# Geophysical Abstracts 174 July-September 1958

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

GEOLOGICAL SURVEY BULLETIN 1086-C

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1958

UNITED STATES DEPARTMENT OF THE INTERIOR

FRED A. SEATON, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U. S. Government Printing Office, Washington 25, D. C. Price 35 cents (single copy). Subscription price $1.25 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 (December 5, 1957).

# CONTENTS

# GEOPHYSICAL ABSTRACTS 174, JULY–SEPTEMBER 1958

By DOROTHY B. VITALIANO, S. T. VESSELOWSKY, and others

## INTRODUCTION

### EXTENT OF COVERAGE

Geophysical Abstracts includes abstracts of technical papers and books on the physics of the solid earth, the application of physical methods and techniques to geologic problems, and geophysical exploration. The table of contents, which is alphabetically arranged, shows the material covered.

Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with limited circulations (such as dissertations, open-file reports, or memoranda) or of other papers presented orally at meetings unless summaries of substantial length are published. Abstracts of papers in Japanese and Chinese are based on abstracts or summaries in a western language accompanying the paper.

### LIST OF JOURNALS

Full titles and abbreviations of journals cited for the first time in this issue (with the sponsoring organization and its address where these do not form part of the title) are given below. This list supplements the List of Journals published in Geophysical Abstracts 160 (January–March 1955, Bulletin 1033–A) and the supplements published in Geophysical Abstracts 161–173.

**Akad. Nauk Turkmen. SSR Izv.**—Akademiya Nauk Turkmenskoy SSR. Ashkhabad.

**Annales géol. des Pays helléniques**—Annales géologiques des Pays helléniques. Athens University, Laboratoire de Géologie. Athens.

**Geologica Bavarica**—Geologica Bavarica. Bayerisches geologischen Landesamt. München.

**Geologiya Nefti**—Geologiya Nefti. Organ gosudarstvennogo nauchno-tekhnicheskogo komiteta Soveta Ministrov SSSR. Moskva.

**Göteborg Oceanog. Inst. Medd.**—Meddelanden från Oceanografiska Institutet i Göteborg.

**Jökull**—Jökull. Ársrit Jöklarannsóknafélags Íslands. [Annals of the Iceland Glaciological Society] Reykjavík.

**Metrologie aplicáte**—Metrologie Aplicáte, Bucuresti.

Náttúrufrae ðingurinn—Náttúrufrae ðingurinn Timarit hins Islenzka Náttúrufrae ðifélags [Journal of the Icelandic Natural History Society] Reykjavik.

Norway Geof. Komm.—Den Geofysiske Kommisjon. [The Geophysical Commission] Norway. Bergen.

Service Carte géol. Alsace-Lorraine Bull.—Bulletin du Service de la carte géologique d'Alsace et de Lorraine. Université de Strasbourg. Strasbourg.

Soc. Naturalisti Napoli Boll.—Bolletino della Società dei Naturalisti in Napoli. Italy.

Swedish Deep-Sea Exped. Repts.—Reports of the Swedish Deep–Sea Expedition. Göteborgs Kunglig Vetenskaps–och Vitterhets–Samhälle. Göteborg.

Technique de l'Eau—La Technique de l'Eau et de l'Assainissement. Revue européenne d'expression française. Brussels.

World Sci. Rev.—Supplement to the Intelligence Digest. World News Service. London.

## FORM OF CITATION

The abbreviations of journal titles used are those adopted by the U. S. Geological Survey and used in many geological journals. For papers in most languages other than English, the title is given in the original language as well as in translation. Slavic names and titles have been transliterated by the system used by the United States Board on Geographic Names. This system of transliteration for Russian was given in Geophysical Abstracts 148 (January–March 1952, Bulletin 991–A). Titles of papers in Japanese and Chinese are given in translation only.

## ABSTRACTORS

Abstracts in this issue have been prepared by J. R. Balsley, R. G. Bates, F. C. Frischknecht, R. G. Henderson, Anna Jespersen, H. R. Joesting, D. R. Mabey, Virginia S. Neuschel, L. Peselnick, E. C. Robertson, A. J. Shneiderov, and H. C. Spicer, as well as by the principal authors. The notation "Author's abstract" followed by the initials of an abstractor indicates a translation of the author's abstract. The cooperation of Miss Marie Siegrist of the Geological Society of America is also gratefully acknowledged.

## AGE DETERMINATIONS

174–1. Haring, A., de Vries, A. E., and de Vries, H. Radiocarbon dating up to 70,000 years by isotopic enrichment: Science, v. 128, no. 3322, p. 472–473, 1958.

In old samples having too small activity, isotopic enrichment of radiocarbon by a factor of $2^n$ shifts the limit of counting by $n$ half-lives. At least 350 liters of sample are required. So far, three samples have been enriched at the mass-spectrography laboratory in Amsterdam and measured in the large counter at the university in Gröningen. The first consisted of recent carbon dioxide diluted with a known amount of inactive $CO_2$; predicted enrichment was $8.70\pm0.5$, measured enrichment $8.06\pm0.05$. The second consisted of dead $CO_2$ from anthracite. If no contamination occurred, the sample should still be inactive; activity actually was $0.04\pm0.02$, corresponding to an apparent age of 73,000 yrs (this experiment will be repeated). The third sample was wood from the last Interglacial or an early Würm interstadial; the age found by enrichment was $64{,}000\pm1{,}100$ yrs, which fits fairly well with the glacial chronology, but as humus extracted from it has an age of only $42{,}300\pm900$ yrs, showing some admixture of recent material, it is a minimum date.—*D. B. V.*

174–2. Shima, Makoto, and Minami, Eiiti. On the geochemical study of carbon 14. (II). Age dating of volcanic product and the rate of peat sedimentation: Tokyo Univ. Earthquate Research Inst. Bull., v. 36, pt. 2, p. 135–138, 1958.

The age of various peat layers at Ozegahara, Japan, and their rate of sedimentation were calculated with the aid of a carbon-14 determination ($5{,}678\pm700$ yrs), and the ages of the pumice horizons were estimated. Results consistent with the degree of compaction were obtained for samples older than 1,000 yrs.—*D. B. V.*

174–3. Roche, Jean. Chronologie absolue de l'Épipaléolithique marocain [Absolute chronology of the Epipaleolithic of Morocco]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 25, p. 3486–3487, 1958.

Three Epipaleolithic horizons from Taforalt, Morocco, have been dated by the carbon-14 method as $10{,}800\pm400$, $12{,}070\pm400$, and $10{,}500\pm400$ yrs. Although the last, representing the oldest of the three, is aberrant, these determinations correlate the cultures with the Alleröd interglacial stage.—*D. B. V.*

174–4. Broecker, W. S., Turekian, K. K., and Heezen, Bruce C. The relation of deep sea sedimentation rates to variations in climate: Am. Jour. Sci., v. 256, no. 7, p. 503–517, 1958.

Variations in sedimentation rates with time have been investigated in a mid-equatorial Atlantic core (*A* 180–74). Measurements of $C^{14}/C^{12}$ ratios, percent coarse fraction ($>74\mu$), and percent carbonate material at frequent depth intervals permit the calculation of absolute rates of sedimentation for each of the major contributors to the sediment. The rates of deposition of both the carbonate and clay fractions are shown to decrease abruptly from the high glacial rate approximately 11,000 years ago. The observed correlation of sedimentation rate with surface ocean temperature and extent of continental glaciation permits the dating of late Pleistocene events by reasonable extrapolations beyond the

limits of radio carbon dating. The beginning and end of the warm period preceding the last cold surface ocean water period are estimated at ~150,000 and ~70,000 years respectively.—*Authors' abstract*

174–5. Saillard, Nicole, Sheibling, Gaston, and Hée, Arlette. Détermination de la teneur en plomb des zircons par l'analyse spectrale quantitative [Determination of the lead content of zircons by quantitative spectral analysis]: Service Carte géol. Alsace-Lorraine Bull., v. 10, no. 2, p. 28–31, 1957.

Determination of the lead content of zircon by spectrographic comparison with samples of $SiO_2$ and of $SiO_2$–$ZrO_2$ mixtures containing known amounts of lead oxide gave the same result on a zircon with both standards (6.5 parts per million); thus either may be used in determining the lead content of zircon for dating purposes. Analysis of zircons from different granites showed that results will be satisfactory as long as the 2833 Å line (chosen for these analyses) is clearly distinct from any other line.—*D. B. V.*

174–6. Millot, Georges. Présentation des déterminations de l'âge absolu de deux granites des Vosges [Presentation of determinations of the absolute age of two granites from the Vosges]: Service Carte géol. Alsace–Lorraine Bull., v. 10, no. 2, p. 27–28, 1957.

A brief summary of the results of lead-alpha measurements of the age of zircons from two granites from the Vosges, France; details have already been published (see Geophys. Abs. 169–17, 171–34).—*D. B. V.*

174–7. Hée, Arlette, and Flesch, Louis. Sur l'âge absolu apparent des zircons d'Espaly (Haute–Loire) [On the apparent absolute age of the zircons from Espaly (Haute Loire)]: Service Carte géol. Alsace–Lorraine Bull., v. 10, no. 2, p. 32–38, 1957.

Complete results of the study reported in the Comptes Rendus de l'Académie des Sciences, Paris, v. 244, no. 13, p. 1796–1798, 1957 (see Geophys. Abs. 169–18).—*D. B. V.*

174–8. Polkanov, A. A., and Gerling, E. K. *K–A* and *Rb–Sr* methods and age of Precambrian of USSR: Am. Geophys. Union Trans., v. 39, no. 4, p. 713–715, 1958.

The technique of argon age determination on mica is described briefly. Since 1951 more than 300 determinations have been made on micas from different regions of the Precambrian of the U. S. S. R. (data are tabulated for 35). The ages range from $2{,}880\times10^6$ yrs to $500\times10^6$ yrs, the oldest being on the Kola Peninsula. Although in the case of Mesozoic and Paleozoic rocks there is no significant divergence between argon age and stratigraphic age, there are great differences for the Precambrian, sometimes as high as $10^9$ yrs. Rubidium-strontium determinations on samples showing great divergence confirm the argon ages, showing that the differences do not result from argon loss or excess. A case where a pegmatite mica proved to be 1,000 million yrs older than the mica from the gneiss intruded by it is being examined. The Precambrian of the Baltic and Ukrainian shields may prove to belong to different periods of the Archean and Proterozoic-Paleozoic eras.—*D. B. V.*

## EARTH CURRENTS

174–9. Yoshimatsu, Takasaburo. Universal earth-currents and their local characteristics: Kakioka Mag. Observatory Mem., supp. v. 1, 76 p., and appendix, 29 p., 1957.

The complete results of Yoshimatsu's analyses of earth current data from various parts of the world and Japan in particular, parts of which have appeared separately (see Geophys. Abs. 158–85, 173–17), are presented in this one volume. The appendix discusses the method and procedure of earth current measurements.—*D. B. V.*

174–10. Shuleykin, V. V. Telluricheskiye toki v okeane i magnitnoye skloneniye [Telluric currents in the ocean and magnetic declination]: Akad. Nauk SSSR Doklady, v. 119, no. 2, p. 257–260, 1958.

The density of rising telluric currents deep in the ocean and their possible effect on the origin and variations of geomagnetic declination has been investigated. Direct measurements of current densities up to 250 m deep, made in the Indian and Atlantic Oceans and in Lake Baikal, showed a linear drop of potential with increasing depth. Extrapolation to the bottom of the ocean of the current density of $3.57 \times 10^{-4}$ amps per $m^2$ found at 250 m leads to 10 amps current passing along the meridian through a "gate" 1 m wide and 5,000 m high (from the surface to the bottom), as against 15 amps through the same cross section required to produce the observed magnetic declination. The sharp increase of telluric current density with depth is attributed to the effect of the sun's corpuscular radiation. The absence of vertical potential gradient in the ocean is explained by hypothetical "eddies" on the background of the earth's potential field, formed by the lines of the Atlantic-Pacific magnetic dipole. The lines rotate with the earth and sweep over the radius-vector of the corpuscular radiation which streams from the sun and is stationary with regard to the earth; the vertical components of the eddies cancel each other, leaving a measurable horizontal component.—*A. J. S.*

174–11. Ivanov, A. G., and Khovanova, R. I. Burya zemnykh tokov 6–8 Oktyabrya 1949 g [Earth-current storm of October 6–8, 1949]: Akad. Nauk SSSR Isv. Ser. geofiz., no. 4, p. 525–526, 1957.

Earth current measurements were made in 1949 in the Pamir foothills in order to investigate a possible relationship between earth currents and seismic phenomena. The measurements were obtained by means of two lines of electrodes (one extending east-west for 1,100 m, the other running across it in a north-south direction for 400 m) and recorded by two circuits, one for comparatively rapid, the other for slow variations. The storm in question began on October 6, 1949, at 0400 hr GMT, reached its maximum intensity during an interval of 4 hours 20 minutes on the night of October 7–8, and abated by 1600 hr on October 8.—*D. B. V.*

174–12. Dubrovskiy, V. G. Metod bystrokhodnoy registratsii zemnikh tokov s primeneniyem yemkostnoy svyazi elektrodov i gal'vanometra [The method of high-speed recording of earth currents using capacitative coupling of the electrodes and galvanometer]: Akad. Nauk Turkmen. SSR Izv., no. 1, p. 3–10, 1958.

During the International Geophysical Year simultaneous observations of earth currents are being made in different parts of the globe, using high-speed regis-

tration. Because of the close relationship between the short period variations in the geomagnetic field and in earth currents, such observations will ultimately be useful in studies of the earth's electromagnetic field; they are of immediate use in the method of telluric current surveying, based on short period variations in earth currents, which is being used increasingly widely. This paper discusses the determination of amplitude and phase of the frequency characteristics of an apparatus for high speed registration of earth currents having capacitative coupling of electrodes and galvanometer. The wiring scheme is described and the theory of the instrument presented mathematically. The theoretical conclusions have been tested by field experiments near the Vannovskaya geophysical station; agreement between computed and measured values was found to be very good.—*S. T. V., D. B. V.*

## EARTHQUAKES AND EARTHQUAKE WAVES

174–13. Richter, C[harles] F. New dimensions in seismology: Science, v. 128, no. 3317, p. 175–182, 1958.

A review of recent developments in instrumental seismology, particularly the classification according to magnitude, which in effect adds a fifth dimension to the science (the other four being latitude, longitude, instant of occurrence, and depth).—*D. B. V.*

174–14. Rothé, J[ean]-P[ierre]. Tableau de la séismicité du globe pendant les années 1955–1956 (Chronique séismologique) [Table of the seismicity of the earth during the years 1955–1956 (Seismological chronicle)]: Rev. Étude Calamités, v. 16, no. 34–35, p. 3–35, 1956–1957.

In 1955–1956 the International Bureau of Seismology studied 3,900 earthquakes, for which 2,727 epicenters were determined. Twenty earthquakes caused loss of life: one in Europe, seven in the Mediterranean area, six in Asiatic mountain ranges, and six in the circumpacific belt. All earthquakes with a magnitude of more than 6½, and a few weaker ones if focal depths were abnormal or if they occurred in regions of low seismicity, are tabulated according to geographic distribution and described briefly.—*D. B. V.*

174–15. Montandon, Frédéric. Les grandes catastrophes causeés par les forces de la nature en 1956 et 1957 [The great catastrophes caused by natural forces in 1956 and 1957]: Rev. Étude Calamités, v. 16, no. 34–35, p. 47–53, 1956–1957; Sur les montants des dommages occasionnés par les calamités naturelles [On the totals of damages caused by natural calamities]: ibid, p. 54–57, 1956–1957.

The first paper is a catalog of great natural catastrophes that occurred throughout the world in 1956 and 1957. These were due mostly to exogene forces (storms, floods, etc.), but included earthquakes in Lebanon on March 16, 1956, on Santorin Island (Greece) on July 9, 1956, on the island of Kutch (India) on July 22, 1956, in Thessaly (Greece) on March 8, 1957, in northern Iran on July 2, 1957, and in western Iran on December 13–15, 1957.

The second paper tabulates estimated damage (in francs) caused by natural catastrophes in 1948 to 1955. Six earthquakes and two volcanic eruptions are mentioned. No data are available for the eruptions of Mount Lamington in New Guinea and Hibok-Hïbok in the Philippines in 1951.—*D. B. V.*

174–16. Kárník, Vít, Michal, Emanual, and Molnár, Alexander. Erdbebenkatalog der Tschechoslowakei bis zum Jahre 1956 [Earthquake catalog of Czechoslovakia to the year 1956]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 69, p. 411–598, 1957 (1958).

A catalog compiling all information known to 898 earthquakes that occurred in Czechoslovakia in the years 460 to 1956; with a bibliography of 304 items, a map of distribution of foci, and list of places that have suffered earthquake damage, with dates.—*D. B. V.*

174–17. Zátopek, Alois. Die seismische Karte der Tschechoslowakei [The seismic map of Czechoslovakia]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 70, p. 599–618, 1957 (1958).

A general picture of the seismicity of Czechoslovakia is drawn from various existing seismic maps (reproduced and described individually) and from data of modern seismic investigations. The Archean and Paleozoic Bohemian massif of the western part of the country is relatively inactive seismically; apart from a few local shocks echoing Alpine pressure from the south, most of the infrequent earthquakes here are from foci outside the country, particularly in the East Alps and Swabian Alb. In contrast, the Carpathian system in the eastern part of the country is quite active, due to the fact that orogenic movements that began in the Tertiary are still going on; in the period 1923–1938 more than 100 earthquakes of macroseismic intensity occurred. Once every few centuries the whole country suffers a shock of considerable intensity, such as that of 1690, with an intensity of 7 (Mercalli-Cancani-Sieberg scale).—*D. B. V.*

174–18. Kárník, Vít, and Vaněk, Jiří. On the investigation of tectonic microtremors in the Komárno basin: Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 1, p. 95–100, 1957.

The Komárno basin in Czechoslovakia suffered a series of severe earthquakes in the period 1763–1822; weak shocks since then, and large vertical movements revealed by precise leveling, indicate that the region is still tectonically active. Microtremors were investigated by means of four mobile seismic stations and one regional station. *P*-wave velocities in the region, determined by means of artificial explosions, were found to be 2.1 kmps in a surface layer one km thick and 4.0 kmps in the underlying basement. The maximum microactivity was found to coincide with one of the seismogenic zones of the basin.—*D. B. V.*

174–19. Tryggvason, Eynsteinn. Jarðskjálftar árin 1954 og 1955 [Earthquakes in 1954 and 1955 (with English summary)]: Náttúrufraeðingurinn, v. 26, no. 2, p. 77–86, 1956.

A catalog of earthquakes in Iceland in 1954 and 1955. Seismic activity was higher than usual in that period, particularly from September 1954 to May 1955. Of approximately 500 tremors recorded at Reykjavík in 1954, some 350 were local (epicentral distance less than 500 km), and of the 365 recorded in 1955 about 300 were local. At the Akureyri station about 90 shocks were recorded in 1954 and 70 in 1955. At least 21 shocks in 1954 and 37 in 1955 could be felt. Those of magnitude 4 or more, or otherwise of special interest, are tabulated; date and origin time, epicenter, magnitude, and maximum intensity are given.—*D. B. V.*

174–20. Cucuzza-Silvestri, Salvatore. Sul periodo sismico di Pedara (Etna) manifestatosi nei primi mesi del 1955 [On the seismic period of Pedara (Etna) manifested in the first months of 1955]: Annali Geofisica, v. 9, no. 4, p. 577–593, 1956.

An earthquake swarm occurred in January and February of 1955 on the south slope of Mount Etna, restricted to a small area in the vicinity of Pedara. Shocks were not strong (intensity 4–5), not very frequent, and generally were unrelated to seismic activity in neighboring areas. The past (macroseismic) history of the area and comparison with eruptive manifestations indicates that the seismicity of the Pedara zone is primarily volcanic in origin rather than tectonic.—*D. B. V.*

174–21. Imbò, Giuseppe, and Vittozzi, Pio. Su due distinti periodi sismici dell'Abruzzo meridonale [On two distinct seismic periods in southern Abruzzi]: Soc. Naturalisti Napoli Boll., v. 66, p. 9–17, 1957(1958).

Southern Abruzzi in Italy has been subjected to two distinct seismic periods in recent years. The first occurred principally in March 1948 and involved a limited area on the northeast slope of the Matese (Matesian mountains), whereas the second, whose first manifestations appeared in August 1956, developed mainly in November 1956 and March 1957 and involved the Apennine zone in extreme southwestern Molise. Twelve shocks were recorded in the 1948 swarm, of which the first, on March 5, was the strongest with an intensity of 6–7 on the Mercalli scale and a focal depth of 0.4 km. Twenty-seven shocks were registered in the 1956–1957 seismic period, with the strongest on March 3, 1957, having an intensity of 6 and a focal depth of 3.9 km. Both swarms are considered to be seismic phenomena of karst origin, caused by collapse of rock masses in underground limestone caverns. Calculations show that open caverns can exist up to depths of 5.9 km.—*D. B. V.*

174–22. Peterschmitt, É[lie]. Quelques données nouvelles surf les séismes profonds de la mer Tyrrhénienne [Some new data on the deep earthquakes of the Tyrrhenian Sea]: Annali Geofisica v. 9, no. 3, p. 305–334, 1956.

Many small intermediate and deep earthquakes occurred in the Tyrrhenian Sea in the years 1952–1956. The shallow shocks were concentrated in two areas, one north of lat 41°, the other forming a well-defined "Calabrian arc" in southern Lucania and Calabria and northern Sicily. Intermediate and deep shocks are of three classes: those at 200–300 km (most numerous and forming arcs at different depths similar to the Calabrian arc); the shock of February 17, 1955 (lat 39°6′ N, long 13°1′ E, depth 450 km), which originated in a supposedly aseismic zone; and some shocks at about 100 km, apparently randomly distributed.

The geographic distribution, together with gravity and volcanologic data, suggests that the seismicity of the Tyrrhenian Sea can be compared with that of a circumpacific arc such as the Tonga Islands. Foci are distributed approximately on a conical surface having its apex downward near lat 40° N, long 12° E at a depth of 700 km, with the Calabrian arc forming its base; the dip of this surface is generally greater than 60°. Records at Italian stations show that earthquake wave velocities inside this surface are anomalously low (for dis-

tances of 500 km, *P*-wave arrivals are generally 4 sec late) whereas outside this surface velocities are normal or (toward Taranto) higher than normal. The surface may actually be a discontinuity.—*D. B. V.*

174–23. Usami, T[atsuo], Utsu, T[okuji], and Ichikawa, M. Seismicity in and near Japan, 1926–1956: Geophys. Mag., v. 28, no. 3, p. 273–289, 1958.

The seismicity of Japan and vicinity is investiagted, based on an analysis of earthquakes in and near Japan during the period 1926–1956. The results are presented in two graphs and a table showing the relationship between number of earthquakes and focal depths and magnitude, and in 15 maps showing distribution of epicenters for every 10 yrs for different focal depths and magnitudes, and one map showing epicenters of earthquakes deeper than 60 km for the whole period.—*D. B. V.*

174–24. Katsumata, M. Table of deep-focus earthquakes which occurred in and near Japan from 1935 through 1957 and some related investigations (in Japanese with English summary): Quart. Jour. Seismology, v. 23, no. 1, p. 1–14, 1958.

Earthquakes occurring from 1935 through 1957 in and near Japan at focal depths greater than 150 km are listed in tables which show the time of occurrence, epicenter, focal depth and magnitude. For earthquakes of magnitude 6, the relation between magnitude $M$ and the mean annual number of earthquakes $N$ may be expressed by the formulas $\log N=-1.45+1.2\ (8-M)$ when $H$ 150 km, and $\log N=-1.5+1.1\ (8-M)$ when $H\lesseqgtr 300$ km; shocks in and near Japan with $H\lesseqgtr 300$ km are more than 30 percent of the total deep shocks of the world, whereas the number of shallow earthquakes is 10 percent of the total shallow earthquakes of the world; earthquakes with focal depth between 300 and 350 km constitute about 30 percent and those with focal depth between 500 and 550 km about 20 percent, of the total deep shocks; the annual energy release is $0.4\times10^{23}$ ergs for deep shocks and $0.5\times10^{23}$ ergs when $H\lesseqgtr$ 150 km, calculated from the equation $\log E=11.8+1.5\,M$.—*V. S. N.*

174–25. Asada, Toshi; Suyehiro, Shigeji; and Akamatu, Kei. Observations of near-by microearthquakes occurring in the vicinity of Matsushiro, Japan [in Japanese with English abstract]: Zisin, ser. 2, v. 11, no. 1, p. 7–19, 1958.

From observations of microearthquakes near Matsushiro, made with a highly sensitive seismometer, the equation $\log N(M)=a-0.8\ M$ previously found to apply to microearthquakes observed at Mount Tsukuba in 1955, was found to hold for shocks of magnitudes from less than zero up to 5. At Matsushiro, microearthquakes of zero magnitude occur about 20 times a day; their foci are shallow, and their geographic distribution coincides with that of the minor shocks of magnitude 4 or 5 that occur once or twice a year. The energy of the smallest shock recorded during these observations is about $10^9$ ergs.—*V. S. N.*

174–26. Akamatu, Kei. On microtremors II (in Japanese with English summary): Zisin, ser. 2, v. 11, no. 1, p. 40–48, 1958.

Describes the results of tripartite observations at Hongo and Kokubunji in Tokyo, Kakioka in Ibaraki Prefecture, and Matsushiro in Nagano Prefecture, Japan, to investigate the character of propagation of microtremors. The ob-

servations revealed phase velocities of 300 m per sec at Kakioka for vertical motion and 600 m per sec at Kokubunji for horizontal motion with wave lengths of 100 and 250 m respectively. Short-period microtremors with frequencies of more than 10 cycles per sec decrease notably in amplitude during the night. Microtremors have the character of surface waves and appear to be composed of waves generated from a number of surface sources.—*V. S. N.*

Shima, Michiyasu. On the second volcanic micro-tremor at the Volcano Aso. See Geophys. Abs. 174–359.

174–27. Boletin Sismológico del Servicio Geológico Nacional de El Salvador. Resumen de la actividad sismica registrada en El Salvador durante les meses de septiembre a diciembre de 1957; tablas sismograficas detalladas; tablas de microsismos [Summary of seismic activity registered in El Salvador during the months of September to December, 1957; detailed seismographic tables; tables of microseisms]: Servicio geol. nac. El Salvador Bol. sismol., v. 3, p. 39–51, 1957 (1958).

A summary of the most important earthquakes registered in El Salvador during the last four months of 1957 accompanies complete tables of the observations made at the San Salvador and Santa Maria stations in that period. Sixteen shocks of intensity 3 or more were felt in different parts of the country. Most were of Central American origin.—*D. B. V.*

174–28. Kondorskaya, N. V., and Postolenko, G. A. Seysmichnost' SSSR za 1955 g [Seismic activity in the U. S. S. R. in 1955]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 255–257, 1957.

A map of epicenters of 176 earthquakes having a magnitude of $M \geqq 4$ that occurred in the U. S. S. R. in 1955 shows two main seismic zones, one in the Far East (Kamchatka-Kuriles) and one in Central Asia. The most severe shocks were those of January 31 ($t_o=16^h2^m11^s$, $\varphi=46°$ N, $\lambda=153°$ E, $M=6¾$, $h=60$ km), March 18 ($t_o=0^h6^m48^s$, $\varphi=54°$ N, $\lambda=161°$ E, $M=6¾$, $h=70$ km), and November 23 ($t_o=6^h29^m23^s$, $\varphi=50°$ N, $\lambda=158°$ E, $M=6¾$, $h=60$ km). Total energies released in various zones are evaluated and expressed relative to that discharged in the Far East: Far East and Arctic, 1; Central Asia, $6\times10^{-1}$; Caucasus, $5\times10^{-5}$; Carpathians, $5\times10^{-5}$; Kopetdag, $1\times10^{-5}$; Near-Baikal, $2\times10^{-6}$; Urals, $1\times10^{-6}$; Crimea, $2\times10^{-7}$.—*D. B. V.*

174–29. Sultanova, F. F. Obrabotka nablyudeniy nad zemletryaseniyami Azerbaydzhana [The analysis of observations on earthquakes in Azerbayijan]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 398–404, 1958.

Riznichenko's method of "time fields" for locating earthquake foci is applied to the Azerbayijan earthquakes of October 27, 1952, September 23, 1953, and October 4, 1953. The method presupposes knowledge of the crustal structure and layer velocities of the region investigated. Foci are determined graphically. Sources of error inherent in the method are analyzed.—*S. T. V.*

174–30. Tskhakaya, A. D. Gegechkorskiye zemletryaseniya v yanvare 1957 [The earthquakes in the Gegechkori area in January 1957]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 990–999, 1957.

