore seems that isostatic compensation holds for Japan. The depth of compensation was determined by trial and error as 185 km. Study of the deviation of the vertical in other parts of the world suggests that the deviation is large and regular in direction in areas of strong volcanic or seismic activity.—*M. C. R.*

#### INSTRUMENTS AND METHODS OF OBSERVATION

- 161-8. Medi, Enrico. Un metodo per la misura assoluta dell' accelerazione di gravita: il rotogravimetro [A method for absolute measurement of gravity: the rotogravimeter]: *Annali Geofisica*, v. 7, no. 4, p. 487-490, 1954.

A method is discussed for an absolute measurement of the constant of gravity. This method is based on the form taken by a liquid set in rotation around an axis parallel to the direction of the acceleration of gravity at the place of observation. By measuring the focal distance of the paraboloid of revolution thus obtained, and the period of rotation of the system, it is possible to obtain a value for  $g$ . There are no temperature effects with this method of measurement, and further sources of errors, normally present in other methods, are eliminated.—*Author's abstract*

- 161-9. Trudu, Renato. Studio del gravimetro North American AG1 no. 125 dell' Instituto di Geofisica Mineraria dell' Universita di Cagliari [The study of the North American AG1 gravimeter no. 125 of the Instituto di Geofisica Mineraria of the Universita di Cagliari]: *Servizio geol. Italia Boll.*, v. 75, (1953), fasc. 2, p. 940-966, 1954.

A detailed description is given of the North American AG1 gravimeter followed by an analysis of its functioning, and its behavior under different conditions of operation, based on Trudu's experiments and observations and on published material.—*S. T. V.*

#### METHODS OF ANALYSIS AND INTERPRETATION

- 161-10. Timofeev, A. N. Raschet gravitatsionnykh anomaly pri lineynom ismenenii plotnosti gornyykh porod s glubinoy [Numerical determination of gravitational anomalies for a linear variation of density of formations with depth]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 2, p. 181-184, 1955.

In interpreting the results of gravimetric surveys the excess of density of the disturbing body over that of surrounding formations is assumed. The density of the latter is often chosen on the basis of specimens from upper layers,

whereas usually density rapidly increases with depth and this increase should be taken into account. The effect of a linear variation of density has been computed for disturbing bodies of the shape of a horizontal infinite prism, a vertical discontinuity, and a horizontal layer of infinite dimensions. The results of the computations are given in tables and graphs.—*S. T. V.*

- 161-11. Oldham, C. H. G., and Sutherland, Don B. Orthogonal polynomials: their use in estimating the regional effect: *Geophysics*, v. 20, no. 2, p. 307-317, 1955.

The examination of experimental data for significant trends by orthogonal polynomials is well known in statistics. The method is adapted here to the estimation of regional trends in potential field observations, and two characteristically different gravity maps are analyzed. The method is found to agree closely with a graphical solution in an area of fairly smooth contours, and to give a reasonable solution in an area where the graphical method would be difficult to apply. It is proposed that the orthogonal polynomials could also be adapted to evaluating total mass and to interpreting second derivative maps.—*Authors' abstract.*

- 161-12. Domzalski, W. Gravity measurements in a vertical shaft: *Inst. Mining and Metallurgy London Bull.*, no. 571, p. 429-445, 1954.

Gravity measurements were made in a vertical shaft at Snowdown Colliery, Kent, using a Worden gravimeter. In addition to the usual latitude, free-air, Bouguer, and terrain corrections, the effect of the shaft must be considered. The effect of the shaft is derived by calculation of the attraction of a vertical cylinder at a point in its axis. Fourteen stations were occupied from the surface to a depth of 2,945.5 feet. Densities were determined from the distance and gravity intervals between stations, and revising them by weighting in terms of thickness of formation (because stratigraphic boundaries did not fall at stations). The error due to inaccuracies in distance and gravity intervals is one of the order of 1.5 percent, and error due to presence of a discontinuity in the horizontal direction more than 1,000 feet away is less than 1 percent.—*M. C. R.*

- 161-13. Domzalski, W. Three dimensional gravity survey: *Geophys. Prosp.*, v. 3, no. 1, p. 15-55, 1955.

An experimental gravity survey was made in the Florence mines, Cumberland, England, with observations made in two mine shafts, on four levels in the mine workings, in the drifts connecting the shafts, and on the surface in the same plan position whenever possible as the stations underground. Gravity measurements were made with a Worden gravimeter and all measurements referred to a base station at the top of the Florence No. 1 shaft. Special attention had to be given to terrain corrections for the shaft stations, and to corrections for the effect of the ore body and the effect of roadways. Interval densities computed from measurements in the shafts are in satisfactory agreement with those derived from stratigraphic information. Gravity contours constructed from observations on different levels, interpreted in terms of horizontal extent and variations in thickness of the ore body, supplemented existing information. The comparison of known geology and the gravity profiles showed that the gravity observations can furnish information which would permit completion of a geologic section if only a few borehole data are available, but extreme care must be

used in determining thickness of layers from gravity observations because of the critical effect of small variations in density. In an appendix a method is given of computing the effects of slabs and blocks as applied to the calculation of corrections for underground drifts and faults.—*M. C. R.*

### OBSERVATIONS OF GRAVITY AND GRAVITY SURVEYS

- 161-14. Garland, G. D. and Cook, A. H. A determination of the differences in gravity between the National Physical Laboratory, Teddington, the Dominion Observatory, Ottawa, and the National Bureau of Standards, Washington: Royal Soc. London Proc., Ser. A, v. 229, no. 1179, p. 445-458, 1955.

Comparisons have been made with the Cambridge pendulum apparatus between the values of gravity at the National Physical Laboratory, Teddington, the Dominion Observatory, Ottawa, and the National Bureau of Standards, Washington. The three measured differences form a satisfactorily consistent set, and the connection between Teddington and Washington is in good agreement with that determined in 1939 by Browne and Bullard with the same pendulums. Gravimeter observations have been used to relate the points occupied to the national reference station in Washington and to the site of the absolute determination in progress at the National Research Council, Ottawa.

If the value on the Potsdam system for the British fundamental station at Teddington is taken as  $981.1963 \text{ cm/sec}^2$ , the following values are obtained for the national reference stations of the United States and Canada: Washington (Commerce)  $g=980.1192 \pm 0.00055 \text{ cm/sec}^2$ ; Ottawa (pier)  $g=980.6191 \pm 0.00045 \text{ cm/sec}^2$ .—*Authors' abstract*

- 161-15. Bruyn, J. W. de. Isogam maps of Europe and North Africa: Geophys. Prosp., v. 3, no. 1, p. 1-14, 1955.

Two maps of Europe and North Africa on the scale 1:5,000,000 show isostatic and Bouguer anomalies contoured for 5-milligal intervals. Colors for 25-milligal intervals emphasize the pattern of isostatic anomalies. The maps are compiled from published data and from data furnished by N. V. De Batoofsche Petroleum Maatschappij (Royal Dutch Shell) and affiliated companies. Data were reduced to Potsdam base using the international ties made by Woollard, Morelli, Martin, and others, the Cassinis International Formula used for latitude correction, and the Bouguer correction computed with a density of 2.67. The isostatic correction was computed using the Airy-Heiskanen method, with  $R=0$  and  $T=30$ , implying local compensation and crustal thickness of 30 km.—*M. C. R.*

- 161-16. Schleusener, Alfred, and Closs, Hans. Schwerekarten von Zentral-europa nach Gravimetermessungen [Gravity maps of central Europe from gravimeter measurements]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9, p. 85-108, 1954.

Two gravity maps of central Europe on a scale of 1:1,000,000 show the mean Bouguer anomaly and mean free-air anomaly. The net of surveyed points ranges between 6 and 40 points per 125 sq km. The Bouguer map shows the disturbing effect of all masses below sea level. The large highs, the Bramsche high, Tempelburg axis, Neckar-Tauber anomaly, Kleiner Belt high, and others are prominent features. Precambrian schists have been found at a depth of 1,300 meters in the Kleiner Belt high, but the Tempelburg axis is a younger uplift. Seismic surveys indicate that sima may be at a depth of only 2,000 meters in

the Neckar-Tauber area. Bouguer and free-air maximums and minimums coincide approximately in the northern part as the elevations are small. The Harz Mountains level is 25 milligals below the Flechtlingen high with respect to the Bouguer effect and 25 milligals above with respect to free-air gravity. Variations are even greater to the south.—*M. C. R.*

- 161—17. Zaccara, Gaetano. Misura di gravità nelle province Pugliesi [Measurements of gravity in the Apulian provinces]: Servizio geol. Italia Boll., v. 75 (1953), fasc. 2, p. 863-907, 1954.

Results of a gravimetric survey of an area of about 19,000 sq km in the Apulian provinces, southeastern Italy, in which 193 stations were occupied, are given in tables and as a map of Fayé anomalies.—*S. T. V.*

- 161-18. Shurbet, B. Lynn, and Worzel, J. Lamar. Gravity anomalies associated with seamounts: Geol. Soc. America Bull., v. 66, no. 6, p. 777-782, 1955.

Southeast of Cape Cod about 60 miles from the continental shelf there are several seamounts. Gravity measurements near two of them show free-air anomalies 30 to 90 milligals higher than values nearby. The seamounts are nearly circular and are part of a chain trending about northwestward. They are probably volcanic peaks, as are all the peaks in the Atlantic Ocean over which magnetic profiles have been observed. The volcanism can be dated only as pre-Pleistocene from the sediment sample showing transported material with Pleistocene fauna and no trace of local volcanic activity.—*V. S. N.*

- 161-19. Garland, G. D. Gravity measurements over the Cumberland Basin, Nova Scotia: Canadian Min. Metall. Bull., v. 48, no. 515, p. 140-148, 1955.

The Dominion Observatory in cooperation with the Nova Scotia Department of Mines conducted gravity studies in the Cumberland Basin, Nova Scotia. The surface rocks of the basin are in general Pennsylvanian, and salt occurs in the Windsor group of Mississippian age. The regional gravity survey indicated the presence of lower density Mississippian rocks upfolded or upthrust into the overlying Pennsylvanian formations. In particular, the Claremont or Malagash anticline has been traced from near Springhill to Malagash Point. Along the axis of the anticline intense negative anomalies were indicated at Oxford and East Wallace. The detailed investigation of the Malagash area indicated that the anomaly over the main deposit, as measured with the gravimeter, agrees very closely with the results of a torsion-balance survey in 1934. Two possible areas of salt-bearing strata are indicated to the east of the known deposit.—*D. R. M.*

- 161-20. Barnes, Virgil E., Romberg, Frederick E., and Anderson, Warren A. Correlation of gravity and magnetic observations with the geology of Blanco and Gillespie Counties, Texas: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9, p. 151-162, 1954.

A gravity survey was made of a 2,000-square-mile area in central Texas where the pre-Cambrian basement rocks are mostly covered by Paleozoic and Mesozoic sedimentary rocks up to a mile in thickness. The variation in gravity found is related to the buried pre-Cambrian rocks which vary in density from

granite (2.64) to schist (2.95) and to basic igneous rocks which are in part even denser.

Structure in the sedimentary rocks and buried topography on the old pre-Cambrian and pre-Mesozoic erosion surface undoubtedly exert some influence on the gravitational forces measured, but this influence is too small to be recognized in a regional survey of the type discussed in this paper. However, sufficiently detailed gravity surveys should make it possible to detect these features.

The magnetic data, while not entirely conclusive, indicate that granite and schist produce little anomaly and that strong positive anomalies are associated with areas of basic igneous rock.—*Authors' abstract*

161-21. Trudu, Renato. Prime note di gravimetria Sarda : sezione gravimetrica nella pianura del Campidano [Preliminary notes on the gravimetry of Sardinia : gravimetric profile across the plain of Campidano] : Servizio geol. Italia Boll., v. 75, (1953), fasc. 2, p. 928-940, 1954.

Gravimetric measurements were made along a 20-km profile from Sardara to Pabillonis to Guspini across the main flatland of Sardinia with 28 main stations occupied using a North American gravimeter. The base station at Sardara was tied by careful measurements to the station of the university at Cagliari and the value of  $g$  was found to be  $980.12147 \pm 0.39$  gal. Fayé, Bouguer, topographic, and the latitude corrections were applied, and the results of the survey are given in tabular and graphic form. Attention is called to an abrupt change in the gravity observed over a line of hydrothermal sources, indicating a deep fault.—*S. T. V.*

161-22. Marçais, J. Presentation d'une carte gravimétrique du Maroc français [Presentation of a gravity map of French Morocco] : Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9, p. 113-114, 1954.

Two gravimetric maps on a scale of 1 : 1,500,000, a Bouguer anomaly map and one corrected for isostatic effect according to the Airy hypothesis, were presented to the Congress. The Bouguer map is said to follow rather closely the orographic picture of Morocco and the isostatic map to offer interesting indications of the deep structure. Neither map is included.—*M. C. R.*

## MAGNETISM

### MAGNETIC FIELD OF THE EARTH

161-23. Jones, H[arold] S[pencer]. Der Magnetismus von Erde, Sonne und Sternen [The magnetism of the earth, sun, and stars] : Naturwiss. Rundschau, Jahrg. 7, Heft 9, p. 378-381, 1954.

After a brief review of the development of knowledge of magnetism, especially of geomagnetism, Jones discusses phenomena leading to the theory that every rotating body becomes magnetized. This theory can be checked on many celestial bodies. It is not confirmed in the sun, whose magnetism is not 50 gauss, as previously thought, but only 1 or 2 gauss, or possibly zero. The greatest objection to this theory is the discovery of oscillating magnetism of some stars; thus the magnetic intensity of star HD 125248 periodically varies from +7,000 gauss to -6,200 gauss in 9,295 days. There are also stars which are constantly mag-

netized, as Gamma Equuloi whose magnetic intensity is constantly 1,900 gauss.—*S. T. V.*

161-24. Gaibar-Puertas, C. Establecimiento de un nuevo proceso de desimación terrestre. Periodo de los ultimos ciclos desimación-reimación registrados por nuestro planeta [The establishment of a new process of demagnetization of the earth. The period of the most recent cycles of the demagnetization-remagnetization recorded for our planet]: *Geofísica Pura e Appl.*, v. 29, p. 22-56, 1954.

On the basis of all available magnetograms from different observatories throughout the world, yearly averages of the total intensity of magnetization have been computed. To eliminate errors because of unequal distribution of observatories, the surface of the earth was divided into eight equal sectors and the average gradients determined for each sector, then for each hemisphere, and finally for the entire globe. These average gradients indicate that the earth was undergoing the process of magnetization from 1885 to 1895; demagnetization from 1895 to 1915; remagnetization from 1915 to 1941; and demagnetization from 1941 to 1950. The period of the cycle of demagnetization and remagnetization is about 50 years.—*S. T. V.*

161-25. Lewis, R. P. W., McIntosh, D. H., and Watson, R. A. Annual variation of the magnetic elements: *Jour. Geophys. Research*, v. 60, no. 1, p. 71-74, 1955.

Annual variations of the horizontal intensity ( $H$  force) were computed for a number of stations, using values for magnetically quiet days where available. These are expressed in terms of Fourier components. Differences found between one pair of stations suggest that the annual variation arises from local as well as world-wide influences.—*Authors' abstract*

161-26. Giorgi, M[aurizio], and Molina, F. Campo normale a variazione secolare media degli elementi magnetici in Sicilia [Normal field and the average secular variation of the magnetic elements in Sicily]: *Annali Geofisica*, v. 7, no. 4, p. 521-537, 1954.

The normal field, referred to 1935.0 of the  $H$  and  $Z$  components of the earth's magnetic field valid for Sicily, has been computed from the measurements at 81 stations by the method of least squares.

The average secular variations of the elements  $D$ ,  $H$ , and  $Z$  for the time interval 1935.0 to 1954.5 were computed as 7.2' per year, 17.8 gammas per year, and 41.2 gammas per year respectively.—*S. T. V.*

161-27. Ota, M. An analysis on the diurnal variation of the terrestrial magnetism, especially on the day-time-variation of geomagnetically quiet days: *Jour. Geomagnetism and Geoelectricity*, v. 6, no. 2, p. 83-98, 1954.

Ota suggests that the  $Sq$  variation in middle and low latitudes takes the form of a sine or cosine during the day and is zero at night.—*M. C. R.*

161-28. Mishin, V. M. Ob osnovnykh tipakh geomagnitnoy aktivnosti [The basic types of geomagnetic activity]: *Akad. Nauk SSSR Doklady*, tom 100, no. 1, p. 53-56, 1955.

Geomagnetic disturbances recorded at the stations of Zuy, Slutsk (Pavlovsk), Tashkent, and Watheroo at geographic latitudes of 41° N., 56° N., 32° N., and

41° S. respectively, are analyzed in a study of the morphology of magnetic disturbances. Several similarities as well as many dissimilarities in the structure of disturbances recorded at individual stations can be noted, most of them previously noted on the records of other magnetic observatories. The observed data do not agree with the predictions of Alfven in his "Cosmic electro-dynamics."—*S. T. V.*

161-29. Junge, Christof. *Bai-Untersuchungen am Geophysikalischen Observatorium Collm* [Investigations of bay disturbance at the Collm geophysical observatory]: *Gerlands Beitr. Geophysik, Band 64, Heft 3, p. 173-193, 1955.*

Geomagnetic records of the Collm Observatory of the University of Leipzig, extending over a period of 9 years, were examined for bay anomalies. Special attention was given to the morphology of the disturbances. Four main types are recognized as a result of a classification of the bays. A new basic type, the "mixed bay," is established. The annual and diurnal dependences and the horizontal vector components are investigated. The horizontal anomaly vector turns in a general way once a day counterclockwise. The periodic tendencies are critically examined, and a comparison of the bay anomalies at the neighboring observatories of Collm and Niemegk is carried out.—*Author's abstract, H. F.*

161-30. Kato, Yoshio, and Yokoto, Kenichi. Further note on a new theory of magnetic storm: *Tohoku Univ. Sci. Repts., 5th ser., v. 5, no. 3, p. 75-84, 1953.*

This paper extends Kato's study of the mechanism of magnetic storms (see *Geophys. Abs. 12905, 12906, 157-32*). It is concluded that magnetic storms are caused by two kinds of solar radiation. The first phase is due to some sort of ultraviolet radiation, whose sudden increase sets the current system  $D_{st}$  moving eastward, and also starts the  $S_D$  current in the day hemisphere, thus producing an increase in the magnetic field. The main phase is caused by emission of charged corpuscles, containing an equal number of positive and negative ions and hence neutral as a whole. Because of the direction of incidence, some of these corpuscles form an equatorial ring current, causing the  $D_{st}$  field of the main phase of the magnetic storm, while others concentrate in the upper atmosphere of the auroral zone, ionizing it and setting up the  $S_D$  field of the main phase under the dynamo action due to air motion near the pole.—*D. B. V.*

161-31. Rush, J. H. A semi-annual periodicity in the beginnings of recurrent magnetic storm series: *Nature, v. 175, no. 4455, p. 517-518, 1955.*

Records of geomagnetic disturbances during the seven sunspot cycles from 1884 to 1954 reveal a strong tendency for the initial disturbance of a 27-day recurrent series to occur near January or July. Final disturbances of such series show only a weak semiannual periodicity. The effect may be related to the fact that the earth crosses the plane of the solar equator on June 6 and December 7.—*R. G. H.*

161-32. Angenheister, G. *Registrierungen erdmagnetischer Pulsationen, Göttingen 1952-53* [Records of geomagnetic pulsations, Göttingen 1952-53]: *Gerlands Beitr. Geophysik, Band 64, Heft 2, p. 108-132, 1954.*

By geomagnetic pulsations we understand variations of the magnetic field vector of 5-700 seconds duration. Several methods of recording the pulsations

are discussed. The methods employing a coil with a galvanometer and the Grenet induction variometer are particularly preferred, and the possibility of recording the pulsations with a resonant receiver is mentioned. Study of the records made in Göttingen in the year 1952-53 permits recognition of essentially two groups of pulsations. Group *a* has periods of 5-700 seconds and a distinct noon maximum which, however, is displaced toward the forenoon for pulsations with short periods. Group *a* may be divided into two parts in view of this. Group *b* is distinguished by an evening maximum. Here we are dealing with clearly independent events. Synclonisation with the geomagnetic numbers *K* (or *A<sub>k</sub>*) shows distinct correlation between pulsations and variations.—*Author's abstract, H. F.*

### MAGNETIC PROPERTIES OF ROCKS AND MINERALS

161-33. Sharpe, Joseph A. Magnetic susceptibility of rocks, its determination and usefulness: *Tulsa Geophys. Soc. Proc.*, v. 1, p. 23-44, 1953.