Western Georgia, including the Gegechkori area, has been relatively quiet seismically. Earthquakes between the years 1912 and 1956 never exceeded 6 in

intensity. Since the end of December 1956, however, earthquakes in this area have been more frequent and stronger. The shocks of January 24 to 26, 1957 had an intensity of 7–8 and a larger felt area than any previous shocks. The destruction of houses and public buildings was very extensive but very different in buildings of the "European type" (such as schools and public buildings) and the often primitive private homes. To eliminate discrepancies in determination of intensity, only the buildings of European type were considered, but considerable difficulty arises from the fact that the macroseismic evidence is the accumulated effect of several shocks. The evaluation of the intensity of the individual shocks is possible only on the basis of the records of seismic stations. The article contains a detailed description of the effect of the earthquake with numerous photographs of damaged buildings.—*S. T. V.*

174–31. Gorshkov, G. S. Seysmicheskiye nablyudeniya v sele Klyuchi [Seismic observations in Klyuchi village]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 19, p. 14–31, 1953.

From August 28 to December 31, 1948, the Kamchatka seismic station registered 259 local earthquakes, related to activity of Klyuchevskaya volcano, 18 near and 3 distant earthquakes, and microseisms with periods between 3 and 6 sec. Of the last, 52 percent were registered on the north-south component, 18 percent on the east-west component, and 30 percent on both.—*D. B. V.*

174–32. Gorshkov, G. S. Seysmicheskiye nablyudeniya *v* 1949 *g* [Seismic observations in the year 1949]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 21, p. 19–39, 1954.

In 1949, 113 local, 97 near, 13 "intermediate-remote" (epicentral distances 800 to 2,000 km), and 42 remote earthquakes were registered at the Kamchatka station. For each of these are listed the date, arrival times of various waves, *S–P* and other intervals, and azimuth, also focal depths, epicenters, amplitudes, and other data where known. In addition, volcanic tremors were recorded for the first time in the U. S. S. R.; these very definitely heralded the weak explosions in the summit crater of Klyuchevskaya volcano on May 24.—*D. B. V.*

174–33. Bune, V. I. Opyt ispol'zovaniya energeticheskikh kharakteristik zemletryaseniy pri izuchenii seysmichnosti Tadzhikistana [The results of the utilization of energy characteristics of earthquakes in studies of the seismicity of the Tadzhik SSR]: Akad. Nauk Tadzhik SSR Izv. otdel. yestestven. nauk, no. 23, p. 19–34, 1957.

The energy of earthquakes in the Tadzhik S. S. R. is calculated from available records, and on this basis the different regions of the republic are classified as to earthquake risk. The principal epicentral zones of strong earthquakes coincide with zones of frequent weak shocks (sometimes only three months apart). For more complete understanding of the seismic zoning of the Tadzhik S. S. R. more seismic stations and more sensitive instruments are necessary.—*S. T. V., D. B. V.*

174–34. Tamrazyan, G. P. O seysmicheskoy aktivnosti severozapadnogo obramleniya Tikhogo Okeana [The seismic activity of the northwestern boundary of the Pacific Ocean]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 664–668, 1958.

Data obtained by Russian seismic stations in the period 1909–1944 on some 240 earthquakes which occurred in the zone extending along the western border of the

Pacific Ocean from the Aleutian Islands, the Kamchatka Peninsula, the Kurile Islands, Japan, the Phillipine Islands, New Guinea, and the Solomon Islands to western Indonesia are analyzed statistically. The foci of these earthquakes ranged from 50 to 800 km in depth. As in his previous studies (see Geophys. Abs. 172–29 and 173–38) Tamrazyan investigated the relationship between the occurrence of earthquakes and different cosmic factors, especially phases of the moon. The earthquakes are classified according to the phase of the moon during which they occurred; at least 40 percent more occurred during the new and full moon than during the rest of the lunar month, or considering only the earthquakes with focal depths of 80 to 350 km, about 66 percent more.—*S. T. V.*

174–35. Kishinouye, Fuyuhiko. A study of the Shōnai earthquake of 1894 (in Japanese with English abstract) : Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 2, p. 227–233, 1958.

The Shōnai, or Sakata, earthquake occurred on October 22, 1894, about 400 km north of Tokyo, Japan. Recently discovered data shows that the epicenter was near the fault on the northern bank of the Mogami River, but did not extend to the confluence with the Aka. Damage to wooden houses, plaster-walled warehouses, number of victims in each street in Sakata, and burned area are shown in maps; graphs show deformation revealed by precise levelings in 1901 and 1934, and daily frequency of aftershocks.—*D. B. V.*

174–36. Okada, Atsushi. Shiroishi earthquake of Sept. 30th, 1956, and precise levelling resurvey of its epicentral area, Miyagi Prefecture (in Japanese with English summary) : Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 1, p. 65–70, 1958.

The earthquake of September 30, 1956, in northeastern Japan had an intensity of 5 (JMA scale), magnitude of 6.1 (Gutenberg-Richter), and a felt area of 260 km maximum radius with the epicenter in Obara village, near Shiroishi. Vertical crustal deformation, determined by a relevelling survey of bench marks along a route running for 24 km through the epicentral area, was found to be a subsidence of less than 1 cm during 1954–1956. In most other inland earthquakes in Japan, movement in the epicentral area (except for alluvial subsidence) has been upward with or without faulting.—*D. B. V.*

174–37. Robbins, R. G. Direct effect of the 1855 earthquake on the vegetation of the Orongorongo Valley, Wellington: Royal Soc. New Zealand Trans., v. 85, pt. 2, p. 205–212, 1958.

This paper, mainly of botanical interest, describes the effects of the sudden and catastrophic damage to forest vegetation in the Orongorongo Valley, New Zealand, caused by landslips due to the Wellington earthquake of January 1855, effects that are still visible more than 100 yrs. later.—*D. B. V.*

174–38. Peronaci, Francesco. Studio microsismico del terremoto di Jenice del 18 Marzo 1953 [Microseismic study of the Yenice earthquake of March 18, 1953] : Annali Geofisica, v. 9, no. 4, p. 549–559, 1956; Il terremoto di Jenice del 18.3.1953 e le caratteristiche sismiche dell'Anatolia [The Yenice earthquake of March 18, 1953 and the seismic characteristics of Anatolia] : v. 10, no. 1–2, p. 97–103, 1957.

In the first paper the focal coordinates, origin time, and focal time, and focal depth of the Yenice, Anatolia, earthquake of March 18, 1953 are calculated,

from records of *Pn* at eleven European stations, as $\varphi_o=40°07'09''$ N $\pm 2'22''$, $\lambda_o=27°17'29''$ E $\pm 30'0''$, $t_o=19^h06^m12.3^s\pm 0.6^s$, and $h_o=5$ km. The probable traveltimes of the *Pn* and *Sn* phases at the base of the crust are also calculated as valid for a distance of about 3,000 km, as 8.17 and 4.40 kmps respectively.

In the second paper the most probable traveltimes of different phases are calculated as follows: *Pg*, 5.49 kmps; *Sg*, 3.02 kmps; $Px_1$, 7.93 kmps; $Px_2$, 7.60 kmps; $P^*_1$, 6.94 kmps; $P^*_2$, 6.30 kmps; $S^*_1$, 4.1 kmps. These results favor the existence of two distinct crustal layers under the granitic layer. Crustal thickness in the Balkan peninsula and northern Anatolia is calculated to be 58 km, with a granitic layer of 24 km and two basalt layers of 6 and 28 km.—*D. B. V.*

174–39. Housner, George W., and Outinen, Hannu. The effect of torsional oscillations on earthquake stresses: Seismol. Soc. Am. Bull., v. 48, no. 3, p. 221–229, 1958.

A comparison is made between the maximum stresses induced by earthquake-excited vibrations of an unsymmetrical structure and those induced in a symmetrical structure. These stresses are compared with the commonly used equivalent static method of analysis, and it is shown that the static method underestimates significantly the magnitude of the maximum stresses. Although the maximum stresses are quite sensitive to changes in the relative rigidity of the walls, an energy analysis of the vibration problem shows that the relative rigidities are not crucially important in determining the ultimate strength of the building.—*Authors' abstract*

174–40. Riznichenko, Yu. V. Metody massovogo opredeleniya koordinat ochagov blizkikh zemletryaseniy i skorostey seysmicheskikh voln v oblasti raspolozheniya ochagov [Methods of mass determination of the focal coordinates of near earthquakes and the velocities of seismic waves in areas where foci are located]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 425–437, 1958.

A new method is suggested for determining the coordinates of near earthquakes, which uses master charts of isochrones to determine the depth of focus. A similar procedure can be used to determine the velocities of the direct wave or of the refracted head wave. The method is based on the comparison of graphs of observed data and of theoretically computed data. The procedure was applied to the data obtained by the Tadzhik seismological expedition and proved to be accurate and less laborious.

The method suggested for determining the velocity profile (the so-called vertical traveltime curve method) gives more accurate values of the individual formation velocities, and thus more accurate data on the structure and the properties of the earth's crust in different areas.—*S. T. V.*

174–41. Kárník, Vít. Magnitudenbestimmung europäischer Nahbeben [Magnitude determination of European near earthquakes]: Československá Akad. Věd. Geofys. Ústav Práce, Geofys. Sborník, no. 47, p. 399–522, 1956 (1957).

Tables and graphs have been constructed for determining the magnitude of near earthquakes in Europe from the ratio $(A/T)_{max}$, using the records at Praha and other European stations for more than 1,000 near earthquakes that occurred in 1930 to 1953 at distances of $2°<\Delta°<30°$ and at normal depths ($h<50$ km). The formula $M=\log (A/T)_{max} - \log (B/T') + C$ was taken as

definitive, based on the wave having maximum speed of vibration ($T$= period of designated wave, $T'$= average period for which corresponding $B$ ($\Delta$) values were calculated; $T$ must $= T'$). Formulas were obtained for the relationship of the calibration value $B$ to period and to distance and for the absorption coefficient. The auxiliary value $B_0(T')$ was determined by two independent methods, and the final values were used to calculate tables and graphs of the value $B$ ($\Delta$, $T'$).

The magnitude $M$ of a near earthquake can be determined, with an accuracy of $\pm 0.25$ $M$, from these tables and graphs at any station whose constants are known. Higher accuracy is not possible at present due to insufficient knowledge of the relationship between $T$ and $M$ and between $B_0$ and $M$. The constants for Praha are investigated closely. An empirical formula is derived for correction for focal depths up to 150 km. Finally, in order to be able to classify historical earthquakes in central Europe according to their magnitude, an empirical relationship between maximum macroseismic intensity and $M$ is found.—*D. B. V.*

174–42. Kárník, Vít. Zur Magnitudenbestimmung der Nahbeben [On the determination of magnitude of near earthquakes]: Československá Akad, Věd Studia Geophys. et Geod., v. 1, no. 1, p. 88–94, 1957.

This is a shorter version of the paper that appeared in the "Geofysikální Sborník" of the Czechoslovakian Academy of Sciences for 1956 (see Geophys. Abs. 174–41).—*D. B. V.*

174–43. Di Filippo, D[omenico], and Marcelli, L. La "magnitudo unificata" per i terremoti a profondità normale e la "magnitudo" dei terremoti profondi per la stazione sismica di Roma [The "unified magnitude" for earthquakes at normal depth and the "magnitude" of deep earthquakes for the Rome seismic station]: Annali Geofisica, v. 10, no. 3–4, p. 247–261, 1957.

The formula $m=0.474\ M+3.590=M-\ 0.526(M-\ 6.822)$ has been worked out for the "unified magnitude" of earthquakes of normal depth registered at the Rome seismic station, combined from the separate equations for the *PH*, *PZ*, *PPH*, *PPZ*, and *SH* waves. Comparison of these unified magnitudes with Pasadena values for 58 earthquakes that occurred in 1949 and 1950 leads to determination of correction coefficients for earthquakes arriving at Rome from different directions: + 0.10 for the E-NNE (and opposite) sector, 0.00 for the NNE-NNW (and opposite) sector, and + 0.30 for the NNW-W (and opposite) sector. The data of 30 earthquakes in 1957 are tabulated, giving the corrected unified magnitudes.

In the second part of the paper, the magnitude of 64 deep earthquakes is determined from body waves using Gutenberg's formula. It is found that the station correction is the same except in the case of distant earthquakes at depths of more than 450 km originating in the E–NNE sector. An attempt to find a function linking the magnitude determined from body waves with that based on surface waves (with periods of about 20 sec) yields a curve which gives approximately the same correction for depths of 250 to 450 km, although for depths above and below this range the differences increase rapidly—*D. B. V.*

174–44. Nagamune, T[omeo], and Seki, A[kira]. Determination of earthquake magnitude from surface waves for Matsushiro Seismological Ob-

servatory and the relation between magnitude and energy: Geophys. Mag., v. 28, no. 3, p. 303–308, 1958.

Formulas are derived for determining magnitude $M$ of distant shallow earthquakes from measurement of the horizontal amplitude of Rayleigh waves of 20 to 30 sec period recorded at the Matsushiro Observatory in Japan: $M=\log A+1.32 \log \Delta+4.11$ for 30 sec period and $M=\log A+1.31 \log \Delta+4.28$ for 20 sec period, where $A$ is horizontal ground amplitude (total amplitude) in microns and $\Delta$ is epicentral distance in 1,000 km; these may be written in one form in terms of $A/T$, which is proportional to ground velocity: $M=\log (A/T)+1.31 \log \Delta+5.58$ where $T=30$ or 20 sec.

The energies of Rayleigh waves of 16 shallow earthquakes in the magnitude range 5.4 to 8.1 are computed and the formula for the relation between magnitude and Rayleigh wave energy $E_R$ is derived as $\log E_R=(1.98\pm0.074) M+(6.65\pm0.48)$. This is almost equal to the relationship obtained by Båth. If total energy is assumed to be twice the Rayleigh wave energy, $\log E=1.98 M+6.95$.—*D. B. V.*

174–45. Nagamune, Tomeo, and Seki, Akira. Determination of earthquake magnitudes from surface wave data at Matsushiro Seismological Observatory, and the relation between magnitude and energy (in Japanese with English abstract): Zisin, ser. 2, v. 10, no. 2, p. 79–85, 1957.

A Japanese version of the paper published in Geophys. Mag. v. 28, no. 3, 1958 (see Geophys. Abs. 174–44).—V. S. N.

174–46. Hudson, D. E., and Housner, G[eorge] W. An analysis of strong-motion accelerometer data from the San Francisco earthquake of March 22, 1957: Seismol. Soc. Am. Bull., v. 48, no. 3, p. 253–268, 1958.

The San Francisco earthquake of March 22, 1957, was recorded simultaneously by accelerometers at five United States Coast and Geodetic Survey stations in the San Francisco area. Response spectrum curves were computed from the acceleration-time records, and from these response spectrum curves the spectrum intensities have been determined. From these spectrum intensities certain conclusions are drawn as to: (1) the effects of local geology on the recorded ground motion; (2) the calculation of total energy released by the earthquake from strong-motion accelerometer records; (3) possible influence of structural dynamic behavior on the accelerations recorded in building basements, and the relationship between basement accelerations and ground accelerations; and (4) the applicability of a simplified type of strong-motion earthquake instrument for investigations of local distribution effects. A general comparison is made between the present earthquake and typical Pacific Coast earthquakes.—*Authors' abstract*

Contini, Camillo. Earthquakes, volcanoes and natural steam deposits. See Geophys. Abs. 174–218.

174–47. Kasahara, Keichi. The nature of seismic origins as inferred from seismological and geodetic observations (2): Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 1, p. 21–53, 1958.

The concluding part of Kasahara's paper on earthquake mechanism (see also Geophys. Abs. 172–41) begins with a mathematical discussion of wave genera-

tion from a fault plane. The seismological and geodetic aspects of earthquakes having been dealt with separately, a unified model is proposed for the origin of the Tango earthquake of March 7, 1927. This model is the sudden occurrence of a fault plane 30 km long and 15 km deep, striking N 30° W and dipping 90°, with stress change (shear) of $3 \times 10^7$ cgs on the fault plane. The model is examined and found to be acceptable, although some uncertainties still remain because of insufficient knowledge of vertical displacements and rapidity of fault displacement. As all the foregoing discussion is based on the assumption that the crust is subject to accumulation of strain large enough to cause large-scale fractures, the last chapter examines the possibility of strain accumulation in a visco-elastic crust and ends with a word on the desirability of continuous observations of crustal deformation in order to get information on strain accumulation and thus permit more reliable prediction of earthquakes.—D. B. V.

174–48. Keylis–Borok, V. I. The determination of earthquake mechanism, using both longitudinal and transverse waves: Annali Geofisica, v. 10, no. 1–2, p. 105–128, 1957.

A description of Keylis–Borok's method of fault plane solutions, which uses both longitudinal and transverse wave data. The principal properties of elastic waves caused by various sources are discussed first. The commonest mechanism, analyzed in detail, is the dipole with moment (symmetrical fault); nodal lines and correlation of signs are also shown for a simple force (very asymmetrical fault), dipole without moment, superposed dipoles with and without moment, superposed simple force on dipole with and on dipole without moment, double dipole with moment, and two dipoles with moment.

The solution includes the following steps: determination of intial motion (ground displacement components); reduction of observations to a homogenous medium (by eliminating the effect of discontinuities and deflections of a ray from a straight line, and plotting the initial observations on a Wulff stereographic net); the fault plane solution itself (by drawing nodal lines based on the signs of displacements and their correlation at each point, taking into account the amplitude ratio wherever possible), and finally estimation of accuracy of the interpretation. Each step is described fully. Use of the initial motion of *P*, *SV*, and *SH* phases considerably reduces the number of observations required and gives unambiguous results.

The Wulff projection used in the interpretation is described in detail in a supplement. (See also Geophys. Abs. 172–38 and 39.)—*D. B. V.*

174–49. Adams, William Mansfield. An improved method of determining direction of faulting in earthquakes: Accad. Sci. fis. e mat. Napoli, Rend., ser. 4, v. 24, p. 24–29, 1957.

An improved method of determining direction of faulting in earthquakes is described that plots two points for each station reporting the initial direction of *P*-wave motion. The graphical fitting procedure can then be made to twice as many points as in previous methods of analysis. This double projection method does not give greater accuracy because the nodal circles which fit the set of initial plots will necessarily fit the set of second plots, but it should make the graphical fitting easier. It is applicable to the focal methods which project from an end of the vertical diameter of the focal sphere. It does not matter which end of the vertical diameter is used as the two ends become equivalent in

practice; that is, the resulting projections will be similar. The method is applied to epicentral distances of 13°, 20°, and 78°, and to the earthquake of March 7, 1927.—*D. B. V.*

174–50. Adams, William Mansfield. A study of earthquake mechanism using *S* wave data: Seismol. Soc. Am. Bull., v. 48, no. 3, p. 201–219, 1958.

The purpose of this paper is to determine from the seismograms of a tectonic earthquake the line of the motion which generated the observed *S* waves (tectonically, the *A* axis). By noting certain geometrical relationships between the faulting motion and the emitted *S* waves, it is possible to derive a method which determines the line of the generating motion from observations of the generated *S* waves. The results of the application of the proposed method of *S* wave analysis should, theoretically, make it possible to determine which of the two solutions given by the *P* wave method of analyzing the tectonic mechanism of earthquakes is the correct solution. The proposed procedure is applied to data collected from the original seismograms of four earthquakes as recorded at seismic observatories throughout the world. There is such poor agreement between the *S* wave results and the previous *P* wave solutions that it is necessary to conclude that one or more of the following is true: either the mechanism assumed is not the type actually occurring; the phase identified as the *S* wave does not correspond to the first *P* wave motion; the *P* wave method is incorrect or inadequate; or the *S* wave method is incorrect or inadequate. To select among the various possibilities necessitates a discussion of the relative merits, defects, and potentialities of the two methods.—*Author's abstract*

174–51. Yanovskaya, T. B. Ob opredelenii dinamicheskikh parametrov ochaga zemletryaseniya po zapisyam poverkhnostnykh voln, I [The determination of the dynamic parameters of the focus of an earthquake from seismograms of the surface waves. Part 1]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 289–301, 1958.

Using the Keylis-Borok method, Yanovskaya determines the amplitudes of the Rayleigh and Love waves propagating in a layer overlying an elastic semispace. The waves are produced by a steady concentrated source within the stratum, consisting of a dipole with moment. The paper is purely mathematical. The formulas obtained as well as the results of observations will be discussed in the second part of the study.—*S. T. V.*

174–52. Hodgson, John H., and Cock, J. Irma. Direction of faulting in some of the larger earthquakes of 1954–1955: Dominion Observatory Ottawa Pubs., v. 19, no. 6, p. 223–258, 1958.

Fault plane solutions are presented for twenty-three of the larger earthquakes of 1954–1955. Solutions are based on data from *P* and *PKP* only as the data from the reflected phases were found to be inconsistent.—*V. S. N.*

174–53. Di Filippo, D[omenico], and Marcelli, L. La natura fisica all'ipocentro del terremoto profondissimo dell'Argentina settentrionale (14 agosto 1950) [The physical nature at the focus of the very deep earthquake in northern Argentina (August 14, 1950)]: Annali Geofisica, v. 10, no. 3–4, p. 221–234, 1957.

A detailed analysis of the records from 23 stations of the deep earthquake of August 14, 1950, in Argentina (magnitude 7¼) establishes the focus at

$\varphi_o$=26°42′42.13″±4′12.34″. $\lambda_o$=−62°41′19″±5′57.25″, focal time as $22^h51^m32.16^s\pm1.16^s$, and focal depth as 662.4±16 km. Analysis of the initial motion at 52 stations leads to the conclusion that the focal mechanism was movement on a fracture oriented N 60°26′ W, almost in line with the San Andreas fault. The inclinations of the two planes with respect to the earth's radius passing through the focus are 8°15′ and 12°31′ respectively, and the intersection of these two planes is inclined 14°30′ with respect to the same radius.—*D. B. V.*

174–54. Hodgson, J[ohn] H., and Cock, J. Irma. Direction of faulting in the Greek earthquakes of August 9–13, 1953: Annales géol. des Pays helléniques, ser. 1, v. 8, p. 29–47, 1957.

The direction of faulting is determined for eight earthquakes of the sequence which damaged the Ionian Islands in August, 1953. The solutions obtained suggest that faulting occurred either on a plane striking NNW–SSE or on a plane striking ENE–WSW. Field evidence collected by Galanopoulos [see Geophys. Abs. 171–57, 58] suggests that in fact faulting occurred on both these planes which constitute a conjugate system of faulting. The agreement between the solutions and the field evidence is satisfactory.—*Author's abstract*

174–55. Jeffreys, Harold. The times of *P* up to 30° (second paper): Royal Astron, Soc. Geophys. Jour., v. 1, no. 2, p. 154–161, 1958.

A new set of earthquakes is studied to check the times of *P* in European earthquakes up to 30°, and especially the behaviour near 20°. The corrections to the author's table of 1939 agree closely with those found from an earlier set in 1935. Lehmann's observations of *Pd* are consistent with her interpretation if *Pr* overtakes *Pd* at about 14°, but in any case $dt/d\triangle$ for *Pd* is remarkaby constant. It seems probable that there is triplication and that the observations refer to a neighborhood of the more distant cusp on the time curve. No useful new data were available for the Japanese region. Several earthquakes in North and Central America showed that from 8° to 30° the 1939 table is correct to a fraction of a second apart from a possible additive constant. Additional information on the times at distances under 8° was given by a paper of Lehmann. The data in this indicate that the European velocity is nearly correct for North America, but that, relative to 5°, the times from 8° to 30° for American earthquakes are about 2 *s* shorter than for European ones.—*Author's summary.*

174–56. Gutenberg, B[eno]. Attenuation of seismic waves in the earth's mantle: Seismol. Soc. Am. Bull., v. 48, no. 3, p. 269–282, 1958.

Contrasting with conclusions from laboratory experiments that the absorption coefficient $k$ for amplitudes of elastic waves is proportional to $1/T$, or, from theoretical considerations, that it should be proportional to $1/T$ or $1/T^2$ observations of body waves through the mantle of the earth show little if any decrease in absorption with increasing period $T$. In teleseismic records *S* rarely shows periods of less than 4 seconds, while in *P* periods of 1 second are observed to the greatest distances. The value $k$=0.06 per 1,000 km, found previously for *P*, *P′P′* and *P′P′P′* through the mantle and the core, is confirmed for *P* and *PP* and is found also for *S* in the mantle.—Author's abstract

174–57. Båth, Markus. Some consequences of the existence of low-velocity layers: Annali Geofisica, v. 9, no. 4, p. 411–450, 1956.

Some problems are outlined for whose solution the low-velocity layers are of decisive importance. The physico-chemical properties obtained as consequences of the assumption of a low-velocity layer in the asthenosphere are calculated and tabulated; incompressibility and rigidity are particularly dependent on temperature and pressure. A new channel wave $L_1$ is described, having a velocity of 3.8 kmps and propagating in the intermediate layer over continental paths only. Various calculations, especially of energies, lead to a revised model for channel-wave propagation in the continental crust.

New evidence is given for the shadow zone corresponding to the asthenosphere low-velocity layer for *P*-waves, based on comparison of Uppsala and Stuttgart records; the importance of such shadow zones in determination of magnitude and focal depth is emphasized, and the possibility of detecting such zones from macroseismic observations is mentioned. The existence of channels in the continental crust may be important in the distribution of microseisms. It is proposed that amplitude measurements be made in refraction shooting in an effort to discover the shadow zones corresponding to low-velocity layers in the lithosphere.—*D. B. V.*

Ruprechtová, Libuše. The 20° discontinuity and the traveltime curves of *P* and *S* for Praha in the range 10°–30°. See Geophys. Abs. 174–231.

174–58. Gutenberg, B[eno]. Spectrum of *P* and *S* in records of distant earthquakes: Zeitschr. Geophysik, v. 23, no. 6, p. 316–319, 1957.

Peaks in the energy spectrum in *P*-, *PP*-, and *S*-waves from distant earthquakes have been investigated using records written by different instruments at Pasadena during the second half of 1957. Values of amplitude-period ratios ($a/T$) have been plotted. Values of $a/T$ found for different periods in the same shock are indicated by the same symbol and connected, but these lines do not indicate a gradual change of $a/T$ with $T$; actually several separate periods prevail strongly in each instance.

The results indicate that at epicentral distances greater than 2,000 km the energy in *P*-, *PP*-, and *S*-waves is carried by a few superposed wavelets with distinctly different periods which usually are greater for *S* than for *P*. This may result from processes at the source, from attenuation in the crust and upper mantle, and from other processes concentrating the energy near certain periods during propagation. Whereas *P* wavelets with periods longer than 10 sec usually do not carry as much energy as the largest wavelets with periods of a few sec, there are usually several *S* wavelets with periods of 4 to 20 ± sec with about equal energy content. In determining magnitude of a given earthquake from body waves, only *P*-waves with periods of less than 10 sec should be used; periods of 2 to 12 sec for *PP* and 4 to 20 sec for *S* may be taken. This is usually done in fact, as most stations lack instruments with long-period characteristics.—*D. B. V.*

174–59. Martin, Hans. Wellenfrontverfahren und Einsätze des Neuseelandbebens vom 1.8.1942 [Wave front behavior and onsets of the New Zealand earthquake of August 1, 1942]: Československá Akad. Věd. Studia Geophys. et Geod., v. 1, no. 2, p. 377–379, 1957.

The course of the $P_1'$, $P_2'$ and *PP* wave fronts from the New Zealand earthquake of August 1, 1942, is worked out by analysis of their arrivals at ten European stations.—*D. B. V.*

174–60. Deist, H. J., and Dohr, G[erhard]. Untersuchungen über Perioden von Erdbebenwellen in Abhängigkeit von Herdgebiet und Herdentfernung [Investigations of the dependence of periods of earthquake waves on epicentral region and epicentral distance]: Zeitschr. Geophysik, v. 23, no. 1, p. 34–40, 1957.

The importance of examining the periods of earthquake waves to understand processes at the focus is emphasized. Records of 128 earthquakes at distances of 18° to 27° (2,000 to 3,000 km) are analyzed. They can be classified into regional groups objectively by means of a "structure element" of the curve. The maximums appearing in the vertical component seismograms in the first two minutes after the arrival were counted and averaged within each group. The dependence of this average value ($L$) on region is clear; the "Mediterranean" and "Asia Minor" groups are about the same distance from the Hamburg station but the value of $L$ for the "Mediterranean" group is 37.8 ± 1.0, outside the limit of error for the "Asia Minor" group.

The records can differ in other ways; the form of the onsets, the amplitude ratios, and the part of the wave train following the first two minutes are also characteristic of individual regions. The effect of distance on the spectra of periods is examined, on the basis of maximum waves at a single station. It is shown that $T = a + bt^1/_n$ where $T$ = period, $t$ = travel time, $a$ and $b$ are constants. The exponent $1/n$ is proportional to the mean velocity of the layers traversed.—*D. B. V.*

174–61. Satō, Yasuo. Attenuation, dispersion, and the wave guide of the G wave: Seismol. Soc. Am. Bull., v. 48, no. 3, p. 231–251, 1958.

Using the strain seismograms of the New Guinea earthquake of 1938 and Kamchatka earthquake of 1952, the decrement of the $G$ wave in the mantle was determined from comparison of the amplitude of Fourier components, obtained by analyzing the $G$ phases at different epicentral distances. The values of $1/Q$ thus obtained are plotted as a function of frequency or period; they are somewhat larger than those found by Ewing and Press using mantle Rayleigh waves (see Geophys. Abs. 158–137). Dispersion curves obtained from ($G_1$ and $G_3$), ($G_2$ and $G_4$) of the New Guinea earthquake and ($G_1$ and $G_3$) of the Kamchatka earthquake agree quite well, giving a nearly constant group velocity of 4.4 kmps as anticipated. The wave guide and shear velocity of the $G$ wave are calculated by applying Takahashi's method (see Geophys. Abs. 165–91) to the dispersion curve derived from the condition of constant group velocity, which is a direct consequence of the fact that the $G$ wave shows almost no dispersion. The theoretically derived curve of $V_s(z)/V_o$ where $V_s(z)$=shear velocity at depth, $z$, $V_o=V_s(O)$, agrees well with that given by the Jeffreys-Bullen distribution of shear velocity in the range between one and several hundred km.—*D. B. V.*

174–62. Kizawa, Takashi. On surface waves propagated through the Pacific bottom and the continent: Geophys. Mag., v. 28, no. 3, p. 261–272, 1958.

The geographic location of the Japanese seismological network makes it possible to compare crustal structure under the Pacific Ocean and under Asia by study of seismograms of earthquakes in, for instance, Chile and Turkey. In the case of the Chilean earthquake of January 25, 1939, many Japanese stations ($149° < \Delta < 164°$) recorded an extremely clear Rayleigh wave that

appeared in place of the expected Love wave, about two minutes ahead of the *L*-phase of Macelwane's table. Means of values observed at 23 stations were: velocity of Rayleigh wave = 4.0 kmps, its period = 33.7 sec., velocity of $W_2$ wave = 3.8 kmps, its period = 25.7 sec., absorption coefficient $K = 0.00029$, travel time around glove = $2^h51^m20^s$. The surface wave recorded for the Anatolia earthquake of December 27, 1939, was not as clear; it arrived about three or four minutes behind Macelwane's *L*-phase and its initial stage showed vibrational features of a Love wave. The differences between the two sets of observations indicate differences between the oceanic and continental crust.—*D. B. V.*

174–63. Schulz, R[udolf], and Berckhemer, H[ans]. Observaciones sobre ondas superficiales extremadamente lentas y de largo periodo registradas en San Salvador in el temblor de corta distancia del 11 de septiembre de 1956, ocurrido frente a la costa de Guatemala [Observations of extremely slow and long-period surface waves registered in San Salvador in the near earthquake of September 11, 1956, that occurred off the coast of Guatemala]: Servicio geol. nac. El Salvador Bol. sismol., v. 3, p. 34–38, 1957 (1958).

The epicenter of the earthquake of September 11, 1956, was on the south slope of the submarine trough off the Pacific coast of Central America, about 250 km from the San Salvador station. The *S*-phase and surface waves recorded there showed long periods like those of continental earthquakes at similar distance; the group velocity of the surface waves was extremly low, and dispersion was great. Perfect surface waves of 18 sec period were observed. The low velocity may be due to the effect of the water layer. Calculations of the Love wave dispersion (as caused by a cap of sediment 2.7 km thick having an *S*-wave velocity of 0.9 kmps, overlying a sedimentary layer of 2.0 kmps velocity) gives results compatible with the observations, especially in the period range $T$=8 to 14 sec. The more complicated calculations for Rayleigh waves were not made. The fact that large period surface waves could be observed at such a short epicentral distance is attributed to the extraordinary conditions of dispersion.—*D. B. V.*

174–64. Tobyáš, Vladimír. Seismic equipment for the investigation of microtremors: Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 1, p. 101–105, 1957.

A description of the seismic equipment used in investigation of microtremors in the Komárno basin (see Geophys. Abs. 174–18). Each of the four mobile stations was provided with a vertical electrodynamic seismograph and recording apparatus equipped to receive time signals, and one of the stations had in addition an ultra-shortwave transmitter of time signals.—*D. B. V.*

174–65. Strobach, K[laus]. Stereoskopische Vektorregistrierung [Stereoscopic vector registration]: Zeitschr. Geophysik, v. 23, no. 6, p. 306–315, 1957.

Strobach's horizontal vector seismograph has been supplemented by a vertical seismograph having the same constants; by means of a simple optical arrangement, seismic ground movements can now be recorded stereoscopically on intermittently moved film. Not only can the orbits of ground particles be seen directly in three dimensions, but they can be measured by means of a comparator. The apparatus will be used mainly to study the particle motion of microseisms, which

is very complex judging from records of microseismic storms. Normal continuous recording hardly indicates the changes of direction of motion, indicating new wave onsets, that often occur.—*D. B. V.*

174–66. Matumoto, Tosimatu. Calibration of an electromagnetic seismograph by means of the frequency analysis: Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 1, p. 55–64, 1958.

The tapping test method for obtaining the response curve of an electromagnetic seismograph by the application of the theory of frequency analysis is described in this paper.

A slight tapping is applied to the pendulum, and the motion of the pendulum and the galvanometer activated by it are recorded at the same time. The spectra of both the recorded motions are calculated, and then the magnification, the frequency characteristics and the phase angle of the electromagnetic seismograph are reckoned.

This method enables us to get the response curve for both the amplitude and phase angle for all frequency ranges and for all kinds of electromagnetic seismographs having arbitrary damping and arbitrary period both for the galvanometer and the pendulum without any shaking table or another special apparatus. This simple method with a high accuracy good enough for ordinary purposes would be very useful for the calibration of the electromagnetic seismograph in field work as well as in routine work.—*Author's abstract*

174–67. Kamamoto, H. Study on the conical pendulum governor for seismograph (Report 1) (in Japanese with English summary): Quart. Jour. Seismology, v. 21, no. 4, p. 7–13, 1957; Report 2: ibid., v. 22, no. 4, p. 1–8, 1958.

The action of two types of conical pendulum seismograph governors is compared mathematically with that of the pulse-regulating governor; the latter is found to be simplest and most accurate.—*D. B. V.*

174–68. Koridalin, E. A. Seysmologiya v Kitayskoy Narodnoy Respublike [Seismology in the Chinese People's Republic]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 3–9, 1957.

Instrumental seismological observations in China began with the founding of the first station in Shanghai in 1904; it is now equipped with a vertical Golitsyn, two horizontal Golitsyn-Vilip, and a 1,200-kg Wiechert horizontal seismograph. Another station established near Peking in 1930 was destroyed during the war, but the one established at Nanking in 1931 has been operating with little interruption; it is equipped with Golitsyn-Vilip vertical and horizontal instruments and Wiechert 17-ton horizontal and 1,300-kg vertical seismographs. In 1954–1955, 22 new stations were organized, mainly in the upper and middle reaches of the Khuan-Khe valley, and are being equipped with mechanically-recording horizontal instruments; 18 more stations are planned for the near future, which will record both distant and near earthquakes. Present work is concentrated in the Geophysical Institute of the republic's Academy of Sciences, consists of study of seismic waves, preparation and analysis of observations, development of new apparatus, and study and coordination of macroseismic data. A monthly bulletin of seismic data is circulated within the country.—*D. B. V.*

## EARTH TIDES AND RELATED PHENOMENA

174–69. Melchior, Paul J. Rapport sur les marées terrestres [Report on earth tides] : Bull. géod., no. 46, p. 28–52, 1957.

A summary of the results of research on earth tides currently being carried on in different countries, including values obtained by different workers for Love's numbers $h$ and $k$, deflection of the vertical ($\gamma=1+k-h$), and the effect of earth tides on speed of rotation. Bibliography of 63 items.—*D. B. V.*

174–70. Pícha, Jan. Gezeitenbeobachtungen in Březové Hory aus den Jahren 1926–1928 [Tidal observations in Březové Hory in the years 1926–1928] : Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 64, p. 281–345, 1957 (1958).

The complete results of earth tide observations 1,000 m underground in the Březové Hory mine (Přibram, Czechoslovakia) in 1926–1928 are tabulated. Analysis of these and observations elsewhere (see Geophys. Abs. 169–73) shows that at the depth in question there is a tilt having one-year period, already noted in analysis of the observations made in 1936–1939 (see Geophys. Abs. 174–71). Also noted was an interesting displacement of the zero point of both pendulums, which will be treated in a later paper.—*D. B. V.*

174–71. Pícha, Jan. Ergebnisse der Gezeitenbeobachtungen der festen Erdkruste in Březové Hory in den Jahren 1936–1939 [Results of observations of tides of the solid earth in Brežové Hory in the years 1936–1939] : Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 42, p. 95–311, 1956 (1957).

Earth tide observations were made with horizontal pendulums in the deep Březové Hory mine (Přibram) from 1936 to 1939. The station, its instruments and the methods of analysis of the data are described in some detail. The records obtained were of such quality that seven tidal terms ($M_2$, $S_2$, $K_2$, $N$, $K_1$, $O$, and $P$) as well as the $S_1$ term could be distinguished by means of harmonic analysis. The results of independent harmonic analyses using the Darwin and Börgen methods correspond so closely that there is no doubt as to the validity of the calculated values. Comparison of the calculated values with those required theoretically for earth tides shows good agreement with the results published by different authors. Both methods of analysis give a mean value of $\gamma=0.66$ for the east-west component of all tidal terms and both methods give a value of $\gamma=0.71$ for the main moon term $M_2$. From these values the mean modulus of torsion of the earth is calculated to be $\bar{u}=11.3 \times 10^{11}$ to $12.6 \times 10^{11}$ dyn per cm$^{-2}$. From the values for the $M_2$ term it is shown that $\gamma_n > \gamma_e$, indicating that the torsion modulus is smaller in the north-south direction than in the east-west; conclusions regarding the dependence of torsion modulus on azimuth and local conditions during observations will be possible when sufficient observational data are available from different parts of the earth.

Further results of this work were the establishment of tilts with periods of about a year and irregular tilts of several days duration. Whether these movements are local in nature or general can only be determined by further work. A bibliography of 77 items and a 156-page complete tabulation of the observational data conclude the paper.—*D. B. V.*

## ELASTICITY

174–72. Chopra, S. D. On the equivalence of saddle point approximations and ray theory in elastic wave problems: Royal Astron. Soc. Geophys. Jour., v. 1, no. 2, p. 164–179, 1958.

In the Bromwich method, solutions of elastic wave problems for stratified media are expanded in negative powers of exponentials. In an example it is shown that the saddle point evaluation of the various terms of a Bromwich expansion, by the method of steepest descents, leads to exactly the same expressions for the displacements in the reflected and refracted waves as are obtained by the ray theory of geometrical optics. The example is that of elastic waves produced by a harmonic point source of dilatational waves situated in the middle of a stratum bounded above and below by half spaces with identical elastic properties. The principle is generally true and the method is applicable to a variety of similar problems.—*R. G. H.*

174–73. Pekeris, C. L., and Longman, I. M. The motion of the surface of a uniform elastic half-space produced by a buried torque-pulse: Royal Astron. Soc. Geophys. Jour., v. 1, no. 2, p. 146–153, 1958.

In this investigation we determine the motion of the surface of a uniform elastic half-space produced by the application of a torque-pulse at a point below the surface. The axis of the torque is taken to be parallel to the surface and its time variation is assumed to be represented by the Heaviside unit function $H(t)$. Our results are compared with those of Pinney (1954) [see Geophys. Abs. 160–72], who treated the same problem by a different method. The principal feature of physical interest which we found is that, for ranges where the direct $S$ wave is preceded by a diffracted $SP$ wave, the displacement at the surface starts with an infinite amplitude at the time of arrival of the $SP$ wave, and that this is followed by an even stronger infinity at the time of arrival of the $S$ wave. Also, for small ranges, for which there is no $SP$ wave, the displacement starts with a sharp pulse in the form of a Dirac delta function. None of these features was brought out by Pinney's curves. The results are shown [in graphs].—*Authors' summary.*

174–74. Pěč, Karel. The mixed external boundary value problem for a sphere: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 45, p. 367–382, 1956 (1957).

This paper presents a mathematical solution of the mixed external boundary value problem for a sphere which is surrounded by an infinite homogeneous, isotropic, perfectly elastic medium, to whose surface is applied a combination of elastic displacement and stress, both radial and tangential, as an arbitrary function of time. In the case of radial displacements and stresses the theory can be used to study the propagation of elastic shock body waves produced by an explosion. The first boundary value problem and the question of the complicated decrease in amplitude with distance from the source are dealt with in particular detail.

In the case of tangential stresses the theory can be regarded as the first approximation of the solution of the problem of the propagation and shape of seismic body waves produced at the focus, for the most part free of shear stresses. In the case of shear stresses the question of decrease in amplitude with distance

is simpler; it is inversely proportional to distance from the source and is not at all affected by the exciting mechanism.—*D. B. V.*

174–75. Rosler, R. Betrachtungen zu den Spannungs-Dehnungs-Beiziehungen nach Nakamura [Considerations of the stress–strain relationships of Nakamura]: Gerlands Beitr. Geophysik, v. 67, no. 1, p. 31–48, 1958.

Using Nakamura's stress-strain relationships, the effects of apparent visco-elasticity on the propagation of plane elastic waves are discussed. These effects include anomalous dispersion and the existence of a finite depth of penetration. Perfect elastic behavior is rapidly approached as the frequency is increased. Two load tests are described for determining the constants in Nakamura's equation.—*L. P.*

174–76. Förtsch, O[tto]. Die Ursachen der Absorption elastischer Wellen [The causes of absorption of elastic waves]: Annali Geofisica, v. 9, no. 4, p. 469–524, 1956.

On the basis of published results of experiments on elastic wave absorption and damping of elastic vibrations in rocks and other solid bodies, it is concluded that elastic wave velocity is not affected by absorption; velocity does not depend on frequency; the maximum amplitude of a stationary sinusoidal wave train decreases exponentially with distance; and the coefficient of absorption relative to group wave length is independent of frequency and must be the same numerically for all types of waves.

Theories developed to explain the physical nature of elastic wave absorption are reviewed. The theory that best fits the observed facts is the Coulomb-friction theory suggested by Born (see Geophys. Abs. 106–6154) and developed by Förtsch (see Geophys. Abs. 159–126). In this theory, frictional forces proportional to the absolute value of all acting forces are added to the elastic forces in establishing the relationship for elastic equilibrium; the proportionality factor is called the friction coefficient; only the amounts of normal and tangential stresses caused by wave propagation are of importance for elastic wave absorption. Every half wavelength, the Coulomb-friction forces undergo a discontinuous change of sign; that sign which allows the friction forces to withdraw energy from the elastic waves is always found. The apparent increase of period in pulse-like elastic shocks, often explained on the basis of visco-elastic behavior, can also be explained by Coulomb friction.—*D. B. V.*

174–77. Karus, Ye. V. Pogloshcheniye uprugikh kolebaniy v gornykh porodakh pri statsionarnom vozbuzhdenii [The absorption of elastic vibrations in rocks in the case of a steady stimulation]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 438–448, 1958.

An experimental study was made of the absorption of elastic waves in different rocks, using the seismo-acoustic method described in a previous study (see Geophys. Abs. 160–75). In general the amplitude of the wave propagating through a visco-elastic medium from a source of steady vibrations is related to other physical parameters by the equation

$$A = A_o(x/x_o)^{-n}e^{-k(x-x_o)}$$

where $A_o$ is amplitude at a point at distance $x_o$ from the source of vibrations, $A$ the amplitude at another point at distance $x$; $n$ is a constant determining the character of dispersion of the wave, and the exponential member $k$ characterizes the variation of the amplitude caused by the decrease of the elastic energy due

to its partial transformation into other forms. There are two physical theories explaining the process mathematically controlled by this equation. One of these attributes the loss of elastic energy to friction of the particles against one another, the second explains it by a kind of elastic hysteresis and elastic after-effect. Numerous data on mechanical properties of different rocks and on their variation with frequency are given. Some of the data obtained do not agree with the results of other scientists. The data on elastic properties of rocks often show discrepancies between experimenters, some of them proving the first, others the second of the theories mentioned above.—*S. T. V.*

174–78. Laval, J. L'énergie potentielle et l'élasticité du milieu cristallin [The potential energy and elasticity of the crystalline medium]: Soc. française minéralogie et cristallographie Bull., v. 80, no. 1–3, p. 18–31, 1957.

Recent works have shown that the potential energy of a crystal cannot be analyzed in biatomic terms (expressing the mutual potential energy taken by two atoms in each other's field of forces). At least triatomic terms that are not negligible are included. The theory of crystalline elasticity has been reworked taking these new data into account. The results obtained do not agree with the conclusions of the classical theory (Voigt). Coefficients of elasticity are found whose symmetry is lower than that of Voigt's coefficients, which are of two kinds, the one related to elastic waves, the other to static deformations. The classical theory corresponds to a central force field. The structure of a crystalline medium precludes such a field.—*Author's summary, D. B. V.*

174–79. Červený, Vlastislav. The reflection of spherical elastic waves at a plane boundary: Československá Akad. Věd. Geofys. Ústav Práce, Geofys. Sbornik, no. 44, p. 343–366, 1956 (1957).

The paper gives a theoretical analysis of the reflection of a spherical wave from a plane boundary. On the basis of the reflection and refraction of plane waves, potentials of the individual waves produced are derived in an approximation of geometrical seismics which assumes a zero wave length. By more accurate calculations which were carried out by expanding the spherical waves into plane waves, these results were extended to the case of an arbitrary wave length. On the one hand we rendered the formula for the potentials of reflected waves more accurate and on the other hand we obtained a formula for the potentials of new types of waves, unknown to geometrical seismics. The most important of these are head waves.

An interpretation of these results for the needs of theoretical and applied seismics will be published later.—*Author's conclusion*

174–80. Bartholomeusz, E. F. The reflexion of long waves at a step: Cambridge Philos. Soc. Proc., v. 54, pt. 1, p. 106–118, 1958.

A train of long waves travelling along a canal of depth $h_2$ encounters a vertical step at which the depth changes to $h_1$. The wave-length is much greater than $h_1$ or $h_2$. The classical Long-Wave theory where vertical acceleration is neglected is clearly inapplicable, although a treatment has been given by Lamb. In the present paper the problem is treated rigorously by the linearized theory of surface waves. A singular Fredholm integral equation of the first kind is obtained for the horizontal velocity above the step and is converted into a

regular equation of the second kind with a kernel which tends to zero as the wave-length tends to infinity. To achieve this we first take the formal limit $\lambda = \infty$ in the integral equation of the first kind. This corresponds to a fluid motion between rigid boundaries which can be solved explicitly by a conformal transformation. In this way we obtain the inverse operator corresponding to $\lambda = \infty$, which is then applied to the original equation where $\lambda = \infty$. An equation of the second kind results which has a kernel tending to zero as $\lambda$ tends to infinity and which is soluble by iteration for large $\lambda$. Although the Long-Wave method of Lamb fails to describe the details of the motion correctly, his predicted relexion coefficient appears as a first approximation.—*Author's abstract*

174–81. Aoki, Harumi. Multiple reflection of a plane wave (in Japanese with English abstract) : Zisin, ser. 2, v. 10, no. 2, p. 97–105, 1957.

Wave noises or coda part of seismic waves may be interpreted as composed of single or multiple reflection waves as well as of dispersive or induced surface waves. Sometimes reflection waves observed on seismograms are due to various composite reflections caused by a set of closely spaced reflecting surfaces. Here we assume that the wave medium consists alternately of two kinds of elastic layers whose thickness is such that the wave travelling time through each layer is just the same. Since this is a kind of regular system, it may represent the case of largest effect of multiple reflections. The results obtained theoretically in this paper are as follows: 1) Reflections of higher order cannot be neglected. 2) In our rough estimation, the general appearance of resulting waves is determined by the value "$Na$", where $N$ is the number of layers between the source and the receiving point, "$a$" is a constant relating to the reflecting factor "$k$" $(a)=k^2/1-k^2)$. 3) The attenuation and reverberation of waves and elongation of wave length are noticed in some cases, but their characters are much too complicated to be expressed in a simple formula. 4) The wave reverberation is remarkably reduced for long waves and a very long wave (the wave length more than eight times of the thickness of a layer) travels as if it were propagated through a homogeneous medium, though there can be seen some slight change in its wave form.—*Author's abstract*

174–82. Červený, Vlastislav. Ob amplitudakh prelomlennykh voln [On the amplitudes of refracted waves (with English summary)] : Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 2, p. 256–284, 1957.

Study of the amplitudes of head waves $P_{121}$ produced by incidence of a harmonic longitudinal wave on a plane boundary shows that amplitudes vary as a function of distance from the source, of depth of the boundary, of frequency, of ratio of longitudinal wave velocities $(a_1/a/_2=n_2)$, of ratio of densities $\rho_2/\rho_1$, and partly also of the Poisson constants $\sigma_1$ and $\sigma_2$. Each of these conditions is treated mathematically in some detail. Amplitude is shown to decrease with increasing distance and with increasing frequency; it increases with depth in a medium without absorption, but in a medium with absorption is increases with depth in certain circumstances, decreases in others. For a given distance, depth, and frequency the ampltiude will be greater as the ratio of longitudinal wave velocities $n_2$ approaches unity; it increases with decreasing Poisson constants and with increase of velocity in the first medium. For $n_2$ close to zero the amplitude decreases with density, and for $n_2$ close to unity the amplitude is a maximum for density=1.—*D. B. V.*

174–83. Parkhomenko, I. S. Izucheniye na modelyakh prokhozhdeniya golovnoy volny cherez sloy s povyshennoy skorost'yu [Model study of the propagation of a head wave through high-velocity layer]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 196–209, 1958.

Using three-dimensional solid-liquid models in his experiments, Parkhomenko presents the results of research on the form of a refracted head wave, and the magnitude of seismic diffraction displacement as measured with the impulse-ultrasonic seismoscope *BI*–4. Both the form of the head wave and the magnitude of the displacement depend upon the ratio of the layer thickness d to the length $\lambda$ of the wave passing through a layer of higher velocity. The cases of wave incidence are considered for angles smaller than and greater than the critical angle for longitudinal waves. It was found that the form of the wave changes as it traverses the layer: it undergoes a distortion and a restoration as the ratio $d/\lambda$ changes from 0.04 to 2. The magnitude of the diffraction displacement becomes greater when the angle of incidence approaches its critical value. The results of the experiment confirm qualitatively the theoretical propagation of seismic waves through layers.—*S. T. V., A. J. S.*

174–84. Parkhomenko, I. S. Izucheniye na modelyakh intensivnosti golovnoy volny pri eye prokhozhdenii cherez sloy s povyshennoy skorost'yu [Model study of the intensity of a head wave passing through a high-velocity layer]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 449–457, 1958.

Continuing the study of the propagation of refracted head waves, the variation in intensity of the refracted head wave for the case when a wave meets a layer of higher velocity has been investigated.

The set-up of the experiments has been described in a previous paper (see Geophys. Abs. 174–83). It was found that in the case of a sufficiently thin layer the head wave decreases for all angles of incidence. The amplitude decreases as the ratio of layer thickness to wave length ($d/\lambda$) increases to 0.2–0.3. At higher values of $d/\lambda$ the intensity decreases somewhat; the decrease in intensity is greater when the medium of the intermediate layer offers more resistance to the propagation of the seismic wave. Theoretically computed values of the amplitudes in the intermediate layer agreed well with the experimental results only for angles of incidence ($\theta$) equal to or smaller than the critical angle ($\theta p$); for $\theta$ greater than $\theta p$ agreement was found only for very small thicknesses.—*S. T. V.*

174–85. Pěč, Karel. Les ondes du type de Rayleigh dans une couche interne (deuxième partie) [Waves of the Rayleigh type in an internal layer (second part)]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 46, p. 383–397, 1956 (1957).

This paper extends the work of the first part (in which expressions were derived for elastic displacements, and the conditions of existence deduced for Rayleigh waves propagating in a layer between two semispaces—see Geophys. Abs. 171–99) to mathematical consideration of the propagation of Rayleigh waves in a medium consisting of a semispace and two plane parallel beds. The theory of Rayleigh wave dispersion can be used, like that of Love waves, for determining thicknesses of crustal layers.—*D. B. V.*

174–86. Kobayashi, Naota, and Tsunekawa, Junkichi. Range of existence of the Rayleigh type dispersive wave (in Japanese with English summary) : Zisin, ser. 2, v. 11, no. 1, p. 29–34, 1958.

The Rayleigh wave propagated along the surface of the superficial layer on a semi-infinite elastic solid is composed of two dispersive wave groups, with each group having an infinite number of branch waves ($M_{11}$, $M_{12}$, $M_{13}$ . . . for one group and $M_{21}$, $M_{22}$, $M_{23}$ . . . for the other). In this paper the possible range of wavelength for a given phase velocity has been studied for some of the higher branches. It was found that any higher branch wave can exist when $\lambda' = \mu'$, $\lambda = \mu$, and $\rho = \rho'$ but the higher the branch, the narrower its range of existence.—*V. S. N.*

174–87. Tazime, Kyozi. Amplitude-distribution of Love-waves in double layers (in Japanese with English summary) : Zisin, ser. 2, v. 11, no. 1, p. 20–28, 1958.

The forms of amplitude distribution and relative sizes of amplitude corresponding to respective phases are discussed. The amplitude maximum is fairly sharp near the surface of the earth but rather blunt at great depths. Amplitude characteristics at various depths within the layers are illustrated.—*V. S. N.*

174–88. Wyllie, M. R. J., Gregory, A. R., and Gardner, G. H. F. An experimental investigation of factors affecting elastic wave velocities in porous media : Geophysics, v. 23, no. 3, p. 459–493, 1958.

Factors affecting the vibratory signals in porous media have been investigated experimentally. Tests on appropriate natural and synthetic porous systems show that the time-average formula previously suggested (see Geophys. Abs. 164–100) is of considerable use. The formula is a good approximation in the case of consolidated rock saturated with high-velocity fluid at high differential pressure. If the saturant has a low velocity the measured velocity is independent of the nature of the fluid. Signal attenuation in an unconsolidated medium is a major factor and merits more study; it may provide a useful diagnostic tool for well logging. The concept that the first arrival travels along certain paths which minimize the transit time can be extended to account for the effects of wettability. By supplementing other logs the continuous velocity logger may yield important information on intercrystalline porosity, vugular porosity, fractures, and permeability which is not otherwise obtainable.—*D. B. V.*

174–89. Shumway, George. Sound velocity vs temperature in water-saturated sediments: Geophysics, v. 23, no. 3, p. 494–505, 1958.

Sound velocity vs temperature was measured in a continental shelf silt, a calcareous ooze, a deep-sea red clay, a continental slope clay, and a quartz sand using a resonant chamber technique. The temperature effect on these water-saturated sediments was approximately the same as for water alone; this similarity to water behavior would be expected inasmuch as the compressibility of a water-sediment mixture is dominantly due to the relatively large water compressibility.—*Author's abstract*

174–90. Nagumo, Shozaburo. Studies on the elastic wave velocity in clastic rock: Part 1. Effect of water content on elastic wave velocity in clastic rock. Part 2. Progressive change of elastic property through

lithofication [sic] in sandstone (in Japanese with English abstract): Geol. Survey Japan Bull., v. 8, no. 9, p. 27–56, 1957.

In the first part the effect of water content on the velocity of longitudinal waves in clastic rocks was determined using ultrasonic pulse techniques. The rocks used were medium- and coarse-grained sandstones and a few shales. The factors controlling the elastic properties of saturated rock at room temperature and atmospheric pressure are the elastic properties of the rock framework itself, internal pressure from capillary pressure in the matrix and cement, and mechanical interaction between the elastic particles and the water. In sandstone the velocity decreases notably as saturation increases from 10 to 20–30 percent, and increases slightly as water content is reduced to zero. In shale the velocity is nearly constant for saturations of 100 percent down to 30–40 percent, then decreases as water content is further decreased. Any increase in velocity in the dry condition is too small to be recognized.

In the second paper the velocity was determined as a function of porosity, after taking into account the effect of water content, in order to investigate the effect of lithification on elastic properties. A soft Pleistocene siltstone having a porosity of 47.3 percent and velocity of 1.54 kmps in saturated state was used. As porosity decreases through lithification, the longitudinal wave velocity increases. When porosity is less than about 15 percent, there is no close relation between porosity and strength of the framework.—*V. S. N.*

174–91. Sollogub, V. B., Galushko, P. Ya., Vopilkin, A. A., and Patiokha, A. M. Skorost' rasprostraneniya prodol'nykh uprugikh voln v gornykh porodakh, eye zavisimost' ot staticheskoy nagruzki i vlazhnosti [The velocity of propagation of longitudinal elastic waves in rocks, its relation to the static load and the moisture content]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy ser. geofiz., no. 2, p. 130–137, 1958.