This is a posthumous paper assembled and arranged by the editor of the journal from brochures on a service for the determination of susceptibilities. Susceptibilities and densities are given for more than 300 samples—*M. C. R.*

161-34. Barnes, Virgil E. Magnetic susceptibility measurements on Llano uplift rocks: *Tulsa Geophys. Soc. Proc.*, v. 1, p. 45-49, 1953.

Data are summarized for determinations of density and magnetic susceptibility of samples of Precambrian and Paleozoic rocks, arranged by groups and as averages for rock units.—*M. C. R.*

161-35. Barnes, Virgil E. Magnetic susceptibility measurements on well cores from pre-Simpson Paleozoic rocks: *Tulsa Geophys. Soc. Proc.*, v. 1, p. 50-55, 1953.

Measurements of magnetic susceptibility were made as one technique in an effort to identify units in the pre-Simpson rocks in Texas. Data tabulated for 74 samples of cores from wells in Val Verde and Crockett counties include depth, density,  $\text{Fe}_2\text{O}_3$  content, and rock type as well as susceptibility. The method was not successful because of the fluctuations.—*M. C. R.*

161-36. Flawn, Peter T. Magnetic susceptibility measurements in west Texas and southeast New Mexico: *Tulsa Geophys. Soc. Proc.*, v. 1, p. 55-58, 1953.

As a part of a petrographic and structural study of the basement rocks in Texas and southeast New Mexico, the magnetic susceptibility of 96 samples of Precambrian cores and cuttings was determined. Results are tabulated.—*M. C. R.*

161-37. Mooney, Harold M. A bibliography of papers having experimental data on the magnetic susceptibility of minerals and rocks: *Tulsa Geophys. Soc. Proc.*, v. 1, p. 59-61, 1953.

51 items.—*M. C. R.*

161-38. Lundbak, Asger. Magnetic properties of basement rocks: *Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9*, p. 135-149, 1954.

Modern accurate gravity observations and observations of magnetic vertical intensity in the same area allow computations of magnetic properties of basement

rocks to be made. The principal assumptions are, that the layers above the basement do not contribute essentially to the magnetic anomalies at the surface of the ground, and that the density of the layers above the basement is fairly uniform and has a constant difference from the density of the basement rocks.

From such computations it is concluded that the mean intensity of magnetization (remanent plus induced magnetism) of basement rocks in Denmark, the Netherlands, and U.S.A. are of the same order of magnitude, about or a little over  $10^{-3}$  cgs-units.

While the magnetic inclination of the basement rocks in a selected area in U.S.A. ( $76^{\circ}$  W.,  $36^{\circ}$ – $37^{\circ}$  N.) seems to be great—like the inclination nowadays at the ground-surface there—the magnetic inclination of the basement rocks in Northern Netherlands and the Danish island Seeland has shown to be small, clearly smaller than the inclination nowadays at the ground surface. Further the direction of the magnetic horizontal component of the basement rocks in the two last mentioned areas has shown to be westerly, that is not northerly as now. This indicates the existence of an ancient—possible early Paleozoic—Northern magnetic pole in the southeastern part of the Pacific (in the neighborhood of South America).—*Author's abstract*

161-39. Matsuzaki, H., Kobayashi, K., and Momose, K. On the anomalously strong natural remanent magnetism of the lava of Mt. Utsukushigahara: *Jour. Geomagnetism and Geoelectricity*, v. 4, no. 2, p. 53-56, 1954.

The natural remanent magnetism of samples from three andesitic lava flows of essentially similar composition from Mt. Utsukushi-ga-hara, central Japan has been measured. In the two lower flows there are different but internally consistent directions and intensity of natural remanent magnetism. In the third flow, which is exposed only at the peak of the mountain, the direction of the natural remanent magnetism has a random distribution and the intensities are as much as 150 times those in the other two flows. Heating experiments on all specimens have shown that all three flows have the same intensity of thermoremanent magnetization and therefore that the natural remanent magnetism must have a different origin. The intense natural remanent magnetism can be removed by alternating demagnetizing fields of 300-400 oersteds and can be restored to the same order of intensity by magnetic fields of 400 oersteds. These facts lead to the conclusion that the natural remanent magnetism of these rocks has been produced by the momentary strong magnetic fields caused by thunderbolts striking Mt. Utsukushi-ga-hara.—*J. R. B.*

161-40. Manley, Horace. The thermo-magnetic properties of the tholeiite dikes of Britain: *Geofisica Pura e Appl.*, v. 29, p. 57-70, 1954.

Samples from the Armathwaite-Cleveland dike heated past the Curie point and allowed to cool in magnetic fields greater than or equal to the earth's field showed no appreciable loss of residual magnetism in a year. Curie points of the Blunderfield quarry samples in general ranged from  $510^{\circ}$  to  $545^{\circ}$  C, with two exceptions. Susceptibility changes during heat treatment ranged from decreases of 50 percent to increases of 20 percent with an average decrease of 20 percent. Remanent magnetism increased by factors ranging from 1.1 to 7. Differences in susceptibility-temperature curves are attributed to impurities in the magnetite and perhaps to the effects of weathering processes.—*M. C. R.*

- 161-41. Kawai, Naoto; Kume, Shoichi; and Sasajima, Sadao. Magnetism of rocks and solid phase transformation in ferromagnetic minerals: Acad. Japan Proc. v. 30, no. 9, p. 864-868, 1954.

Specimens of volcanic rocks with inverse remanent magnetism were heated to about 600° C and the polarization measured at 30° intervals. Two critical temperatures were found, at about 100° C and 350° C, at which the polarity was suddenly inverted. In similar tests, the magnetization of samples of normally magnetized volcanic rock decreased continuously. Measurements of the effect on temperature of the intensity of saturation magnetization of ferromagnetic minerals separated from the inversely polarized rock show the presence of three kinds of magnetites with Curie points of 120°, 410°, and 550° C. By heating a specimen to 800° C for 20 hours and then quenching it to room temperature, the three kinds of magnetites were mixed into a homogeneous magnetite with the intermediate Curie point. This magnetite is unstable in crystal structure at room temperature, and a fractional part separates into two magnetites, one with a higher and the other a lower Curie point. The inverse magnetization could be the result of the formation of these two magnetites which would be magnetized in the direction of the demagnetizing field of the parent magnetite. The remanent magnetism of the rocks would be the resultant of the polarization of the three magnetites.—*M. C. R.*

- 161-42. Pehrman, Gunnar. *Über den Magnetismus einiger Magnetkiese* [On the magnetization of some pyrrhotites]: Acad. Aboensis Acta, math. phys. 19, and Åbo Akad. Geol. Mineralog. Inst. Medd., no. 36, 8 p., 1954.

Studies of 13 pyrrhotite samples, 6 hexagonal, 3 monoclinic, and 6 a mixture, (two samples were separated magnetically into fractions of stronger and weaker magnetization), indicate that magnetic permeability increases continuously with increasing content of the monoclinic phase, increases in the hexagonal pyrrhotite with sulfur content, and that the pure monoclinic pyrrhotite has a higher sulfur content.—*M. C. R.*

- 161-43. Hospers, J. Magnetic correlation in volcanic districts: *Geol. Mag.*, v. 91, no. 5, p. 352-360, 1954.

Alternating zones of normal and reverse natural permanent magnetization, each comprising about 25 flows, have been found in the Tertiary and Quaternary plateau basalts of Iceland. These zones may form a useful tool for correlating sections in a series of plateau basalts; the correlation is otherwise often extremely difficult. For purposes of correlation it is generally sufficient to determine the direction of the vertical component of magnetization, by holding a compass near the top and bottom of an exposed flow if the intensity is great enough, or by measuring at least two specimens with top and bottom marked from each flow with a compass or vertical magnetometer. For smaller intensities or more accurate measurements a simple astatic magnetometer may be used. Correlation of individual flows and dating of recent flows by means of secular variations are also possible. As the mean intensity of natural permanent magnetization apparently decreases with increasing age, it also may serve as a criterion of age.—*M. C. R.*

**INSTRUMENTS AND METHODS OF OBSERVATION**

- 161-44. Legat, W. H. Orientierung von Bohrkernen mit Hilfe ihres permanenten Magnetismus [The orientation of drill cores by means of their permanent magnetism]: Glückauf, Jahrg. 90, Heft 43-44, p. 1414-1417, 1954.

A new instrument which makes possible the determination of the direction of the magnetic axis of a drill core and of its magnetic intensity is described. It consists of a device which can be rotated from the surface of the ground; the produced electromotive force is then amplified and, from its graph, observed on a cathode ray oscilloscope, the phase sequence and the position of the magnetic axis corresponding to the local field created by the magnetism of the core are determined. The attainable accuracy of the measurement is estimated to be  $\pm 5^\circ$ .—*S. T. V.*

**METHODS OF ANALYSIS AND INTERPRETATION**

- 161-45. Nuttli, Otto W. Determining depth of faulting from magnetic field intensity measurements: Mining Engineering, v. 7, no. 6, p. 570-572, 1955.

Using the horizontal distance between the maximum and minimum values of the vertical component of the magnetic field intensity, it is possible to compute a unique value of the mean depth to a faulted surface. From the field intensity measurements it is not possible to compute unique values for the vertical displacement of the fault or the susceptibilities of the rocks involved in the faulting.—*D. R. M.*

- 161-46. Zietz, Isidore, and Henderson, R. G. The Sudbury aeromagnetic map as a test of interpretation methods: Geophysics, v. 20, no. 2, p. 307-317, 1955.

A north-south strip across the western part of the Sudbury basin was surveyed at quarter-mile spacing. The map shows that in general the trend of the magnetic contours follows the grain of the geologic formations, and there is good correlation between the larger magnetic features and the magnetic character of the surface rocks. Analysis of several anomalies by the method described by Vacquier and others [see Geophys. Abs. 13207] gave average depths that deviate from known values by less than 10 percent.—*M. C. R.*

**MAGNETIC OBSERVATIONS AND SURVEYS**

- 161-47. Hambleton, William W., and Merriam, Daniel F. Magnetic anomalies in Wilson and Woodson Counties, Kansas: Kansas Geol. Survey Bull. 114, pt. 3, p. 113-128, 1955.

A survey of vertical magnetic intensity was conducted in northern Wilson and southern Woodson Counties, Kans., in order to aid in determining the character and extent of the igneous rocks associated with the Rose and Silver City domes. These unique intrusives have at times aroused considerable attention as a possible source of economically useful minerals and rocks. Granite is exposed at the Rose dome and periodotite is exposed at the Silver City dome; both

are intruded into sediments as young as the Missourian Series of the Pennsylvanian System.

The survey consisted of a regional magnetic study and detailed magnetic studies of the Rose and Silver City domes. These data are compared with structure maps on top of the Plattsburg limestone of Pennsylvanian age and on top of the Mississippian rocks.

Results of the survey indicate that the magnetometer may be used as a reconnaissance tool to map location and trend of geologic structures in this area, but that it was not successful in determining the character and extent of the intrusive igneous rocks because the intrusives lack magnetic contrast with the sedimentary rocks. The survey indicates also that structural highs are reflected as negative magnetic anomalies. A combination of basement characteristics and thinning or absence of Pennsylvanian sandstones over structural highs may account for this condition.—*Authors' abstract.*

161-48. Cook, Kenneth L. Magnetic surveys over serpentine masses, Riley County, Kansas: *Mining Engineering*, v. 7, no. 5, p. 481-488, 1955.

Magnetometer surveys have been made by the U. S. Geological Survey over four of five serpentine masses exposed in Riley County, Kans. About 2,700 magnetometer stations were established. The basic igneous rock, now serpentinized, has intruded sedimentary rocks of late Permian age. The serpentine is magnetic and produces pronounced anomalies. In general the strong positive anomalies over the central and southeastern parts of the intrusions are accompanied by weaker negative centers located symmetrically to the northwest. The magnetic data indicates the near-surface size and form of the serpentine masses. The masses vary in form from a small circular plug to large elongated dikes which are more extensive than indicated by the sparse outcrops. The serpentine masses have probably resulted from the intrusion of igneous rock along fractures whose directions are possibly related to the development of the Abilene anticline.—*D. R. M.*

161-49. Dixius, Richard. Anomale Magnetisierungsrichtungen der Rhön-Basalte [Anomalous direction of magnetization of the Rhön basalts]: *Geofisica Pura e Appl.*, v. 28, p. 109-148, 1954.

In a magnetic survey of the region of the Rhön Mountains, Germany, in which more than 5,000 stations were occupied, magnetic extremes ranging in places from -5,300 gammas to +6,500 gammas were measured only 10 meters apart. The magnetic properties of rock samples were determined; in many, negative remanent magnetism was observed. This can be best explained by A. Dauvillier's theory of geomagnetism.—*S. T. V.*

161-50. Ergin, Kazim. Gravity and magnetometer surveys for chromite ore deposits in Turkey: *Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus*, Sec. 9, fasc. 9, p. 123-130, 1954.

Experimental magnetic surveys for chromite in different parts of Turkey show that the method may be useful but only under favorable conditions—when the chromite is magnetic and the country rock nonmagnetic. Positive anomalies were found in surveys over chromite at the Uçköprü and Zimparalik mines in Mugla. Breusse had previously observed positive anomalies at the Guleman mine in 1941. A gravity survey was made at the Uçköprü mine, and fair correlation with the results of the magnetic survey was found in spite of the rugged topography.—*M. C. R.*

## ELECTRICITY

## GENERAL AND THEORETICAL STUDIES

- 161-51. Berdichevskiy, M. N., and Zavadskaya, T. N. K voprosu o stanovlenii elektricheskogo polya v zemle [On the building up of the electric field in the ground]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 178-180, 1955.

Results are presented of experiments made in 1952 in the southern plains of the U.S.S.R. on the building up of the electric field in the ground under different conditions. Ordinary galvanometers were used in these measurements; their inertia produced a slight deformation of the curve of field intensity so that the obtained data are only approximations. The final data are presented in the form of graphs from which the correlations can be seen between the electric properties of the ground, the spacing of the electrodes, and the time of the building up of electric field. The greatest electrode spacing in these experiments was about 10 km.—*S. T. V.*

- 161-52. Belluigi, A[rnaldo]. Sull'effetto elettromagnetico diretto di emittori alternativi in un terreno omogeneo [On the electromagnetic direct effect of an alternating emitter in a homogeneous terrain]: Annali Geofisica, v. 7, no. 3, p. 415-440, 1954.

Belluigi first briefly analyzes Sommerfeld's classical theory of the horizontal oscillating dipole placed on the surface of a homogeneous ground, and presents the fundamental results of this theory in graphs and tables in a form adapted for use in electric prospecting. The behavior of the radial and tangential "reduced components" of the earth's electromagnetic field is shown as a function of the distance, and an approximate formula which gives the real part of the radial component (that which is generally measured at the surface of the earth) is derived. This formula agrees with that given by Horton (Geophys. Abs. 9041). Detailed examination of part of the Horton-Lewis theory shows it to be closer to experimental results. A theory is developed showing the dependence of the dielectric constant of the ground on the frequency. At the very lowest frequencies the alternating electric field must be increased and the transmission velocity of electromagnetic waves propagating through the ground reduced to the order of magnitude of the seismic wave velocity.—*M. C. R.*

- 161-53. Epstein, P. S. On the possibility of electromagnetic surface waves: Natl. Acad. Sci. Proc., v. 40, no. 12, p. 1158-1165, 1954.

The investigation of the propagation of an independent surface wave consisting of two inhomogeneous waves running along the interface, in general, leads to negative results. Two nonconducting media could support this type of surface wave provided one of them has a negative dielectric constant. Media having the peculiar properties required are hardly available in nature.

The problem of propagation of waves from an oscillating electric dipole at the surface of a plane earth is analogous in some respects to the problem treated in this paper, and is to be the subject of further investigation.—*R. G. H.*

- 161-54. Belluigi, A[rnaldo]. Sui "campi geoelettromagnetici normali" attivati da sistemi galvanico-induttivi e induttivi ["Normal geoelectromagnetic fields" produced by galvanic-inductive and inductive systems]: Gerlands Beitr. Geophysik, Band 64, Heft 3, 147-165, 1955.

Some fundamental properties of "normal geoelectromagnetic fields" (that is, in uniform media) are determined, for instance properties of fields produced by galvano-electromagnetic, inductive, or united systems. Among others, these properties then permit an estimate of the geoelectromagnetic fields by means of a unique method. For this purpose one uses closed quasistationary transmitters (coils or loops), the magnetic field of which can be accurately determined; or one uses open transmitters with which it does not matter whether one determines the electric or the magnetic field, for the electric energy is of the same order of magnitude as the magnetic energy.—*Author's abstract, H. F.*

161-55. Wait, James R., and Froese, Charlotte. Reflection of transient electromagnetic wave at a conducting surface: *Jour. Geophys. Research*, v. 60, no. 1, p. 97-103, 1955.

A solution is given for the reflection of a transient electromagnetic plane wave, at oblique incidence, from the plane interface of a dissipative medium. The inversion of the Laplace transforms can only be carried out in closed form in special cases. Series solutions are developed for the general case and the numerical results are presented in graphical form. Brief mention is made of the possible application of this solution to the reflection of a radio atmospheric at a sharply bounded ionosphere.—*Author's abstract*

#### INSTRUMENTS AND METHODS OF OBSERVATION

161-56. Enslin, J. F. A new electromagnetic field technique: *Geophysics*, v. 20, no. 2, p. 318-334, 1955.

A technique has been developed for accurate location of narrow vertical or inclined structures such as joints, fault planes, mineralized fissures, and weathered dikes. A series of suitable center points is selected to cover the area to be surveyed, and an alternating current of audiofrequency is introduced conductively into the ground at these points. Relative or absolute measurements of the tangential component of the resultant horizontal electromagnetic field are made at stations on concentric circles around the center point. Curves of the amplitudes in decibels are plotted as ordinates against the station positions. Positions of peaks of field intensity are plotted on the base map, and corresponding peaks are joined to show positions of conducting structures. The dip of the structure is indicated by the asymmetry of the amplitude curves. The method has been used in routine surveys by the Geological Survey of South Africa for location of faults, lodes, and veins, and for selection of borehole sites in bedrock formations.—*M. C. R.*

161-57. Belluligi, Arnaldo]. Un Eltranslog Schlumberger [A Schlumberger Eltranslog]: *Annali Geofisica*, v. 7, no. 1, p. 125-133, 1954.

The author proposes a calculation of an Eltranslog under quadripolar conditions of a classical Schlumberger resistance log. The Elmatranslogs thus far examined are of the inductive or galva-inductive types. The "indicated behavior" of such an Eltranslog is very characteristic and is inserted in the classification given by the author of "mean results" of the transitory measurements, with the advantage of greater simplicity of the corresponding apparatus.—*Author's abstract*

- 161-58. Dakhnov, V. N., Latyshova, M. G., and Ryapolova, V. A. Issledovanie skvazhin metodom iskusstvenno vyzvannykh potentsialov (elektroliticheskiy karottazh) [Investigations of drill holes by the method of induced potentials (electrolytic well logging)]: *Promyslovaya geofizika*, p. 46-82, 1952.

The theory of electrolytic phenomena in an oil well or in a hole drilled through a coal-bearing formation is presented. Arrangements for measuring artificially produced reverse potentials are discussed in detail, and examples of the application of this method of induced potential for logging drill holes are given. Under normal conditions the average value of the induced potential is only 6-7 percent of the initial one, but the addition to the mud of even minute quantities of a diluted oxide causes a great increase of the induced potential, sometimes making it greater than the initial one.

The method has been used in logging oil wells and in surveying coalfields and hematite deposits, in some places giving more detailed and more reliable data than the resistivity or self-potential methods.—*S. T. V.*

#### METHODS OF ANALYSIS AND INTERPRETATION

- 161-59. Huber, A. Der scheinbare spezifische Widerstand einer geneigten ebenen Schichte [The apparent resistivity of an inclined plane layer]: *Archiv Meteorologie Geophysik u. Bioklimatologie, Ser. A, Band 8, Heft 1-2*, p. 95-112, 1955.

Starting from the rigorous representation of the electrical potential for a wedge the apparent specific resistance is derived for both a parallel and a normal direction of the measuring basis with regard to the outcrop of an even inclined stratum boundary. Comparison of the resistance curves with the normal two-layer curves indicates possible errors in evaluating geoelectric soundings. Furthermore it is shown how the apparent specific resistance varies when an outcrop is being crossed with a horizontal sonde and how the direction of a stratum boundary can be determined by radial sounding. Finally, the theoretical bases for investigation of the influence of slopes on geoelectric sounding are developed.—*Author's abstract*

#### ELECTRICAL SURVEYS

- 161-60. Mosetti, Ferruccio. Misure geoelettriche in zone prevalentemente argillose. Un caso di stratificazione a resistivita non costante [Geoelectric measurements in predominantly argillaceous zones. A case of stratification with varying resistivity]: *Industria Mineraria*, anno 5, no. 5, p. 257-259, 1954.

This is a discussion of the shape of the apparent resistivity curves from measurements by the Wenner method over different geologic structures, such as a homogeneous medium with constant electric resistivity, a medium composed of two horizontal layers, each with constant resistivity, a medium of three or four similar layers, and a layer with resistivity continuously increasing with depth.

In the last the resistivity curve must be a straight line at an angle of 30° to 40° with the abscissa axis. With a set of such graphs computed for different variations of resistivity, it is possible to interpret the field measurements.—*S. T. V.*

- 161-61. Schenk, Erwin. Isoohmen [Isoohms]: Gerlands Beitr. Geophysik, Band 64, Heft 3, p. 223-224, 1955.

Schenk suggests the use of the term "isoohm" instead of the "line of equal resistivity" or "equirestivity contour." The numerical value of the resistivity may precede the name of the unit, as for example, 60 isoohms.—*S. T. V.*

- 161-62. Société Nationale de Recherches et d'Exploitation des Pétroles en Algérie and Bouchon, M. Etude tellurique dans le bassin du Hodna [Telluric study in the basin of Hodna]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9, p. 231-243, 1954.

Exploration in the eastern part of the Hodna basin is an example of what telluric reconnaissance can show about a sedimentary basin. Geologically the basin is of interest because the lower Eocene is present on the northern border and plunges to the south under the Miocene cover. A seismic survey in reconnaissance of the structures of Chouf Djelf and Chott El Hammam indicated a progressive thinning of the sedimentary series from the northern border almost to the Chott El Hammam structure. Unfortunately the area immediately north of the Chott did not produce any deep reflections so it was not possible to trace the different horizons from place to place or to determine the formations that would be found in a drill hole near Chott El Hammam.

A preliminary telluric reconnaissance of the structure indicated that it corresponded to a more marked telluric anomaly than would result from a regular fold of the size of Chott El Hammam. It is necessary to assume that another phenomenon has been added to the rise of the Chott El Hammam anticline and that there is a resistant substratum under the sand of high telluric values at a relatively shallow depth. A borehole through the interior of the sand confirmed this.

Meanwhile the telluric reconnaissance was continued. The map is well differentiated and shows that the thickness of the conductive sediments (Miocene, Eocene, and probably a part of the Cretaceous) is very variable in the interior of the basin and is only important in a small part of it. Considering also the results of the drilling, the telluric study will give a new orientation to petroleum exploration in the region.—*Authors' abstract, M. C. R.*

- 161-63. Manfredini, Antonio. Alcuni risultati della campagna geo-elettrica del 1953 [Some results of geoelectric surveying during 1953]: Servizio geol. Italia Boll., v. 75, (1953), fasc. 2, p. 969-971, 1954.

A preliminary report on the activity of the Italian survey during 1953. Surveys in the Pontine lowland, at Monte Circeo, and at Spoleto are described. Several important sources of underground water, of which the most important are those around Monti Lepini, were discovered.—*S. T. V.*

## SEISMOLOGY

### ELASTIC WAVES

- 161-64. Karus, Ye V., and Pasechnik, I. P. O prirode uprugikh voln, vozvuzhdaemykh v real'nykh shedakh garmonicheskim istochnikom [The nature of elastic waves produced in actual media by a harmonic source]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 89-100, 1955.

In a continuation of investigations of the elastic and absorptive properties of rocks [see Geophys. Abs. 160-175], the nature and the properties of elastic vibrations produced by a harmonic source have been experimentally determined.

Traveltime curves and the curves of amplitude variation were studied. These experiments have shown that the observed waves are complex, being the result of different interfering longitudinal, transverse, and surface waves. Longitudinal waves predominate at distances greater than 8–10 wave lengths; transverse and surface waves were found to be more intense, with Rayleigh waves predominant. Coefficients of energy absorption in the medium were determined by averaging successive amplitudes and could be reliably found for dominant waves.—*S. T. V.*

161–65. Hardtwig, E[rwin]. Oberflächenwellen in energieverzehrenden Medien [Surface waves in energy-absorbing media]: *Annali Geofisica*, v. 7, no. 2, p. 143–193, 1954.

In an introductory part the fundamental principles of the propagation of surface waves in media not perfectly elastic, especially the possibilities for the tension-deformation relation, are discussed, and the limits of validity of Hooke's law are indicated. The theories of Maxwell, Larnor-Jeffreys and Galitzin for energy-absorbing media are discussed. In the second part the theory of Galitzin for a medium with internal friction is completely treated. It is assumed that the damping of waves does not depend on the frequency or the phase velocity. The third chapter is concerned with a firmo-elastic medium. The setting up of particular solutions depends upon the solution of an algebraic equation of the ninth degree, which is reduced to the well-known equation of Rayleigh of third degree with the introduction of certain simplifications about the viscosity constants. The theory of the cubic equation which contains the constant of Poisson as parameter is developed, and the particular solutions are determined. The damping proves dependent on the period. Damping and phase velocity contain the relation "relaxation time: period" which exerts a considerable influence on the physical behavior of the medium.—*Author's abstract, M. C. R.*

161–66. Satō, Yasuo. Study on surface waves VIII. Nomogram for the phase velocity of Love waves and maximum thickness of the surface layer: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 31, pt. 2, p. 81–88 and plate, 1953.

A nomogram has been devised to obtain the velocity of Love waves corresponding to any given state of media, or to get a material constant by means of the velocity and period data: If the velocity of *S* waves and the rigidity of both media are given, and the period and phase velocity of Love waves are observed, the thickness of the surface layer can be determined from the nomogram; a maximum thickness can be determined if the velocity of *S* in the upper medium, phase velocity, and period are given.—*M. C. R.*

161–67. Satō, Yasuo. Study on surface waves IX. Nomogram for the group-velocity of Love waves: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 31, pt. 4, p. 255–260 and plate, 1953.

A nomogram for obtaining the group velocity of Love waves.—*M. C. R.*

161–68. Satō, Yasuo. Study on surface waves X. Equivalency of *SH*-waves and sound waves in a liquid: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 32, pt. 1, p. 7–16, 1954.

It is shown mathematically that *SH*-surface waves and sound waves in a liquid are equivalent if the frequency, wave length, and velocity of body waves

are equal in the two problems and if the density is inversely proportional to the rigidity. The free surface of one corresponds to a fixed surface of the other and displacement in one to stress in the other.—*M. C. R.*

- 161Q69. Perri Emilio. Sopra un'onda lenta superficiale provocata da esplosione vicina: II [On a slow surface wave produced by a nearby explosion: Pt. 2]: *Geofisica Pura e Appl.*, v. 29, p. 84-105, 1954.

The author completes his investigation of the surface wave ( $\epsilon$ ) already discussed in Part I [see *Geophys. Abs.* 158-132]. The following subjects are treated: the spatial distribution of the displacement vector and correlative "locus" (ideal stationary trajectory) of a point displaced by periodic strain of the wave; the ratio between the maximal components of the  $\epsilon$ -wave motion, as well as the corresponding group velocity; an estimate of  $\lambda$  and  $\mu$  of surface rocks, through the dynamic method given by the author based on the recording of any pulses ( $\epsilon$ ) spread by an explosion (Genoa-Fegino experiments, 1939); and an analytical demonstration of the geometric divergence between (rectilinear) seismic rays relative to a theoretical plane wave and the (curvilinear) rays along which flows the energy of the wave motion examined.—*Author's abstract, M. C. R.*

- 161-70. Matuzawa, Takeo. *S*-wellen an der fest-flüssigen Schichtgrenze. I [*S*-waves at a solid-liquid interface. Pt. 1]: *Tokyo Univ. Earthquake Research Inst. Bull.* v. 32, pt. 1, p. 1-5, 1954.

The behavior of *SH*-waves at the boundary between viscous and solid bodies is developed mathematically. If the viscosity determined by Minakami for fresh lavas of the 1951 eruption of Oosima is the same order of magnitude as the viscosity of magmas, it seems possible that reflections of *S*-waves may be used to detect phase changes in the earth's crust.—*M. C. R.*

- 161-71. Das Gupta, Sushil Chandra. Propagation of Rayleigh waves in a layer resting on a yielding medium: *Seismol. Soc. America Bull.*, v. 45, no. 2, p. 115-119, 1955.

The effect of an underlying elastic medium on the propagation of Rayleigh waves in a homogeneous layer is considered, and the results are compared with those of Sezawa and Kanai for the propagation of waves in a layer lying on a rigid foundation. Assuming that a Rayleigh-type wave is propagated in the medium in question, an approximate value of the constant of proportionality between the upward thrust on the lower surface of the layer and the vertical displacement is determined (assuming a linear relationship). If Rayleigh waves of 20-second period travel with velocity of 0.03 kmps, and the velocity of shear waves is 3.34 kmps, the constant is  $1.5 \times 10^6$  dynes per  $\text{cm}^3$ . From boundary conditions and from this approximate value the existence of a minimum group velocity is shown.—*P. E. B.*

- 161-72. Skuridin, G. A. Priblizhennoye resheniye zadachi o diffraksii ploskoy uprugoy volny otnositel'no shcheli [The approximate solution of the problem of the diffraction of a plane elastic wave on a slot]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 1, p. 3-16, 1955.

The high precision of modern seismic investigations makes it necessary to take into account the diffraction of the waves on various heterogeneities along the wave path. Skuridin follows the procedure first suggested by Kirchhoff and based on the Huygens principle and derives the formulas for the displacement

at different points of infinite space under the action of a force placed at the coordinate center. Solutions of the equations are found for Fresnel's and Fraunhofer's diffraction. The derived formulas are applied to specialized conditions, and the computed solutions are given also in the form of graphs. Analysis of the given formulas determines the conditions when they can be used as sufficiently accurate approximations.—*S. T. V.*

#### INSTRUMENTS AND METHODS OF OBSERVATION

161-73. Semanate, A. D. Breves lecciones de sismometria [Short course in seismometry]: Bol. informaciones cient. nac. Ecuador, v. 6, no. 57, 248-268, no. 58, p. 353-368, no. 59, p. 529-559, no. 60, p. 633-651, no. 61, p. 762-779; v. 7, no. 62, p. 87-97, no. 64, p. 285-302, 1954.

This is the text of a short course on seismometry given to prospective staff members of the recently established Quito seismologic observatory. It contains in brief form much of the fundamental information necessary in the servicing of the observatory, especially in understanding the operation of seismographs. A short study of the propagation of seismic waves through the ground, of the seismograms, and of the methods of determining the position of the epicenter is included.—*S. T. V.*

161-74. Nishimura, Genrokuro; Suzuki, Masazi; and Furukawa, Eiichi. Theory of Eden's twin strips and application of it to magnifying mechanism of seismometer: Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 1, p. 86-111, 1954.

"Eden's twin strips" is a magnifying mechanism chiefly used for comparators of high sensitivity. It has been used in vibration measuring instruments including vibrographs, accelerographs, and vibration tables. The theory of the strips and the application in seismometry is developed in this paper.—*M. C. R.*

161-75. Gurvich, I. I. Seismorazvedka [Prospecting by seismic methods]: 242 p., Moscow, Gosgeoltekhizdat, 1954.

This book is written to be used as a textbook of applied geophysics by the students of the colleges of geologic prospecting. It is divided into twelve chapters dealing with the physical and geologic foundations of the seismic methods, the instruments used for observing and producing seismic waves, and the interpretation of seismograms. Problems are included to aid in use as a textbook.—*S. T. V.*

161-76. Coker, Frank B. How to reap the maximum magnetic tape recording benefits: World Oil, v. 140, no. 5, p. 120-129, 1955.

This is a discussion of the steps that should be taken in order to obtain the maximum benefit from magnetic tape recording in seismic exploration, and of the advantages of magnetic tape recording over conventional seismic work.—*L. C. P.*

161-77. Clayton, Neal, and Pohly, Richard A. New techniques being used to find stratigraphic traps: World Oil, v. 140, no. 5, p. 116-118, 129, 1955.

Magnetic tape recording and the high-resolution reflection seismograph are two recent improvements in the seismic method that should prove helpful in locating stratigraphic traps. Using the high-resolution system, smaller lithologic

changes can be "seen." Under favorable circumstances, reflections may be recorded from both the top and bottom of thin beds. "Isotime" maps, which permit separation of lower velocity sands from higher velocity shales, may be helpful in locating stratigraphic traps, particularly using the high-resolution reflection seismograph. The gravity method may be useful in mapping relief on erosional surfaces associated with stratigraphic traps, and low-density porosity zones in limestones. Very accurate gravity measurements are required.—*L. C. P.*

161-78. Manry, Leon V., and Sax, William. Airshooting useful as reconnaissance tool: *World Oil*, v. 140, no. 5, p. 150-154, 1955.

This is a description of the Poulter air-shooting method of seismic reflection reconnaissance.—*L. C. P.*

161-79. Muratori, G[iovanni]. Drilling methods in sand and gravel formations: *Geophys. Prosp.*, v. 3, no. 1, p. 56-64, 1955.

In the development of seismic drilling methods in northern Italy, the most important considerations have been those of ease in transport and quickness of operation. Different drilling systems are described that are adapted to the different types or near-surface formations that are encountered in the area. In soft sands a high-pressure water jet is used, a rotary table not being required in a great many cases. In medium consistency sand and small gravel, the drill rods are rotated by a special roller wrench equipment instead of the more usual kelly. In coarse formations, gravel and boulders, casing is driven by special pile driving equipment with collapsible mast for easy transport.—*Author's abstract*

161-80. Hales, F. W., and Edwards, T. E. Some theoretical considerations on the use of multiple geophones arranged linearly along the line of traverse: *Geophys. Prosp.*, v. 3, no. 1, p. 65-73, 1955.

An analytical treatment is given of the response of linear arrays of multiple geophones, as a function of the direction of incidence of the wave and of the wave frequency. The relation between the response and the direction of incidence may be quite complicated, the response being zero in several directions. As function of wave frequency, the response may also have several zero values within the frequency band in which reflections are expectable. This would result in a serious modification of the filter characteristics of the amplifier. It is shown, however, how such a modification of the filter characteristics may be avoided by a judicious choice of the number and the spacing of the geophones in a multiple group.—*Authors' abstract*

161-81. Lombardi, Leonard V. Notes on the use of multiple geophones: *Geophysics*, v. 20, no. 2, p. 215-226, 1955.

Multiple detector groups may be used as a means of improving the sampling obtained with one geophone, or as a means of cancellation of unwanted energy. In the former case, elementary sampling theory appears applicable, at least to a first approximation, to the design of the detector array that will insure, to a reasonable degree of certainty, that the output gives a representative sample. In the latter case, the use of rather long spreads and a large number of detectors greatly increases tolerance to variations in the surface waves to be cancelled. Indeed, it would appear that the upper limit of the number of geophones to be

used in a given area is determined by economic rather than by theoretical considerations. However, it is believed that the efficiency with which a given number of geophones can be used may vary quite appreciably—*Author's summary*

161-82. Massé, Lucien. Probability distribution of reflections on seismic records: *Geophysics*, v. 20, no. 2, p. 243-253, 1955.

The process of picking reflections on a seismic record is essentially that of detection of signals in the presence of noise when the signal-to-noise ratio is rather low. A modification of the theory of radar information, in which given prior probability, posterior probability of signals to noise may be computed after study of the receiver output, may be applied to the analysis. An example of the use of the method is given.—*M. C. R.*

161-83. Simpson, Stephen M., Jr. Similarity of output traces as a seismic operator criterion: *Geophysics*, v. 20, no. 2, p. 254-269, 1955.

The problem of emphasizing signals on multiple trace seismograms is approached by considering a relationship between the input and output records. It is proposed that the transformation to output record be one which causes the output traces to be most "similar" or "inphase" according to a certain definition of this property. If the noise and signal are "properly behaved," it may be demonstrated that a linear transformation chosen by this criterion must have a response emphasizing frequency ranges of high-input signal-to-noise ratio. The determination of such a transformation from the input data alone is carried out for discrete linear operators. The numerical work involved in computing such operators is formidable. As an example the computations were carried out for a mixture of an artificial signal introduced into a noise record. The results are about as good as those obtained with conventional filtering techniques depending on prior knowledge of input signal-to-noise ratios.—*Author's abstract*

#### METHODS OF ANALYSIS AND INTERPRETATION

161-84. Zav'yalov, V. D., and Timoshin, Yu. V. Godografy otrazhennykh voln dlya krivolineynykh granits rasdela i ikh interpretatsiya [Traveltime curves of waves reflected from curvilinear boundaries and their interpretation]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 2, p. 118-129, 1955.

The question of the shape of the traveltime curve is discussed, and various forms of this curve are given for many special cases of the reflecting surface. In the general case, assumption of a hyperbolic shape of the traveltime curve is inadmissible. An analytic method of finding the traveltime curve is first given, and later a more convenient graphic procedure is given for its determination. The suggested method is based on the laws of geometric optics and naturally leads to only approximate solutions. The solutions found theoretically were later checked by experiments with an ultrasonic seismoscope designed by Riznichenko and others, and good agreement was found between the computed and experimental results.—*S. T. V.*

161-85. Weber, Max. Die Bestimmung der Frontgeschwindigkeit in einem einachsigen inhomogenen Körper aus seismischen Reflexionsmessungen [The determination of wave-front velocity in a uniaxial heterogeneous medium from seismic reflection measurements]: *Geofísica Pura e Appl.*, v. 29, p. 11-21, 1954.

A new direct method of determining the wave velocity  $C(Z)$  from the recorded traveltimes curves is developed. The computations stem from the characteristic partial differential equations of the seismic waves, and the procedure followed is one of successive approximations similar to the method used in solving Fredholm's integral equation. A practical example is given.—*S. T. V.*

161-86. Zeuch, Richard. Eine Methode zur Bestimmung von Tiefe und Neigung einer reflektierenden Schichtgrenze aus der Laufzeitkurve des reflektierten Impulses [A method for the determination of depth and dip of a reflecting horizon from the traveltime curve of a reflected impulse]: *Gerlands Beitr. Geophysik*, Band 64, Heft 3, p. 194-207, 1955.

A method is described which permits<sup>4</sup> determination of the depth and dip of a reflecting horizon from no more than the traveltime curve. The determination of the average velocity of the reflected impulse is included in the method. The effect of layers between the surface and the reflector is investigated qualitatively for a normal case by means of an example. The described method, taking advantage of certain simplifications, is based on the results of that investigation. An estimate of error indicates the accuracy of the values obtained in using the method. The application of the method is illustrated by a numerical example. The method is not applicable to the steep flanks of salt domes.—*Author's abstract, H. F.*

161-87. Opitz, D. Universaldiagramme für die Geschwindigkeits-Tiefenfunktionen  $v=v_1+az$  und  $v_m=v_0\sqrt{1+nz}$  [Universal diagrams of the velocity-depth functions  $v=v_1+az$  and  $v_m=v_0\sqrt{1+nz}$ ]: *Gerlands Beitr. Geophysik*, Band 64, Heft 3, p. 209-213, 1955.

Curves of the functions  $v=v_1+az$  and  $v_m=v_0\sqrt{1+nz}$  are presented, and their use is briefly discussed.—*H. F.*

161-88. World Oil. New computing device aids seismic interpretations: *World Oil*, v. 140, no. 5, p. 142-148, 1955.