The velocity of propagation of ultrasonic impulses in cubes (3 to 10 cm on edge) of sandstone, limestone, and silicate bricks has been investigated, using the ultrasonic impulse seismoscope under pressures varying from atmospheric pressure to 600–700 kg per cm$^2$. The velocity was measured in two directions, parallel to the applied pressure and perpendicular to it. For sandstone it was found that as the load increased from 0 to 120 kg per cm$^2$ the velocity of ultrasonic waves increased from 3,200 to 3,900 *m* per sec ($dV/dp$=5 *m* per sec per atm); as load increases to 420 kg per cm$^2$ the velocity increases to 4,100 *m* per sec ($dV/dp$=0.7 *m* per sec per atm); above 420 kg per cm$^2$ the velocity decreases, and at 610 to 620 kg per cm$^2$ the specimen is destroyed. Similar results were obtained for all rocks of sedimentary origin. Measurements of velocity in the direction perpendicular to the applied pressure again showed a much slower increase of velocity with pressure. Changes in velocity caused by the application of uniaxial pressure are explained by the decrease of the porosity of the compressed specimens, especially at the beginning of the application of the pressure. Variation of water content also affected the velocity. The results of cyclic variations of the load are presented in graphs. (See also Geophys. Abs. 153–14479 and 162–112.)

It is concluded that velocity increases as static load increases, as porosity decreases, and as saturation increases. When rocks have been deformed, velocity depends not only on static load but also on the geologic processes that have been at work. It is recommended that ultra-acoustic logging be carried on side by side with electrical logging.—*S. T. V.*

174–92. Kolgina, A. N. Nekotoryye opyty seysmicheskogo modelirovaniya sbrosov i kontaktov, kharakternykh dlya Ukrainskogo kristallicheskogo shchita [Some experiments with seismic models of faults and contacts, typical of the Ukrainian crystalline shield]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy ser. geofiz., no. 2, p. 187–192, 1958.

Neither gravimetry nor electric profiling can give positive results when formations on both sides of a fault have approximately the same physical parameters. Experiments made in 1956 by the institute of geology of the Ukrainian academy of sciences show that the problem can be solved by using the high frequency seismic method. The interpretation of the seismic data is often made difficult by the appearance of waves diffracted at the edges of the fault, but the refracted waves can be distinguished from the diffracted waves by the very characteristic rapid damping of the diffracted waves, noticeable on seismograms.

Experiments were made on models using an ultrasonic seismoscope with a piezoelectric transmitter (see Geophys. Abs. 152–14284 and 153–14479). Three models represented finite and infinite faults. The first consisted of a horizontal piece of Ovruch quartzite with a 2-cm displacement, submerged in water; in the second group, one model was a polished slab of granite submerged in water, the other a specimen with granite and pegmatite in contact. The seismograms obtained are reproduced. On the basis of the results, it is recommended that high frequency seismic surveys be used in the exploration of vertical contacts, particularly pegmatite bodies.—*S. T. V.*

174–93. Klíma, Karel, Pros, Zdeněk, and Waniek, Ludvík. Eine elektronische Apparatur zur Messung der Elastizitätskonstanten an Gesteinsproben [An apparatus for measurement of the elasticity constants of rock samples]: Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 1, p. 106–113, 1957.

A description of a device for direct measurement of the velocities of longitudinal and transverse waves in cylindrical rock samples. The impulses are produced by an electronic generator and converted into mechanical energy by means of an electroacoustic transformer. The results of measurements on a granite, a diabase, and a limestone are tabulated, giving density, *P*- and *S*-wave velocities, Poisson's ratio, and the three elastic constants for each.—*D. B. V.*

174–94. Lotze, W. Schallgeschwindigkeitsmessungen von Eis in Abhängigkeit von Druck und Temperatur [Measurements of acoustic velocity of ice dependent on pressure and temperature]: Zeitschr. Geophysik, v. 23, no. 5, p. 243–249, 1957.

Acoustic wave velocities (longitudinal) of ice rods 50 cm long and 5 cm in diameter were measured electronically. The results show a slight increase of velocity with decreasing temperature and with increasing pressure.—*D. B. V.*

Brockamp, B. Seismic ice investigations. See Geophys. Abs. 174–176.

174–95. Uhlmann, Manfred. Über die Erkundung der Spannungsverhältnisse in Stützpfeilern des Kali- und Steinsalzbergbaus auf akustischer Basis [On the investigation of the strain relations in supporting

pillars of potash and rock salt mines by means of acoustics]: Freiberger Forschungshefte C 36 Geophysik, 84 p., 1957.

The strain relations in pillars in rock salt and potash mines have been investigated theoretically and experimentally in various German mines by measurements of acoustic velocities, using an elastic impulse with a frequency of 60 kc. The theory, methods and apparatus, and accuracy are discussed first, then the results of the underground measurements are presented. These yield a qualitative interpretation of the strain relations that agrees well with theoretical strain distribution. In one case the information on the time variation of acoustic velocity permitted the prediction of the beginning of rupture in a pillar of solid salt.—*D. B. V.*

174–96. Yoshikawa, Sōji. The propagation of waves near explosion and fracture of rock (1): Kyōto Univ. Disaster Prevention Research Inst. Bull., no. 21, 22 p., 1958.

The processes of fracture and plastic deformation occurring in rocks under the high but transitory pressure of an explosion were studied experimentally at the Ikuno, Kamioka, and Kishu mines in Japan, using a seismometric pickup and strain gage designed to measure the mode of propagation of the waves within the fracture and plastic zones formed by the explosion.

Strain wave shapes were found to be influenced by pressure, distance from shot point, and the free surface; the pulses were found to consist of component waves having different velocities. Two kinds of waves were detected near the shot point, an elastic wave of relatively high frequency and a plastic wave of lower frequency. An increase in the amount of explosive caused a decrease in velocity of the plastic wave. In general, most rock fractures produced by explosion pressures result from tensional strain reflected from the free surface, while at the same time compressional strain is within the elastic limit of the rock. Rock in intimate contact with the explosion is fractured by direct pressure, but the amount thus fractured is small in comparison with the total rock fractured.—*V. S. N.*

174–97. Bergmann, Ludwig. Die Bestimmung der elastische [sic] Konstanten kubischer Kristalle mittels der Methode der Ultraschall–Elastogramme [The determination of the elastic constants of crystals by means of ultrasonic elastograms]: Zeitschr. Naturforschung, v. 12a, no. 3, p. 229–233, 1957.

The elastic constants of many cubic crystals of 10 different compounds were determined by means of the Schaefer-Bergmann method involving refraction of light in crystals vibrating at high frequencies. A relationship was sought between the form of the elastogram and the forces in the crystal lattice. One particularly noteworthy result was that a rather regular single crystal of BaF behaves elastically like an isotropic body.—*D. B. V.*

174–98. Fatt, I. Pore structure in sandstones by compressible sphere–pack models: Am. Assoc. Petroleum Geologists Bull., v. 42, no. 8, p. 1914–1923, 1958.

Porosity and flow measurements made on packs of rubber spheres under compression indicate that ideal sphere packs do not model the flow properties of consolidated sandstones. Packs of rubber cubes have plate-like pore spaces. Under compression brine-saturated packs of rubber cubes display the same rapid

increase in electrical conductivity observed when brine-saturated sandstones are compressed. This observation leads to the hypothesis that pore spaces in consolidated sandstones are plate-like, that is, they have two large and one small dimension. Compression of consolidated sandstone causes collapse of these plate-like pores.—*Author's abstract*

174–99. Fatt, I. Compressibility of sandstones at low to moderate pressures: Am. Assoc. Petroleum Geologists Bull., v. 42, no. 8, p. 1924–1957, 1958.

Bulk volume compressibilities of petroleum-bearing sandstones were measured in the range, 0—15,000 psi. Compressibilities were found to be function of pressure, rock composition, and texture. If sandstones are divided into two classes; one with well sorted, well rounded grains, the other with poorly sorted, angular grains; then within a class the compressibility is a linear function of the amount of intergranular material. A useful model for a sandstone is the sphere pack composed of a mixture of very hard and very soft spheres. This model correctly predicts (a) the pressure at which grains crush, (b) the compressibility of the intergranular material, and (c) the relation between compressibility and pressure.—*Author's abstract.*

174–100. Ménard, Louis. Mesures in situ des propriétés physiques des sols [Measurements in place of the physical properties of soils]: Annales des Ponts et Chaussées, v. 127, no. 3, p. 357–377, 1957.

The pressiometer, a one-man portable instrument for measuring in place the plastic and elastic properties of a foundation, creates a field of stress in the ground and measures the corresponding deformations; from the data obtained, the modulus of elasticity and shearing strength can be calculated. Over 75 controlled experiments with very different types of ground have tested the soundness of the theory of the apparatus and have shown the important part played by the elastic coefficients in foundation problems, especially for sands. The apparatus is described, and the interpretation of the diagrams explained. Comparison of pressiometer results with laboratory measurements on a series of saturated clays from the Chicago area shows good agreement particularly for compaction, at shallow depths, and for soils worked on by pile drivers, at any depth; but for soils not so treated, discrepancies between the field and laboratory measurements increase with depth, the pressiometer giving higher values for elasticity and cohesion. Tests on copper metal likewise show good agreement with experimental results. After presenting detailed results of the measurements in the Chicago area, Ménard concludes that there is another important application of the instrument—determination of compaction; large scale measurements to this end are to be made in the course of construction of an earth dam near Seattle.—*D. B. V.*

174–101. Meisser, Otto. Die seismischen Grundlagen der neuzeitlichen Erschütterungsmesstechnik bei Verkehr und in der Industrie [The seismic basis of modern vibration measuring techniques for traffic and industry]: Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 2, p. 375–377, 1957.

The scale considered most convenient for estimation of the possibility of vibration damage from traffic and industry is that based on velocity of ground motion, obtained from the formula $v=2\pi f A_{cm}$ where $v$ is velocity in cm per sec, $f$ is frequency, $A$ is amplitude in cm. At velocities of 0.5 cm per sec the danger

of damage is "very improbable", at 1 cm per sec it is "improbable", at 5 cm per sec "probable", and at 10 cm per sec "very probable."—*D. B. V.*

174–102. Dvořák, Arnost. Měření otřesů při výbuchu trhavin [Measurement of vibrations from blasting operations (with English and Russian summaries)]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 49, p. 543–557, 1956 (1957).

The suitability of existing scales for measuring intensity of vibration from explosions, analogous to the Mercalli-Cancani-Sieberg earthquake scale, was tested by measuring the maximum amplitude, frequency, acceleration, vibration factor *K* (Zeller scale), degree of damage (Risch scale), intensity in vibars (Koch scale), velocity, and physiological intensity (in "pal" units) of vibrations from routine blasts where damage was actually seen to occur. Comparison of different records shows that most of these scales are not reliable for estimating explosion damage. The physiological scale is most suitable, the limit of permissible intensity lying between 30 and 40 pals. It is probable that the final scale will be based on velocity and duration of vibrations.—*D. B. V.*

174–103. Hardtwig, E[rwin]. Grossprengung und Mikroseismik [Large explosions and microseismics]: Annali Geofisica, v. 9, no. 3, p. 273–284, 1956.

A two-layered medium disperses surface waves generated by explosions; the frequency equations for wave velocity and group velocity are broken down into two separate equations; therefore, there are two dispersion curves. With plausible values for the physical constants and a layer thickness of 6 to 10 m, it is calculated that the most abundant waves (more or less of the character of Rayleigh waves) are in the period ranges of 1/5 to 1/10 cycles per sec and 40 to 50 cycles per sec; this is in excellent agreement with seismic survey practice.

In large explosions the crust-substratum dispersive system should favor periods of 30 sec and more, but this is contrary to probability. If the earth is considered to be a freely vibrating plate, the most common periods correspond to the periods of microseisms. Microseisms, therefore, can be explained most simply as free vibrations of the earth's crust independent of the manner of generation (surf or cyclone center).—*D. B. V.*

Bolt, B. A., Doyle, H. A., and Sutton, D. J. Seismic observations from the 1956 atomic explosions in Australia. See Geophys. Abs. 174–233.

174–104. Labrouste, Yvonne. Enregistrements séismiques d'explosions nucléaires [Seismic registrations of nuclear explosions]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 3, p. 321–323, 1958.

The sites of four nuclear explosions at Bikini atoll calculated from seismic records are within 10 km of the exact locations recently published by the U. S. Atomic Energy Commission. The *PP* waves were particularly clear at Nouméa, Parc–Saint–Maur, and Tamanrasset observatories; surface waves were absent at Nouméa and Tamanrasset, but Rayleigh waves showing marked dispersion were recorded at Parc–Saint–Maur by the long-period vertical seismograph. The first arrival is interpreted as a compressional wave at four stations at very different azimuths (Riverview, Palisades, Bermuda, and Tamanrasset).—*D. B. V.*

174–105. Reich, H[ermann]. Die geologischen Ergebnisse seismischen Registrierungen grosser Sprengungen in Deutschland [The geologic results of seismic registration of large explosions in Germany]: Geofisica Pura e Appl., v. 40, p. 41–48, 1958.

A review of the results of seismic records of large explosions in Germany south of Hamburg, west of Würzburg (Main), west of Regensburg and Ulm in the Danube district, and in the foreland of the Bavarian Alps. Travel times for distances of 15 to 30 km, basement velocities, intercept times, and approximate depths of the basement are given. In the Alps foreland and northwestern Germany travel times were more than 7 sec for 30 km and basement depths more than 5 km; in the Main and Danube areas travel times for 30 km were 5.5 sec, basement depths less than 1 km. Velocities of more than 6.4 kmps were noted near Ingolstadt (in the Danube area) at 600 m depth, southwest of Würzburg at 2,400 m, and southwest of Hamburg at 7,000 m. These are gabbroic rocks; all three cases correspond to positive magnetic and gravity anomalies.—*D. B. V.*

## ELECTRICAL EXPLORATION

174–106. Krayev, A. P. Osnovy geoelektriki [The principles of geoelectrics]: Gostechteorizdat, Moscow, 455 p., 1951.

The first 283 pages of this graduate level textbook include a brief historical review of the development of geoelectric survey methods; the electric parameters of mono-mineralic, two-component, and complex rocks and the variability of those parameters in an electromagnetic field; and methods of measurement of the electrical properties of rocks. A description and mathematical treatment of general electromagnetic conditions of the earth, and the facts and theories of the natural regional and local electric fields serve as a background to the second part of the book, concerned with the application of induced geoelectric fields. The fundamental problems of geoelectrical prospecting are treated. Normal fields in homogeneous rock masses are represented by the two-electrode configuration, Petrovskiy's configuration, current-carrying loop, and half-dipole line electrode methods. The electric field of ore deposits and the excitation method, and the anomalies caused by geological structures and the resistivity method, are presented in two separate chapters. The book concludes with a discussion of the problems of electric mapping of the earth's crust.—*A. J. S.*

174–107.—Kolbenheyer, Tibor. On the boundary problem of geoelectricity for a homogeneously laminated prolate spheroid: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 56, p. 653–667, 1956 (1957).

The electrical model considered is a confocally laminated semi-ellipsoid inserted into a homogeneous half space. First, only two confocal semi-ellipsoids are considered and the potentials and the telluric parameter are determined in terms of Legendre functions for the case of a homogeneous steady state primary field. The extension of this solution to the case of an arbitrary number of ellipsoids is indicated. Next the potentials are determined for two ellipsoids when point sources of current located at the surface are used, then the extension of this solution to an arbitrary number of confocal semi-ellipsoids is indicated. Finally Green's theorem is used to prove that the selections obtained are the only ones.

The results are useful in prospecting synclines by the telluric current method or by direct current resistivity methods.—*F. C. F.*

174–108. Vozoff, Keeva. Numerical resistivity analysis: horizontal layers: Geophysics, v. 23, no. 3, p. 536–556, 1958.

The direct numerical solution of resistivity data for the case of horizontal layering is presented as the solution of a set of nonlinear algebraic equations. Two specific methods, Newton and Steepest Descent, were set up for three-layer analyses on a digital computer. These were applied to field data and to data derived theoretically for three- and four-layer cases.

The case of a thin second layer was found to display a special kind of indeterminacy. It was found that the analyses do not and cannot theoretically be expected to yield the actual values of resistivity and thickness for these thin layers, but, rather, a good value for their ratio (conductive layer) or product (resistive layer) can be obtained. The question of ultimate resolubility of this type of information in the presence of measurement error is discussed quantitatively. It was found that, as the resistivity of the third (lowermost) layer increases, it becomes increasingly difficult to detect a thin, resistive second layer. When the second layer is not thin relative to the first, the resistivities and thickness are determined with reasonable accuracy. These solutions do not appear to be unique, but alternate solutions differ sufficiently for the true solution to be easily distinguished.—*Author's abstract*

174–109. Golovtsyn, V. N. K interpretatsii elektrorazvedochnykh nablyudeniy pri poiskakh rudnykh ob"ektov [On the interpretation of electric survey observations in prospecting for metallic ores]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 105–119, 1958.

The potential fields produced by different kinds of ellipsoids of revolution are computed. The problem discussed is that of the anomalous electric field produced by an ellipsoid of revolution of conductivity $\sigma_2$, in a homogeneous field created by a constant electric current in an infinite medium of an electric conductivity $\sigma_1$. The initial electric field is in the direction of the $x$-axis, the zero point of the coordinates is in the center of the ellipsoid. Using the methods of the potential theory, the value of the potential function at any point outside of the ellipsoid is computed. The solution found is extended to the case when the axis of the ellipsoid forms an angle $\alpha$ with the horizontal, of elongated and oblate ellipsoids of revolution, and finally of an infinitely long elliptic cylinder. The last section of the study gives practical examples of the use of the theory in the interpretation of electric survey data. In many cases the solutions are only approximate.—*S. T. V.*

174–110. Krinari, A. I. O zavisimosti mezhdu udel'nym soprotiveleniyem *i* kollektorskimy svoystvami vodonosnykh terrigennykh porod [On the relationship between specific resistance and the reservoir characteristics of water-bearing terrigenous rocks]: Geologiya Nefti, no. 7, p. 52–56, 1958.

The formula $k=\frac{12.5\times10^{-4}\ m^3\ (2-\log m)^2}{(\log \rho)^2\ S^2}$ is derived for the permeability coefficient $k$ of water-bearing sandstone and siltstone of the terrigenous Devonian formation of Tartar A. S. S. R. for a rock of known porosity $m$, resistivity $\rho$,

and specific surface area $S$ of the rock grains. The lithologic and reservoir characteristics of the rock, such as tortuosity of its capillaries and their cross section, porosity, density of grain packing, and cementation are taken into account. The laborious core analysis of reservoir rock can be considerably curtailed, and replaced by much cheaper electrical logging when a dependable value for $k$ is available.—*A. J. S.*

174–111. Belluigi, A[rnoldo]. Asymptotische Formeln zur Bestimmung des von einer oder von mehreren Elektroden im geschichteten Boden hervorgerufenen Potentials [Asymptotic formulas for the determination of the potential produced in a layered earth by one or more electrodes]: Zeitschr. Geophysik, v. 23, no. 3, p. 135–168; no. 4, p. 182–196, 1957.

In the first part, using several rigorous methods, Belluigi derives the apparent resistivity function for horizontally layered soils with arbitrary subsurface, energized on the surface by direct current. In the second part he uses these results to develop new rigorous formulas for the asymptotic equivalence of horizontally layered soils and subsurface with high conductivity; with high specific resistivity; and without constant conductivity.—*D. B. V.*

174–112. Wilckens, F[riedrich]. Elektrokinetische Grenzflächenerscheinungen im Bereich oberflächennaher Erdschichten [Electrokinetic boundary plane phenomena in the region of layers near the earth's surface]: Zeitschr. Geophysik, v. 23, no. 1, p. 46–56, 1957.

The electrochemical bases of electrokinetic boundary plane phenomena are discussed. In applied geophysics, only current potentials arising in near-surface layers under certain conditions are of importance. It is shown that it is impossible to measure these potentials exactly by means of the usual electrode arrangements in wells and on the surface; therefore, electrokinetic effects do not seriously affect self-potential measurements.—*D. B. V.*

174–113. Tyapkin, K. F. K voprosu interpretatsii anomaliy yestestvennogo elektricheskogo polya [On the interpretation of anomalies of the natural electric field]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 98–101, 1958.

Quantitative computations of the anomalies of the natural electrical field present numerous difficulties, particularly in selecting the "zero level" of the observed values of the potential, or more precisely, distinguishing the anomalous portion of the field. In this paper a mathematical solution of the problem is suggested which uses the relationships resulting from the solution of Neumann's problem, a method sometimes applied in magnetic surveying. The cases of a plane field and three-dimensional field are treated. In addition to giving the anomalous part of the field, the relationships obtained yield a series of supplementary properties applicable in interpretating self-potential or induced potential surveys.—*S. T. V.*

174–114. Patella, Luigi Vincenza. Il ritrovamento dei paleoalvei fluviali con la misura dei potenziali elettrici naturali (*P. S.*) [The rediscovery of former river channels by measurement of natural electrical potentials (*S. P.*)]: Geofisica Pura e Appl., v. 40, p. 85–96, 1958.

Theoretical natural potentials are calculated for the diffuse electrical field of a river (a two-layer case involving the river with its bed, and river banks);

for the field due to filtration across the river bed–water boundary; for the electrokinetic current in the river; and for the thermoelectric and piezoelectric fields in the river. It is shown that the greater part of the transverse profiles are characterized by strong jumps in potential across the boundary between water and banks, obviously determined by the fields of electrofiltration and electrodiffusion, whereas longitudinal profiles are characterized by a more or less regular drop in potential. Applied to recognition of former river channels, which show as anomalies in the profiles, this constitutes a new method of electrical prospecting. Such channels may be used as auxiliary water supply in periods of low water or may be exploited continuously, especially when found at a distance from present channels.—*D. B. V.*

174–115. Rogers, George R. Electromagnetic prospecting methods: Mines Mag., v. 47, no. 12, p. 26–30, 1957.

Describes in detail inductive electromagnetic methods used as exploratory tools in ground surveys for sulfide mineralization. Two variations of the method are given: a system dependent upon a vertical reference where the plane of the pickup coil is free to rotate about the plane of the applied field, and a co-planar system where the transmitter and receiver coils are in the same plane. Brief mention is made of the adaptation of the electromagnetic methods to airborne surveys. The report is well illustrated.—*V. S. N.*

174–116. MacKay, D. G. Electro-magnetic mineral prospecting: World Sci. Rev., p. 25–28, June, 1956.

The electromagnetic method of measuring the electrical properties of rocks can now be operated in conjunction with an airborne magnetometer, and a good idea of the source of any anomaly can be deduced from the results. The major drawback is the impossibility of maintaining a 500-foot ground clearance in mountainous country.—*V. S. N.*

174–117. Törnqvist, G[östa]. Some practical results of airborne electromagnetic prospecting in Sweden: Geophys. Prosp., v. 6, no. 2, p. 112–126, 1958.

Coils mounted at right angles and energized with quadrature voltages from a common oscillator produce circular polarization around the line of intersection between the planes of the two coils. By constructing the transmitting and receiving coil in such an arrangement an airborne electromagnetic system was made and tested with about 10,000 km of traverse. Signals caused by variations in distance between transmitting and receiving coil are compensated by bucking the output of the two receiving coils after phase shifting. Angular orientation changes between the transmitting and receiving coil-sets result in small noise levels. The important parameter $a/\tau$ (ratio of flight height to distance between receiver and transmitter) should be a maximum as indicated by theoretical curves. This is best accomplished by carrying the transmitter and receiver in separate aircraft with spacings of 170 to 200 meters and flight altitude of 75 to 100 meters. Typical airborne amplitude and phase profiles and a comparison with ground *EM* results over known mineralized areas are shown.—*W. J. D.*

174–118. Barsukov, O. M. O vybore sposoba izmereniy peremennogo elektromagnitnogo polya [On the choice of method of measuring the alter-

nating electromagnetic field]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 365–369, 1958.

A method is given for computing the field produced by an infinite cable or equivalent ungrounded loop for the case when the surveyed area contains different bodies producing anomalies. A physical picture of the distribution of the electromagnetic field over the terrestrial surface and an approximate interpretation can be obtained only if a sufficient number of parameters sensitive to the changes of the field are considered. As always in the case of an alternating electromagnetic field, both electrical and magnetic characteristics must be analyzed. Tables are given of the ratio of major and minor axes of the ellipse of polarization and the angle between these axes for different geologic conditions. In addition the shortest distance between the electrodes necessary to produce a field approximating that of an infinite cable is given. The inclination of the ellipse of polarization is independent of the intensity of the current in the cable; this angle can be measured precisely by a single frame attachment.—*S. T. V.*

174–119. Praus, Oldřich. Das electromagnetische Wechselfeld eines Horizontaldipols auf der Oberfläche einer geschichteten Erde [The electromagnetic alternating field of a horizontal dipole on the surface of a layered earth]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sbornik, no. 57, p. 669–680, 1956 (1957).

A general solution is found for the electromagnetic alternating field of a horizontal dipole at the surface of a non-homogeneous horizontally layered earth, based on Sommerfeld's method of calculating the electromagnetic field of a vertical antenna on the plane homogeneous earth. The tangential components of the electrical field wave determined by means of auxiliary functions $F(r)$ and $G(r)$, which have the form of infinite integrals. The general solution will serve as the basis for extension of the discussion to some important special cases.—*Author's conclusion, D. B. V.*

174–120. Praus, Oldřich. An approximate calculation of the electrical field of an alternating horizontal dipole on the surface of stratified earth: Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 2, p. 285–301, 1957.

The auxiliary functions $G(r)$ *and* $F(r)$, which determine the electric field of an alternating horizontal dipole on the surface of stratified earth were integrated by an approximate method. Expressions were derived and numerically calculated after neglecting displacement currents for the amplitude and phase of the correction factors $Q_{s1}$ and $Q_{s2}$, which express the influence of stratification on the amplitude and phase of an electric field on the surface of a two- and three-layer earth.

During a more detailed analysis of the results it was found that the maximum depth $h_1$, to which a current of given frequency $\varpi = 2\pi f$ penetrates, is controlled by the approximate relation $h_1 = 3/2\pi \sqrt{\sigma_1 f}$, which can be considered as an expression of the skin-effect for a stratified medium. An analysis of the three-layer curves showed the equivalence of geoelectrically different profiles for small thicknesses of the layers and for sufficiently low frequencies, when displacement currents can be neglected.

The results obtained can be used for developing a new method of geophysical prospecting.—*Author's conclusions*

174–121. Praus, O[ldřich]. Příspěvek k teorii dipólove sondáže a experimentální výsledky [On the theory of dipole probing, and the experimental results]: Československá Akad. Věd Geofys. Ústav Práce Geofys. Sborník no. 58, p. 681–718, 1956.

Referring to his previous work (see Geophys. Abs. 174–119, 120) Praus derives fundamental equations for the electric field of a dipole fed with direct current on the surface of a layered earth and uses them for the calculation of the curves for some theoretical dipoles such as axial dipole and perpendicular dipole arrangements. It was found that the segment cut on the axis $\eta=1$ of the axial dipole has twice the longitudinal conductivity of layers overlying a basement of infinitely great resistivity. For the perpendicular dipole arrangement, the corresponding segment has ¾ of the value found for the parallel arrangement. Field experiments have provided the data for the possible probing by the axial dipole method up to the depth of 1,000 m approximately, and its application to electrical prospecting.—*A. J. S.*

174-122. Belluigi, Arnaldo. Ricerche elettro-idrologiche con polarizzazioni indotte [Electrical hydrologic investigations with induced polarization]: Annali Geofisica, v. 9, no. 4, p. 525–548, 1956.

Starting from a classic statement of Maxwell, Belluigi calculates the values of "relaxation times" of induced polarization in the ground. The purely physical theory is applied to a number of cases possible in ground water investigations, showing that formations saturated with fresh or highly ionized water can be distinguished from barren layers. The use of "electrorelaxameters" (built in Italy as well as in the United States, Japan, and Russia) in Wenner-type set-ups will replace or at least supplement electrical logging, which is uncertain and ambiguous in hydrological research.—*D. B. V.*

174–123. Khalfin, L. A. Radiolokatsionnyy metod geofizicheskoy razvedki s nakopleniyem i vremennoy selektsiyey [The radio method of location in geophysical exploration with accumulation and intermittent selectivity]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 374–378, 1958.

Radio-wave surveying offers great possibilities for reconnaissance work if the signal-to-noise ratio can be increased substantially. The accumulation method recently used in sending signals to the moon offers such a possibility. This paper presents a detailed analysis of the method. The effect of interference on reception of the signals is discussed, applying the theory of probability and assuming that disturbances occur at random and have no relation to the periodicity of the radio signals. It is concluded that modern radio methods are capable of overcoming existing difficulties and should play an important role in geophysical investigations in the near future.—*S. T. V.*

174–124. Khmelevskoy, V. K., and Frolov, A. D. Izmereniya napryazhennosti radiovolnovogo polya shirokoveshchatel'nykh stantsiy dlya geologicheskogo kartirovaniya [Measurements of the radiowave field intensity of broadcasting stations for geologic mapping]: Razvedka i okhrana nedr, no. 5, p. 38–44, 1958.