This is a description of the Reynolds seismic cross-section plotter.—*L. C. P.*

161-89. Alvarez-Castrillon y Bustelo, M. Interpretacion de un sismograma [The interpretation of a seismogram]: *R. Acad. Cien. y Artes de Barcelona Mem.*, v. 31, no. 16, p. 415-432, 1954.

This is the text of an address to the academy. Seismic waves and their properties are discussed in a nonmathematical treatment.—*S. T. V.*

#### OBSERVATIONS OF SEISMIC WAVES

161-90. Ramirez, Jesus Emilio. Las ondas sismicas [Seismic waves]: *Dyna*, año 21, no. 70, p. 58-62, 1954.

A brief review.—*M. C. R.*

161-91. O'Brien, P. N. S. Model seismology—the critical refraction of elastic waves: *Geophysics*, v. 20, no. 2, p. 227-242, 1955.

Head waves were observed with three different pairs of media: oil overlying calcium chloride solution, water overlying wax, and water overlying concrete. In the first pair no distortional wave is possible, and the observed head wave

travelled along the interface with the dilatational velocity of the lower medium. In the second pair the distortional velocity in wax is less than the velocity through water, and no head wave was observed which travelled with the distortional velocity through wax. In the third pair, both the dilatational and distortional velocities through concrete are greater than the velocity through water, and head waves travelling with both velocities were observed.

Quantitative measurements were made on the amplitude of the head wave, and, within the experimental error, the data agree with the predictions of Cagniard and others that the decrease with distance should be proportional to  $r^{-1/2}L^{-3/2}$ , where  $r$  is the orthogonal projection on the interface between the source and detector, and  $L$  is the distance the wave has travelled in the lower medium.—*Author's summary*

161-92. Berzon, I. S. Granichnyye skorosti v nekotorykh metamorficheskikh i kristallicheskikh poro dakh [Boundary velocities in some metamorphic and crystalline rocks]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 101-117, 1955.

Boundary velocities of seismic waves were determined experimentally in several vertically stratified metamorphic rocks bordering on crystalline formations by the method of correlation of refracted waves. Seismic velocities in metamorphic and crystalline formations vary over a wide range, from 2,000 to 7,000 meters per second. The boundary velocity between slates and ferrous hornstones is 4,000 to 5,000 meters per second; between gneiss and granite, 4,500 to 6,000 meters per second. Boundary velocities of more than 6,000 meters per second were established at relatively shallow depths, although such velocity is ordinarily considered as typical for depths of not less than 10 to 15 km. In vertically stratified formations only 50 to 250 meters thick, the boundary velocity constantly remains within the indicated limits.

The identification of different strata often cannot be reliably made on the basis of determined velocity. Comparison of the characteristic variations in the amplitudes of the waves is recommended.—*S. T. V.*

161-93. Yepinat'yeva, A. M. Eksperimental'nyye dannyye o prelomlennykh volnakh v sredakh so slaboy skorostnoy differentsiatsiyey [Experimental results on refracted waves in media with small differences in velocities]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 130-136, 1955.

The smallest difference in seismic velocities in adjacent strata producing a noticeable refractive effect on seismic wave was determined experimentally in an area of horizontally stratified carbonaceous formations more than 1,200 meters thick. The results show that refracted waves can be formed with only small velocity differences; refracted waves were observed for  $V_1/V_2$  ratios of 0.90 or even 0.98 in the velocity range of 5.0 to 5.5 km/s.

It is thus impossible to obtain any indication of the presence of different layers from kinematic data such as the shape of the traveltime curves. Only the dynamic characteristics affected by such factors as the difference in energy dissipation can be used. An abrupt decrease in amplitude of seismic waves may indicate the presence of a new formation.—*S. T. V.*

161-94. Kasahara, Keichi. Experimental studies on the mechanism of generation of elastic waves I: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 3, p. 259-268, 1952.

To investigate the mechanism of generation of elastic waves, model experiments were made using agar-agar as the elastic medium and a wave transmitter constructed from parts of a dynamic loudspeaker. The first experiment was determination of the behavior of the surface of a homogeneous semi-infinite elastic body under the effect of an impulsive external force acting in a vertical direction at a point on the surface. Three phases were observed with arrival times increasing with distance, a dilatational wave, a surface (Rayleigh-type) wave, and a transverse wave reflected from the base of the agar-agar. There was satisfactory agreement between the character of the displacement predicted by Lamb and that observed at 30 cm. An upward displacement was observed near the origin.—*M. C. R.*

161-95. Kasahara, Keichi. Experimental studies on the mechanism of generation of elastic waves II: Tokyo Univ. Earthquake Research Inst. Bull., v. 31, pt. 1, p. 71-79, 1953.

This is a theoretical study of wave phenomena on the surface of a semi-infinite elastic body subjected to an external impulsive force to check the model experiments. Only the two-dimensional problem is studied. A rising ("swelling-up") is shown to occur near the origin at which the external force acts downward.—*M. C. R.*

161-96. Kasahara, Keichi. Experimental studies on the mechanism of generation of elastic waves III: Tokyo Univ. Earthquake Research Inst. Bull., v. 31, pt. 3, p. 235-243, 1953.

Both model experiments and mathematical considerations are used to show how a free surface wave is produced from the initial deformation of the surface. In the model experiments particle motions at points near the origin are affected by the form of excitation, but at points more than 15 cm away, particles move in ordinary free surface wave regardless of the phase angle of excitation. Mathematically it is shown that the total strain energy accompanying the Rayleigh wave is less than that of any other deformation.—*M. C. R.*

161-97. Kasahara, Keichi. Experimental studies on the mechanism of generation of elastic waves IV: Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 1, p. 67-77, 1954.

A series of experiments was performed to determine the wave form and amplitude of elastic waves resulting from impact of a falling ball. Wave forms (periods) of the initial motions were not dependent on distance ball was dropped. The amplitude was essentially proportional to the square root of the distance of fall except near the point of origin. The effects of different kinds of material at the point of impact could be seen in initial motion.—*M. C. R.*

161-98. Lehmann, I. Characteristic earthquake records: Denmark Geod. Inst. Skr., 3 raekke, bind 18, 33 p., 1954.

Thirty-five typical seismograms from the Galitzin-Wilip, Wiechert, and Benioff instruments at København, Scoresby-Sund, and Ivigut have been reproduced, arranged in order of increasing epicentral distance, to exhibit the characteristic features of the various ranges of distance. Each record is briefly described.—*M. C. R.*

161-99. Gutenberg, B[eno]. Channel waves in the earth's crust: Geophysics, v. 20, no. 2, p. 283-294, 1955.

Three major low-velocity layers seem to exist in the earth's crust, of which two, the lithosphere channels, are found respectively in the "granitic" and "basaltic" ("gabbro") layers of the continents; a third channel extends from the Mohorovičić discontinuity downward into the asthenosphere. Several types of waves are guided by these channels, especially  $P_a$  and  $S_a$  by the asthenosphere channel,  $L_{g1}$ ,  $L_{g2}$  and  $R_g$  by the lithosphere channels; waves guided by low-velocity layers in sediments must also be expected. Many records of the Southern California earthquake of July 21, 1952 show channel waves with periods and velocities as reported for other paths. The regular microseisms with periods of 4 to 10 seconds have properties similar to those of the  $L_g$ - $R_g$  group in earthquake records and are probably propagated by the same mechanism.

Most of these interpretations and conclusions are tentative; pertinent observations are scanty; and complications have thus far prevented development of adequate equations to calculate the amplitudes of waves guided by a given channel.—*Author's abstract*

161-100. Caloi, Pietro. L'astenosfera come canale-guida dell'energia sismica [The asthenosphere as the guide-channel of seismic energy]: *Annali Geofisica*, v. 7, no. 4, p. 491-501, 1954.

Waves of unknown origin have long been observed between  $P$  and  $S$  and between  $S$  and  $L$  on seismograms of distant earthquakes. These unknown types of waves are especially evident in records of earthquakes originating at depths of 50 to 250 km. Two distinct groups of such waves have been observed, one propagating with a velocity of 8.0 km/s, the other with a velocity of about 4.4 km/s. The unknown waves apparently originate in the zone beneath the crust in which, according to Gutenberg, the velocity decreases and then increases. The origin of the observed phenomenon is attributed to the velocity flexion. Energy injected parallel to the limiting surfaces or at an angle such that it is reflected within the layer will be transmitted for great distances. Under some conditions, the greater part of the energy that would normally go into formation of  $PP$  and  $PPP$  may be concentrated as  $P_a$  ( $P$  in the asthenosphere). Several examples are given.—*S. T. V., M. C. R.*

161-101. Crary, A. P. A brief study of ice tremors: *Seismol. Soc. America Bull.*, v. 45, no. 1, p. 1-9, 1955.

During seismic studies of Arctic ice at Barter Island, Alaska, in 1951 a great many inaudible ice tremors caused by ice fracturing under various stresses were recorded. Some hinge cracks were noted parallel to the shore. Seismic studies of the tremors were made, in part with a three-component seismograph system and in part with a two-component horizontal system. Well-defined  $P$  and  $SH$  waves with sharp initial breaks were recorded. Flexural waves showed large variations in amplitude with different tremors. Distances to source were determined from the  $SH$ - $P$  interval, and from the flexural waves. Directions were available both from the usual first-motion methods and from the retrograde particle motion of the flexural waves, for which the ratio of vertical to horizontal motion is about 10:4. The source of most of the tremors fell mainly along the shore just outside the contour for the 5-foot depth. The nature of the first motion was correlated in time with onshore and offshore winds, but there was little correlation between wind speeds and frequency of tremors. It is quite possible that pressures from the main ocean icepack, governed by winds over relatively large expanses of ice, play an important role here, influenced somewhat by the tidal forces.—*P. E. B.*

## EARTHQUAKE OCCURRENCES AND EFFECTS

- 161-102. Cloud, W. K., and Roberts, E. B. Seismological activities of the U. S. Coast and Geodetic Survey in 1952 and 1953: *Seismol. Soc. America Bull.*, v. 45, no. 2, p. 121-147, 1955.

This report summarizes all seismological activities of the U. S. Coast and Geodetic Survey, including geodetic work of seismological importance. The subjects discussed are: the teleseismic program, questionnaire program, descriptions of principal earthquakes in the United States for 1952-53, strong-motion seismograph program, tiltmeter work, instrumental and other research and development, cooperative activities, and the reobservation of geodetic control surveys.—*P. E. B.*

- 161-103. Kogan, S. D. K voprosu ob izuchenii mekhanizma glubokikh zemletryaseniy [On a study of the mechanism of deep earthquakes]: *Akad. Nauk SSSR Doklady*, tom 99, no. 3, p. 385-388, 1954.

The dynamic characteristics of the foci of 29 deep earthquakes in the Pacific area (along the northwestern shores of the Pacific Ocean, and along the arcs formed by the Aleutian, Kurile, Japanese, and Bonin-Marianas Islands) and 10 shocks in central Asia (near the Pamirs and Hindu Kush) were studied by the method of V. I. Keylis-Borok. The dynamic characteristics of the foci were all found to be equivalent to a double force and an additional moment, a mechanical scheme that produces a dislocation. The resulting ruptures had an important horizontal component, almost perpendicular to the borderline of the continent. Kogan suggests that the earthquakes investigated are caused by the nonuniform flow of subcrustal material, causing different tectonic movements in the epicentral regions.—*S. T. V.*

- 161-104. Trapp, E. Zur praktischen Darstellung der Seismizität [Practical representation of seismicity]: *Gerlands Beitr. Geophysik*, Band 64, Heft 2, p. 133-140, 1954.

It is proposed to state the seismicity  $S$  in erg per square metre and hour ( $\text{erg}/\text{m}^2\text{h}$ ), and to use the logarithm of  $S$  in practice. This gives the advantage of dealing with small and convenient figures. According to M. Toperczer the "efficiency"  $w$  of an earthquake is derived from the macroseismic quantities  $J$  (epicentral intensity) and  $f$  (macroseismic surface) by the formula  $w = Jf^*$  where  $f^*$  denotes a rough measure for the area of macroseismic surface. According to the present author it is changed to  $w = J \log_{10} f$ . The sum of efficiency  $\sum w_i$  as well as the sum of energy  $\sum E_i$  can successfully be used to represent the seismicity of a country.—*Author's summary*

- 161-105. Sagisaka, K. On the energy of earthquakes: *Geophys. Mag.*, v. 26, no. 1, p. 53-82, 1954.

The energy of an earthquake may be represented by the total energy of the seismic waves or by the energy necessary to accomplish the deformation of the crust accompanying an earthquake. Formulas have been developed for the energy of seismic waves from a deep-focus earthquake. These indicate total energy of  $3.1 \times 10^{20}$  ergs for the shock of June 2, 1929, whereas the Gutenberg-Richter magnitude is  $5.8 \times 10^{24}$  ergs. The energy of the Kwanto earthquake was estimated by considering the deformation of the crust, assuming all parts of the deformation took place at the time of the earthquake. The energy thus

computed was  $10^{24}$  ergs, in contrast to Gutenberg's estimate of  $7.4 \times 10^{26}$  ergs. The energy of the North Idu earthquake of 1929 was calculated as  $7 \times 10^{21}$  ergs; Homma later calculated the energy to be  $10^{23}$  ergs.—*M. C. R.*

161-106. Barriga, V. M. Los terremotos en Arequipa [Earthquakes in Arequipa]: 426 p., Arequipa. La Colmena, 1951.

Historical records from the archives of Arequipa, Peru, relating to earthquakes which occurred there from 1582 to 1868, have been collected in this volume. On the basis of these documents three earthquakes have been classed as 11 on Mercalli scale, one as 10, two as 9, one as 7, and several of lesser intensity.—*S. T. V.*

161-107. Wurster, Paul. Erdbebenschaden—tektonisch gesehen [Earthquake damage—tectonically regarded]: Geol. Rundschau, Band 42, Heft 2, p. 237-238, 1954.

A discussion of the effects of the earthquake of March 14, 1941, on the church at Obergartzen, near Euskirche, particularly the symmetrical pattern of cracks developed in the vault.—*D. B. V.*

161-108. Filippo, D[omenico] Di, and Marcelli, L. Uno studio sul terremoto di Cefalonia (del 12 agosto 1953) con particolare riguardo alla natura fisica della scossa all' ipocentro [Study of the Cephalonia earthquake (August 12, 1953) especially of the physical nature of the shock in the focus]: Annali Geofisica, v. 7, no. 4, p. 547-561, 1954.

A long series of seismic shocks of varying intensity occurred between August 9 and 12, 1953 on the islands of the Ionian Sea. The epicenter of the violent shock of August 12 has been located at lat.  $38^{\circ} 10' 26.8'' \pm 2' 43.04''$  N., long.  $20^{\circ} 42' 12.54'' \pm 4' 02.57''$  E. The magnitude of the shock was  $7\frac{1}{4}$ , and the total energy  $10^{25}$  erg. The depth of the focus was found to be 16 km, the time of origin  $9^{\text{h}} 23^{\text{m}} 50.35032^{\text{s}} \pm 0.63983^{\text{s}}$ .

The study of the distribution of dilatations and compressions led to the conclusion that the first movement at the focus was a sinking. Studies of earthquakes in the upper Adriatic and the Apennines suggests that sinkings in the Adriatic, probably associated with rising of the Apennines, are aligned along the Adrio-Ionian depression.—*S. T. V.*

161-109. Gulatee, B. L. Geodetic and geophysical aspects of the earthquakes in Assam: Survey of India Tech. Paper no. 5, 9 p., 1951, reprinted 1954.

On the basis of Bond's triangulation following the earthquake of 1897, Burard concluded that the average horizontal displacement had been 7 feet in a northwesterly direction and that there was on the whole an upheaval, but pointed out that these discrepancies were relative and were of the same order of magnitude as the errors of the triangulation. The epicenter of the earthquake of 1950 is in an out-of-the-way region. The triangulation within isoseismal 10 was done in 1874-76, and the stations have since disappeared. Changes in height produced by the 1897 earthquake are not definitely known. Upheavals of more than 20 feet indicated by Bond's work may be due at least in part to errors. An association between negative gravity anomalies and earthquakes has been postulated, but in Assam the centers are distributed at random irrespective of the sign of the gravity anomaly. The epicentral tract of the 1897 earthquake is in a region of

elevated geoid and positive gravity anomalies, and the 1950 shock apparently is in a markedly negative region.—*M. C. R.*

161-110. Kvale, Anders. Seismic seiches in Norway and England during the Assam earthquake of August 15, 1950: *Seismol. Soc. America Bull.*, v. 45, no. 2, p. 93-113, 1955.

During the Assam earthquake of August 15, 1950, unusual waves were observed in at least 37 places in fjords and lakes in Norway. Reports from 29 of these are discussed in this paper. In most places the waves were standing waves, with periods of 1 to 3 minutes and amplitudes of 5 to 100 cm and began when the acceleration at the seismological observatory in Bergen surpassed 20 milligals in the east-west direction and 40 milligals in the vertical direction. The movements generally ceased when the acceleration decreased to below 10 milligals. The main periods of the long waves declined during this period from about 30 to 15 seconds, but the seismograms also indicate longer periods, of about 1 to 3 minutes, which may have some connection with the seiches.

The calculated periods for the basins where waves were observed are, assuming one mode, in most places between 1 and 3 minutes. In England, similar phenomena were observed in water reservoirs.—*P. E. B.*

161-111. Hayes, R. C. Earthquakes in New Zealand during the year 1953: *New Zealand Dept. Sci. Indus. Research, Seismol. Observatory Bull.* S-99, 6 p., 1955.

Earthquake activity in New Zealand was greater in 1953 than in 1952. Of the 132 shocks reported felt, 114 were felt in the North Island and 24 in the South Island; 6 were felt in some part of both Islands. The deepest earthquake yet recorded in New Zealand (nearly 570 km) occurred on March 24 with its epicenter in north Taranaki; mainly because of its deep origin, it was not reported felt. In the latter part of June a swarm of very shallow earthquakes was experienced at Great Barrier Island, originating just northeast of the island; none exceeded intensity 4 (modified Mercalli). Other noteworthy shocks included those of July 4, in the Tokaanu region, which reached intensity 7; Sept. 29, with its epicenter in the Bay of Plenty, focal depth of 300 km, instrumental magnitude of 7-7¼; Oct. 18, originating north of Taranaki, with a maximum intensity of 5. Five others reached intensity 5.

A table gives the time of origin, epicenter position, instrumental magnitude, and maximum reported felt intensity for all 1953 earthquakes; the epicenters are shown on an accompanying map.—*D. B. V.*

161-112. Taylor, W. B. Earthquake distributions in the central and southern New Zealand regions: *New Zealand Jour. Sci. Technology, Sec. B.*, v. 36, no. 4, p. 347-350, 1955.

New Zealand has been divided into four seismic regions on the basis of maximum intensity and average frequency of shocks. A complete analysis of all recorded shocks occurring in the central and southern regions during the period 1891-1952 has been undertaken in order to answer questions relating to a suggested reduction of the building seismic coefficient for the southern area of the South Island. Results show that during this period the number of shocks recorded in the central region is approximately 18 times that of the southern, but that during recent years (1943-53), owing largely to advances in instrumental seismology, the ratio is 6 to 1. There is little apparent difference between inten-

sity distributions of these regions; for the central region the distribution of time intervals between major earthquakes with felt intensity of 6 (modified Mercalli) or greater is in reasonably close agreement with that of the gamma function. Although they are less frequent, it does not seem possible to conclude that the southern region is immune to severe shocks.—*D. B. V.*

- 161-113. Eiby, G. A. The direction of fault movement in New Zealand: *New Zealand Jour. Sci. Technology, Sec. B.*, v. 36, no. 6, p. 552-556, 1955.

The direction of the initial movement on seismograms from Karapiro, Wellington, Cobb River, and Kaimata has been examined for all well-recorded earthquakes between July 1, 1951 and June 30, 1952. Most of the active faults of New Zealand strike northeast. The observed pattern in the geographical distribution of epicentres giving a displacement in a given direction is regarded as evidence that the western side of the fault moves north-eastward with respect to the eastern side.—*Author's summary*

- 161-114. Duke, C. Martin, and Brisbane, Robert A. Earthquake strain measurements in a reinforced concrete building: *Seismol. Soc. America Bull.*, v. 45, no. 2, p. 83-92, 1955.

A description is given of the disposition of strainmeters and jointmeters in a reinforced concrete building on the campus of the University of California at Los Angeles, and records are presented for the earthquakes in Kern County of August 23, 1952 and January 12, 1954. The two earthquakes produced about the same maximum ground accelerations, but the later earthquake, with dominant frequencies close to the resonant building frequency, produced strains about six times as great as the first. Small magnitudes of maximum concrete stress were noted.—*P. E. B.*

#### SEISMIC SURVEYS

- 161-115. Beaufort, Lucien; Bruneau, Jean; Grépin, André; and Yves, Julien. Ampleur de l'érosion pontienne et du comblement pliocène en Camargue [Extent of Pontian erosion and Pliocene fill in Camargue]: *Soc. Géol. France Bull.*, 6<sup>e</sup> sér., tome 4, fasc. 1-3, p. 175-184, 1954.

Data obtained from seismic surveys and from drilling in the Camargue region of France have been utilized in plotting the Pontian (late Miocene) drainage pattern of the area and working out of its Pontian and early Pliocene history.—*D. B. V.*

- 161-116. Kraume, Emil. Ergebnisse der reflexionsseismischen Untersuchungen am Rammelsberg und in seiner Umgebung [The results of seismic reflection investigations made in the Rammelsberg Mountain and its vicinity]: *Zeitschr. Erzbergbau u. Metallhüttenwesen*, Band 7, Heft 7, p. 277-280, 1954.

Seismic reflection surveys were made in prospecting for new ore deposits on the Rammelsberg in Germany, with shots placed in existing mine galleries and at the surface. A new ore-bearing horizon exists at a depth of about 2,000 meters, and several other reflecting horizons were discovered. The results of the survey are presented as seismic profiles and geologic cross sections.—*S. T. V.*

- 161-117. Research Group for Explosion Seismology. Explosion-seismic observations in northeastern Japan: Tokyo Univ. Earthquake Research Inst. Bull., v. 29, pt. 1, p. 97-105, 1951.

Eight stations approximately 20 km apart were set up along the Tohoku railway to observe an explosion of 57 tons of dynamite at Isibuti. Two phases with velocities of 5.26 and 6.13 km/s were observed. The thickness of the upper layer is 1.3 km. A phase with velocity of 3.37 km/s observed at three stations may be the *S* wave.—*M. C. R.*

- 161-118. Research Group for Explosion Seismology. The second explosion-seismic observations in northeastern Japan: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 3, p. 279-291, 1952.

Eighteen stations were set up in two profiles east and south from an explosion of 7.8 tons of dynamite at Isibuti. In the eastern profile, three layers were recognized, in which the velocities are 2.56, 4.67, and 6.08 km/s. The upper layers are 0.75 and 1.59 km thick. In the southern profile, no second layer was observed, and the velocity in the lower layer was 5.91 km/s. A phase with velocity of 3.37 km/s was observed in both profiles.—*M. C. R.*

- 161-119. Research Group for Explosion Seismology. The third explosion-seismic observations in northeastern Japan: Tokyo Univ. Earthquake Research Inst. Bull., v. 31, pt. 4, p. 281-288, 1953.

Nineteen stations were set up along two profiles, one south along the arc of the island for 300 km and the other west from the shot point transverse to the island. Velocities of 5.91, 7.17, and 3.58 km/s were observed on the southern profile and of 5.81 and 3.5 km/s on the western profile. If a sloping interface between the surface and the granitic layer is assumed for the western profile, then the velocity is 5.94 km/s, and the granitic layer would come to the surface about 70 km east of Isibuti.—*M. C. R.*

- 161-120. Research Group for Explosion Seismology. The fourth explosion-seismic observations in northeastern Japan: Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 1, p. 79-86, 1954.

To study the seismic waves from an explosion of 29.7 tons of dynamite in the Kamaisi mine about 18 km west of the city of Kamaisi, 19 temporary observation points were set up in 2 profiles, the farthest away at a distance of 510 km. In the southern profile, three velocities were identified: 6.19, 7.37, and 8.20 km/s. Thicknesses of the layers were computed as  $27.2 \pm 3.0$  km,  $5.1 \pm 3.3$  km, and  $32.3 \pm 1.3$  km. In the western profile, an apparent *P*-wave velocity of 5.76 km/s was observed.—*M. C. R.*

- 161-121. Tateishi, Tetsuo. Seismic prospecting on Kusano plain at the central part of Joban coal field [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 5, no. 12, p. 39-44, 1954.

From seismic refraction and reflection surveys, six velocity layers have been identified in the Kusano plain. These results are useful in determining coal-field structure.—*M. C. R.*

- 161-122. Ninagawa, Shinji. Seismic prospecting on Tomioka district, Joban coal field [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 5, no. 9, p. 41-50, 1954.

Four velocity layers have been identified by refraction surveys in the Tomioka district. In the western part of the field, the structure is complex; elsewhere it is simple with each layer dipping gradually eastward.—*M. C. R.*

#### MICROSEISMS

161-123. Mosetti, Ferruccio. Principi sui filtri per le onde microbariche [The principles of filter operation for microbaric waves]: *Annali Geofisica*, v. 7, no. 2, p. 221-239, 1954.

In an improved microbarograph, using the filter principle, the effects of the wind and of industrial disturbances of relatively high frequency are eliminated, and the amplitudes of longer period waves characteristic of microseismic disturbances are magnified.—*S. T. V.*

161-124. Dinger, J. E., and Fisher, G. H. Microseism and ocean wave studies on Guam: *Am. Geophys. Union Trans.*, v. 36, no. 2, p. 262-272, 1955.

Simultaneous operation of ocean wave gages and seismographs on the island of Guam from July 1952, to February 1953, provided data for studying the correlation between waves and microseisms. The use of a wave gage on the east and another on the west side of the island made it possible to record waves incident from opposite directions and thus to determine whether an area of wave interference existed in the water areas around the island. The results of these data can be summarized as follows: large microseisms were recorded when higher than normal waves of about the same period were incident on the east and the west; wave activity well above normal on only one side of the island was not accompanied by any marked increase in microseisms; where higher than normal waves were incident on both sides of the island but where the wave periods had a ratio of 0.75 or less, little increased microseismic activity resulted; when both high waves and microseisms existed, the period of the microseisms was close to one-half that of the wave periods; and an intense typhoon 800 miles distant produced no microseisms. From these observations one may conclude that strong support is given to Longuet-Higgins' theory of microseismic generation by interfering wave trains. Interfering waves generated by two independent areas of wind gave rise to particularly high microseismic activity. The attenuation of microseismic transmission over ocean areas appeared to be high.—*Authors' abstract*

161-125. Westerhausen, H. Uber die Ortung mikroseismischer Unruheherde [On the location of microseism sources]: *Annali Geofisica*, v. 7, no. 1, p. 71-124, 1954.

Two methods of locating sources of microseisms are discussed: by determinations of direction (from the amplitudes of the waves), and of distance (from a period-amplitude relationship). Several storms recorded at Hamburg, Uppsala, Helgoland, Uccle, DeBilt, Reykjavik, and Gross Raum are given as examples.—*M. C. R.*

#### ISOTOPE STUDIES AND AGE DETERMINATIONS

161-126. Senftle, F. E., and Bracken, J. T. Theoretical effect of diffusion on isotopic abundance ratios in rocks and associated fluids: *Geochim. et Cosmochim. Acta*, v. 7, no. 1/2, p. 61-76, 1955.

The theoretical framework of diffusion as a mechanism of isotope separation in natural materials is developed. Both diffusion in solids and diffusion in liquids are considered as possible mechanisms, the latter being the more important. Thermal diffusion is not considered important as an isotope-fractionation process. The results indicate that although substantial isotopic fractionation is possible it can occur only in very small parts of the original material. It is highly improbable that a large body exists in which a major constituent is isotopically enriched by diffusion processes; significant isotopic fractionation will be localized and most apparent in minor elements. It is possible that there may be an enrichment in the lighter isotopes of a major element in replacement bodies formed by elements that have moved by diffusion of solute in magmatic solutions or in water-saturated rocks.—*M. C. R.*

161-127. Rollier, Mario A.; Saeland, Einar; Morpurgo, Armando; and Cagliaris, Albertina. Half-life and radiations of the long-lived isotope of niobium ( $^{91}\text{Nb}$ ): *Acta Chem. Scandinavica*, v. 9, no. 1, p. 57-67, 1955.

In order to investigate the half-life and radiation energies of  $^{91}\text{Nb}$ , spectroscopically pure metallic niobium was irradiated for 23 days with thermal neutrons in the JEEP pile. The short-lived 6.6 minutes  $^{91m}\text{Nb}$  beta activity was confirmed. The bulk of the slow decaying activity is due to  $^{152}\text{Ta}$  beta and gamma radiations. Many ways were tried to free efficiently the niobium metal from the tantalum impurity: anion exchange column, coprecipitation of Ta as potassium fluorotantalate, and Ta/Nb solvent extraction using di-isopropyl ketone. Only the last of these proved successful. The residual activity of the purified  $\text{Nb}_2\text{O}_5$  is very low. From an Al-absorption curve the beta energy can be estimated to be between 0.5 and 0.6 MeV. The gamma spectrum, investigated with a scintillation spectrometer, points to three energies, namely 0.73 MeV, 0.90 MeV and 1.63 MeV. The counting rate of the beta activity, corrected for counting efficiency, indicates a half-life for the  $^{91}\text{Nb}$  of  $1.77 \times 10^4$  years ( $\pm 25$  percent).—*Authors' abstract*

161-128. Dansgaard, Willi. The  $\text{O}^{18}$ -abundance in fresh water: *Geochim. et Cosmochim. Acta*, v. 6, no. 5/6, p. 241-260, 1954.

Fresh water of various origins as distinct from ocean water shows great variations in  $\text{O}^{18}$ -abundance. Proceeding from the temperate towards the colder climates, a considerable decrease is noticeable. It is demonstrated that the  $\text{O}^{18}$ -abundance in atmospheric water vapour is dependent on the precipitation temperature, the origin of the vapour, and the average cooling of the vapour during the circulation of the water in nature, whereas the  $\text{O}^{18}$ -abundance in a certain precipitation, further, depends on the condensation temperature, the cooling since the beginning of the condensation of the vapour in question, and the evaporation during the fall of the precipitation from cloud to ground. Furthermore, the  $\text{O}^{18}$ -abundance in ground water from a certain locality depends on the evaporation from the precipitation since its reaching the ground and the possible exchange of  $\text{O}^{18}$  between the water and oxygenic substances in the ground. Computations on this basis and on measurements of the  $\text{O}^{18}$ -abundance of ocean water are in agreement with measurements of fresh water of various origins.—*Author's abstract*

161-129. Thode, H. G., Wanless, R. K., and Wallouch, R. The origin of native sulfur deposits from isotope fractionation studies: *Geochim. et Cosmochim. Acta*, v. 5, no. 6, p. 286-298; 1954.

Sulfur and carbon isotope abundance studies have been made on the sulfur well cores and adjacent formations of the Texas and Louisiana salt domes. The free sulfur was found to be depleted in  $S^{34}$  with respect to associated sulfate by 3.9 percent on the average. This compares to a 3.2 percent fractionation of the sulfur isotopes in the formation of free sulfur from sulfate by bacterial action in North African lakes. Also, the associated sulfate was found to be enriched in  $S^{34}$  as compared to adjacent anhydrite formations to various extents depending on the sulfur well investigated.

Carbon isotope ratios obtained for the calcite matrix of the sulfur well cores showed that the carbon of the calcite was depleted by from 3.3 to 5.5 percent in  $C^{13}$  as compared to standard limestone. These results indicate that the calcite was formed simultaneously with the free sulfur from carbon of organic origin by a process resulting in some further fractionation of the carbon isotopes.

All the isotope abundance data can be reconciled with the conclusion that the large sulfur deposits of the southwestern United States have been formed by living organisms.—*Authors' abstract*

161-130. Cailleux, André. État actuel des données sur l'âge de la terre [Present state of data on the age of the earth]: *Geol. Rundschau*, Band 42, Heft 2, p. 246-248, 1954.

This is a brief summary of age determinations from geological and paleontological evidence and from astronomical calculations. Methods based on rates of evolution suggest that life began 1,500-5,000 million years ago; this is compatible with estimates based on radiogenic lead (3,350 million years) and on decrease in speed of rotation of the earth (3,300-3,500 million years for the origin of the earth-moon system). These figures are considerably greater than the 2,000 million years or less suggested by the expanding universe hypothesis. Recent work, however, shows that calculations of the distances of galaxies should be approximately doubled, which would bring the astronomical hypothesis in agreement with the geological estimates.—*D. B. V.*

161-131. Holmes, Arthur, and Cahen, Lucien. African geochronology. Results available to 1 September 1954: *Colonial Geology and Mineral Resources*, v. 5, no. 1, p. 3-39, 1955.

Age estimates based on the radiogenic lead, strontium, argon, helium, and ordinary lead methods, and on the size of unit cell of uraninites have been compiled and are described in eleven groups: younger than 485 million years (5 rocks or minerals); 485 million years (9); 630 million years (19); 1,025 million years (9); 1,200-1,400 million years (8); 1,650-1,850 million years (5); the Witwatersrand uraninites (4); 2,000-2,300 million years (7); 2,650 million years (8); about 2,900 million years (4); and greater than 2,900 million years (4). Seven Precambrian geological cycles have been dated. Based on data so far assembled, the degree of reliance that may be placed on these estimates is greatest for those determined by the lead method in its complete application—when the ages corresponding to the four ratios (207/206, 206/U, 207/U, and 208/Th) are sufficiently concordant not to require any hypothetical manipulation to bring about such concordance. Next are those for which the four ratios yield discrepant ages and so require interpretation in the light of their numerical order, and those deduced from the 207/206 ratio alone.—*M. C. R.*

161-132. Wasserburg, G. J., and Hayden, R. J.  $A^{40}-K^{40}$  dating: *Geochim. et Cosmochim. Acta*, v. 7, no. 1/2, p. 51-60, 1955.

The  $A^{40}/K^{40}$  ratios and the Pb-U ages of various coexisting potassium feldspars and uraninites were determined. It was found that with a branching ratio  $\lambda_e/\lambda_\beta=0.085\pm 0.005$  and a decay constant  $\lambda=0.55\times 10^{-9}$ /year, the  $A^{40}/K^{40}$  ages could be brought into agreement with the Pb-U ages for samples ranging from 260 to 1,860 million years. No evidence was found for the loss of argon by diffusion from potassium feldspars.—*Authors' abstract*

161-133. Rafter, T. A. Carbon dioxide as a substitute for solid carbon in  $^{14}C$  age measurements: *New Zealand Jour. Sci. Technology, Ser. B.*, v. 36, no. 4, p. 363-370, 1955.

Techniques developed for the preparation of carbon dioxide gas, free from electronegative contaminants and all but traces of radon, for use in  $C^{14}$  age determinations are described. The use of carbon dioxide in place of solid carbon has greatly simplified the chemical operations, increased the accuracy, and extended the limits of the radiocarbon dating method. It is possible to begin combustion of a carbonaceous specimen, purify the carbon dioxide, and fill the proportional counter in a working day. The sample can be checked for contamination by a few minutes counting, and, after an overnight count of 1,000 minutes, the age of the specimen can be determined.

Preliminary experiments have been made to determine the fractionation factor between shell and wood carbon; results will be discussed in a subsequent paper.—*D. B. V.*

161-134. Fergusson, G. J., and Rafter, T. A. New Zealand  $^{14}C$  age measurements—H: *New Zealand Jour. Sci. Technology, Ser. B.*, v. 36, no. 4, p. 371-374, 1955.

Using an 8-liter carbon-dioxide-filled proportional counter it is possible confidently to report ages as great as 35,000 years, and if necessary, by increasing the filling pressure from 1 to 3 atmospheres, ages of 42,000 years for a counting time of 1 day, and 45,000 years for a counting time of 2 days. It is felt that there are now no systematic errors in this method other than those of counting statistics and the uncertainty in the half-life of  $C^{14}$ .

Fifteen new age measurements of New Zealand samples, all but three of which were determined by this new method, are given.—*D. B. V.*

161-135. Rubin, Meyer, and Suess, Hans E. U. S. Geological Survey radiocarbon dates II: *Science*, v. 121, no. 3145, p. 481-488, 1955.

Age determinations made between May 1 and October 15, 1954 are listed. Principal subjects of investigation have been the establishment of an absolute time scale for the pre-Mankato substages of the last glaciation and a time scale of climatic fluctuations during the Wisconsin stage, using the dating of calcareous deep-sea sediments where  $O^{18}/O^{16}$  ratios had been used to determine environmental temperatures of growth.—*M. C. R.*

161-136. Flint, Richard Foster, and Rubin, Meyer. Radiocarbon dates of pre-Mankato events in eastern and central North America: *Science*, v. 121, no. 3149, p. 649-658, 1955.

From the radiocarbon dates of samples measured in the U. S. Geological Survey laboratory [see *Geophys. Abs.* 158-172 and 161-135] it is inferred that a major glaciation began 25,000 or more years ago, reached a maximum about 20,000 to 18,000 years ago, and was in oscillating retreat 13,000 to 12,000 years

ago. Existing correlations and nomenclature will need some revision if  $C^{14}$  dates are accepted as a more reliable basis of correlation than that afforded by field methods where there are no fossils.—*M. C. R.*

161-137. Kulp, J. L., and Eckelmann, W. R. Anomalous uranium-lead ages: *Geol. Soc. America Bull.*, v. 66, no. 6, p. 767-768, 1955.

In principle, the time of formation of a uranium mineral can be determined from one of the following isotopic ratios:  $Pb^{206}/U^{238}$ ,  $Pb^{207}/U^{235}$ , or  $Pb^{207}/Pb^{206}$ . Actually for a large fraction of the mineral samples on which these ratios have been measured, the three isotopic ages do not agree and it is important to understand these anomalies. A process that might produce the observed ages is that of the removal of lead from the uranium minerals at a time or times of recrystallization. It is concluded that detailed study of the uranium and lead isotopic content of a district may make it possible to evaluate the time of deposition despite successive alterations. Some idea of the time or times of lead removal may be obtained from the isotopic ratios.—*V. S. N.*

161-138. Cahen, L. Extension et âge d'une minéralisation Cu-Pb-Zn en Afrique centrale et australe [Extension and age of a Cu-Pb-Zn mineralization in central and southern Africa]: *Soc. Belge Géologie Bull.*, tome 63, fasc. 1, p. 90-100, 1954.

Eight galena leads from Belgian Congo and four others from southern Africa show very similar isotopic constitutions that confirm their common origin which was suggested by their geological setting and the mineral associations of several of the mineralizations to which they belong. These mineralizations are younger than the Katanga groups and its equivalents and older than the base of the Karroo system. Their average model age is near 630 million years; they are therefore practically contemporaneous with the uranium mineralization of Katanga (630 million years).—*Author's abstract*

## RADIOACTIVITY

### RADIOACTIVITY CONSTANTS

161-139. Boganik, N. S. Yadernaya geokhimiya—novaya oblast' issledovaniya [Nuclear geochemistry—new field of investigation]: *Akad. Nauk SSSR. Izv. Ser. geol.*, no. 6, p. 54-66, 1953.

Nuclear geochemistry, the study of natural nuclear processes, is a borderline science necessitating cooperation between physics and geology and other sciences. Boganik claims that experimental data indicate that such processes are neither as invariable nor as independent of external conditions as generally believed.—*D. B. V.*

161-140. Kovarik, A. F., and Adams, N. I., Jr. Redetermination of the disintegration constant of  $U^{238}$ : *Phys. Rev.*, v. 98, no. 1, p. 46, 1955.

A recount of alpha particles from previously used specimens of natural uranium gives  $1.538 \times 10^{-10} \text{ yr}^{-1}$  for the disintegration constant of  $U^{238}$ .—*Authors' abstract*

### INSTRUMENTS AND METHODS OF OBSERVATION

161-141. Lutz, W[alter]. Neue geologische Gammastrahlungsmessungen mit Zählrohren [New geologic gamma-ray measurements with Geiger-Müller counters]: *Gerlands Beitr. Geophysik*, Band 64, Heft 2, p. 89-94, 1955.