Describes a new method of surveying, the "radio-comparative" method, which uses high frequency radio waves (above a hundred kc per sec), measuring the electromagnetic field of long wave radio broadcasting stations. The intensity of

such a field depends on the energy transmitted, distance to the receiver, and geoelectrical properties of the ground in the vicinity of the receiver. The horizontal ($H_p$) and vertical ($H_z$) components of the electromagnetic field are measured by an apparatus which includes an antenna rotated around vertical and horizontal axes and a high frequency selective microvoltmeter. The presence of anomalous bodies underground produces a variation in the ratio $H_z/H_p$ which is characteristic of a given area and remains constant for years. Parallel geologic and radio-comparative measurements in several different areas should yield a set of curves typical of different geological conditions. Productivity of the method is high; some 50 to 60 stations can be occupied in an hour by one operator with two assistants.

Tests were made in the summers of 1954, 1955, and 1956 in the North-Ural bauxite basin, using the field of a station broadcasting on a wave length of 1,980 m. Observed intensities ranged from 0 to 300 microvolts per meter. The curves obtained correspond well with the geology. It is concluded that the method can be used to distinguish steeply dipping and tilted layers having different electrical properties; that it is suitable for detailed surveys of local anomalies, with an optimum interval of 10 to 20 m in general, and 3 to 5 m in anomalous zones. The radio-comparative method should develop into an important exploration procedure, especially in combination with magnetic surveys and vertical electric profiling.—*S. T. V., D. B. V.*

174–125. Kokourov, V. D., and Bashmakov, A. A. Polevoy lampovyy vol'tmeter [A vacuum-tube voltmeter for field use]: Akad. Nauk SSSR Ural Branch, gorno-geol. Inst. Trudy no. 30, geofiz. Sbornik no. 2, p. 32–36, 1957.

A description is given, with wiring diagram, of a portable vacuum-tube voltmeter using low frequency alternating current designed for field use, particularly for surveying sulfide deposits where very low voltages must be measured as accurately as possible. The frequency used ranges from some tens to a few thousand cycles per sec. This improves the use of the vacuum-tube voltmeter with preliminary amplification of the voltage to be measured. An inherent defect of this instrument is the variability of the amplification coefficient; this makes systematic checking of its calibration necessary. With this precaution, the error of the measurement is estimated not to exceed three percent. Dimensions of the instrument are only 90×160×150 mm, its weight 1.4 kg. The voltmeter described was found to be reliable under severe tests in the laboratory and in the field.—*S. T. V.*

174–126. Summers, B. Geophysical prospecting for manganese in the Gold Coast: Colonial Geology and Mineral Resources, v. 3, no. 3, p. 219–230, 1952 (1953).

An account of electrical resistivity surveys made during a search for manganese in the Nsuta area, Gold Coast Colony (Ghana). Prospecting was extended to the outlying areas of Asikuma, Kubekro, and Nyankumasi. Results on known ore-bodies at Nsuta were encouraging but have not led to discovery of valuable new ore-bodies. At Nyankumasi, a low-grade deposit of manganese ore, the presence of which was suspected on general geological grounds, was located by geophysical methods.—*V. S. N.*

174–127. Suyama, Junji; Saitō, Tomosaburō; and Futsukaichi, Hiroshi. Report on the electric and magnetic investigations for titanic iron-sand deposits, in the Kaimon-onsen District, Ibusuki-gun, Kagoshima Prefecture (in Japanese with English abstract): Geol. Survey Japan Bull., v. 9, no. 2, p. 43–50, 1958.

The results of geophysical investigations of the titaniferous iron-sand deposits of the Kaimon-onsen District of Japan are reported. Resistivity profiling using the Wenner configuration showed a horizontal layer 20 m thick. Magnetic measurements (vertical component) showed several anomalies, due either to the induced magnetization of the iron sand or to the topographic effect of a weakly magnetic sedimentary bed. On the basis of magnetic susceptibility measurements the sedimentary rock specimens are divided into two groups having different thermoremanent characteristics.—*V. S. N.*

174–128. Suyama, Junji; Kobayashi, Hajime; and Takagi, Shin'ichirō. Report on the electrical investigation for silica-stone deposit of Ugusu Mine, Shizuoka Prefecture (in Japanese with English summary): Geol. Survey Japan Bull., v. 9, no. 3, p. 47–62, 1958.

A report on resistivity and self-potential surveys at Ugusu Mine, Japan, in an epithermal replacement-type silica-stone deposit in Tertiary volcanic rocks. In general the distribution of the self-potential corresponded to the resistivity distribution and to the geology; low resistivity and a positive flat potential curve were recorded over the shallow clay zone, and high resistivity and a negative potential curve over the silicified zone.—*V. S. N.*

174–129. Janakiramaiah, B., and Ramana, E. V. Geophysical investigations near the old workings for copper in Yanambail area, Khamman district, Andhra Pradesh: Indian Acad. Sci. Proc., sec. A, v. 47, no. 5, p. 310–322, 1958.

Self-potential, resistivity and magnetic investigations were made of old copper workings north of Yanambail in the Khamman district, India. Strong negative anomalies over the old workings suggest that a rich orebody may still lie at a depth of about 30 feet (maximum depth reached by the old workings was 25 feet). Another group of high negative centers about 500 feet to the east may be due to a parallel mineralized vein.—*D. B. V.*

174–130. Tüllstrom, Helge. Geoelektrisk undersökning av Brunkebergsåsen vid Antuna i Sollentuna kommun [Geoelectrical investigation of the Brunkeberg esker near Antuna in Sollentune commune]: Geol. Fören. Stockholm Förh., v. 80, no. 2, p. 149–165, 1958.

Electrical resistivity surveys were made by the Swedish Geological Survey to determine the character, thickness, and extent of an esker gravel deposit near Antuna. The Wenner method was used, with constant electrode spacing at 20 and 40 m along straight lines; 15 electrical soundings were made to determine depth to bedrock, water table, and other discontinuities. Gravel-covered hills of bedrock were found, dividing the groundwater, and thick layers of fine sand covered with secondary deposits of wave-washed gravel.—*D. B. V.*

174–131. Buchheim, W[olfgang]. Anwendungen der Methode der induzierten Polarisation an schwedischen Erzlagerstatten [Application of the method of induced polarization to Swedish ore deposits]: Zietschr. Geophysik, v. 23, no. 1, p. 26–33, 1957.

The theory of the induced polarization method is outlined briefly and results are presented of its application to some rock models (moist quartz sand containing powdered galena or graphite of uniform particle size) and to three Swedish ore deposits. At Akulla, not far from Boliden, reduced curves obtained across a disseminated pyrite zone 100 m wide showed a shift of the maximum to low frequencies and back, corresponding to a decrease in grain size at the borders of the zone. At Idre in Dalarne application of the induced polarization method by means of frequency variation to a disseminated galena deposit showed that in this type of ore impregnation, which is of the nature of cement, the effect is clear in the frequency range of 0.1 to 10 cycles per sec. Finally the method was used to distinguish between massive ores and graphite schists of extremely high conductivity, such as the Kankberg ore bodies near Boliden and the accompanying pyrite zone. Although the curves of in-phase and out-of-phase components of both disturbing zones show no significant difference, the dispersion curves of the out-of-phase components are totally different if the whole frequency range is covered, when the electrodes are oriented along the strike.—*D. B. V.*

174–132. Buchheim, Wolfgang, and Malmquist, David. Anwendungen der Methode der induzierten galvanischen Polarisation an Sulfiderzvorkommen des Skelleftebezirkes in Nordschweden [Application of the induced galvanic polarization method to sulfide ore occurrences of the Skellefte district in northern Sweden]: Geologie, v. 7, no. 1, p. 3–13, 1958.

Theoretical considerations of a disseminated ore model, consisting of a spherical inclusion of a mineral (ore and graphite) in an electrolytically homogeneous conductor, show that induced galvanic polarization can indicate the size of these particles if the frequency of the induced alternating current field is varied. Experiments on rock samples showed that electrolyte can regularly be distinguished from metalliferous or graphitic rocks, but ores can be distinguished from such rocks by induced polarization only if the particle size of the included mineral is distinctly different. Field tests in the Skellefte region of Sweden, using frequencies ranging from 0.16 to 1,000 cycles per sec with a type of "four-point method", indicated that compact massive orebodies could in fact be distinguished from impregnated ores and/or from graphite schists, and that disseminated ores should be detectable in every case.—*Authors' summary. D. B. V.*

174–133. Ankara, Said-Ali. La prospection des eaux souterraines par les méthodes géophysiques et en particulier par la mesure de la résistivité électrique [Prospecting for underground water by geophysical methods and in particular by the measurement of electrical resistivity]: Technique de l'Eau, v. 12, no. 136, p. 49–50, 1958.

A brief outline of the results of geophysical exploration for ground water in Turkey by the resistivity method. Borings at Orman Çitligi, Akçakale, and Baskuyu encountered water exactly as predicted from resistivity data.—*D. B. V.*

174–134. Maurseth, Ray O., Howe, Charles S., Jr., and Mitchell, Stanley N. Experiences with electrical resistivity surveys on foundation and subsurface investigations in southern California [with discussion]: Am. Soc. Testing Materials Spec. Tech. Pub., no. 206, p. 103–114, 1957.

This paper presents the results, in the form of resistivity curves, of electrical surveys made to obtain information on subsurface soil conditions at six construction sites in southern California; their interpretation, descriptions of the apparatus, and procedure are also included. The resistivity method was used largely to supplement drilling data, but it was also used in those places where conditions precluded drilling, for example within the city of Los Angeles, when a major storm drain several miles in length was to be located, and at an ammunition depot where the optimum location for a water well in the bed of the Santa Margarita River was to be determined.—*A. J.*

## ELECTRICAL LOGGING

174–135. Ovchinnikov, I. K. K teorii odnoelektrodnogo karottazha [On the theory of single electrode logging]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 370–373, 1958.

Single electrode well logging is used for detecting a conducting (ore-bearing) layer in a drill hole, missed during the drilling because of non-recovery of the core or other cause. The arrangement described consists of a metal ring sunk into the hole to the desired depth and touching its walls. The potential of the grounded ring in a homogeneous infinite medium (here the mud) can be represented in terms of a cylindrical function of an imaginary argument of zero order of the second type. Applying to this function the theorem of the summation of cylindrical functions and integrating, the value of the potential for the surface of the ring is obtained; dividing this value by the current, the transient resistance of the formation can be obtained for the general case as well as for the case when the surrounding rock has infinite resistivity so that current can flow only in the hole. A table of numerical values to facilitate the computations is presented.—*S. T. V.*

174–136. Hamilton, R. G., and Charrin, Paul. Quantitative log analysis no. 5. How to get true resistivity from normal curves: Oil and Gas Jour., v. 55, no. 11, p. 121–123, 1957.

An outline of a method of curve matching to determine true resistivity from a system of two or three normal resistivity curves using simplified departure curves. Twelve sets of graphs are given for determining true resistivity of a single bed under the following conditions: the bed is between 10 and 33.3 feet thick; it is cut by a hole 8 inches in diameter; its invasion diameter is between 8 inches (no invasion) and 40 inches and the resistivity of the invaded zone is not greater than 51 times the mud resistivity; it is surrounded above and below by a thick formation having a resistivity approximately equal to that of the mud; its apparent resistivities have been obtained using two-electrode arrangements with spacing of 16, 38, and 64 inches; and mud resistivity and bed thickness have been estimated fairly accurately.—*V. S. N.*

174–137. Guyod, Hubert, and Kanner, L. C. How to find true resistivity from three normal curves: Oil and Gas Jour., v. 55, no. 36, p. 107, 110–111, 1957.

This describes a systematic method of curve matching using three normal resistivity curves and taking into account non-uniform formations and errors in reported *Rm* (mud resistivity) values as a supplement to Chart 8 of Hamilton and Charrin (Geophys. Abs. 174–136). The method uses the same *Ra* index scales used by Hamilton and Charrin but supplements the matching procedure with a "Form sheet for systematic curve-matching for three normals."—*V. S. N.*

174–138. McVicar, B. M., Heath, J. L., and Alger, R. P. New logging approaches for evaluation of carbonate reservoirs, *in* Oklahoma Univ., 5th biennial Symposium on subsurface geology Proc., p. 13–27, 1957.

Information from the typical carbonate reservoirs of the Williston Basin of the United States and Canada was used as a basis for investigation of the most efficient logging techniques to be used in making saturation interpretations of carbonate oil reservoirs. The basic method for determining the presence of hydrocarbons in a reservoir is to compare true resistivity of the formation to the resistivity it would have if no oil or gas were present. In general, the greater the difference between these values, the greater the proportion of oil or gas in the pore space. A minimum logging program for saturation interpretation requires the use of MicroLaterolog, Laterolog, and neutron log plus *S–P* curve. The log combination to be used depends on the efficiency of flushing during invasion by mud filtrate. When neutron-derived porosity is higher than the MicroLaterolog porosity index, the flushing has been poor and the neutron-Laterolog combination is used for quantitative analysis; if neutron porosity is close to the MicroLaterolog porosity index, flushing has been efficient and saturation interpretation is based on the MicroLaterolog-Laterolog combination.

The continued use of MicroLaterolog in development wells is recommended for detailed studies for completion purposes as well as to verify flushing efficiency, which in turn permits conclusions concerning the character of the porosity and permeability and provides a basis for invasion corrections of the Laterolog.—*V. S. N.*

174–139. Doh, C. A. Application of induction in Louisiana and Mississippi: Gulf Coast Assoc. Geol. Soc. Trans., v. 5, p. 125–134, 1955.

The basic advantages of induction logging over conventional logging are: the focused and symmetrical system permits a greater depth of investigation without loss of detail; greater penetration gives a more accurate true resistivity; a high accuracy of reading is attained in low resistivity beds; drilling fluid has little influence on readings; and the great affinity for water sands makes it possible to detect even thin layers of water-sand on top of oil sand. These advantages are illustrated with examples of typical logs.—*V. S. N.*

174–140. Sergatyuk, A. F. K metodike elektrokarottazhnykh rabot na ugol'nykh mestorozhdeniyakh Donbassa [On the methods of electrical logging on the Donbas coal deposits]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 193–197, 1958.

At present geophysical exploration in the Donbas region [Donetz basin] is limited to the location of coal seams. Further questions, such as that of the quality of the coal discovered, are answered by physico-chemical analysis of cores in the laboratory. Neither the electrical resistivity nor the spontaneous potential curve indicate the properties of a coal under investigation; Sergatyuk

has investigated the possibility of using the curve of induced potential for this purpose. Several graphs show the induced potential curves as a function of depth or as a function of time interval after the cutting off of the inducing current; a close relationship is found with the ash content and with the volatile content. The results are regarded as very promising for the development of an electrical method which could eventually replace the very costly procedure of core extracting and analysis.—*S. T. V.*

174–141. Whiting, L. L., and Oros, Margaret O. Electric-log cross-sections of the Silurian–Devonian formations of a part of central Illinois: Illinois State Acad. Sci. Trans., v. 50, p. 172–179, 1957.

Three electric-log cross sections of an area between Tps. 6 to 18 N and Rs. 8 W to 1 E in central Illinois are part of a study being made preparatory to a revision of Bell's subsurface structure map published in 1943 and contoured on the New Albany shale (Mississippian). The electric logs and cross sections furnish new data concerning the subsurface geology and suggest possible new interpretations of stratigraphy and structural history that may be of value in the search for oil. The New Albany shale dips eastward and lies unconformably over Silurian and Devonian formations in all the area of this study to form a possible stratigraphic trap.—*A. J.*

## ELECTRICAL PROPERTIES

174–142. Yoshimatsu, T[akasaburo]. The electric conductivity of the earth deduced from geoelectromagnetic observations and its connection with the crustal deformation: Geophys. Mag., v. 28, no. 3, p. 319–321, 1958.

This is a digest of a paper read at the general meeting of the Society of Terrestrial Magnetism and Electricity of Japan held in May 1953. From 1934 to 1949 the mean annual direction of maximum electrical conductivity in the earth's crust was determined by measurements of electric and magnetic fields taken from records of about 20 carefully selected *SSC's* per year. The change in direction of maximum conductivity is as much as about five degrees from year to year and it shows a close correlation with the deformations of a base line measured at Mitaka, about 80 km west of Kakioka.—*F. C. F.*

174–143. Noritomi, Kazuo. Migration of charged carrier in the case of electric conduction of rocks: Tōhōku Univ. Sci. Repts., 5th ser., v. 9, no. 9, p. 120–127, 1958.

When a potential difference is applied to a rock like basaltic andesite, certain material from the rock is deposited on the negative electrode by electrolysis. Such material was analyzed spectroscopically for samples of two rocks in order to determine which elements migrate at given temperatures. Examination of a basaltic andesite at temperatures of 680° and 868° C showed that nearly all the elements that migrate at the higher temperature also migrate at the lower, but those with large ionic radii such as Na, Ag, and $Pb^{+}$ seem to move more readily at the higher temperature. Examination of a perthite at 890°C showed that Al, Ca, and Na migrate toward the negative electrode. It is concluded that silica and alumina play the main role in conduction in rocks and that the other constituents may be considered as impurities in the semiconductor.—*D. B. V.*

## EXPLORATION SUMMARIES AND STATISTICS

Crary, A. P., and Goldstein, Norman. Geophysical studies in the Arctic Ocean. See Geophys. Abs. 174–353.

174–144. Oil in Canada. Exploration: Oil in Canada, v. 10, no. 31, p. 46–47, 1958.

Geophysical exploration activity in western Canada declined again in the first five months of 1958. This is a continuation of the trend apparent since the peak of geophysical activity in 1952 and reflects the maturing of the Canadian petroleum industry with the completion of the mapping of broad patterns of potential oil and gas areas.—*V. S. N.*

174–145. Ward, S. H. The role of geophysics in exploration in New Brunswick: Canadian Mining Metall. Bull., v. 51, no. 551, p. 162–166, 1958; and Trans., v. 61, p. 90–94, 1958.

Mineral exploration programs in the past five years in central New Brunswick have been planned almost exclusively around geophysical techniques because of the physical setting and lack of geological knowledge, and because ore found to date has been associated with massive sulfides. A typical exploration program involves first on airborne electromagnetic survey which locates four groups of anomalies: caused by massive sulphides, mostly pyrrhotite; by massive sulphides, mostly pyrite with some pyrrhotite and massive magnetite; by massive magnetite with some pyrite; and by carbonaceous sediments with disseminated pyrite or pyrrhotite. About 50 percent of these anomalies may be eliminated by a ground electromagnetic survey and the remainder further qualified by a gravity survey which eliminates all but sulphides and magnetite and to some extent permits evaluation of amounts and concentrations of these materials. Massive magnetite as a separate unit may be eliminated by geochemical soil sampling. Lastly, a magnetic survey indicates the probable occurrence of ore-grade pyrrhotite and(or) magnetite mineralization, if the magnetic anomalies coincide with anomalies found by electromagnetic, gravity, and geochemical methods.

The work in New Brunswick has shown that geophysical methods should not be considered static but should be subject to constant review and revision as knowledge of any mining area grows.—*V. S. N.*

174–146. Andres, Jakob. Geologische und geophysikalische Untersuchungen in Saar–Nahe–Trog [Geological and geophysical investigations in the Saar–Nahe trough]: Erdöl u. Kohle, v. 11, no. 7, p. 441–450, 1958.

A preliminary report on the results of a program of geophysical surveys and geologic mapping in the Rhine Palatinate and Saar regions of Germany from 1952 to 1957. The gravity anomalies correspond largely to structural features of the basement, the magnetic to deep-seated basic intrusions. Seismic reflection and refraction surveys show details of structure in the sediments. Details are shown in maps of gravity and magnetic anomalies, of structure contours on horizons *C* (near the Rotliegende–Upper Carboniferous boundary) and *H* (deeper in the Upper Carboniferous), and in several diagrams, profiles, and an acoustic log.—*D. B. V.*

Nemoto, Tadshiro; Hayakawa, Masami; Takahashi, Kiyoshi; and Oana, Shinya. Report on the geological, geophysical, and geochemical studies of Usu Volcano (Shōwa-Shinzan) (in Japanese with English abstract). See Geophys. Abs. 174–357.

174–147. Den Geofysiske Kommisjon. Geophysical research in Norway 1956–57: Norway Geof. Komm. Ann. Rept. no. 7, 21 p., 1958.

An outline of the geophysical work of various Norwegian organizations and institutions during the period July 1, 1956, to June 30, 1957, with bibliography of publications.—*D. B. V.*

174–148. Sojka, K[rzysztof], Szul, J., and Żytka, J. Służba geofizyczna przemysłu naftowego [Geophysical services to petroleum industry]: Nafta (Poland), v. 13, no. 10, p. 270–275, 1957.

Geophysical prospecting for petroleum in Poland is discussed, seismic prospecting in particular. Features of the surface and deep geology in different parts of the country are discussed in detail with reference to the detailed exploration of an area prior to the drilling. Increased operations in electric logging are recommended as an efficiency measure.—*A. J. S.*

174–149. Sobakar', G. T. Tektonika zakrytoy chasti zony sopryazheniya Donbassa s Priazovskvim massivom po geofizicheskim dannym [The tectonics of the covered portion of the junction between the Donbas and the pre-Azov massif, as revealed by geophysical data]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 57–61, 1958.

During the years 1955–56 the junction of the Donbas (Donetz Basin) and the pre-Azov massif, geologically very interesting, was explored by gravitational, magnetic, and electrical methods and exploratory drilling. This paper presents briefly the geologic conclusions drawn from these investigations.

The pre-Azov massif is found to be very extensive, underlying Tertiary and younger sediments to a depth of 100 to 150 m. At the northern edge the crystallines suddenly plunge under the coal basin; the gavity gradient there is 3 mgal per km, the magnetic (vertical) gradient −40 to −50 mgal per km. This indicates a major fault. Several other faults are indicated by sharp gravity and magnetic gradients, including one on the southern part of the region where the magnetic intensity jumps from −350 to +2,000 within 0.5 km. Numerous other structural details are described.—*S. T. V.*

174–150. Sollogub, V. B. K voprosu o tektonicheskom stroyenii Pred-Dobrudzhinskogo progiba i Yugo-Zapadnoy granitse Russkoy platformy po dannym geofizicheskikh issledovaniy [Concerning the tectonic structure of the Fore-Dobrudzha depression and the southwestern boundary of the Russian platform according to data from geophysical surveys]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 15–26, 1958.

Extensive geophysical surveys made recently over the Moldavian S. S. R. primarily in search of oil, have been of great importance for the elucidation of the deep geology of the region. In this paper Sollogub gives an interpretation of the data from these gravity, magnetic and seismic surveys. The gravimetric

surveys revealed two types of anomalies, linear and mosaic. The first type is probably related to petrographic discontinuities in the basement where it is shallow. Linear anomalies also occur over long faults, either in the sedimentary formations or in the crystalline basement. A wide band of negative anomalies ranging from −80 to −100 mgals surrounds the main Carpathian Ridge. The mosaic type of anomalies appear in many parts of the territory and are the manifestation of very complex deep geology.

The magnetic surveys disclosed that the entire territory can be divided into several regions of local positive anomalies, ranging from +300 γ to several thousand γ.

The seismic method brought the most reliable and interesting data on the Fore-Dobrudzha depression proper and the southwestern border of the Russian platform. Two intersecting depressions were found. Under the narrow, deep Tertiary depression trending almost north-south, is an older Jurassic depression trending northwest-northeast and going beyond the boundaries of the Moldavian S. S. R. Near Belgorod-Dnestrovsky a third depression of Cretaceous age was established. A structure map of the region studied is given.—*S. T. V.*

174–151. Godin, Yu. N. Kompleksnyye regional'nyye geofizicheskiye issledovaniya yugo-vostoka Russkoy platformy [The complex regional geophysical investigations of the southeastern part of the Russian platform]: Geologiya Nefti, no. 5, p. 37–48, 1958.

Large-scale geophysical exploration for petroleum was carried out during 1956–57 in the Volga-Ural region of the Russian platform, and similar exploration was begun in the Uzbek, Azerbaijan, and Kazakh republics, and northern Caucasus. Three traverses totalling 1,100 km established a network of regional seismic profiles over the Volga-Ural region. The seismic method was used together with aeromagnetic and gravimetric methods. The feasibility of determination of the depth of the disturbing bodies according to the structure contours and the gradients of individual local anomalies was firmly established.—*A. J. S.*

## GENERAL

174–152. Neltner, L., and Lasfargues, P. Le développement actuel de la géophysique et de la géochémie. Application à la recherche des gisements metallfères [The present development of geophysics and geochemistry. Application to investigation of metalliferous deposits]: Rev. Industrie Minérale, v. 39, no. 9, p. 773–807, 1957.

After a very brief outline of gravimetric, seismic, magnetic, and electric methods, including airborne, from the point of view of their application to mining exploration, the principles, instruments, and interpretation of gravity and magnetic surveying are described in some detail.—*D. B. V.*

174–153. Oulianoff, Nicolas. Sédimentologie et géophysique [Sedimentology and geophysics]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 3, p. 313–315, 1958.

Perpetual nonuniform vibration of the ocean bottom caused by geophysical forces such as earthquakes, volcanism, tides, storms, and atmospheric pressure changes can explain several sedimentological problems better than previous explanations that invoke only local mechanical forces. These problems are the partial elimination of original pore water from sediments and their hardening,

the presence of coarse sediments far from shores, and prolonged maintenance of fine particles in suspension.—*D. B. V.*

174–154. Ponomarev, V. N. K voprosu o vliyanii temperatury na magnitnyye kompensationnyye ustroystva [On the effect of temperature on magnetic compensating devices] : Akad. Nauk SSSR Ural Branch, gorno-geol. Inst. Trudy no. 30, geofiz. Sbornik no. 2, p. 97–99, 1957.

The intensity $H$ of a magnetic field at points on the continuation of the axis of the magnet can be expressed approximately by the formula $H=2M/l^3$ where $M$ is the magnetic moment of the magnet and $l$ the distance from the center to the point of observation. The variation of $H$ with temperature ($t$) is found from the equation $\frac{dH}{dt}=\frac{-2M}{l^3}\frac{3}{l}\frac{dl}{dt}+\frac{2}{l^3}\frac{dM}{dt}$. If the temperature coefficient of the linear prolongation of the axis of a magnet is $\alpha$ and the temperature coefficient of the magnet is $K$, then $dH/dt=-3\alpha H-KH$. The derivative $dH/dt$ can become zero only is $K=\alpha=0$, which is physically impossible, or if $K=-3\alpha$; that is, for complete temperature compensation a material with negative $K$ or $\alpha$ is needed. This condition can be fulfilled by a special construction or by the use of two magnets. An example of such very simple bi-magnetic construction is given in the article.—S. T. V.

174–155. Kinsman, Blair. Proper and improper use of statistics in geophysics: Tellus, v. 9, no. 3, p. 408–418, 1957.

Methods for treating the data on which geophysical hypotheses are based are often selected by analogy with those used on laboratory data; but the materials are sufficiently different as to require justification of the method, and this is seldom explicitly given. Geophysical observations cannot be repeated as can a controlled experiment; this is a grave difficulty since most significant statistical tests are fundamentally rooted in the idea of repetition. Nor can it be insured that factors considered negligible in order to simplify complex equations really are negligible. Simplified models should not be offered as "reality". When observations agree with such models it suggests that the neglected terms were small; but verification of theories has sometimes been claimed with discrepancies as high as ±20 percent.

Other handicaps in applying statistical methods to geophysics are the unwieldiness of the space and time scales and the fact that available data may have been obtained for other purposes and do not directly measure the properties being investigated. It is suggested that the data be split into two groups, one to be used in formulating a hypothesis and the other to be reserved for testing it. Finally, the danger of inferring cause and effect from "high" correlation, particularly when data are "adjusted", is emphasized. As illustration, it is shown that a correlation based on the number of commas on certain pages of "Tellus" gives as good correlation as the method used in a particular paper.—*D. B. V.*

174–156. Engineering and Mining Journal. How aeroplanes speed mining progress: Eng. Mining Jour., v. 159, p. 77–83, 1958.

Twelve brief case histories are given to illustrate the successful use of the airplane in exploration and development of mining areas in Canada, United States, South America, and Africa. The various surveys described include air-

borne magnetometer and electromagnetic detector surveys to locate copper, lead, zinc, and nickel sulphide deposits as well as different types of iron deposits; and aerial photographic surveys for locating boundaries, mining community sites, and railroad sites.—*V. S. N.*

174–157. Muratori, G[iovanni], Manara, G., and Chizzoni, G. L'enregistrement électronique simultané de plusieurs courbes dans les opérations de carottage [Simultaneous electronic recording of several curves in logging operations]: Geophys. Prosp., v. 6, no. 2, p. 127–134, 1958.

An experimental 4-curve electronic recorder has been constructed using modern miniaturized servomechanism components. A general description with diagrams and photographs is given, together with performance data. The apparatus consists of a motor, potentiometer, amplifier, and movable heads carrying the pens. By using photographic registration, up to 12 curves can be recorded. Electronic recorders are no less sensitive or accurate than galvanometers.—*D. B. V.*

## GEODESY

174–158. Ledersteger, K. Die Definition des Normalsphäroides der Erde [The definition of the normal spheroid of the earth]: Koninkl. Nederland. Geol.-Mijnb. Genootschap Verh., geol. ser., v. 18, p. 203–213, 1957.

The normal spheroid is simultaneously the free surface and an equipotential surface of the adjusted earth. The same relationships for the parameters $\epsilon$, $\alpha$, $\beta$, $\beta_4$, and $\delta$ are valid as for Helmert's niveau-spheroid of rotation $U_4$, for the normal spheroid can be explained as a niveau-spheroid resulting from a development in spherical harmonics of the force function of the adjusted earth. The determination of the normal spheroid involves hypothetical assumptions that introduce some uncertainty. It differs but little from the ellipsoid of revolution having the same axes and is best identified with Helmert's niveau-spheroid $U_4$, which is identical with the mean ellipsoid of the earth; for the parameter $\delta = +105 \times 10^{-7}$ the results are in full agreement with Somigliana's theory.—*D. B. V.*

174–159. Ledersteger, K. Zur Theorie des Normalsphäroides [On the theory of the normal spheroid]: Geofisica Pura e Appl., v. 40, p. 1–14, 1958.

Starting from Helmert's relationships for the rotation niveau-spheroid of the fourth order, artificial geoids approximating the actual geoid can be defined for any given configuration of masses of the earth by the requirement of a constant value of potential. It is shown that in this case, if sixth order terms are neglected, the ratio $\epsilon$ of centrifugal force to gravitation at the equator is constant; the relative changes of axis and equatorial gravity coincide up to fourth order values. For the two boundary figures (MacLaurin's homogenous ellipsoid and the spheroid of greatest concentration of masses), not only the boundary values of flattening, well known for about 200 years, but also the strictly pertinent values of the other parameters can be derived. The parameter $\beta_4$ is almost constant; from its value it follows that the normal spheroid is approximately a niveau-ellipsoid. In the vicinity of the normal spheroid a series of neighboring artificial geoids is calculated, from which the normal spheroid can be determined on the basis of the requirement of constancy of the rotation impulse. The series leads to various interesting conclusions. Several fundamental conclusions for the hypothesis-free solution of the problem of the figure of the

earth justify the method proposed by the author in 1956.—*Author's summary, D. B. V.*

174–160. Bernasconi, Carlo. La risoluzione dell'equazione di Laplace nel campo esterno a uno sferoide [The solution of Laplace's equation in the external field on a spheroid]: Geofisica Pura e Appl., v. 39, p. 26–34, 1958.

It is shown that in the system of polar coordinates $\rho$, $\phi$, $\lambda$ it is possible to determine $s$ functions only of the variable $\phi$: $Q_1$, $Q_2$ . . . . . $Q_{2s-1}$ in such a way to make the summation of the $Q_{2i-1}/\rho^{2i-1}$ represent the potention $V$ of a rotational geoid. The harmonic condition, except for an arbitrary constant, determines each $Q$, which is reduced to a polynomial in the powers of sin $\phi$; therefore one determines $s$ constants for use in satisfying $V$ on the geoid. As illustrations, gravity on the spherical geoid is determined, confirming Somigliana's results, and on a spheroid, verifying Clairaut's relationship.—*D. B. V., R. G. H.*

174–161. Arnold, K[urt]. Die Co-Geoide der Freiluftreduktion [The co-geoid of the free air reduction]: Gerlands Beitr. Geophysik, v. 66, no. 3, p. 181–198, 1957.

The disturbance-potential of the earth's gravitational field is inserted into the second identity of Green. The integrals referred to the earth's surface are transformed to the mean terrestrial sphere, admitting a relative error in the undulations of the order of magnitude of polar flattening.

This leads to a formula for the corrections to be applied to the undulations calculated from free-air anomalies. The order of magnitude of these corrections is evaluated. To determine these corrections approximate values of gravimetric geoid undulations and deflections of the vertical are necessary.

It is pointed out that in the case of undulations determined from free-air anomalies it is advantageous to introduce two co-geoids ($S_1$) and ($S_2$). The determination of undulations in reference to both these co-geoids does not require any assumption concerning the density of the mass of the earth's crust.

In order to reduce further the relative error of about 1/300 in the formula, Lamé functions can be introduced instead of spherical functions.

In this manner it is established that if free-air anomalies are used, the reduction of plumb-line curvature must be applied to the gravimetric plumb-line deflections if they are to be referred to the geoid.—*Author's summary, D. B. V.*

174–162. Pick, Miloš. Transformation der relativen Lotabweichungen aus einem Bezugssystem in ein anderes [Conversion of relative plumb-line deflections from one reference system into another]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 40, p. 69–88, 1956 (1957).

Formulas are derived for conversion from one system of plumb-line deflections to another. These formulas are then applied to converting the Czechoslovakian trigonometric network into that position with respect to the original reference ellipsoid in which the geodetic values best correspond to the astronomic values. It is shown that the system of plumb-line deflections thus determined cannot be regarded as absolute, as they do not include the continental undulations of the geoid.—*D. B. V.*

Harrison, J[ohn] C., and Jackson, J. E. Plumbline deflections in Cyprus. See Geophys. Abs. 174–204.

## GEOTECTONICS

174–163. Scheidegger, Adrian E. Principles of geodynamics: Berlin, Springer Verlag, 280 p., 1958.

The first two chapters of this book summarize the known physiographic, geologic, and geophysical facts about the earth, and the third gives the principles of the theory of deformation of continuous matter, which is the basic mechanical background of geodynamics. The last five chapters present a synoptic view of theories of the dynamics of the earth, including the effects of rotation; the continents and oceans; orogenesis; the dynamics of folding and faulting; and the dynamics of meteor craters, boudinage, domes, volcanism, and post-glacial uplift. The most competent presentations of each of the basically tenable hypotheses are compiled, and no stand is taken for or against any.—*D. B. V.*

Belousov, V. V. On some problems of geotectonics. See Geophys. Abs. 174–225.

Perrin, René. Metamorphism, solar energy and thermal data on the earth. See Geophys. Abs. 174–213.

174–164. Subbotin, S. I. O prichinakh vertical'nykh dvizheniy zemnoy kory [On the causes of vertical movements of the earth's crust]: Akad. Nauk Litovsk. SSR, Inst. geol. i geog. Nauchnyye Soobshcheniya, v. 5, p. 5–20, 1957.

Study of the gravity anomalies over the Black Sea, Mediterranean, and other seas leads to the conclusion that the main cause of vertical movements of the crust is expansion and contraction of the subcrust rather than convection currents. This expansion and contraction is produced by polymorphic changes in the subcrust at high temperature and pressure. Very small changes in temperature (which may be due to exogenic as well as endogenic causes) can bring about such reactions, if conditions are close to the critical temperature and pressure.—*D. B. V.*

174–165. Kraus, Ernst C. Fünfzig Jahre Unterströmungs-Theorie [Fifty years of "Unterströmung" theory]: Geologie, v. 7, no. 3–6, p. 261–283, 1958.

Outlines the evolution of the "Unterströmung" geotectonic theory conceived by Ampferer in 1906 and further developed by Kraus to the present time. The theory involves convection currents at two levels in the earth, in the "hyporheon" and "bathyrheon" (see Geophys. Abs. 164–144).—*D. B. V.*

174–166. Balkay, Bálint. Kéregszerkezeti adatok a földtágulás kérdéséhez [Geological evidence on the problem of expansion of the earth]: Földtani Közlöny, v. 87, no. 4, p. 395–399, 1957.

An attempt is made to calculate the amount of expansion of the earth in regions of normal faulting by analyzing many geological profiles given in the literature. For Europe, quantitative estimates are possible for the Rhine Graben, the Hungarian Basin, the Molasse Basin, and some parts of southern Germany; in each case the expansion amounts to about three percent. In several other regions of the world qualitative determinations alone are possible.

The zones of distension are of two types. The first type is parallel to folded mountain systems—for example, the Molasse Basin or the Amotape Basin of Peru—and could be formed by phenomena complementary to orogenic compression. The second type, exemplified by the Rhine Graben, cuts diagonally across the structure and is assumed to be related to forces at such great depth that crustal inequalities have no effect. It is concluded that although compressive stresses may prevail in the continental parts of the crust, the main deformation of the earth as a whole is tensional.—*D. B. V.*

174–167. Stassi–D'Alia, Ferdinando. La teoria della plasticità e la formazione dei continenti e dei rilievi montagnosi [The theory of plasticity and the formation of the continents and mountainous relief]: La Ricerca Sci., v. 28, no. 3, p. 575–592, 1958.

With regard to the questions of the origin of major crustal features, Stassi's theory of plastic deformation is similar to the theory of isostasy in application but leads to different results, for it takes into account resistance of the materials to tension and compression. The plastic theory involving plastic flow under very high stresses explains some features of the earth's surface more satisfactorily than isostasy. It is not necessary to postulate an asthenosphere that is dense and lacking in resistance. Superficial fractures of the crust and archipelagos are the result of processes acting at relatively shallow depths, whereas continents and mountain ranges result from much deeper processes. Certain simplifications and omissions are justified, because the stresses represent boundary values corresponding to the state of equilibrium which can be attained only over time intervals of the order of whole geological periods.—*D. B. V.*

174–168. Wegener, Kurt. Das Schwimmgleichgewicht des Sial im Sima [The floating equilibrium of the sial in the sima]: Geofisica Pura e Appl., v. 40, p. 49–54, 1958.

Gravity measurements in various parts of the earth are interpreted as indicating that the continents are for the most part in simple floating equilibrium in the sima. Large areas of positive Bouguer anomalies over the sea indicate that the sial is thin and the sima surface higher than usual, being held up by lateral pressure or tension.—*D. B. V.*

Galushko, P. Ya. Some possible interpretations of gravitational anomalies corresponding to different structures of the earth's crust. See Geophys. Abs. 174–180.

174–169. Stille, Hans. Einiges über die Weltozeane und ihre Umrahmungsräume [On the world oceans and their border areas]: Geologie, v. 7, no. 3–6, p. 204–306, 1958.

The origin, development, bordering structures, and age of the three great oceans are examined. The Pacific ("primeval ocean"), Atlantic ("mixed ocean"), and Indian ("new ocean") occupy the same relative positions with respect to geographic position (west to east), size, age and stage of development. The Pacific is oldest and is "finished"; it was formed in the original partitioning of the crust into an ocean basin and continent ("Megagaea"); it is bordered by folded zones developed from orthogeosynclines, with respect to which it is the hinterland. The Atlantic formed soon after when Megagaea broke up, under the

influence of the earth's rotation, into the Old and New World masses; germanotype structures (the only kind of deformation that can occur in continents under contraction) and alpinotype are superposed. The Indian Ocean formed still later, but the westward drift of sial that produced it probably had already begun in Huronian time; this ocean is "unfinished", surrounded only by germanotype structures.

It is shown that an overthrusting on the sub–Pacific kraton by Megagaea from the west can explain the distribution of deep and intermediate earthquakes and of volcanoes, the Meinesz zone of gravity anomalies, and border deeps.—*D. B. V.*

174–170. Ma, Ting Ying H. Continental drift and the present velocity of shift of the continental margin of eastern Asia: Research on Past Climate and Continental Drift, v. 13, 22 p., 1957.

The course of continental drift, traced from coral reef data, shows that an ancient continent "Laurasiafrica" separated into major fragments which reached their present positions by widening of the Arctic, Atlantic, and Indian Oceans; Australia meanwhile shifted toward southeast Asia with counter-clockwise rotation. Motion of the Americas toward the Pacific produced the coastal orogenic belts, motion of the Americas toward each other produced the West Indies intercontinental tectonic complex. Clockwise rotation of Africa from India against Europe caused the belts of the Mediterranean intercontinental complex. Motion of Asia toward the Pacific produced the Indonesian belt against the northwestward motion of Australia, the Himalaya-Assam complex against the stable Deccan massif, and the marginal island arcs and geanticlinal ridges of the western Pacific.

The shear planes represented by earthquake foci on the margin of a continent or between two crustal masses are the zones of weakness over which crustal masses were thrust in the last sudden displacement of the solid shell. Rotation of the earth causes slow movement of the crustal masses over these shear planes. The amount of lateral shift can be determined from the amount of uplift because the angle of the shear plane is permanent; for the margin of eastern Asia it is calculated to be 30 cm per century.—*D. B. V.*

174–171. Ma, Ting Ying H. Cause of change in sea level in the western Pacific: Oceanographia Sinica, v. 4, no. 2, 6 p., 1957.

Topographic and tide gage evidence indicates a gradual rise of the coast of East Asia and the geanticlinal ridges of the western Pacific amounting to 17 cm per century. The regions in question are all on the forward edges of crustal masses shifted in the last sudden displacement of the solid earth shell; the shear zone of the overthrust plane is a weak zone over which there is gradual movement of the upper limb, due to rotation of the earth, which is represented by earthquake foci to a depth of 700 km. Although movement is small the total amount of uplift on this overthrust plane has a greater effect on sea level than the amount that can be attributed to eustatic withdrawal.—*D. B. V.*

174–172. Ma, Ting Ying H., and Pan, Chia-Lin. Development of volcanic belts together with zones of deficient gravity along the margin of crustal masses: Oceanographia Sinica, v. 4, no. 3, 4 p., 1957.

The course of continental drift, as determined from studies of fossil coral growth rate, shows that volcanic belts coinciding with negative gravity zones

are distributed along the forward margin of a crustal mass that has moved, or between two colliding masses. The overthrusting of one mass over another due to sudden total displacement of the solid earth shell caused folding of sial layers to produce the gravity deficiencies; volcanism resulted wherever pressure was reduced in the geanticlines.—*D. B. V.*

174–173. Saito, Y. On the dynamics of faulting: Geophys. Mag., v. 28, no. 3, p. 329–342, 1958.

Saito considers the interaction between uniform plane stress fields and cracks in a homogeneous isotropic continuum. The crack is interpreted in terms of a model consisting of a pair of dislocations and the complex and Airy stress functions for various dislocation pairs are found using the equation $^4F(x, y)=0$. The strain energy of the system having uniform stress and a dislocation pair is found to contain an interaction energy term as well as energy terms due to the uniform stress field and dislocation pair. The expressions for the forces acting on the dislocation, $F_x=\frac{\sigma u}{\sigma x}$, are then found in terms of radial and angular components. Considering that the growth of the cracks can occur only when the radial forces act outward along its direction, four cases for which faulting can occur are obtained; the normal faults result from uniform extension, the reverse faults from uniform compression. Finally, the equation for the breaking stress is derived in terms of the elastic constants, surface tension, and the dislocation strength.—*L. P.*

174–174. Tsumurā, Kenshiro. Study of change in the difference of monthly and daily mean sea-levels between two stations, as an indicator of the vertical crustal deformation (in Japanese with English abstract): Zisin, ser. 2, v. 10, no. 2, p. 67–78, 1957.

The Japanese coast can be divided into several regions in each of which the monthly mean sea levels at mareograph stations change almost identically. The change in the difference in monthly mean sea levels between selected stations within a region is used to study the vertical crustal deformation, and the change in the difference in daily mean sea levels between stations for tracing detailed processes of vertical deformation. The observations are particularly useful for study of vertical crustal deformations before and after destructive earthquakes.—*V. S. N.*

## GLACIERS

174–175. Förtsch, Otto, and Vidal, H. Die seismische Vermessung des Grosser Gurgler Ferners in den Ötztäler Alpen in Spätsommer 1956 [Seismic survey of the Grosser Gurgler Ferner in the Ötztäler Alps in late summer 1956]: Gerlands Beitr. Geophysik, v. 67, no. 1, p. 1–30, 1958.

Seismic measurements, using refraction methods, were made on the Grosser Gurgler Ferner, a glacier in the Ötztäler Alps in Austria. Ice thicknesses were determined using an estimated longitudinal velocity for the whole glacier of 3,600 m per sec. Poisson's ratio computed from average values of longitudinal and transverse velocities was 0.36.

The velocity of the bedrock and velocities in the ground moraine were determined. The lower part of the moraine was found to have higher velocities

than the upper parts, possibly due to the different compaction of the moraine by the ice load.

Contour-line maps for the surface of the ground moraine and the bedrock of the valley are shown. The total volume of ice and ground moraine in the surveyed area is computed as 0.64 km$^3$ (0.24 km$^3$ of ice plus 0.40 km$^3$ of moraine).—*L. P.*

174–176. Brockamp, B. Eisseismische Untersuchungen [Seismic ice investigations]: Zeitschr. Geophysik, v. 23, no. 5, p. 241–242, 1957.

Available data on longitudinal wave velocities in ice are compiled in a graph showing dependence of velocity on temperature.—*D. B. V.*

Lotze, W. Measurements of acoustic velocity of ice dependent on pressure and temperature. See Geophys. Abs. 174–94.

## GRAVITY

174–177. Merson, R. H., and King-Hele, D. G. Use of artificial satellites to explore the earth's gravitational field: Results from Sputnik 2 (1957 $\beta$): Nature, v. 182, no. 4636, p. 640–641, 1958.

Information from Sputnik 2 shows a discrepancy between observed and theoretical values for the mean rate of rotation of the orbital plane for a near satellite in the gravitational field; this indicates that one or both of the constants $J$ and $D$, which enter into the formula for the gravitational potential of the earth at an exterior point, are in need of revision. A change in $J$ from 0.001637 to 0.001626 (corresponding to a change in $1/\epsilon$ from 297.1 to 298.1$\pm$ 0.1 where $\epsilon$ is polar flattening) or a change in $D$ from $10.6\times10^{-6}$ to $45\times10^{-6}$ would explain the discrepancy; preliminary observations suggest that it is the $J$-term which needs to be reduced, though not necessarily to the value given.—*D. B. V.*

174–178. Yevseyev, S. V. O nekotorykh zakonomernostyakh gravitatsionnogo polya zemli i ikh znachenii dlya geodezii i geofiziki [On some regularities of the earth's gravity field, and their meaning to geodesy and geophysics]: Akad. Nauk Ukraynskoy RSR, 72 p., 1957.

This is a theoretical monograph on the gravitational field of the earth. Using the gravimetric network of several tens of thousands of points scattered over two-thirds of the U. S. S. R., Yevseyev investigates gravity phenomena related to problems of higher geodesy and the theory of the figure of the earth within the ranges of median, interpolated, and extrapolated values of gravity anomalies. Methods of treatment of observational data for their more dependable interpretation, and the meaning of such an interpretation in terms of geodesy and geophysics are discussed throughout the monograph. For the gravity force as a function of altitude $h$ over oceans and continents, Yevseyev derives the simple formula $\Delta g=A+Bh$ in which the higher harmonics part $Bh$ is separated from part $A$. Such a separation allows a treatment of $\Delta g$ problem with the aid of the regular Fourier series $\sum_{0}^{\eta} A_j$, instead of Fourier double entry interpolation series, and it leads to a considerable improvement in convergence. The methods of determination of regional, local, and isostatic anomalies are discussed, and mathematical short-cuts are suggested which do not sacrifice accuracy. Twenty-two diagrams, 10 tables, and 33 references (26 by Russian authors) are given.—*A. J. S.*

Arnold, K[urt]. The co-geoid of the free air reduction. See Geophys. Abs. 174–161.

174–179. Perrin, R[ené]. Conceptions nouvelles sur l'interprétation des anomalies de la pesanteur [New concepts concerning the interpretation of gravity anomalies]: Bull. géod., no. 46, p. 65–80, 1957.

Perrin attempts to explain the predominance of negative Bouguer gravity anomalies over continents and positive anomalies over oceans in terms of his concept of solid diffusion. The outer crust must have originally been more uniform and richer in iron than at present (probably similar to the basaltic subcrust); erosion and sedimendation and biological processes have tended to concentrate iron in large local deposits, and metamorphism and granitization have involved a downward migration of the heavier elements and upward movement of the lighter. All continental formations visible today, except lavas, are ultimately of sedimentary origin. Negative anomalies reflect a present deficiency of density with respect to that of the original crust which was more or less in hydrostatic equilibrium. The concept embraces everything from local anomalies, explicable entirely in terms of local geologic features, to very broad scale structures. It is considered to be more reasonable than the concept of isostasy, for considerable variations are to be expected; therefore no strong forces need be invoked to explain departures from the normal.—*D. B. V.*

174–180. Galushko, P. Ya. Vozmozhyye znacheniya gravitatsionnykh anomaliy pri razlichnykh structurakh zemnoy kory [Some possible interpretations of gravitational anomalies corresponding to different structures of the earth's crust]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 79–93, 1958.

On the basis of an extensive analysis of different possible geological structures which could be met in gravimetric surveying over continents and oceans, it is concluded that all observed gravity anomalies whether total, Bouguer, or isostatic, can be attributed to structural features of the crust, without resorting to hypotheses of subcrustal flow currents or the like. (See also Geophys. Abs. 174–229).—*S. T. V.*

174–181. Andreyev, B. A. Gravitatsionnyye anomalii i moshchnost' zemnoy kory kontinental'nykh oblastey [Gravity anomalies and thickness of the earth's crust in continental regions]: Akad. Nauk SSSR Doklady, v. 119, no. 2, p. 255–256, 1958.

Crustal thickness in km is plotted against Bouguer anomaly intensity $\Delta g$ in mgals to find out whether the regional gravity anomalies reflect the deep structure of the crust according to seismological data. Data of seismic and gravity profiles from Central Asia, western Siberia, Germany, Alps, Canada, Sierra Nevada, central Appalachians, New York, Pennsylvania, Tennessee, Maryland, and Minnesota suggest a linear correlation between the anomalies $\Delta g$ and crustal thicknesses. A thickness of 30 km was found to correspond to zero values of $\Delta g$, a thicker crust to negative anomalies.—*A. J. S.*

Ma, Ting Ying H., and Pan, Chia-Lin. Development of volcanic belts together with zones of deficient gravity along the margin of crustal masses. See Geophys. Abs. 174–172.

Subbotin, S. I. On the causes of vertical movements of the earth's crust. See Geophys. Abs. 174–164.

174–182. Baranov, V[ladimir] [I.]. Interprétation des anomalies gravimétriques; quelques développements récents [Interpretation of gravity anomalies; some recent developments]: Bull. géod., no. 45, p. 20–25, 1957.

A review of the problem of separating gravity anomalies due to different causes in order to study and interpret them individually. Current methods of calculating regional anomalies, second derivatives, and vertical gradients are discussed. Although for prospecting purposes accuracy is often sacrificed for the sake of rapidity, it is possible to establish practical formulas that are both very exact and very rapid; the only limitation is the precision of the gravity map itself. Two very precise and hitherto unpublished formulas are presented for the vertical gradient and second derivative, respectively:

$$-g=\frac{\pi^2}{4}\,g_0-\frac{2}{1!}\,\overline{g}(1)-\frac{2}{3!}\,\overline{g}(3)-\frac{2}{5!}\,\overline{g}(5)-\cdots\cdot$$

$$g''=\frac{2\pi^2}{3}\,g_0-8\left[\overline{g}(1)-\frac{\overline{g}(2)}{2^2}+\frac{\overline{g}(3)}{3^2}-\cdots\cdot\right]$$

Calculation of these coefficients is simple; the practical difficulty consists of reducing their number in order to replace the series by a finite expression.

—*D. V. B.*

174–183. Bulakh, Ye. G. Ob interpretatsii anomaliy $\Delta g$ pryamym metodom [On the interpretation of gravity anomalies by the direct method]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 12, p. 1512–1514, 1957.

Beginning with a determination of a potential $V(\xi, \zeta)$ of the masses distributed over a two-dimensional region $S$ of excess density $\sigma$, with respect to a point outside the region, Bulakh extends the Lyapunov and Smolitskiy interpretation of gravity anomalies (see Geophys. Abs. 170–173). Applying the mean value theorem to Lyapunov's criterion integral, he determines the mean values $x_{mn}$ and $z_{mn}$ of point coordinates within $S$, and of the excess mass $M$, thus arriving at a formula for $\Delta g$. The derivations are not completely rigorous, and the formula should be applied with caution. (See also Geophys. Abs. 174–184).

—*A. J. S.*

174–184. Bulakh, Ye. G. O nekotorykh kriteriyakh dlya proverki interpretatsii gravitatsionnykh i magnitnykh anomaliy [Some criteria for checking interpretations of gravitational and magnetic anomalies]: Akad. Nauk SSSR Izv. Ser. geofiz., no 9, p. 1173–1177, 1957.

Referring to the criteria established previously by Lyapunov, Smol'nitskiy, and himself (see Geophys. Abs. 164–164, 164–160, 170–173, respectively) Bulakh derives mathematically three additional criteria for checking interpretations of gravity anomalies $\Delta g$ and $V_{zz}$, and the vertical and horizontal components of the anomalous magnetic field of a uniformly magnetized body.—*A. J. S.*

Timofeyev, A. N. The interpretation of geophysical anomalies by the graphic method of tangents. See Geophys. Abs. 174–287.

174–185. Vyskočil, Vincenc. Determination of the shape of a boundary between two media from gravitational data for varying density with depth: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 38, p. 33–54, 1956 (1957).

Existing methods of determining the shape of a boundary between two media in gravity surveying (usually based on the assumption that the disturbing masses are of constant density) are summarized and evaluated, and optimum conditions for their use are considered. Then these methods are generalized for cases where density is a function of depth, as in sedimentary basins. It is shown that the differences between depths calculated for linear and exponential dependence of density on depth are small and are within the limits of accuracy; therefore it is sufficient to consider only the simple linear dependence.—*D. B. V.*

174–186. Duska, Leslie. Maximum gravity effect of certain solids of revolution: Geophysics, v. 23, no. 3, p. 506–519, 1958.

This paper presents formulae for calculating the gravitational attraction, at points on their central vertical axes, of several solids of revolution. Such calculations are sometimes desirable to find the maximum anomalies which may be caused by geologic bodies which are assumed to have the approximate shape of a solid of revolution. A reasonable set of density differences must be used in such preliminary gravity calculations to find the limits of the anomalies to be expected. A table of formulae is presented.—*Author's abstract*

174–187. Válek, Rostislav. Charts for calculating the gravitational effect $V_z$ of a sphere, cylinder and step: Československá Akad. Věd Geofys. Ustav Práce, Geofys. Sborník, no. 36, p. 11–20, 1956 (1957).

Charts are presented for speeding up the calculation of the gravity effect of a sphere, a two-dimensional (infinite) cylinder, a finite cylinder, and a horizontal step with incline. The method of calculating the charts is explained. Accuracy is about ± 5 percent.—*D. B. V.*

174–188. Válek, Rostislav. Opredeleniye topograficheskikh popravok pri gravimetricheskoy razvedke [Determination of topographic corrections in gravimetric surveys (with English and Czech summaries)]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 37, p. 21–31, 1956 (1957).

Several aids to determination of topographic corrections in gravity surveying are presented. The first consists of double scales giving the relationship of the altitude difference of a sector and the topographic correction for an equidistant step $H$; if a strip of paper with an identical altitude scale is placed on this double scale so that the altitude of the point in question corresponds to zero on the double scale, the absolute heights of the sectors indicate the corresponding topographic corrections on the double scale. An alinement chart is also given, by means of which the topographic correction can be obtained up to 500 m in the case where the generalized terrain of a point $Q$ can be depicted by a profile; the values obtained from the profile are added up on the chart to give the correction. Finally, substantial saving of time can be achieved by not calculating the topographic correction for each point separately but by constructing a map of the corrections. The topographic corrections must be known for points characteristic of the altitude; the isolines of the corrections are drawn

so as to have a course similar to the generalized contours and the corrections are read off the map for an arbitrary point.—*D. B. V.*

174–189. Lyubimov, L. M. Nivelvinyy komplekt *VITR* dlya ucheta vliyaniya rel'yefa mestnosti pri rabote s gradientometrari [The *VITR* leveling system for calculating the topographic effect of a locality in work with gradiometers]: Razvedka i okhrana nedr, no. 9, p. 29–34, 1957.

A special leveling instrument of a relatively simple design has been developed by the Russian topographic research institute for rapid determination of the topographic correction in surveys using gradiometers. The instrument is provided with a Cardan suspension which saves much time in the exact leveling of the instrument. Readings at eight or even only four angles were found sufficient for the desired accuracy. The outfit was mounted on an ordinary leveling instrument and tested in the field for accuracy and speed. The error was not greater than with the usual instruments, but the time spent was only one sixth of the normal.—*S. T. V.*

174–190. Arnold, K[urt]. Betrachtungen zur Bestimmung der gravimetrischen Lotabweichungen aus Freiluftanomalien der Schwere [Considerations on the determination of gravimetric plumb line deflections from free air gravity anomalies]: Gerlands Beitr. Geophysik, v. 67, no. 2, p. 97–134, 1958.