Goldplating of the cathode surface increases the efficiency of a Geiger-Müller counter by a factor of  $2\frac{1}{2}$ . Measurements with such a counter in the field and underground, over faults and contacts, are briefly described. No maximums were found on faults and the often-reported circulation of radon along fractures is questioned.—*H. F.*

161-142. Charrin, Paul, and Russell, J. H. Radiation logging and its application in the oil fields: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9, p. 354-374, 1954.

This is a brief history of the development and application of radioactivity logging. The applications described are in reworking and recompletion of wells, control of depth of completion, determination of gas and oil contacts and porous zones, and the quantitative evaluation of porosity.—*M. C. R.*

161-143. Blum, E[ugen]. Zur Eichung von Gammastrahl Diagrammen [On the calibration of gamma-ray logs]: Erdöl u. Kohle, Jahrg. 8, Heft 1, p. 5-6, 1955.

Quantitative evaluation of gamma-ray logs and comparison of logs from different wells is possible only when a zero line on the coordinate axis measuring the radioactivity is established and the scale constant is known. Even in a single well, the measurement corresponding to any one layer contains a certain component caused by radioactive contamination of different metallic parts, of the mud, and other factors. An approximate evaluation of the necessary correction makes it possible to locate the line of absolute zero of radiation.

In comparison of logs in different wells it is necessary to take into account the possible deviations of the curves caused by such factors as differences in hole diameters, and of instrumental constants. An approximate calibration of the log is possible only by measuring the indications of the instrument corresponding to several precisely known radioactivity intensities.—*S. T. V.*

161-144. Agocs, W. B. Airborne scintillation counter surveys: Canadian Min. Metall. Bull., v. 48, no. 515, p. 109-111, 1955.

The scintillation counter has nearly 100 percent efficiency in detecting gamma rays. The response of the instrument to a sudden variation in radioactivity of the surrounding medium is not instantaneous, but is a function of the time constant of the instrument. The optimum time constant is determined by the speed at which the instrument is moving and the areal extent of the radioactivity anomaly. The value of the measurements obtained may be increased considerably if the instrument is calibrated against an absolute source. The cosmic ray ionization effect on an airborne scintillation counter may be determined by taking readings over water-covered areas. The choice of flight elevation in making an airborne radioactivity survey must be a compromise between the requirements of: a safe flying altitude, a flight altitude low enough to increase the relative amplitudes of the useful anomalies over the background, or a flight altitude high enough to scan a wide swath with each traverse.

The term "anomaly" means a gamma radiation that is unexpectedly large for the type of rock and the field conditions with which it is associated. The sharpness and shape of the anomalies may be key characteristics. The correct interpretation of gamma-radiation anomalies must be aided by accurate estimations of the surface and near-surface weathering and solution effect. The effect of topography on gamma-radiation intensity may be as great as, or greater than, the radiation from a ore deposit.—*D. R. M.*

## RADIOACTIVITY OF ROCKS, WATERS, AND AIR

- 161-145. Voytkевич, G. V. *Sovremennye problemy radiogeologii* [The present problems of radiogeology]: Akad. Nauk SSSR Izv. Ser. geol., no. 5, p. 3-20, 1954.

Radiogeology is the investigation of radioactive processes in the earth and their effect on geologic phenomena. The main problems of radiogeology—the determination of geologic age; radioactive sources of terrestrial heat; chemical reactions in the earth's crust resulting from alpha, beta, and gamma radiations; and changes in chemical and isotopic composition of the earth—are discussed.—*S. T. V.*

- 161-146. Festa, C[amilla], and Ippolito, F[elice]. Sulla possibilità di reazioni a catena nella crosta terrestre [On the possibility of chain reactions within the terrestrial crust]: *Annali Geofisica*, v. 7, no. 3, p. 441-449, 1954.

The existence of nuclear chain reactions inside the earth's crust has been supposed by some authors in order to explain some geological and geophysical problems. The possibility of such processes is discussed from the geological and nuclear point of view. As a result of this discussion the existence of nuclear chain reactions in the earth's crust seems to be excluded.—*Authors' abstract*

- 161-147. Hills, G. F. S. The distribution of radioactivity with depth in the continents: *Geol. Mag.*, v. 91, no. 5, p. 372-376, 1954.

The heat generated by the radioactive elements in the surface of the earth has been calculated by Evans and Goodman as  $4.3 \times 10^{-13}$  cal per  $\text{cm}^3$  and by Jeffreys as from  $5.1 \times 10^{-13}$  cal per  $\text{cm}^3$  in Greenland, Iceland, Scotland, Ireland, and Japan to  $14.9 \times 10^{-13}$  cal per  $\text{cm}^3$  in the Alps. The amount of radioactivity in the depths of the continents obviously cannot be directly calculated. Two reasons are offered for believing that radioactivity is greater at depth than near the surface of the continents. One is connected with the total absence of water in the granite surface. Excess silica at depth probably exists in an uncrystallized aqueous solution. Near the surface the silica crystallized to quartz, and the contained water and with it the radioactivity were excluded. Cracks, veins, and pegmatites formed near the early-formed granitic surface containing the quartz and other minerals have long since been denuded. The second reason depends on the hypothesis that the continents were formed as the result of convection currents in the magma when the magma was in a fluid state. In the process the lighter crystals rose, and the heavier ones sank. As thorium and uranium do not enter many of the important early-formed silicates, the magma would become more radioactive. Ultimately the residual magma when it became too viscous would cool into the intermediate layer.—*M. C. R.*

- 161-148. Faul, Henry, Gott, G. B., Manger, G. E., Mytton, J. W., and Sakakura, A. Y. Radon and helium in natural gas: *Internat. Geol. Cong.*, Algiers, 19th sess., *Comptes Rendus*, Sec. 9, fasc. 9, p. 339-348, 1954.

Radon has been discovered in some of the helium-bearing natural gas in the United States. So far, the radon content of about 500 producing gas wells has been explored. Concentrations up to  $500 \times 10^{-12}$  curies per liter (S.T.P.) were observed. The more highly radioactive wells are clustered in several groups.

Measurements of radon content under conditions of transient gas flow and theoretical analysis of steady-state conditions indicate that the radon originates in the immediate vicinity of the bore in most wells. This result is tentatively confirmed by gamma-ray logs in two wells, but so far it has not been possible to obtain adequate samples of the gas-producing beds. A few grains of uraniumiferous solid asphalt and radioactive petroleum residues have been found disseminated in several drill samples of dolomite from above the gas-producing zones. At the present time, it is not clear whether the radioactive concentration is sufficient to explain the high helium content of the gas. The research continues, and comprehensive studies of subsurface geology and reservoir characteristics of the gas field are in progress.—*Authors' abstract*

161-149. Ferretti-Sforzini, M., Festa, C[amilla], and Ippolito, F[elice]. Sulla applicazione del metodo delle emulsioni nucleari allo studio della radioattività delle lave Vesuviane [On the application of the method of the nuclear emulsions to the investigation of the radioactivity of Vesuvian lavas]: *Annali Geofisica*, v. 7, no. 4, p. 539-546, 1954.

Nuclear emulsions have been used in a threefold study of Vesuvian lava to determine if there is a variation of radioactive content of lava with the date of eruption, if it is possible to localize the alpha-emitters centers, and if a method can be found to determine the existence of radioactive equilibrium among the members of the uranium series. For lava of the eruption of A. D. 79 there were  $8.5 \times 10^{-4}$  alpha-particles per sq cm per sec; for lava of the 1760 eruption,  $31.5 \times 10^{-4}$  alpha-particles per sq cm per sec; and for the lava of the 1872 eruption,  $37.7 \times 10^{-4}$  alpha-particles per sq cm per sec. Assuming that the uranium in the lavas is in equilibrium with its daughter products, the initial content of uranium (in  $10^{-5}$  grams U per gram lava) was: 0.85 in the A. D. 79 lava, 3.02 in the 1760 lava, and 371 in the 1872 lava. To determine the existence of equilibrium it is necessary to have statistical errors smaller than generally admitted in order to get a reasonable approximation of the Th/U ratio. Experimental studies are in progress of possible radon diffusion through surface layers of the lava as a cause of disequilibrium.—*M. C. R.*

161-150. Thomas, C. D., Gainer, M. K., and Ball, T. W. Relation of radon to non-active air contamination: *Nature*, v. 175, no. 4460, p. 732, 1955.

Variation of the radon content of air at Morgantown, W. Va., was investigated in a manner similar to that of Anderson, Mayneord, and Turner [see *Geophys. Abs.* 159-186]. The activity of samples collected on filter paper was determined by means of ionization chamber and by means of beta-emission counting with a mica-window counter. A striking correlation was found between variations in radon and dust present in the air.—*R. G. H.*

161-151. Ljunggren, Pontus. Geochemistry and radioactivity of some Mn and Fe bog ores: *Geol. Fören. Stockholm Förh.*, Band 77, Hafte 1, p. 33-44, 1955.

Measurements of the trace-element content and radioactivity of some Swedish bog ores show that both trace elements and radioactivity are higher in manganese than in ferriferous ores. Clearly the adsorbing capacity increases rapidly with increasing manganese content.—*D. B. V.*

161-152. Urbain, Pierre. Contribution de l'hydrogéologie thermique à la tectonique: l'aire d'émergence d'Hammam Meskoutine (Département de

Constantine) [Contribution of thermal hydrogeology to tectonics: the area of emergence of Hammam Meskoutine (Department of Constantine)]: Soc. géol. France Bull. 6<sup>e</sup> sér., tome 3, fasc. 1-3, p. 247-251, 1953.

The hot springs of Hammam Meskoutine, in the Department of Constantine, Algeria, are extraordinarily hot (93.9° C), discharge at least 15 m<sup>3</sup> per minute, and deposit 2 tons of calcareous material per day. Their radioactivity ranges from 0.24 to 15.5 millimicrocuries per liter; the latter although mediocre as an absolute value, is remarkable for waters issuing from Cretaceous and Tertiary sedimentary formations. The points of emergence are alined north-northeastward and north-northwestward, along principal structural directions of the region.—*D. B. V.*

161-153. Lutz, W[alter]. Radioaktive Borlochmessungen im Lias-Ölschiefer [Radioactivity logs of Lias oil shales]: Gerlands Beitr. Geophysik, Band 64, Heft 2, p. 83-88, 1954.

Gamma-ray logs of two shallow holes in the oil shales of the Swabian Lias are shown. No correlation between radioactivity and oil content was found.—*H. F.*

#### HEAT

161-154. Scott, D. R. Transient heat flow in anisotropic strata: Phys. Soc. London Proc., Section B, v. 67, pt. 9, p. 731, 1954.

A solution has been obtained for the problem of transient heat flow from an infinite line source embedded in an infinite region exhibiting two-dimensional anisotropy, the direction of the line source being perpendicular to the plane containing the direction of the principal conductivities, in terms of the standard solution in cylindrical coordinates for an infinite line source in isotropic regions.—*M. C. R.*

161-155. Newstead, G. and Beck A. Borehole temperature measuring equipment and the geothermal flux in Tasmania: Australian Jour. Physics, v. 6, no. 4, p. 480-489, 1953.

The equipment for measuring temperatures in boreholes developed by Newstead consists of a thermistor connected by a polythene cable to an alternating-current bridge at the top of the hole. The alternating-current bridge was used rather than a direct-current bridge because of the ease of obtaining amplification. Under typical field conditions the absolute accuracy of the equipment is of the order of 0.01° C. The circuit diagram is given. Temperatures and conductivities were determined in five boreholes from 252 to 1,033 feet deep. The heat flux is about  $2 \times 10^{-6}$  cal cm<sup>-2</sup> sec<sup>-1</sup>.—*M. C. R.*

161-156. Dakhnov, V. N., and Ryapolova, V. A. Differentsial'nyy metod termometrii skvazhin (Differentsial'nyy termokarottazh) [The differential method of thermometry in drill holes (Differential thermologging)]: Promyslovaya geofizika, p. 104-136, 1952.

In thermometric surveying of a drill hole it is important to find the discontinuities on the temperature curve corresponding to lithologic changes. Processes of oxidation or reduction, exothermic or endothermic solution of salts contained in the formations, endothermic processes of the expansion of gases or of the evaporation of liquids as a result of decreased pressure, and local

thermal fields created by the influx of water from porous formations affect the measurements.

A special differential thermometer, consisting of a Wheatstone bridge of material with a high thermal coefficient of resistivity, was constructed to measure local changes in temperature. Two sides are thermally insulated, the other two have very little thermal insulation, so that when the thermometer is brought into a medium of a new temperature, the indication of the Wheatstone bridge at the beginning is very nearly proportional to the temperature change. The thermometer should be lowered not too slowly into the drill hole, preferably a constant speed. In this manner several thermal surveys have been made, and temperature curves which could be easily interpreted have been obtained. As a rule it was found that sandstone layers produce positive thermal anomalies, and argillaceous strata negative anomalies.—*S. T. V.*

161-157. Grosjean, André. Sur une mesure assez précise de la température à 1.877 m de profondeur dans le sondage de Turnhout (Campine belge) [On a rather precise measurement of temperature at a depth of 1,877 meters in the Turnhout borehole (Belgian Campine)]: Soc. Belge Géologie Bull., tome 63, fasc. 1, p. 69-73, 1954.

Measurements with three mercury thermometers indicate a temperature of between 85.26° and 85.60° C at the depth of 1,877 meters.—*M. C. R.*

161-158. Grosjean, André. Mesures de température aux profondeurs de 2.185 et 2.225 m dans le sondage de Turnhout (Campine belge) [Temperature measurements at depths of 2,185 and 2,225 meters in the borehole of Turnhout (Belgian Campine)]: Soc. Belge Géologie Bull., tome 63, fasc. 2, p. 193-201, 1954.

Measurements with mercury thermometers indicate the temperature at the depth of 2,185 meters is 102.865° C  $\pm$  0.295° and at 2,225.35 meters 103.565° C  $\pm$  0.565°. Between 1,877 and 2,185 meters, the geothermal gradient is 17.67 meters per degree. The gradient of 57.10 meters per degree between 2,185 and 2,225 meters may be explained by the change from schists to calcareous rocks at a depth of 2,175 meters, although it needs confirmation because of the small interval involved.—*M. C. R.*

161-159. Ellis, A. J. and Wilson S[tuart] H. The heat from the Wairakei-Taupo thermal region calculated from the chloride output: New Zealand Jour. Sci. Technology, Sec. B., v. 36, no. 6, p. 622-631, 1955.

An estimate has been made of the rate of discharge of chloride from the Wairakei-Taupo thermal region both from the natural hot springs and the bores at Wairakei. The rate of discharge,  $2.5 \times 10^{10}$  g chlorine per year, is about the same as that of the whole of the Yellowstone Park region.

On the assumption that the thermal activity is all derived from a homogeneous body of hot water contained in porous strata at depth, it was calculated from the total chloride output and the ratio of heat to chloride in the discharges from the bores at Wairakei that the heat output of the Wairakei basin was 144,000 kcal per sec. As the average bore output in 1954 was approximately 62,000 kcal per sec, the natural heat output was 82,000 kcal per sec.—*Authors' summary*

- 161-160. Bouwer, R. F. Bore hole temperatures in the Klerksdorp and Orange Free State areas: South Africa Dept. Mines Geol. Survey Bull. 22, 35 p., 1954.

Temperature measurements in 30 boreholes are given in tabular form. For the most part, measurements were made with the "electronic thermometer" and are believed generally accurate to about  $0.2^{\circ}$  C; in a few holes where there was considerable electrical interference mercury thermometers were used. Depths of holes ranged from 2,158 to 8,100 feet. The average mean geothermic step (feet per degree C) in the Karroo system is 130; in the Pretoria, 280; in the dolomite, 350; in the Vetensdorp, 210-240; and in the Witwatersrand, 370 in the Upper Division and 290 in the Lower Division. The temperature at 8,100 feet was  $52.3^{\circ}$  C.—*M. C. R.*

- 161-161. Quiring, Heinrich. Permiklima und Sonnentemperatur [Permian climate and temperature of the sun]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1954, Heft 7, p. 322-328.

The temperature of formation of the potash and magnesium minerals precipitated in the upper Permian remnant seas of central and western Germany is  $70^{\circ}$ - $110^{\circ}$  C. Such temperatures can be explained only by greater effective radiation from the sun at that time, here calculated to have been about  $430^{\circ}$  C higher than at present. The mean surface temperature of the earth must then have been  $23.1^{\circ}$  C.—*D. B. V.*

- 161-162. Quiring, Heinrich. Paläogeothermik und Sonnenentwicklung [Paleogeothermics and development of the sun]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1954, Heft 11, p. 485-490.

Calculations of the sun's temperature in past ages (see above abstract) have been extended as far back as Algonkian. Since the end of the early Algonkian, the sun has lost about  $1000^{\circ}$  K of its effective temperature (at present,  $5714^{\circ}$  K). The rate of cooling has been variable, retarded in the Mesozoic and accelerated in the Cenozoic; the acceleration is reflected in paleontological and geological changes, such as strong tectonic movements, rapid cooling of the oceans, Quaternary glaciation, more rapid mutation of organisms, and the coming of man.—*D. B. V.*

- 161-163. Sappa, Mercurino. Prospetto delle ricerche per "forze endogene" in varie regioni del mondo durante l'ultimo trentennio [Review of research on "endogenous power" in different regions of the world during the last 30 years]: Annali Geofisica, v. 7, no. 3, p. 451-462, 1954.

A review of recent work in exploring hot springs in different countries of the world is presented in the form of short summaries of published articles. Geoelectric, seismic, geothermal, gravimetric, and other geophysical methods have been used.—*S. T. V.*

- 161-164. Penta, Francesco. Ricerche e studi sui fenomeni esalativo-idrotermali e il problema delle "forze endogene" [Investigations of exhalative hydrothermal phenomena and the problem of "endogenous power"]: Annali Geofisica, v. 7, no. 3, p. 317-408, 1954.

Research on the utilization of underground natural water vapor and thermal waters for transformation into electrical energy is reviewed. The most important such source in Italy is at Larderello, where during 1953, 1,860 million kilowatt-hours of electrical energy were produced. Other areas studied are the Napoletano, Viterbese, and Isola Vulcano fields. An extensive bibliography is included.—*S. T. V.*

### VOLCANOLOGY

161-165. Powers, Howard A. Composition and origin of basaltic magma of the Hawaiian Islands: *Geochim. et Cosmochim. Acta*, v. 7, no. 1/2, p. 77-107, 1953.

Silica-saturated basaltic magma is the source of the voluminous lava flows, erupted frequently and rapidly in the primitive shield-building stage of activity, that form the bulk of each Hawaiian volcano. Silica-deficient basaltic magma, enriched in alkali, is the source of commonly porphyritic lava flows erupted less frequently and in relatively negligible volume during a declining and decadent stage of activity at some Hawaiian volcanoes.

Hawaiian volcanism and petrology can be explained by a process involving melting of "batches" of magma from a crystalline peridotite by a recurrent process (distortion of one equatorial bulge by forced and free nutational stresses). Only the plagioclase and pyroxene component is melted but not the excess olivine, and more refractory components within a zone of fixed and limited depth are not melted. Eruption exhausts the supply of melted magma under a given place, and, unless there are more violent melting processes, a layer of crystalline refractory components is left.—*M. C. R.*

161-166. Hantke, Gustav. Übersicht über die vulkanische Tätigkeit 1948-50 [Review of the volcanic activity 1948-50]: *Bull. volcanolog.*, sér. 2, tome 14, p. 151-184, 1953.

Worldwide volcanic activity during the years 1948-50 was of varying intensity. In 1948, 33 volcanoes were active, the most important eruptions being those of Shiveluch in Kamchatka, Lama Heroe in Lomblen, and Nyamlagira in central Africa. In 1949, 40 were active, but only 2 strongly—La Palma Island in the Atlantic and Roeang in Indonesia. A volcanic island arose in the New Hebrides. For 1950, 28 active volcanoes have been reported (the list is not yet complete), of which Mauna Loa in Hawaii, Etna in Sicily, Asama and Mihara in Japan, and Camiguin Island in the Philippines were most violent. All volcanoes which showed any form of activity during the period in question are listed by regions, and the activity is described briefly.—*D. B. V.*

161-167. Thorarinsson, Sigurdur. The crater groups in Iceland: *Bull. volcanolog.*, sér. 2, tome 14, p. 3-44, 1953.

After detailed description of the crater groups in the Myvatn area, Laxárdalur, and Adaldalur, Thorarinsson concludes that these, and probably all crater groups in Iceland and elsewhere, are not the result of areal eruptions, but are pseudocraters, as defined by Thoroddsen. Such craters are formed when lava flows cover areas where the surface layers contain much ground water. The water is shut in, converted into steam, and explodes upward through the lava after movement has ceased at least at the surface; no deformation of the craters by subsequent lava movement has been noted. Although such crater groups are found in other parts of the world, they are most common in Iceland, simply

because conditions in recent times have been most favorable there (broad plains, humid climate, and extensive basalt flows). This may explain why volcanologists with experience in other areas are reluctant to accept this explanation whereas it is generally accepted in Iceland.—*D. B. V.*

161-168. Juhle, Werner, and Coulter, Henry. [W.] The Mt. Spurr eruption, July 9, 1953: *Am. Geophys. Union Trans.*, v. 36, no. 2, p. 199-202, 1955.

The July 9, 1953, eruption of a subsidiary cone of Mt. Spurr, Alaska, is of particular interest because the initial phases were under close observation by the crews of two jet aircraft which were in the vicinity when the eruption started. Within one hour the eruption cloud assumed a mushroom shape which reached an altitude of approximately 70,000 ft. Extremely heavy rains accompanying the eruption, and water supplied by the melting of ice in the immediate vicinity of the vent, caused flash floods which carried sufficient debris to dam one of the major rivers in the area and form a lake nearly five miles long. A one-quarter-inch blanket of ash was deposited on the city of Anchorage, 80 miles from Mt. Spurr; but, in the opposite direction, no discoloration of snow fields and glaciers could be seen within two or three miles of the volcano. Observations of this eruption of Mt. Spurr particularly emphasize the importance of prevailing wind direction in the control of ash-fall distribution resulting from an eruption of this type.—*Authors' abstract*

161-169. Signore, Francesco. Le ricerche vulcanologiche in Italia nel triennio 1948-1950 [Volcanological researches in Italy in the triennium 1948-50]: *Bull. volcanolog.*, sér. 2, tome 14, p. 133-149, 1953.

This consists mainly a series of individual reports on the volcanological activities of various observatories and universities in Italy for the period 1948-50, together with a bibliography of the principal papers published during those years.—*D. B. V.*

161-170. Scherillo, Antonio. Nuovo contributo allo studio dei prodotti dell'eruzione vesuviana del 1944 [New contribution to the study of the products of the Vesuvian eruption of 1944]: *Bull. volcanolog.*, sér. 2, tome 13, p. 129-144, 1953.

Study of the composition of the material erupted by Vesuvius during its 1944 activity seems to indicate that the mode of emission depends on the chemical composition. Fragmentary emissions such as cinders and scoria and, probably, bombs, are definitely more basic in character than the lavas. It is suggested that when there has been differentiation, resulting in concentration of melanocratic components, the magma is largely crystallized by the time of emission, and can be ejected only as fragments, whereas undifferentiated magma is erupted as a continuous emission (lava).—*D. B. V.*

161-171. Parascandola, Antonio. Lo stato attuale del Vesuvio [The present state of Vesuvius]: *Soc. geol. italiana Bull.*, v. 70, fasc. 3, p. 513-522, 1950 [1954].

This is a description of Vesuvius following the eruption of 1944. The present crater is in the northwest and southwest quadrants of the crater platform formed after the 1906 eruption. Present activity is production of gas, with consequent mineral alteration, thermal phenomena, and fumaroles.—*M. C. R.*

- 161-172. Volcano Letter. Eruption in the Galapagos Islands: Volcano Letter, no. 526, p. 7, 1954.

The first recorded eruption of Alcedo Volcano, in the central part of Isabela (Albermarle) Island, on November 9, 1954, was reported by Adrian Richards of the Scripps Institution of Oceanography. According to Richards, the eruption was preceded in late 1953 or early 1954 by upheaval of the shore on the western flank of the Alcedo cone, in the vicinity of Bahia Urvina and southward. The reef surface was raised as much as 15 feet causing the shoreline to migrate about 2,400 feet seaward.—*V. S. N.*

- 161-173. Macdonald, G. A., Davis, D. A., and Cox, D. C. Kauai, an ancient Hawaiian volcano: Volcano Letter, no. 526, p. 1-3, 1954.

A short description of the history of Kauai Volcano, one of the oldest and structurally the most complicated of the Hawaiian Islands. The growth of the Kauai shield is believed to have started in early or middle Pliocene and to have been essentially completed by the end of the epoch.—*V. S. N.*

- 161-174. Minakami, Takeshi, and Sakuma, Shūzō. Report on volcanic activities and vulcanological studies concerning them in Japan during 1948-1951: Bull. volcanolog., sér. 2, tome 14, p. 79-130, 1953.

This is a summary of volcanic activity and vulcanological studies in Japan during 1948-51. Most of this report is devoted to a detailed summary of the eruption of Oo-sima from July 1950 to June 1951. Geophysical and geological investigations of this eruption included topographic surveys near the active crater, temperature and viscosity measurements on fresh lavas, recording and analysis of accompanying earthquakes, gravity surveys and geomagnetic measurements in the vicinity, study of the magnetic properties of new lavas, geochemical measurements of magmatic waters and gases (including radon content of fumarolic gases), and geological and petrological study of the ejecta. The results of all these studies, undertaken by many investigators, have been published in full in other journals.

The remainder of the paper treats briefly the eruptions of Aso in 1948-50, the minor eruption of Sakura-Zima in 1950, explosive activity of Asama in 1949 and again in 1950 and of Yake-Yama in 1949, and fumarolic activity of Azuma, Akita-Yakeyama, and Kurikoma.—*D. B. V.*

- 161-175. Foster, Helen L. Volcanic activity in Japan: Volcano Letter, no. 526, p. 7, 1954.

Mihara-yama, on O-shima, has been quiescent since February 1954, although steam and other gases have been emitted continuously. Volcanic tremors were recorded in April, June, September, and early November, and on September 24 an earthquake originated beneath O-shima. On November 9, the volcanic tremors ceased, and steam and gas emission decreased.

Small explosions of Asama-yama have continued since the activity of 1953 and of January and February 1954. Volcanic ash has been ejected during many of the explosions, but no serious damage has been reported.

Renewed eruption at Myojin-sho, a rock bank about 50 kilometers south of Aoga-shima, Izu Islands, was reported by the fishing boat, the *Eikichi-maru*, on November 4, 1954.—*V. S. N.*

- 161-176. Tsuya, Hiromichi; Morimoto, Ryōhei; and Ossaka, Joyo. The 1950-1951 eruptions of Mt. Mihara, Oshima volcano, Seven Izu Islands,

Japan. Part 1. The 1950 eruption: Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 1, p. 35-66 and 22 plates, 1954.

After about 10 years quiescence, Mihara erupted on the morning of July 16, 1950. The activity at first was explosive, but later lava was extruded. A second vent became active in late August. Lava overflowed from the crater in mid-September. The total volume of lava and ejecta produced is estimated to have been  $2.105 \times 10^4 \text{ m}^3$ . Temperatures of the lava measured with optical pyrometers, thermocouples, and calorimeters ranged from 820 to  $1,210^\circ \text{ C}$ . Specific heat was determined by quenching samples in calorimeters; a mean value of 0.213 was determined. Apparent specific gravities of samples were 2.1 to 2.9, bulk specific gravities 1.1 to 2.8, and porosities 4.3 to 54.7 percent. Fifty-nine photographs of various stages of the eruption are included.—*M. C. R.*

161-177. Foster, Helen L., and Mason, Arnold C. 1950 and 1951 eruptions of Mihara Yama, O Shima Volcano, Japan: Geol. Soc. America Bull., v. 66, no. 6, p. 731-762, 1955.

Mihara-yama, the active central cone of O-shima Volcano, Japan, erupted on July 16, 1950, after 10 years of quiescence. Activity continued until September 24, resumed on February 4, 1951, and continued until April 2 after which it was sporadic and ceased entirely on June 28.

In the 1950 eruptions, molten basalt was ejected explosively accompanied at times by flows. About 52 million metric tons of material were erupted. In the 1951 eruptions about 20 million metric tons of material erupted, and between eruptions and especially after the final eruption the crater floor subsided.

Numerous geophysical observations were made during the eruptive period including observations of seismic activity, a three-component magnetometer survey, and four gravity surveys.—*V. S. N.*

161-178. Foster, Helen L., and Mason, Arnold C. Activity in 1953-54 of Mihara Yama, O Shima, Japan: Science, v. 121, no. 3155, p. 876-877, 1955.

Renewed activity at Mihara began with minor earth tremors on the evening of October 4, 1953. An explosion opened a new vent the next morning. Periods of explosive activity and of steam and gas emission alternated until February. In December incandescent ejecta and small lava flows were emitted. The most violent eruption of the series occurred on January 27.—*M. C. R.*

## TECTONOPHYSICS

161-179. Turner, Francis J., Griggs, David T., Heard, Hugh, and Weiss, Lionel W. Plastic deformation of dolomite rock at  $380^\circ \text{ C}$ : Am. Jour. Sci., v. 252, no. 8, p. 477-488, 1954.

A cylinder of dolomite rock from Dover Plains, New York was compressed 9.4 percent at  $380^\circ \text{ C}$ , 3,000 atmospheres confining pressure. Deformation was plastic; but the dolomite rock is less ductile and three times as strong as Yule marble deformed under comparable conditions.

Fabric analysis shows a rather weak pattern of preferred orientation of *c* and *a* crystal axes prior to deformation. This is somewhat modified in the deformed rock, but reorientation has not proceeded far enough to give a pattern symmetrically related to the system of applied stress. Before and after deformation the fabric is essentially homogeneous within the field of a thin section. Two mechanisms of plastic deformation have been demonstrated: twin gliding on {021}, the sense of shear being such that upper layers of the crystal lattice are

displaced downwards from the upper end of the  $c$  axis; translation gliding on {0001}, with the  $a$  axes as probably glide directions.—*Authors' abstract*

- 161-180. Caloi, P[ietro], and Spadea, M. C. Decadimento del modulo elastico in roccia a contatto con bacini idrici artificiali [The decay of the elastic modulus of rocks adjacent to artificial hydraulic reservoirs]: *Annali Geofisica*, v. 7, no. 4, p. 563-583, 1954.

In 1948 before the construction of the dam of Pieve di Cadore, the modulus of elasticity of the foundation rocks was found by the seismic method to be about 480,000 kg per sq cm. Measurements were repeated in 1952 after the dam had been in operation for about three years, and the elastic modulus found to be only 350,000 kg per sq cm. Records from seismic and clinographic stations near the dam show that innumerable small shocks had occurred. Caloi and Spadea conclude that the weight of the structure, especially the variable mass of water in the reservoir, produces a continuous settling of the rocks, with equilibrium being disturbed and new equilibrium established. In the process innumerable small fractures are produced, and the porosity of the rock is increased with a resultant decreased modulus of elasticity.—*S. T. V.*

- 161-181. Roux, A. J. A., and Denkhaus, H. G. An investigation into the problem of rock bursts. An operational research project. Part II. An analysis of the problem of rock bursts in deep level mining: *Chem. Metall. Min. Soc. South Africa Jour.*, v. 55, no. 5, p. 103-124, 1954.

An excavation at depth is surrounded by a zone of fractured rock. This intradosal ground is de-stressed but the zone within which the rock is de-stressed does not necessarily coincide with the fractured zone. Results of studies underground and on models illustrate the existence of these zones and their configurations.

The abutments of the solid ground beyond the boundary of the de-stressed zone are highly stressed. The nature of the stress distribution around simple excavations is illustrated mathematically and photo-elastically.

When an excavation is extended, the fractured zone broadens with consequent settlement of the intradosal ground. If this readjustment is violent it is termed an "intradosal burst." An "extradosal burst" occurs when an advancing face approaches the boundary of the stressed ground and the stress is high enough to cause sudden failure. Experimental investigations into the mechanical properties of rock are in progress to determine the conditions under which failure can be expected.

When the reef is bedded on soft shale the advancing face is probably de-stressed naturally with the result that bursts do not occur. Possibilities are being investigated of artificially de-stressing faces when the footwall is of quartzite.—*Authors' abstract*

- 161-182. Matschinski, Matthias. Formation des fissures primaires de l'écorce terrestre [Formation of primary fissures of the crust of the earth]: *Annali Geofisica*, v. 7, no. 1, 1-31, 1954.

Primary fissures are those formed independently of each other under the influence of forces which are still almost uniform over the entire earth's crust. They may be shallow open fissures (first type) or steep-sided deep fissures (second type). The primary cause is in the thermal regime of the earth. By use of Stokes' theorem, however, it is possible to calculate the tensions in the earth's

mantle during the formation of the primary fissures without the necessity of considering the hypothetical distributions of temperatures in the earth's interior.—*M. C. R.*

161-183. Arakawa, H. Field of relative displacement of the earth's crust produced by earthquakes and volcanic eruptions: *Geophys. Mag.*, v. 26, no. 1, p. 19-28, 1954.

If the displacement  $(u, v, w)$  at a point  $(x, y)$  of the earth's crust is known, the strained state may be determined. The areal dilation  $\Delta (\Delta = \delta u / \delta x + \delta v / \delta y)$ , and the vertical component of rotation  $\zeta (\zeta = \delta v / \delta x - \delta u / \delta y)$ , are the same as the horizontal divergence and vertical component of vorticity in hydrodynamics and may be computed from a triangulation survey by Bellamy's method for determination of divergence and vorticity from observations at the corners of a triangle. Lines of relative displacement, or lines drawn from point to point so that the direction is everywhere that of the relative displacement of the earth, may be used if the triangulation network is dense enough. These are similar to streamlines in hydrodynamics and may be analyzed by the isogon method used in meteorology. Displacements resulting from the eruption of Miyake-sima in July 1940, the Idu earthquake in November 1930, Fuki earthquake in June 1948, and the Kwanto earthquake in September 1923 are shown in this way.—*M. C. R.*

161-184. Ritsema, A. R. The sense of the principal shearing stresses in the Tonga-Kermadec seismic zone: *Indonesia Madjalah Ilmu Alam Untuk*, v. 110, no. 4, 5, 6, p. 161-175, 1954.

Directions of first motion of *P* and *PkP* of 105 earthquakes in the Tonga-Kermadec region, tabulated in the International Seismological Summary for 1935 to 1943, were studied. Seventy-five were caused by a shearing stress with principal components in directions up-down, east northeast-west southwest and south southeast-north northwest, and the other 30 may have been caused by the same stress system. In the crust the east northeast-west southwest directed stress component is greatest, and the vertical component is usually smallest; below the crust, the vertical component is usually greatest, and the south southeast-north northwest component greater than the east northeast-west southwest. Tangential compressions are more common within the crust and vertical compressions more common below the crust, as would be expected from the contraction theory with a level of no strain near the boundary between crust and mantle.—*M. C. R.*

161-185. Bergsten, Folke. The land uplift in Sweden from the evidence of the old water marks: *Geog. Annaler*, Årg. 36, häfte 1-2, p. 81-111, 1954.

Watermarks made in the 18th and 19th centuries, though meant to mark the mean level of the sea at the time they were cut, are admittedly inaccurate because no regular observations of water level were made and due allowance apparently was not made for tides. They do, however, extend knowledge of level changes for about 150 years before the last 65 years during which more accurate data have been available. Detailed study of these suggests that the maximum uplift per unit of time is localized to the Västerbotten and Norrbotten coasts, approximately along the Umea-Pitea line.—*M. C. R.*

161-186. Mortelmans, G. Les antécédents tectoniques du Graben de l'Upemba (Katanga) [The antecedent structures of the graben of the Upemba (Katanga)]: *Bull. volcanolog.*, sér. 2, tome 13, p. 93-98, 1953.

The Upemba graben in central Katanga, a branch of the Great Western Rift Valley of Africa, is a remarkable example of the permanence of tectonic depressions. During its entire geologic history it has been a zone of crustal weakness, characterized by alternating subsidence and elevation complicated by extensive faulting (along Kibarian trends) sometimes accompanied by basic eruptions. This bears out Escher's suggestion that the fractures limiting such large-scale structural depressions originated during the cataclysm which created the moon at the expense of the earth.—*D. B. V.*

161-187. Rittmann, A[lfred]. Magmatic character and tectonic position of the Indonesian volcanoes: *Bull. volcanolog., sér. 2, tome 14, p. 45-58, 1953.*

The relation between chemical composition of magmas and geologic structure of the region in which they occur is expressed by the general rule: calc-alkaline ("pacific") magmas are erupted in folded active orogenic belts, and alkaline ("atlantic") magmas occur in nonorogenic faulted regions; and potassic ("mediterranean") magmas are usually limited to subsiding hinterlands of active orogenic belts. In any given cross section of the Indonesian orogenic belt the calc-alkaline character of the active volcanoes decreases regularly from the foredeep toward the hinterland, becoming alkaline in the hinterland itself. Furthermore, at single volcanoes the calc-alkaline character decreases with increasing age, confirming the migration of the axis of the orogen toward the foredeep, already observed by geologists. There are a few exceptions to the rule which cannot be explained in the light of present knowledge; possibly they are merely the result of careless sampling or chemical analysis. More good analyses of fresh volcanic rocks should throw light on the origin of magmas and the mechanism of eruptions.—*D. B. V.*

161-188. Tyrrell, G. W. Distribution of igneous rocks in space and time: *Geol. Soc. America Bull., v. 66, no. 4, p. 405-426, 1955.*

Consanguinity in an assemblage of rocks, associated in time and place, is held to indicate that it has been derived by a more or less uniform geological process from a common initial magma. The most fundamental grouping of igneous rocks is thus based on distributional relations, which are in turn dependent on geological process and event.

The close association of igneous activity with earth movement is well known. The repetition of petrographic "provinces" or "kindreds" in time and place is clearly a manifestation of the cyclic character of tectonic events in geological history. The tectono-igneous cycle is elaborated and discussed with special reference to Scotland and Northwest Europe, and comparisons are made with eastern North America and Indonesia.—*Author's abstract*

161-189. Demay, André. Sur les relations entré la tectonique générale, la microtectonique, et la granitization [On the relations between general tectonics, microtectonics, and granitization]: *Geol. Rundschau, Band 42, Heft 2, p. 239-241, 1954.*

Although granitization is not necessarily related to large-scale orogenesis, it is certainly favored by processes such as folding and overthrusting. In many instances granitization is clearly younger than the main orogenetic phase, especially at higher levels. Details of the relation between folding and granitization are revealed by study of the microtectonics of syntectonic granites.—*D. B. V.*

## INTERNAL CONSTITUTION OF THE EARTH

161-190. Bonchkovskiy, V. F. Vnutrenneye stroyeniye zemli [The internal structure of the earth]: 175 p., Moscow, Akad. Nauk SSSR, 1953.

This book is included in the popular series published by the Russian Academy of Sciences, but the treatment of the subject matter is on a more difficult level than usual, especially in the sections dealing with seismology.—*S. T. V.*

161-191. Subbotin, M. F. Entstehung und Alter der Erde [Origin and age of the earth]: 36 p., Berlin, Verlag Neues Leben, 1954.

A translation from the Russian "Proiskhozhdenie i vozrast zemli," which is a popular account. Non-Russian references include Aristotle, Anaximander, Anaximenes, Marie Curie, Descartes, Jeans, Kant, Kepler, Copernicus, Laplace, Newton, Ptolemy, Pythagoras, and Thales of Milet.—*M. C. R.*

161-192. Bullen, K. E. Some trends in modern seismology: Science Progress, v. 43, no. 170, p. 211-227, 1955.

A summary of knowledge of the internal structure of the earth, based on the contributions of seismology, especially such recent studies as those of blasts, surveys at sea, surface waves, more precise velocity determinations, and the magnitude and energy of earthquakes.—*M. C. R.*

161-193. Dauvillier, A. La structure interne de la Terre [The internal structure of the earth]: Zürich Naturf. Gesellschaft Vierteljahrsschr., Jahrg. 99, Heft 4, p. 217-239, 1954.