A formula for the determination of "aboslute" deflections of the plumb line by gravity measurements executed on the surface of the earth is given. The deductions show that free-air anomalies must be used. The formula contains the integral of Vening-Meinesz, the difference between the real and the "normal" reduction on behalf of the curvature of the plumb line; further there appear some terms, which depend in the first approximation on the value of the integral of Vening-Meinesz and on the slope of the surface of the earth in the surroundings of the point for which the deflection of the plumb line is to be determined. In these deductions only such terms are taken into account, that are a linear function of the inclination of the surface of the earth.—*Author's summary*

174–191. Botezatu, Radu. Asupra calculului anomaliei gravitatiei in reducerea Bouguer [On the calculation of gravity anomalies in Bouguer reduction]: Metrologie aplicate, no. 8, p. 2–10, 1957.

The usual method of gravity anomaly determination is analyzed, the form and magnitudes of the approximation taken into consideration as they follow from the Bouguer reduction. The degree of accuracy of the determination under the conditions of geomorphology and geography of the Rumanian People's Republic is discussed. Gravity anomalies in areas of considerable density variation in the surface deposits and in rugged terrain are described.—*Author's abstract, A. J. S.*

174–192. Lundberg, Hans. Airborne gravity surveys: Canadian Mining Jour., v. 78, no. 6, p. 121, 1957.

An enlargement of the article previously published in Canadian Oil and Gas Industries, v. 10, no. 4 (see Geophys. Abs. 169–153). The airborne gravity sur-

vey provides an efficient means of obtaining information on deposits of hematite, chromite, manganese, and zinc, (none of which can be detected by other geophysical methods) as well as a means of screening electromagnetic and magnetic anomalies to determine those carrying ore. Fairly small ore bodies are clearly indicated by this method. The optimum altitude for conducting surveys is higher than in other methods.—*V. S. N.*

174–193. Lundberg, Hans. Airborne gravity surveys: Canadian Inst. Min. Metallurgy Trans., v. 60, p. 251–259, 1957.

Essentially the same article as that previously published in Canadian Mining Jour., v. 78, no. 6 (see Geophys. Abs. 174–193), and in Canadian Oil and Gas Industries, v. 10, no. 4 (see Geophys. Abs. 169–153).—*V. S. N.*

174–194. Kuzivanov, V. A. Opredeleniye sily tyazhesti gravimetrom na more [The determination of the gravity force at sea with a gravimeter]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 648–654, 1958.

The main difficulty in the determination of gravity at sea by means of gravimeters is the necessity of taking into account the movement of the support of the gravimeter, which can be vertical, horizontal, or rotational accelerations due to displacements, as well as inclinations on the moving ship. Analyzing the differential equation of the moving support, Kuzivanov recommends using a gravimeter with over-damped system and adjusting the pendulums almost horizontally. This decreases the effect of disturbing terms in the differential equation of the motion, making it possible to neglect many of them. A further decrease of the disturbing effect can be attained by the use of two pendulums mounted in opposite directions. The readings of these pendulums must be corrected for the effect of the angles of inclination of the base and of horizontal accelerations, which must be recorded by special vertical and horizontal accelerometers.—*S. T. V.*

174–195. Graf, A[nton]. Über die bisherigen Erfahrungen und Messergebnisse mit dem Seegravimeter [On the experiences so far and results of measurements with the sea gravimeter]: Zeitschr. Geophysik, v. 23, no. 1, p. 4–25, 1957.

The results of tests of the Graf sea gravimeter are reported. Two trips were made on the Starnberger See aboard a 100-ton ship and one on the Mediterranean aboard a 5,000-ton ship. On the lake accuracy was found to be $\pm 0.3$ mgal under good weather conditions and $\pm 0.8$ under bad. Some of the measurements in the Adriatic could be compared with the results of Moselli's submarine gravity measurements; although the Brown effect could not be determined and therefore was not taken into account, agreement was about $\pm 2$ mgal.—*D. B. V.*

174–196. Worzel, J. L[amar], and Graf, A[nton]. Comparison of the Graf sea gravimeter with the Vening Meinesz apparatus on board the submarine U.S.S. *Becuna:* Bull. géod., no. 45, p. 38–53, 1957.

Gravity measurements were made aboard the submarine U. S. S. *Becuna* with a Vening Meinesz pendulum and a Graf sea gravimeter at approximately the same time. Comparison of data (uncorrected for depth, Eötvös correction, and second order effects of horizontal acceleration) showed a change related to time

of observation. This could be caused by instrumental drift or scale calibration. After removal of this effect by visually fitting the data trend with a straight line, there were three observations with large discrepancies, 17 with discrepancies of 3 to 9 mgals, and 39 with discrepancies of 0 to 3 mgals. The first may be dismissed because of very poor depth control during those observations, but the second group are larger than expected, and may be due to poor depth control and inadequate observation time for the Graf instrument. It is concluded that the Graf sea gravimeter shows great promise for use on a submarine, but that an apparatus to take into account the effects of horizontal acceleration must be added and suitable drift characteristic must be obtained. More comparisons should be made before the Vening Meinesz pendulum is displaced by the more convenient Graf instrument. The latter is probably usable on a stable platform on a surface vessel in calm seas.—*D. B. V.*

174–197. Matsuda, Takeo, Sugiyama, Tomonori, and Suda, Yoshirō. On the calibration of the North American Gravimeter *AGI*–157: Geol. Survey Japan Bull., v. 8, no. 10, p. 33–34, 1957.

The scale value of the North American gravimeter *AGI*–157 was found to be $0.1207 \pm 0.0001$ mgal per scale division, as determined by comparison of results of observations in Chiba Prefecture with results obtained with a pendulum apparatus.—*V. S. N.*

174–198. Popov, Ye. I. Novye experimental'nyye dannyye o spolezanii nul'punkta kvartsevykh gravimetrov, osnovannykh na ispol'zovaniya uprugikh svoystv zakruchennykh nitey [New experimental data on the creep of the zero point of quartz gravimeters, based on the use of the elastic properties of torsion fibers]: Akad Nauk SSSR Izv. Ser. geofiz., no. 5, p. 655–665, 1958.

The elastic properties of torsion fibers made of different kinds of quartz glass and used in the elastic systems of the Norgaard and the Russian CH–3 gravimeters were investigated, in order to find the best material and optimum conditions for decreasing the drift of the zero point of these instruments. It is concluded that under constant external conditions the zero-point drift of the quartz system is determined by creep of the quartz fibers and the resulting elastic aftereffect. The duration of a high rate of creep can be reduced to 5 to 10 days, instead of 80 to 100 days, by first twisting the threads over a greater angle and holding them in this state for a short while, then heating to a temperature of 186° to 200° C. The reduction of the rate of final creep of the zero point can be attained by increasing the thickness of the fiber and adjusting the thermostatic temperature to about 0° C.

Neither the kind of quartz nor the variation of the stress on the threads from 4 to 30 percent of their strength affect the rate of final creep. The same result was obtained by the use of tubular threads. The decrease of the diameter of the thread to about 30 to 40 $\mu$ causes a sharp increase of the creep. The change from pure quartz glass to one with different materials added increased the creep in all trials.—*S. T. V.*

174–199. Thulin, Åke. Résultat d'une nouvelle détermination absolue de l'accélération due à la pesanteur, au Pavillon de Breteuil [Result of a new absolute determination of the acceleration due to gravity, at the

Pavillon de Breteuil]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 24, p. 3322–3324, 1958.

The mean value of twenty measurements of absolute gravity at Pavillon de Breteuil, France, was 980,927.7±1 mgal; according to the best available measurements the value of this station in the Potsdam system should be 980,940.8 mgal. The new measurements thus indicate that a correction of —13.1 mgal should be applied to the Potsdam system.—*D. B. V.*

174–200. Reichender, K. Zur Neubestimmung der absoluten Schwere in Potsdam [On the new determination of absolute gravity at Potsdam]: Zeitschr. Geophysik, v. 23, no. 1, p. 1–3, 1957.

Recent determinations of gravity acceleration at different places indicate that the Potsdam gravity system is more than 10 mgals too high. Preparations are being made for a new determination at Potsdam, which will be based on the principle of the reversible pendulum. To eliminate the effect of movements of the support, two pendulums swinging in opposite directions are used. They need not be removed from the vacuum either for measurement of length or for the reversal; for the latter purpose the whole apparatus is turned, being equipped with an upper and a lower bearing. Lengths are measured by interferometric comparison with quartz gages. To eliminate the effect of the bearing and the knife edge, three pairs of pendulums of different lengths are used.—*D. B. V.*

174–201. Morelli, C[arlo]. A new comparison of the Italian "conventional" mgal and the German pendulum values: Bull. géod., no. 45, p. 1–19, 1957.

Gravity differences between some selected German pendulum stations were measured in 1951 in order to calibrate two Worden gravimeters; on the basis of these measurements a "conventional" calibration line was established in Italy. A new series of comparison measurements was completed in 1956, using only the small dials of the two gravimeters. All the 1951 measurements have been reduced according to the new conventional calibration, which corrects for periodic errors in the large dials in the earlier measurements. Results are tabulated. There is good agreement between the earlier and later measurements. The difference between the "conventional" Italian milligal and the old German milligal is found to be —0.5 percent.—*D. B. V.*

174–202. Bancroft, A. M. Gravity measurements in the Queen Elizabeth Islands of Arctic Canada: Am. Geophys. Union Trans., v. 39, no. 4, p. 615–619, 1958.

Five gravity stations were established using a North American gravimeter at permanent weather reporting stations in the Queen Elizabeth Islands north of latitude 74° N. The observed gravity is referred to the Churchill Airport gravity station. The gravimeter readings and the principle data for the gravity stations are presented. The values of observed gravity are probably consistent among themselves to better than 0.2 mgal; however, they may be one mgal too high or too low relative to the Ottawa pendulum station.—*D. R. M.*

174–203. Goetz, Joseph F. A gravity investigation of a sulphide deposit: Geophysics, v. 23, no. 3, p. 606–623, 1958.

A detailed gravimetric survey was made of "Anomaly 96", a sulfide body located by truck-borne electromagnetic equipment in Dufrenoy Township, Que-

bec. A total of 205 stations were established at 100-foot intervals along nine straight 2,000-foot traverses, covering the anomaly and some surrounding areas. The residual gravity map shows a clearly defined anomaly on a relatively smooth background; a high in the northwestern part of the area and lows in the southeast and northeast can be correlated with observed and assumed overburden thickness. With the help of available drilling data the shape of the disturbing body is assumed to be an elongated, tapered, tabular or lens-shaped body dipping almost vertically, generally parallel to the surface and almost 1,000 feet long and at most 600 feet deep. The calculated gravity effect of such a structure, with a concentration of disseminated pyrite in the north wall, compares well with the observed anomaly. Total mass is calculated as $3.21 \times 10^6$ tons.—*D. B. V.*

174–204. Harrison, J[ohn] C., and Jackson, J. E. Plumbline deflections in Cyprus: Bull. géod., no. 45, p. 35–37, 1957.

Variations in deflections of the vertical measured at five places in Cyprus are very large in relation to the size of the island, and the deflections themselves are of the order of half a minute, towards the center of the island, at points near the coast. This indicates the presence of very dense rocks beneath the island. Large positive gravity anomalies were found over the center of the island, but preliminary calculations showed that these would account for deviations only about half as great as those observed. Deflections are calculated on the basis of new geodetic data tying Cyprus in with the Egypt–Israel–Syria geodetic system, and on the basis of free-air gravity anomalies; the results agree qualitatively, but there are consistently positive differences averaging 9 seconds in latitude. This could be due to erroneous positioning of Cyprus on the reference spheroid.—*D. B. V.*

174–205. Chudoba, Vratislav. Das tschechoslowakische Gravimeternetz I. und II. Ordnung [The Czechoslovakian gravimetric network of the first and second orders]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 63, p. 217–280, 1957.

A detailed account of the Czechoslovakian gravimetric network of the first and second orders, comprising 607 points, is presented in this paper. The survey was organized during 1948–1954, and completed with a Nörgaard gravimeter TNK 310 in 1955–56. It is believed that the actual error at any point of first and second orders does not exceed ± 0.5 mgal with reference to the base. A schematic map of the network is given, to accompany an extensive table (25 pages) of gravimetric points. The table gives local name of the point, its geographical coordinates, altitude above Adriatic Sea level, observed acceleration, Faye and Bouguer reductions, and their respective anomalies calculated after Helmert and Cassinis. These data are preliminary, and expected to be improved to the hundredths of a mgal before the Czechoslovakian network is included in the international network.—*A. J. S.*

174–206. Ibrmajer, Jaroslav. Gravimetricheskaya razvedka yugovostochnoy Slovatskoy vpadiny [Gravimetric survey of the southeastern Slovakian basin (with German summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 2, p. 233–255, 1957.

A gravity survey was made in 1953 of the Neogene basin in southeastern Slovakia, using two GKA gravimeters; accuracy was ± 0.3 to 0.4 mgal, station density one per km$^2$. The results are presented in a Bouguer map and are

compared locally with those of earlier gravity and magnetic surveys. The geology is interpreted, using all available geological and geophysical data; regional anomalies are correlated in part with basement relief, in part with igneous rock bodies at depth, and local anomalies are correlated with different factors such as structures or facies changes in the thick upper Tertiary sediments, or the presence of local shallow igneous rock masses. Two profiles of the basement are constructed, using different values for the density difference between sediments and basement (0.4 and 0.5 g per $cm^3$).—*D. B. V.*

174–207. Polanský, Jindřich, and Dobeš, Miroslav. Interpretace gravimetrického měření v Kladensko–Slánsko–Rakovnické pánvi [Interpretation of gravimetric measurements in the Kladno–Slaný–Rakovník basin (with English and Russian summaries)]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sbornik, no. 39, p. 55–67, 1956 (1957).

The results of a gravity survey in the Kladno–Slaný–Rakovník basin in Czechoslovakia are presented, including a gravity map (topographically reduced) and graphs of the gravity effects of spilite bodies. The effects of known geologic structures are interpreted first; these include anomalies due to the outcropping Říp basalt and some spilite bodies, one due to the relief of the Proterozoic, and one due to the Čistá granite massif. Other anomalies are interpreted as representing unexposed spilite bodies (positive anomalies) and granite (negative anomalies).—*D. B. V.*

174–208. Facsinay, László, Pintér, Anna, and Pollhammer, Manóné. A magasabb deriváltak számításának gyakorlati eredményei néhány magyarországi gravitációs mérési területen és a maradékhatások számításának kiterjesztése nagyobb területegységre [The practical results of calculations of higher derivatives in gravity surveys in some areas in Hungary and the extension of the calculations of residual effects to larger areas (with English summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, v. 7, no. 1, p. 33–55, 1958.

The results of calculations of higher derivatives of gravity in three areas in Hungary (Bobocsa, Nagylengyel, and Esztergom–Dorog areas) are compared with results of seismic surveys and deep drilling, and the applicability of the anomalies calculated by the formulas given by Peters, Elkins, Rosenbusch, Baranov, and Sharpe is analyzed for the first two areas. The second part of the paper discusses the calculation of the regional and residual effect of isostatic anomalies in Hungary and Slovakia by the method of mean values. The regional source explains the differences in anomalies between the northwestern and southeastern parts of the Hungarian Basin.—*D. B. V.*

174–209. South African Department Mines Geological Survey. Gravitasiekaart (Bouguer–anomalieë) van die Unie van Suid–Afrika [Gravity map (Bouguer–anomalies) of the Union of South Africa]: South Africa Dept. Mines Geol. Survey Map, 4 sheets, 1958.

This map shows gravity data overprinted on the 1955 geological map of the Union of South Africa on the 1 : 1,000,000 scale.—*V. S. N.*

174–210. Krzivanek, G. A. Nekotoryye dannyye o glubinnoy strukture tsentral'noy chasti Prichernomorskoy vpadiny [Some data on the deep structure of the central portion of the Black Sea marginal depression]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 1, p. 65–74, 1956.

Using the data of geological and geophysical (gravity and magnetic) surveys made in recent years in southern Ukraine, Krzivanek analyses the deep structure of the central part of the depression which embraces the Crimean Peninsula, extends north to Krivoy Rog, west to the Tarkhankut uplift, and east to the Sea of Azov. He describes two profiles, one extending from Simferopol' to Karkinit Bay, the other crossing the eastern slope of the Tarkhankut uplift. The anomalies of the deep structure along the profiles indicate oscillatory movements in time and space. Interruptions in the process of sedimentation in the region of the central Crimean steppes, and the erosion and decomposition of Cenozoic and Mesozoic rocks suggest a predominance of positive movements.—*S. T. V., A. J. S.*

Skopichenko, M. F. Some peculiarities of the geomagnetic and gravitational anomalous fields of the central part of the Black Sea marginal depression and their geologic interpretation. See Geophys. Abs. 174–294.

174–211. Lebedev, T. S. Gravitatsionnyye i magnitnyye anomalii Pripyatskoy vpadiny i ikh svyaz' s geologicheskim stroyeniyem [The gravitational and magnetic anomalies of the Pripet River basin and their relation to geologic structure]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy ser. geofiz., no. 2, p. 27–42, 1958.

During the last ten years extensive geophysical surveys were made in the southern part of the White Russian S. S. R., including the Pripet River basin. These surveys were later supplemented by exploratory drilling for oil and rock salt. This paper describes and interprets the gravity and magnetic anomalies of the Pripet depression. The depression is bounded on the south, west, and north by weak positive anomalies. Three isolated gravity minimums were established here, the Yel'skaya (−70 mgal, lowest of the area), the Shatilkov (−66 mgal), and the Turovskaya (−42 mgal), all characterized by rather large gravity gradients (up to 10 mgal per km) at their margins. In most cases the gravity and magnetic anomalies coincide; they are caused by a variety of factors and reflect structural details in the basement and in the sedimentary formations. A long analysis of local details is given in the article, and special attention is given to the density characteristics of geologic profiles. See also Geophys. Abs. 173–217.—*S. T. V.*

174–212. Woollard, G[eorge] P[rior]. Results for a gravity control network at airports in the United States: Geophysics, v. 23, no. 3, p. 520–535, 1958.

Results are presented for a network of gravity control bases located at the major airports throughout the United States. This network of bases was established as a means of integrating existing gravity surveys into a unified whole. It provides not only control of data but also a means of checking and adjusting calibration differences to a common standard. The gravity standard used is that determined by measurements with the Gulf compound quartz pendulum apparatus at a series of sites covering a range of 4,800 mgals between

Fairbanks, Alaska, and Mexico City, D. F., Mexico. The accuracy of the individual measurements on an absolute basis is believed to be within 0.3 mgal using a Potsdam datum value of $g$ equal to 980.1190 gals taken at floor level in the United States Coast and Geodetic Survey gravity vault in the Commerce Building, Washington, D. C. Observation sites are described with sufficient detail to permit reoccupation within 5 to 6 feet.—*Author's abstract*

## HEAT AND HEAT FLOW

174–213. Perrin, René. Métamorphisme, énergie solaire et données thermiques sur la terre [Metamorphism, solar energy and thermal data on the earth]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 4, p. 505–511, 1958.

Geologic evidence supports the concept that thermal autocatalysis and storage of solar energy in the outer layers of the crust are a reality. This energy is liberated in metamorphism, granitization, and orogenesis to complete a cycle. Attention is drawn to certain consequences of the concept. First, the presence of living things indicates that temperature has been fairly constant for a billion years; this constancy means that the difference between the amount of solar energy absorbed and stored (by surface alteration, erosion, sedimentation, and life) and the amount of energy liberated (by metamorphism, orogenesis, and volcanism) has been constant, although the actual amounts of each have differed throughout space and time.

The proportion of solar energy absorbed and accumulated at any instant due to alteration is affected by the ratio of oceanic to continental area, by the shape of the continents, by glaciation, and by life; the amount of energy liberated is a function, variable in space and time, of chemical processes and their results. The relative importance of these factors probably has played a part in climatic evolution through the ages.

Another consequence is the fact that it is imprudent to extrapolate known geothermal gradients to calculate temperatures deep in the earth, because heat flow could be, at least locally, downward as well as outward in the outer layers; this is particularly plausible in the case of volcanoes.—*D. B. V.*

174–214. Lubimova, H. A. [Lyubimova, Ye A.] Thermal history of the earth with consideration of the variable thermal conductivity of its mantle: Royal Astron. Soc. Geophys. Jour., v. 1, no. 2, p. 115–134, 1958.

Data on the abundance of the radioactive elements and the thermal conductivity of the earth favor the view that its initial temperature $T_0(r)$ must have been below the melting temperature. In this paper $T_0(r)$ is calculated for an earth formed through accumulation of particles of a gas-dust protoplanetary cloud, assuming that the radioactive elements were redistributed from a uniform to a layered disposition and that the matter of the mantle is a dielectric possessing not only molecular conductivity but radiative transfer of heat in the high temperature range. The Green's function and hydraulic analogy methods are used in the solution of the equation of thermal conductivity.

It is concluded that the wide distribution of radioactive elements and the low thermal conductivity of the earth's upper layers, which can only decrease with the rise of temperature, must result in heat accumulation in the interior; but the rise in temperature must have proceeded so slowly that no catastrophe could occur, only a slight expansion of the globe. The rate of this expansion is about

7 cm per 1,000 yrs. The outer layers were not heated but rather cooled down during the last one or two billion yrs. The resulting compression of the surface layers overlying the expanding layers may be one of the causes of elastic strains in the upper mantle which in turn result in faults and earthquakes. The possibility of a molten layer in the upper mantle below the crust may explain the nonuniformity of this part and the origin of magma chambers.—*D. B. V.*

174–215. Lawson, A. W., and Jamieson, John C. Energy transfer in the earth's mantle: Jour. Geology, v. 66, no. 5, p. 540–551, 1958.

Several processes of energy transfer in the earth's mantle are examined: (1) gray radiation, (2) ambipolar diffusion of electron-hole pairs, (3) exciton transfer, and others. Using Rikitake's values of the electrical conductivity and correcting for the frequency dependence of the conductivity and the variation of the index of refraction with depth, the values for the radiative contribution to the heat flow are found to be appreciably larger than those estimated by Clark. Estimation of contributions from the electronic processes shows that conduction by excitons may play an important role in the lower parts of the mantle.—*Authors' abstract*

174–216. Valle, P[aolo] E[milio]. Sul gradiente di temperature necessario per la formazione di "low-velocity layers" [On the temperature gradient necessary for the formation of low-velocity layers]: Annali Geofisica, v. 9, no. 3, p. 371–377, 1956.

The minimum temperature gradient necessary for the formation of low-velocity layers in the asthenosphere is calculated as 14° per km for *P*-waves, 11° per km for *S*-waves. The fact that the gradient is smaller for *S*-waves than for *P*-waves explains why the thickness of the low-velocity layer for *S*-waves is greater than that of its *P*-wave counterpart.—*D. B. V.*

174–217. Chetayev, D. N. K opredeleniyu termicheskikh koeffitsientov metodom lineynogo mgnovennogo istochnika [On the determination of the thermal coefficients by the method of instantaneous linear source]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 363–364, 1958.

The thermal coefficients of solid substances were determined by Dergunov's method, in which a narrow hole is drilled in a specimen or in the wall of a mine gallery, a current-carrying spiral is introduced into it for a measured interval of time, with a thermocouple in another similar hole. The thermal coefficients of the medium can be calculated from the measured amount of heat introduced, the highest temperature observed, and the time necessary for its attainment, based on the equation for the variation of temperature $t$ of the medium produced by the action of a linear heat source of a constant intensity:

$$\frac{\delta^2 t}{\delta r^2}+\frac{1}{r}\frac{\delta t}{\delta r}=\frac{1}{a}\frac{\delta t}{\delta \tau},$$

where $a$ is the temperature coefficient of the medium, $t$ the temperature, $\tau$ the time; with known initial conditions the solution can be found as integral exponential function, and the numerical values of this function can then be obtained from two graphs given in the article.—*S. T. V.*

174–218. Contini, Camillo. Terremoti, vulcani e giacimenti di vapore naturale [Earthquakes, volcanoes and natural steam deposits]: Annali Geofisica, v. 9, no. 4, p. 561–575, 1956.

Approximate formulas are given for calculating energy developed, in the form of heat and seismic waves, by gliding along faults. It is shown that not only can such gliding cause earthquakes but that the heat accumulated may lead to volcanic phenomena. Steam can accumulate in the ground directly from magma or from vaporized pore water of strata, or it may develop on the fault plane with or without volcanic associations. Areas in Italy that should be favorable for exploitable accumulations of geothermal steam are enumerated.—*D. B. V.*

174–219. Andō, Takeshi, and Watanabe, Kazue. On the Matsukawa geothermal district in Iwate Prefecture: Geol. Survey Japan Bull., v. 8, no. 10, p. 29–32, 1957.

Test borings at the Matsuo sulphur mine produced natural flows of steam varying in duration from 9 to 360 days. The low chlorine content indicates that the steam is derived chiefly from surficial water heated in the subterranean zone and not from volcanic gas.—*V. S. N.*

174–220. Bödvarsson, Gunnar. Geothermal effects of the Pleistocene glaciation in Iceland: Jökull, v. 7, p. 1–20, 1957.

Abnormal subsurface temperatures in Iceland are indicated by the many hot springs and high temperatures found in shallow wells. Heat flow determinations for three wells in non-thermal areas are 3.3, 4.4, and 6.5 $\mu$ cal per cm$^2$ sec. The average is 4.7 $\mu$ cal per cm$^2$ sec. Correction of these heat flow values is made using three different assumptions about the rate and magnitude of erosion. The heat flow is reduced by these assumed conditions to 3.6, 3.0, and 2.6 $\mu$ cal per cm$^2$ sec, but these values are above those reported elsewhere. Evidence is presented supporting the conclusion that the present topography of Iceland was formed mainly during the latter part of the Pleistocene.—*H. C. S.*

## INTERNAL CONSTITUTION

174–221. Spencer Jones, Harold. The origin of the solar system: Endeavour, v. 17, no. 67, p. 140–144, 1958.

Theories of the origin of the solar system can be divided into two groups, those assuming slow evolution from a primordial mass, and those based on the idea of a catastrophic interaction of the sun and another body. The theories of Kant and Laplace, Chamberlin and Moulton, Jefferys and Jeans, Russell, Lyttleton, Spitzer, Alfvén, Weiszäcker, Kuiper, and Schmidt are examined critically. Kuiper's concept (see Geophys. Abs. 171–200), although not entirely free from objection, appears most satisfactory; with some modifications it may prove capable of leading to a theory that can be generally accepted.—*D. B. V.*

174–222. Gómez, Vicente Lauro. El origen del sistema solar [The origin of the solar system]: Bol. informaciones cient. nac. Ecuador, v. 9, no. 83, p. 253–286, 1957.

A review of various theories.—*D. B. V.*

174–223. Damon, Paul E., and Kulp, J. Laurence. Excess helium and argon in beryl and other minerals: Am. Mineralogist, v. 43, no. 5–6, p. 433–459, 1958.

All beryl crystals appear to contain a quantity of helium and argon in great excess over that which can be accounted for from radioactive decay. Other magmatic minerals which have structural sites suitable for large non-essential atoms such as cordierite and tourmaline also show this excess in variable amount. It seems that this excess inert gas must represent a sample of the magmatic gases in the immediate environment of the forming crystal and as such can provide useful information on magmatic conditions. Although there are considerable differences in the helium and argon concentration even in the same beryl crystal, these are small compared to the one hundred-fold difference between crystals formed in the early Precambrian ($3.0\times10^9$ yrs) and Paleozoic eras. This strong age effect is interpreted as suggesting more extensive outgassing of the mantle in the earlier phases of earth history.—*Authors' abstract*

174–224. Bullen, K. E. Ástand efnisins í iðrum jarðar [Nature of the material in the earth's interior]: Náttúrufraeðingurinn, v. 27, no. 1, p. 14–20, 1957.

This is the Icelandic translation of the text of a lecture delivered before the Natural History Society of Iceland in April 1956, reviewing what has been deduced from seismological data as to the nature of the earth's interior.—*D. B. V.*

174–225. Belousov, V. V. On some problems of geotectonics [in Japanese]: Geol. Soc. Japan Jour., v. 64, no. 749, p. 99–102, 1958.

A Japanese translation of a lecture by Belousov to the Geological Society of Japan on March 8, 1957, covering the substance of his paper published in Russian in Akad. Nauk SSSR Geofiz., Inst. Trudy, no. 26 (153), p. 51–100, 1955 (see Geophys. Abs. 164–191) and in a French version in Bur. central séismol. internat. Pubs., ser. A, Travaux sci., no. 19, p. 129–135, 1956 (see Geophys. Abs. 173–235). See also Geol. Rundschau, Band 45, Heft 2, p. 325–369, 1956 (Geophys. Abs. 167–114).—*V. S. N.*

174–226. Boaga, G[iovanni]. Relazioni fra i parametri che caratterizzano la più generale funzione di variazione della densità nell' interno della Terra e quelli della funzione atta alla determinazione degli schiacciamenti delle superfici isopicnotiche [Relations between the parameters characterizing the most general function of variations of density in the earth's interior and those of the functions suitable for the determination of departures of the isopycnic surfaces]: Annali Geofisica, v. 9, no. 3, p. 293–298, 1956.