The composition of the terrestrial planets results from the fractional evaporation at high temperature of a mass of solar matter less than the critical mass assuring the formation of a giant planet. In other words, the terrestrial planets are the cores of giant planets. It is shown how the primitive earth could have escaped from the sun at a temperature of 4,000° K (that of sunspots) with a radius 25 times the present radius and an average density about that of air. At about 3,000° K the iron vapor would condense, forming a core surrounded by a gaseous atmosphere of silica, volatile oxides, and alkaline halogens. Hydrogen would largely escape, the biogenic elements, carbon, nitrogen, and oxygen, would escape except where retained by their chemical affinities. In Dauvillier's earth model a core of iron-nickel has a volume 47 percent of that of the earth and a radius of 4,946 km; the lithosphere has a thickness of 1,425 km with the same density as the moon. The internal heat of the earth is composed of a residue of solar heat, heat of gravitation from condensation of the planet, and heat of chemical and radioactive origin. The last is the most important.—*M. C. R.*

161-194. Keane, A. The gravitational compression of an elastic sphere: Australian Jour. Physics, v. 8, no. 1, p. 167-175, 1955.

On considering a sphere in hydrostatic gravitational equilibrium composed of a homogeneous elastic material for which the variation of incompressibility  $\nu$  with pressure  $p$  is given by  $d\nu/dp=n$ , a constant, we find that there is an upper bound to the radius  $R$  of the sphere provided  $n \geq 2$ , and that for all values of  $n$  there is a lower bound to the value of  $I/MR^2$  where  $I$  is the moment of inertia about a diameter and  $M$  is the mass of the sphere.

For a sphere composed of material for which  $d\nu/dp$  is a decreasing function of pressure and  $d\nu/dp > 5/3$ , as  $p \rightarrow \infty$ , it emerges that  $0.40 > I/MR^2 > 0.23$  and that the maximum radius is of the order of  $10^4$  km.—*Author's abstract*

- 161-195. Rikitake, Tsuneji. On the electrical conductivity in the earth's core: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 3, p. 191-205, 1952.

If the core is electrically conducting and has a magnetic field, a kind of magnetohydrodynamic wave would be excited by seismic waves reaching the core boundary from the mantle, would be propagated along the magnetic lines of force and appear again at the core surface if of sufficient intensity, and seismic waves which passed through the core as magnetohydrodynamic waves would be observed. As such waves are not observed and *ScS* waves are seemingly not affected, the electrical properties and magnetic field in the core must be such that no magnetohydrodynamic waves of appreciable intensity can be generated. On this basis the conductivity of the core is in the range  $10^9 > \sigma_c > 10^{-8}$  emu. If the shielding and canceling effect for geomagnetic secular variation produced by time-dependent electric currents flowing near the surface of the core,  $\sigma_c > 10^{-6}$  emu. Conductivity within the range  $10^{-5}$ - $10^{-8}$  emu is consistent with conductivities estimated from the physics of metallic iron at high temperature and pressure.—*M. C. R.*

- 161-196. Bâth, Markus. The density ratio at the boundary of the earth's core: Tellus, v. 6, no. 4, p. 408-414, 1954.

A theoretical study is made of the behavior of a *P* wave incident from the mantle on the boundary of the earth's core, with special reference to phase reversals. When the wave functions for the incident and reflected *P* waves on the mantle side of the core boundary, the reflected *S* wave, and the refracted *P* wave are inserted in the equations representing the boundary conditions, three equations in the ratios of the respective amplitudes are obtained. In addition, the insertion of the wave functions in the wave equation yields two equations from which the phase constants for refracted *P* and reflected *S* can be determined for given phase values of incident *P*.

The ratio  $A_1/A$  of the amplitude of reflected *P* to that of incident *P* is greater than, equal to, or less than zero according as an expression of form  $f(\rho'/\rho e) < / > 1$ , where  $\rho'$  is the density just inside the core,  $\rho$  the density just outside, and  $e$  the angle of emergence. Calculations are presented graphically that give the conditions for given values of  $e$  and the density ratio  $\rho'/\rho$  or the ratio of the elastic parameters  $\lambda/\lambda+2\mu$ , where the prime refers to the material just inside the core.

The dependence of the phase changes on the density ratio is clear; for instance, for  $\rho'/\rho=1$  (no density discontinuity), there is a change of phase both for  $e < 10^\circ$  and for  $e > 55^\circ$ , whereas for  $\rho'/\rho > 1.7$ , there is a change of phase only for  $e < 6.2^\circ$ . Observations of *PcP* waves at epicentral distances of about  $30^\circ$  prove conclusively that there is a first-order density discontinuity at the core boundary. They also show that  $\lambda/\lambda+2\mu > 0.34$ . A method for determining the density ratio by more complete observations of *PcP* is indicated.—*P. E. B.*

- 161-197. Keane, A. An investigation of finite strain in an isotropic material subjected to hydrostatic pressure and its seismological applications: Australian Jour. Physics, v. 7, no. 2, p. 322-333, 1954.

An attempt is made to reduce the generality of the usual theories of finite strain and to concentrate on the case of hydrostatic pressure. The method used has been based on the works of Murnaghan and Birch, and yields a general relation giving the elastic constants in terms of the strain and the derivatives of

pressure with respect to strain. In order to proceed with the mathematical theory a law in place of Hooke's law is necessary, so various elasticity equations in the literature were investigated. A linear relation between the second- and third-order elastic constants is proposed. The law of finite hydrostatic strain agrees favorably with experiment and also with deductions from the atomic theory of solids.

It is suggested that Bullen's values for incompressibility in the inner core need modification; that the ratio incompressibility/density used by Birch when extrapolated to zero pressure is too high because with Birch's formula, incompressibility would be too high and density too low; and that the large initial increase in the variation of incompressibility density with pressure for potassium may help to explain part of the large increase in seismic velocities in layer *C*.—*M. C. R.*

161-198. Valle, P. E. Sull'omogeneita e sullo stato di equilibrio del mantello interno della Terra [On the homogeneity and state of equilibrium of the mantle of the earth]: *Annali Geofisica*, v. 7, no. 1, p. 33-44, 1954.

An equation is derived for the rate of change of the isothermal velocities of elastic waves in a homogeneous gravitating layer with an arbitrary gradient of temperature. On the basis of this equation an attempt is made to test the uniformity and adiabaticity of layer *D* in Bullen's earth model *A*. It is concluded that if the mantle is approximately in adiabatic equilibrium, as seems to be indicated, the temperature gradient is probably no more than a few tenths of a degree per kilometer even if the temperature at a 1000 km is a few thousand degrees.—*M. C. R.*

161-199. Runcorn, S. K. The electrical conductivity of the earth's mantle: *Am. Geophys. Union Trans.*, v. 36, no. 2, p. 191-198, 1955.

The rapid rise in electrical conductivity at depths of 700 km in the Earth's mantle, inferred by S. Chapman and his collaborators from a study of the transient variations of the geomagnetic field, may be well explained on the hypothesis that the process of intrinsic semi-conduction is of importance in this region. H. Hughes of the Department of Geodesy and Geophysics, Cambridge University, has demonstrated the various conduction processes occurring in olivine and similar minerals and has shown that the results fit in quantitatively with the observational data referred to above. An indirect method of estimating the effect of pressure on the process of intrinsic semi-conduction has been attempted and does not appear to alter the view that the rapid rise in conductivity is, in essence, a temperature effect. From this work estimates can be made of the electrical conductivity of the lower part of the mantle, which agree with estimates inferred from the spectrum of the secular variation of the geomagnetic field and the explanation of the irregular fluctuations in the length of the day.—*Author's abstract*

161-200. Bullen, K. E. Note on New Zealand crustal structure: *Royal Soc. New Zealand Trans.*, v. 82, pt. 5, p. 995-999, 1955.

Attention is drawn to implications of Gutenberg's new interpretation of southern Californian near-earthquake data and his suggestion that indications of velocities near 5.6 km/s may arise from the presence of a low-velocity layer near a depth of 16 km rather than immediately below the sediments. It is

shown that Gutenberg's new model for southern California crustal structure fits remarkably well an earlier interpretation of data for the New Zealand region when allowance is made for a possible decrease of velocity with increase of depth. It is possible that the average focal depth of normal earthquakes may be a little less in the New Zealand region than in California. It is shown that there is now no evidence of significant differences of crustal structure below the sediments in California, New Zealand and Japanese regions. Thus the suggestion arises that regions bordering on the Pacific basin may have common structural features which deviate from the structure of more specifically continental regions.—*Author's abstract*

- 161-201. Melchior, Paul J. Sur la constitution du Bassin Arctique et les caractéristiques du mouvement saisonnier du pôle [Constitution of the Arctic Basin and the nature of the seasonal movement of the pole]: Acad. Royale Belgique Bull., Cl. Sci., 5<sup>e</sup> sér., tome 41, no. 1, p. 51-53, 1955.

Recent explorations in the Arctic Basin have proved the existence of two independent basins separated by a submarine mountain range aligned along the 30° W. meridian. This line coincides with the long axis of the ellipse described by the pole in its annual movement.—*Author's abstract, H. F.*

- 161-202. Officer, Charles B., Jr. A deep-sea seismic reflection profile: Geophysics, v. 20, no. 2, p. 270-282, 1955.

A series of seismic reflection measurements were made in 1953 in the northern Atlantic. In one profile over the abyssal plain north of Bermuda, four reflection groups were identified and followed from record to record. The reflection measurements indicate that almost the entire sedimentary column is low-velocity (and therefore for the most part unconsolidated) material. Traveltime differences between the bottom reflection and a prominent subbottom reflection as a function of range and frequency, and variation of amplitudes of the two reflections with frequency and angle of incidence indicate the sediment is dispersive. At lower frequencies the velocity in the sediment is less than that in the adjacent ocean. This may be explained in terms of propagation in a porous medium. The low-velocity sediment forms a wave guide which may account for previously observed single-frequency arrivals.—*M. C. R.*

- 161-203. Heezen, Bruce C., Ewing, Maurice, and Ericson, D. B. Reconnaissance survey of the abyssal plain south of Newfoundland: Deep-Sea Research, v. 2, no. 2, p. 122-133, 1955.

A new chart of the abyssal plain south of Newfoundland, contoured on 5-fathom intervals, has been based on a survey made with a newly developed precision depth recorder with an accuracy of better than  $\pm 1$  fathom. Every core obtained from the abyssal plains to date contains evidence of turbidity currents. The plains slope away from areas adjacent to sediment sources. It is considered likely that all abyssal plains represent areas in which most of the original relief is buried beneath the deposits of turbidity currents. Only isolated hills and seamounts remain of the original topography. Continued turbidity-current transportation of material into the basins continually extends the abyssal plains.—*D. B. V.*

- 161-204. Heacock, John G., Jr., and Worzel, J. Lamar. Submarine topography west of Mexico and Central America: Geol. Soc. America Bull., v. 66, no. 6, p. 773-776, 1955.

A bathymetric chart of the Pacific Coast from Mexico to Panama is presented with a brief discussion of the topographic features shown. Gravity data from a survey in March and April 1949 were used although soundings made along the track of the gravity survey were not adequate for making topographic corrections for the gravity values. The most interesting feature is the trench extending from  $10^{\circ}$  N.,  $86^{\circ}$  W. to about  $20^{\circ}$  N.,  $106^{\circ}$  W. This trench is similar to those associated with island arcs in its relationship to shallow- and intermediate-depth earthquakes, and to volcanoes.—*V. S. N.*

- 161-205. Worzel, J. Lamar, and Shurbet, B. Lynn. Toro Seamount: Geol. Soc. America Bull., v. 66, no. 4, p. 465-466, 1955.

In March 1952, USS *Toro* located a seamount at  $33^{\circ}15'$  N.,  $60^{\circ}46'$  W., 7 miles southeast of a location predicted by Luskin in 1952. This position is 5 miles southeast of Seamount George reported in 1954 by Northrop and Frosch (see Geophys. Abs. 159-221). Differences in minimum soundings reported for the two places suggests that this is a compound feature with at least three peaks. It must present a broad face, at least 10 miles in length, with possible extensions to the southeast toward Bermuda.—*V. S. N.*

## GEOPHYSICAL EXPLORATION

- 161-206. Mooney, H. M. Geophysics and geochemistry move ahead in 1954: Mining Engineering, v. 7, no. 3, p. 251-256, 1955.

During 1954 there was a significant trend toward increased use of electromagnetic and geochemical methods of exploration. Airborne scintillometer and magnetic measurements have become a routine combination. Ground magnetic and gravity surveys continued to play an important role in geologic studies. The use of resistivity methods has shown a moderate increase. The application of seismic exploration was extended. The most promising instrumental developments were airborne electromagnetic equipment, a magnetometer based on nuclear resonance, and reflection seismic equipment operable at depths of less than 100 feet. Important theoretical and experimental research was conducted in the improvement of established methods of exploration and in the development of new methods.—*D. R. M.*

- 161-207. Litvinov, S. Ya., and Arkharov, L. V. Promyslovaya geofizika [Geophysics of oil fields]: 184 p., Moscow, Gostoptekhizdat, 1954.

This is a survey course of geophysics in exploration for oil for students of technical colleges not majoring in geophysical prospecting.—*S. T. V.*

- 161-208. Wilson, Gilbert M. How will tomorrow's oil be found: World Oil, v. 140, no. 5, p. 82-85, 1955.

This paper is in the form of an interview with E. B. Noble, a Los Angeles petroleum consultant. No new exploration tools are foreseen, although some improvement in geophysical instrumentation is anticipated. The reflection seismograph and the core drill will continue to be our most reliable tools, particularly when used in combination. Periodic review of old geophysical records, and improved well-logging techniques and interpretation, will result in new dis-

coveries. The development of the "exploration team" of geologists, paleontologists, stratigraphers, and geophysicists is a logical approach to more efficient oil-finding procedure.—*L. C. P.*

161-209. Morrisey, Norman S. Geophysics can find more oil for you: Oil and Gas Jour., v. 54, no. 7, p. 95-99, 1955.

Records show that the success of an exploratory drilling campaign can be improved more than one-third by using geophysics. New drillable oil prospects can still be found today, but it requires the coordinated effort of both geologist and geophysicist to find them.—*D. R. M.*

161-210. Borrego González, Joaquin. Papel de la prospeccion geofisica en las investigaciones petroliferas [The role of geophysical prospecting in petroleum exploration]: Minería y Metalurgia, no. 157, p. 15-20, 1954.

Geophysical exploration for oil always involves a geologic problem in addition to the geophysical considerations. Therefore, before applying any of the geophysical methods it is necessary to summarize all possible geologic information on the area. Several examples of American investigations are given.—*S. T. V.*

161-211. Dakhnov, V. N., and Kobranova, V. N. Izucheniye kollektorskikh svoystv i neftenasyshchennosti produktivnykh gorizontov neftnykh mestorozdeniy po dannym promyslovoy geofiziki [Investigations of the oil saturation and accumulative properties of the producing horizons of oilfields using the data obtained by geophysical methods]: Promyslovaya geofizika, p. 5-45, 1952.

Results are presented of experimental and theoretical investigations of the correlation between physical properties of rocks measurable from the surface of the earth, and characteristics indicating the presence of oil. These investigations were made to obtain as much useful information on a well as possible without coring. The properties studied were electric resistivity, electrochemical activity, radioactivity, and thermal properties, and correlations between them and such properties as porosity, permeability, degree of saturation with water or oil, and mineralization of the water. Numerous empirical formulas and experimental graphs related to the wells in different parts of Russia are given.—*S. T. V.*

161-212. Brant, Arthur A. The role of geophysical methods in modern exploration programs: Eng. Min. Jour., v. 156, no. 3a, p. 25-32, 1955.

This is a discussion of the role of geophysics in mining exploration programs, including the uses and limitations of each of the geophysical methods employed in exploration for metals.—*L. C. P.*

161-213. Todd, David K. Investigating ground water by applied geophysics: Am. Soc. Civil Engineers Proc., v. 81, Separate no. 625, 14 p., 1955.

The basic principles of and information provided by resistivity, seismic-refraction, and electrical-logging methods, particularly in their application to problems of ground-water exploration, are briefly described. A bibliography of 66 English-language items is included.—*M. C. R.*

- 161-214. Cantos [Figuerola], Jose. Aplicacion de los metodos geofisicos a la prospeccion de aguas subterraneas [Application of geophysical methods to prospecting for ground water]: Internat. Geol. Cong., Algiers, 19th sess., Comptes Rendus, Sec. 9, fasc. 9, p. 163-189, 1954.

A résumé of the work of the Seccion de Geofisica of the Instituto Geologico y Minero in Spain in prospecting for ground water. Electrical, gravimetric, and seismic methods have been used.—*M. C. R.*

- 161-215. Kisłow, Afrikan. Geofizyka na uslugach geologii inzynierskiej [Geophysics at the service of engineering geology]: Przegląd geol., zeszyt 11, p. 474-482, 1954.

After a brief exposition of the principles of different geophysical methods, the application of these methods in engineering is discussed, including exploration of the underground for information for dams, bridges, large buildings, prospecting for water, and exploration of nearsurface layers.—*S. T. V.*

- 161-216. Agnich, F. J. Geophysical instrumentation is making rapid progress: World Oil, v. 140, no. 5, p. 109-111, 114, 1955.

Significant recent advances in geophysical instrumentation include magnetic tape recording, automatic computing systems, electromechanical reflection plotters, weight dropping for seismic energy, single-ship marine seismic shooting, and the use of very low and very high frequency seismic recording. "The period of greatest development in the science of geophysics lies still in the future."—*L. C. P.*

- 161-217. Oliphant, Charles W., and Fullerton, Paul. How computers facilitate stratigraphic correlations: World Oil, v. 140, no. 5, p. 132-138, 1955.

Cross-correlation and autocorrelation functions, used in conjunction with specially designed computing machines, may be helpful in stratigraphic correlation of lithologic and resistivity logs.—*L. C. P.*

- 161-218. Kemler, Emory N., and Lacabanne, W. D. The Williston Basin: 272 p., Spring Park, Minnesota, Summary Reports, 1954.

This book is a compilation of information on the development of the Williston Basin. The section on exploration (p. 101-127) is largely based on articles in World Oil, July 1954, and by Dobrin (in Oil and Gas Journal March 24, 1952), Burg (in Geophysics July 1952), and Kornfeld (in Oil and Gas Journal April 19, 1954).—*M. C. R.*

- 161-219. Tribalto, Giuseppe, and Amadei, Gaetano. L'attività geofisica svolta durante l'anno 1953 [Geophysical activity during the year 1953]: Servizio geol. Italia Boll., v. 75, (1953), fasc. 2, p. 972-973, 1954.

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This is a description of the foreign operations of a typical geophysical contracting company.—*L. C. P.*



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The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that every entry, no matter how small, should be recorded to ensure the integrity of the financial data. This includes not only sales and purchases but also expenses and income. The text suggests that a consistent and thorough record-keeping system is essential for identifying trends and making informed decisions.

Next, the document addresses the issue of budgeting. It explains that a well-defined budget helps in controlling costs and maximizing resources. By setting clear financial goals and limits, individuals and organizations can avoid overspending and stay on track. The text provides practical advice on how to create a budget that is realistic and adaptable to changing circumstances.

The third section focuses on the role of technology in modern accounting. It highlights how software solutions can streamline processes, reduce errors, and provide real-time insights into financial performance. The document discusses various types of accounting software and offers tips on how to choose the right one for specific needs. It also touches upon the importance of data security and backup procedures when using digital tools.

Finally, the document concludes by stressing the value of professional advice. While many accounting tasks can be handled in-house, consulting with a qualified accountant or financial advisor can provide valuable expertise and ensure compliance with complex regulations. The text encourages readers to seek professional help when needed to optimize their financial health and achieve their long-term goals.

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The third section focuses on the importance of regular financial reviews. It argues that periodic assessments of financial performance are necessary to catch any deviations from the budget or to identify areas for improvement. This process involves comparing actual results against the budgeted figures and analyzing the reasons for any variances. The document stresses that these reviews should be conducted consistently to maintain a clear picture of the financial health.

Finally, the document concludes by highlighting the value of financial literacy. It encourages individuals to take the time to understand their financial situation and to seek professional advice when needed. By becoming more financially literate, people can make better choices and secure their financial future. The text ends with a call to action, urging readers to implement the principles discussed throughout the document.