A mathematical treatment of density distribution within the earth, to determine the shape of the internal ellipsoidal surface of constant density.—*D. B. V.*

174–227. Gaskell, T. F. A borehole to the earth's mantle?: Nature, v. 182, no. 4637, p. 692–695, 1958.

At the meeting of the International Union of Geodesy and Geophysics in Toronto in 1957 a resolution was passed urging the importance of drilling a borehole deep enough to penetrate below the Mohorovičić discontinuity. The

best place to drill would be an oceanic atoll where the crust is only about 10 miles thick, or through the sediments that cover the three-mile-deep oceans. The type of research required to produce a workable method of drilling a 50,000-foot hole is already under way as part of the normal progress of oil well drilling and rock mining. The most promising method seems to be a combination of the diamond bit with turbo-drill and fully automatic lifting mechanism, using sea water circulation. The research effort to make the necessary improvements in these various components of the scheme would undoubtedly be well repaid by benefits to normal oil well drilling. For the second course, of drilling through deep sea sediments, deep water drilling techniques developed for use off the California coast could probably be improved, possibly to include the use of a folding, retractable drill bit. There would be only about 10,000 feet of solid material to penetrate before reaching the mantle, the upper 20,000 feet being water, so that if it becomes at all possible to drill continuously in deep water it would be easier to penetrate the crust here than from an atoll. Once the technical difficulties are surmounted, the site would have to be selected for optimum weather and negligible currents.—*D. B. V.*

174–228. Mart'yanov, N. Ye. Oblasti rastyazheniya v obolochke zemli [Regions of distension in the earth's mantle]: Akad. Nauk SSSR Doklady v. 116, no. 6, p. 949–951, 1957.

From the known formulas for the longitudinal and transverse velocities $v_p$ and $v_s$ of seismic waves, and the measured values of these velocities as a function of the depth $h$, density $\rho$, the bulk modulus $K$, or the rigidity $\mu$ respectively, Mart'yanov, computes the ratio $K/\mu$ in terms of depth. The plot of $K/\mu$ versus $h$ shows that compression increases with the depth, but that within the depth intervals of 30–96 km, 450–900 km and 2,700–2,900 km the ratio $K/\mu$ decreases, indicating a relative distension of the mantle substance at those depths. The ratios $K/\rho=v_p^2+\frac{3}{4}v_s^2$ and $\mu/\rho=v_s^2$ also increase rapidly at depths of 30–96 km and 450–900 km, which can only be explained by a decrease in density due to a distension of these layers.—*A. J. S.*

174–229. Latynina, L. A. O sushchestvovanii konvektsionnykh techeniy v obolochke zemli [On the existence of convection currents in the earth's mantle]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 391–397, 1958.

A critical analysis is presented of the reality of Vening Meinsz' theory of convection currents in the mantle. The physical conditions required to generate these currents are analyzed; it is found that the necessary assumptions are reasonable but that the reality of convection cannot be proven, primarily because the numerical values of many physical factors entering into the equations are not even approximately known. It is concluded that although present knowledge of the physics of the earth does not permit a positive solution of the question, the existence of these currents is possible because the required thermodynamic conditions (for instance, the great difference in temperature between the ocean bottom and land masses at the same depth) are without doubt fulfilled.—*S. T. V.*

174–230. Shimazu, Yasuo. Decomposition reaction of $Mg_2SiO_4$ within the gravitational field and the origin of the *C*-layer (in Japanese with English abstract): Zisin, ser. 2, v. 11, no. 1, p. 1–6, 1958.

The possible chemical decomposition of $Mg_2SiO_4$ under pressure conditions existing in the *C*-layer is discussed, based upon an assumption that gravitational separation due to density differences as well as chemical interactions among participating components controls the equilibrium condition of stable phases. $Mg_2SiO_4$ decomposes into MgO and $SiO_2$ with the $SiO_2$ squeezing upward at about 600 km in depth, thus explaining the gradual change in the character of the *C*-layer with depth. The squeezing of $SiO_2$ is based upon a thermodynamic theory of irreversible processes and has some relationship to terrestrial evolution.—*V. S. N.*

174–231. Ruprechtová, Libuše. The 20° discontinuity and the traveltime curves of *P* and *S* for Praha in the range 10°–30°: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 48, p. 523–542, 1956 (1957).

Existing views of the structure of the upper part of the mantle are summarized; then the effect of the 20° discontinuity and low velocity layer on the traveltime curves is examined on the basis of seismic records at the Praha station. The greatest deviation of the *P* and *S* traveltime curves is found to be at a distance of 17° to 18°. This interval agrees with the range of maximum amplitude of *P* and *S* waves found by Vaněk and Zátopek (see Geophys. Abs. 171–79). A further analysis of material with respect to later waves and a more detailed investigation of amplitudes might contribute to understanding of deeper structure of the earth's interior.—*D. B. V.*

Valle, P[aolo] E[milio]. On the temperature gradient necessary for the formation of low-velocity layers. See Geophys. Abs. 174–216.

174–232. Riznichenko, Yu. V. K izucheniyu stroyeniya zemnoy kory v period tret'yego mezhdunarodnogo geofizicheskogo goda [On the study of the earth's crust during the third International Geophysical Year]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 129–140, 1957.

The methods of determining the deep structure of the earth's crust (gravity, magnetic, electrical, and seismic) are reviewed. The seismic methods assigned by the International Geophysical Year to the United States and U. S. S. R. are the most expensive and labor consuming, and the most effective. Four methods are used: observation of various phases of *P* and *S* waves during natural earthquakes; observations of surface waves from earthquakes and microseisms; observations of elastic waves from industrial explosions; and deep seismic sounding. Specific examples are given of the application of these methods, both at sea and on land. The seismic sounding of the crust in the U. S. S. R. prior to the IGY program is described, and the seismic programs of the U. S. S. R. and United States for the third International Geophysical Year are outlined. In the United States the investigations, coordinated by the Special Committee for the Geophysical Study of the Continents, are planned in the Atlantic and Pacific Oceans, along the coast, and on the continent. In the U. S. S. R. the seismic exploration of the deep crust, directed by the Geophysical Institute of the Academy of Sciences, are planned for the Kurile-Kamchatka arc, certain areas of the Pacific Ocean, Central Asia, the Caucasus, Near-Baikal, and some other regions.—*A. J. S.*

Andreyev, B. A. Gravity anomalies and thickness of the earth's crust in continental regions. See Geophys. Abs. 174–181.

174–233. Bolt, B. A., Doyle, H. A., and Sutton, D. J. Seismic observations from the 1956 atomic explosions in Australia: Royal Astron. Soc. Geophys. Jour., v. 1, no. 2, p. 135–145, 1958.

Both $P$ and $S$ phases from the four 1956 British atomic explosions, at Maralinga in South Australia, were observed at field stations set up along the Trans-Australian railway for $0.4° < \Delta < 11°$, and on a Benioff seismograph located near Adelaide at 8°. The travel times indicate a $P_n$ velocity of 8.21 ±0.005 kmps and an $S_n$ velocity of 4.75 ±0.01 kmps. There is also evidence for $P$ and $S$ phases travelling near the surface with velocities of 6.03 ±0.009 kmps and 3.55 ±0.04 kmps, respectively. No onsets corresponding to paths through intermediate layers were observed. The observations can best be explained by a single crustal layer having constant seismic velocities; this hypothesis gives a crustal thickness of 32 km from $P$ and 39 km from $S$. These results agree with those of Hodgson for the Canadian shield (see Geophys. Abs. 157–117) and of Willmore, Hales, and Gane for the western Transvaal (see Geophys. Abs. 148–13340), suggesting that the old continental shields are seismically very similar.—*D. B. V.*

174–234. International Geophysical Year Bulletin No. 11. Seismic studies in the Andes: Am. Geophys. Union Trans., v. 39, no. 3, p. 580–582, 1958.

Investigations were made by the Carnegie Andes Expedition for the International Geophysical Year during the summer of 1957 in the high regions of Peru, Bolivia, and northern Chile to test the idea that mountains may be held up by a network of relatively narrow roots or veins projecting into the earth's mantle layer to depths as great as 200 km. For this purpose, seismic waves from explosions in the great open-pit copper mines of Peru and Chile (where single shots of 40 to 60 tons of dynamite are exploded almost daily) were measured. Recordings were made at more than 200 selected points deep in the mountains. Preliminary results indicate that the Andean structures are highly non-uniform. Reflections from the Mohorovičić discontinuity were obtained only in limited sectors along lines more or less parallel to the mountains. Reflections passing under the antiplano were extremely attenuated.

The principal result of this seismic reconnaissance is the indication that there appear to be non-uniformities and regional differences in the mantle as in the crust. Under northern Chile the lighter crustal rocks project down to nearly 55 km, whereas in southern Peru the crust has the normal depth of 34 km and the Andes in that area are presumably held up by more diffuse roots projecting into the mantle.—*D. B. V.*

174–235. Richards, T. C. Measurement of the thickness of the earth's crust in the Albertan plains of western Canada: Nature, v. 182, no. 4632, p. 384–385, 1958.

Crustal structure in the Albertan plains of western Canada was investigated by 15 seismic refraction parties spaced at roughly uniform intervals over a distance of 130 km, making two-way observations from 900-pound buried dynamite charges at each end of this range. The line roughly paralleled the frontal thrust of the Rocky Mountains between lat 50°45′ N and 51°47′ N, some 100 km to the east of the thrust. A velocity of 3.5 kmps represented Cretaceous shales and sands 2.3 km deep, 6.0 kmps the known Paleozoic limestones. Distinct events with a velocity of 7.2 kmps were also recorded; a later event of 8.2 kmps is ascribed to reflections from the Mohorovičić discontinuity amplified by refractions from

beyond the critical angle. Taking all factors into account the total crustal thickness is computed to be in the range of 40 to 47 km, thicker than that generally observed in plains elsewhere in the world; apparently the crustal thickening under the Rockies extends at least 100 km east from the mountain front. The 7.2 kmps layer is inferred to lie at about 25 km depth; it may be comparable to the 7.0 kmps zone of eastern Canada and the 7.2 to 7.4 kmps layer in California and Nevada and lends support to the existence of the Conrad discontinuity.—*D. B. V.*

174–236. Caloi, P[ietro]. La struttura della crosta terrestre, con particolare riguardo alle zolle continentali, quale risulta dallo studio dei terremoti e delle grandi esplosioni (Eurasia) [The structure of the earth's crust, with particular regard to the continental layers, resulting from the study of earthquakes and large explosions (Eurasia)]: Annali Geofisica, v. 10, no. 3–4, p. 183–188, 1957.

It is shown that for the Eurasian continent there is no serious discrepancy between the crustal structure as deduced from earthquake data and that deduced from explosion data. Both give a thickness of about 18 to 20 km for the granite layer under central Europe, both give longitudinal wave velocities of 5.0 to 5.8 kmps in the granite, 6.1 to 6.7 kmps in the basalt, and 7.8 to 8.2 kmps below the Mohorovičić discontinuity.—*D. B. V.*

174–237. Caloi, P[ietro]. Caratteristiche della crosta terrestre dalle Alpi agli Appennini [Characteristics of the earth's crust from the Alps to the Apennines]: Annali Geofisica, v. 10, no. 3–4, p. 189–192, 1957.

Study of seismic waves from an earthquake in the Po valley in 1951 and from an explosion in the Vajont valley, Italy, in February 1957 shows that the root of the Alps involves both the granitic and the intermediate layers of the crust. The former is only 13 km thick; therefore the thickened part of the root is in the latter. The case is probably similar under the Apennines.—*D. B. V.*

174–238. Caloi, P[ietro]. Differenze strutturali fra Alpi meridionali e Valle padana [Structural differences between the southern Alps and the Po valley]: Annali Geofisica, v. 10, no. 3–4, p. 209–210, 1957.

The geologic structure between the southeast-central Alpine system and the Po valley has been investigated by means of explosion observations with a three-dimensional vibrograph. Longitudinal wave velocities at the bottom of some deep narrow pre-Alpine and Alpine valleys and on some of the massifs of the Dolomites were unusually high (7.5 kmps), and invariably associated with maximum frequencies. According to the theory of firmo-elasticity these velocities can be reduced to 5.8 kmps (see Geophys. Abs. 174–326), the average velocity in the granitic layer. Thus, it appears that in this part of the Alps at least the top of the granite layer rises from the Po valley toward the Dolomites, where erosion of the Tertiary cover brings the granite close to the surface. In the section from Parma to Marmolada the top of the granite layer rises from about seven km below sea level in the middle of the Po valley to about 2.5 to 3 km above sea level in the Dolomites. The relationship of the Po valley to the dolomites is analogous to that of some ocean troughs to some archipelagos in the Pacific Ocean.—*D. B. V.*

174–239. Caloi, P[ietro]. The crust of the earth, from the Apennines to the Atlantic, reconstructed in accordance with the data supplied by seismic surveys: Zeitschr. Geophysik, v. 24, no. 2, p. 65–95, 1958.

Crustal structure in the north central Alps, the Apennines, the Po Valley, and a larger part of Württemberg, Germany, has been worked out from analysis of earthquake data. Highest *P*-wave velocities in the granite layer are found in the Alps (*Pg*, 5.5–5.7 kmps), lowest in the Po Valley and north Germany (5.1 kmps). The thickness of this layer is 6.0 km in north Germany, 10 km in the Po Valley, 13 km in the southern Alps, 18 km in Württemberg, and 25 km in the north-central Apennines. *P** wave velocities vary between 6.1 and 7.0 kmps suggesting the presence of an intermediate (diorite?) layer above the gabbro layer. Total thickness of the crust under the central Apennines is 50 to 55 km, under the southern Alps 40 to 45 km. The root of the southern Alps, Cansiglio, seems to be formed by the intermediate layer. In the Po Valley and Württemberg the crust is not more than 30 km thick, and in the Atlantic basin it is of the order of 17 km. The granite layer is very thin under the large seas; it may be absent under a large part of the southern Tyrrhenian and around the Rokall rock in the north Atlantic. The Po Valley is filled with sediments varying from 3 to 7 km thick.

Velocities clearly tend to increase in the upper part of the mantle, beginning at about 120 km; this is the "axis" of the asthenosphere, where diminution of velocity is at its minimum.—*D. B. V.*

Reich, H[ermann]. The geologic results of seismic registration of large explosions in Germany. See Geophys. Abs. 174–105.

Schulz, G. Reflections from the crystalline basement in the region of the Pfalzer Bergland. See Geophys. Abs. 174–343.

Peronaci, Francesco. Microseismic study of the Yenice earthquake of March 18, 1953. The Yenice earthquake of March 18, 1953 and its seismic characteristics of Anatolia. See Geophys. Abs. 174–38.

174–240. Research Group for Explosion Seismology (Japan). Observations of seismic waves from four explosions near Kamaisi Mine (in Japanese with English abstract): Zisin, ser. 2, v. 10, no. 2, p. 86–96, 1957.

Seismic observations were made of the waves generated by four explosions near the Kamaisi Mine in May 1954 to check conclusions drawn from the results of five earlier explosions concerning the crustal structure of northeastern Honshu, Japan. Results from both sets of explosions indicate an anticline with axis trending north-south and a well-defined boundary between the Paleozoic rocks and underlying granites. (See also Geophys. Abs. 173–256.)—*V. S. N.*

Rikitake, Tsuneji; Yokoyama, Izumi; Uyeda, Seiya; Yukutake, Takesi; and Nakagawa, Eiko. The anomalous behaviour of geomagnetic variations of short period in Japan and its relation to the subterranean structure. The 7th report. See Geophys. Abs. 174–264.

## ISOTASY

174–241. Havemann, H[ans]. Zur Frage der pazifisch-kontinentalen Isostasie [On the question of Pacific-continental isostasy]: Gerlands Beitr. Geophysik, v. 67, no. 2, p. 135–157, 1958.

The dip of the seismic regions on the Pacific border is attributed to a shearing action in which the upper subcrustal layers are displaced toward the Pacific and the deeper layers toward the continents. This action in turn is ascribed to contraction due to cooling, which makes the suboceanic layers more dense than corresponding layers. The high heat loss required for this process might be provided by the cooling of a hot layer brought up by convection. Calculations of isostasy are made for a four-layer model which includes the overcompensated layers needed to explain the predominance of unreducible negative gravity anomalies on continents and of positive anomalies over oceans, especially the Pacific.—*D. B. V.*

Perrin, R[ené]. New concepts concerning the interpretation of gravity anomalies. See Geophys. Abs. 174–179.

Wegener, Kurt. The floating equilibrium of the sial in the sima. See Geophys. Abs. 174–168.

## ISOTOPE GEOLOGY

174–242. Vinogradov, A. P. Izotopnyy sostav porod zemli i meteoritov [The isotopic composition of terrestrial rocks and meteorites]: Akad. Nauk SSSR Atomnaya Energiya, v. 4, no. 5, p. 409–416, 1958.

In his lecture presented at the international conference on the application of radioactive isotopes in scientific investigation held in Paris in September 1957, Vinogradov compared the isotopic composition of sulphur, oxygen, carbon, and light gases in siderites, siderolites, and chondrites with the isotopic composition of the same elements found in various terrestrial rocks. He found that the isotope ratios are completely identical in siderites and chondrites, or meteorites in general, while for similar rocks of terrestrial origin the isotopic composition varies with the origin of the rock (igneous, hydrothermal, or sedimentary). Therefore, if the variation in the isotopic composition of terrestrial rocks is due to processes of differentiation of the earth's substance, no analogous process took place in meteorites; and consequently they were not formed as a result of an aggregation of primordial dust.—*A. J. S.*

174–243. Goel, P. S., Kharkar, D. P., Lal, D., Narsappaya, N., Peters, B., and Yatirajam, V. The beryllium-10 concentration in deep-sea sediments: Deep-Sea Research, v. 4, no. 3, p. 202–210, 1957.

The cosmic-ray-produced radioactive isotope, $^{10}Be$ (half-life 2.7 million years) has been discovered in the upper and lower portions of a 15 m long core from the sediment of the Pacific Ocean [Swedish *Albatross* expedition, 04° 04′ S, 152° 52′ W at a depth of 5,200 m]. A comparatively simple chemical procedure for its extraction has been developed.

If the investigated core represents sedimentation which has remained physically and chemically undisturbed for several million years, the following

tentative conclusions can be drawn: The measured concentrations of $^{10}Be$ in layers at various depth indicate a sedimentation rate of about 5 mm per 1,000 years which is not far from current estimates.

The concentration in the upper layers leads to a present-day deposition rate of $2.55 \times 10^{10}$ $^{10}Be$ nuclei per $cm^2$ per year, in excellent agreement with estimates based on the $^{7}Be$ contents of rainwater.

The decrease of concentration with depth indicates an intensity of cosmic rays in the past which has changed not at all or very slowly during the last ca. 2.5 million years.—*Authors' abstract*

174–244. Landergren, Sture. On the geochemistry of the North Atlantic sediment core no. 238: Swedish Deep-Sea Exped. 1947–1948 Repts., v. 7, no. 2, p. 125–148, no date.

This paper on the results of spectrochemical analysis of one of the sediment cores from the Romanche Deep in the North Atlantic Ocean collected by the "Albatross" expedition, includes a report on the relative abundance of the stable carbon isotopes in calcite from different depths. The $C^{12}/C^{13}$ ratio in several samples is rather uniform, ranging from 88.67 to 88.80 (average 88.74) which is higher than significant for an open marine milieu and more similar to the ratio determined in shelf sediments formed under more quiet water conditions. It suggests that conditions at the bottom of an isolated deep are quieter than those of marine surface water, thus giving rise to an increase in the amount of the lighter isotope. The ratio in calcite from Pacific red clay is even higher (average 89.49), indicating water so quiet that a local carbon dioxide cycle has developed.—*D. B. V.*

174–245. Vinogradov, A. P., Dontsova, Ye. I., and Chupakhin, M. S. Izotopnyi sostav kisloroda izverzhennykh porod i meteoritov [Isotopic composition of oxygen in igneous rocks and meteorites (with English summary)]: Geokhimiya, no. 3, p. 187–190, 1958.

The oxygen isotope ratios have been measured on a number of silicate-bearing meteorites and igneous rocks, and the results tabulated. The average $O^{16}/O^{18}$ ratio for three pallasites and two chondrites is 490.4; for five dunites, 490.0; for three basalts 489.5; and for three granites 488.7. This suggests that in the formation of the earth's crust the material of the mantle, having a composition similar to that of silicate meteorites, underwent a change involving oxygen isotope exchange in particular.—*D. B. V.*

174–246. Rafter, T. A., Wilson, S. H., and Shilton, B. W. Sulphur isotopic variations in nature. Part 6—Sulphur isotopic measurements on the discharge from fumaroles on White Island: New Zealand Jour. Sci., v. 1, no. 2, p. 154–171, 1958.

A method has been developed for sampling the discharge gases from fumaroles on the volcano, White Island [New Zealand]. Forms of sulphur other than free sulphur and sulphate have been identified. Initially, sulphate forms a very small part of the total sulphur in the discharge. The $^{34}S$ enrichment values for the sulphur, as free sulphur and as total soluble sulphur, have been measured for six fumaroles. The percentage of each form of sulphur was determined quantitatively and an overall $^{32}S/^{34}S$ ratio of 22.15 calculated for these fumaroles. This value indicates that the sulphur in the parent magma is of igneous origin.

The so-called "volcanic sulphur" appears to be enriched in $^{32}S$ by chemical reactions at the vent mouth. The wide spread of isotopic values for sulphate found, means that little significance can be placed on sulphate isotopic values around volcanic areas. The necessity for careful sampling of the discharge is emphasized before basic information can be obtained as to the origin of volcanic sulphur.

If sulphur from volcanic exhalations can be shown generally to have an average sulphur isotopic ratio similar to that of sulphur in the igneous rocks, then these additions of sulphur to the ocean cannot account for the present enrichment of the heavy isotope of sulphur in ocean sulphate.—*Authors' summary*

## MAGNETIC FIELD OF THE EARTH

174–247. Cole, G. H. A. The earth and its magnetic field: Sci. Progress, v. 45, no. 180, p. 628–645, 1957.

A review of modern arguments designed to explain the presence and properties of the observed geomagnetic field in terms compatible with the structure of the earth as determined by seismic data. It is concluded that the origin of the earth's main field is still not understood, but that it is virtually certain that the effect is hydrodynamic and located in the core (possibly the inner core), and that the nonlinear form of the theory is fundamental. (A review of this paper appears in Current Science, v. 26, no. 11, p. 335–338, 1957.)—*D. B. V.*

174–248. Lucke, O. Über die Veränderlichkeit des erdmagnetischen Hauptfeldes und seine Theorien [On the variability of the main geomagnetic field and its theories]: Zeitschr. Geophysik, v. 23, no. 4, p. 197–224, 1957.

This is a continuation of a paper by Fanselau and Lucke (see Geophys. Abs. 169–218). The westward drift of the different multipoles representing the main geomagnetic field has various magnitudes; the strongest drift is shown by the field of the quadripole, the next strongest by that of the octupole, and so on. There must be olivine and metallic iron in the core of the earth. Temperature distribution within the earth is calculated, using Gilvarry's theory of fusion, and compared with results of other authors. It does not seem possible to base a theory of the main field on hydromagnetics; a dynamo theory seems possible only in Parker's manner.

A theory of the main geomagnetic field can be built up on the Tolman effect only if one assumes an eastward circulation at the equator of the core having greater velocity than those caused by westward drift of the main geomagnetic field and by the variation of the earth's rotation.—*D. B. V.*

174–249. Fanselau, G[erhard]. Zur Frage des geomagnetischen Normalfeldes [On the question of the geomagnetic normal field]: Gerlands Beitr. Geophysik, v. 67, no. 1, p. 49–59, 1958.

The normal field of a geomagnetic component may be computed in two different ways. Either the data obtained from observatories or surveys may be used without taking theoretical interpretation into consideration, or the normal distribution may be deduced from the potential theory. The latter method, based on observational data from all over the world, is preferable for various reasons, particularly for the comparability of the results. This paper shows how a

thorough analysis of data obtained by such computations is used to develop appropriate formulas for the normal field. The $X$, $Y$, and $Z$ components as a function of longitude, latitude, and altitude may be derived from the potential formulas by differentiation; from these calculations the normal field formulas can be developed, using Taylor's theorem, in the form of power series of the differences between the coordinates of the place of observation and those of the central point.

In geomagnetic survey practice the $H$ and $D$ components are measured rather than $X$ and $Y$; their normal fields can be computed simply by vector addition. A preferable procedure is the following: The potential term is tranformed into another system of coordinates, the meridian of which running through the observation point forms the angle $D$ with the astronomical meridian. The location of the pole in this system may be derived from the averages of declination and inclination at the central point. Then $H$ and $D$ can be calculated by simple differentiation; the normal field formulas follow from this using Taylor's theorem. This procedure is currently being tested practically.—*D. B. V.*

174–250. Schmidt, H[erbert]. Methoden zur Bestimmung der räumlichen Gradienten des geomagnetischen Feldes [Methods of determining the three-dimensional gradients of the geomagnetic field]: Zeitschr. Geophysik, v. 23, no. 6, p. 273–286, 1957.

This is a discussion of old and new methods of determining gradients of the geomagnetic field in three dimensions. It is concluded that the most suitable instruments for the continuous recording of local gradients as desired during the International Geophysical Year, are current-subtraction gradiographs. The set-up in the vicinity of Neimegk observatory consists of four out-stations and one chief station connected by cables. Each out-station contains three photoelectrically compensated magnetometers for the $X$, $Y$, and $Z$ components, whereas the chief station contains only the service and recording elements.—*D. B. V.*

174–251. Heppner, J. P., Stolarik, J. D., and Meredith, L. H. The earth's magnetic field above WSPG, New Mexico, from rocket measurements: Jour. Geophys. Research, v. 63, no. 2, p. 277–288, 1958.

The absolute magnetic field was measured from ground level to an altitude of 163 km [above White Sands Proving Ground, New Mexico] in this first rocket flight of a proton processional magnetometer. The change in field with altitude differs significantly from that of a dipole. The field was typically quiet at firing time and an ionospheric discontinuity was not detected.—*Authors' abstract*

174–252. Barta, György. A földmágneses tér évszázados változásának longitudinális es transzverzális effektusa [The longitudinal and transverse effect of secular variation of the geomagnetic field (with English summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, v. 7, no. 1, p. 3–31, 1958.

The 50-yr wave of secular geomagnetic variation is caused by helicoidal movement of the end point of the magnetic vector. The position of measured and calculated points on the wave can be determined by solid geometry. The measured points are found to be occasionally fast or slow with respect to the theoretical course of secular variation. The acceleration and retardation correspond to a wave of longitudinal character, whereas the components in the direction of the

binormal and principal normal represent the projection of the superposed wave on to the normal plane and the helicoidal movement; this phenomenon is called the transverse effect of secular variation.

Comparison of records from different parts of the earth shows that in the north temperate zone the transverse effect is in a clockwise direction with a period of 40 to 50 yrs, large amplitude, and that the curve of rotation is relatively flat. In equatorial zones, the course of the transverse vector diagrams is negative on the whole, the period is about 20 to 25 yrs, and amplitude is small compared to Europe and Asia. At Sitka the course is negative, period about 36 yrs. The longitudinal effect in the northern hemisphere is very regular, a wave of 40 to 50-yr period whose extreme values appear simultaneously on the whole earth. Its period in equatorial regions is also about 20 to 25 yrs.

It may be generally stated that where secular variation is great (Eurasia, America, Africa) the amplitude of the transverse and longitudinal effect is also large, and vice versa. The longitudinal effect predominates where the course of secular variation is not strongly curved during the observation period, whereas the transverse effect becomes stronger when the sense of the main course of secular variation is changing.

Finally, it is suggested that if the 50-yr period in the variation of rate of rotation of the earth is related to the 50-yr period of secular magnetic variation and is due to motion in the earth's core, a similar secular variation should also be observed in gravity.—*D. B. V.*

174–253. Green, G. Polar wandering, a random walk problem: Nature, v. 182, no. 4632, p. 382–383, 1958.

If one assumes that the earth's magnetic field when averaged over a few thousand years has approximated the geocentric axial dipole, then the paleomagnetic data can be used to define the random walk of the pole over a sphere. The best straight line fit to the data gives a mean value of angular displacement of $3.0° \times t^{1/2}$ if $t$ is in millions of years. This is a useful quantitative value for the mechanism of polar wandering. It is emphasized that since the movement of the pole may be considered to be a random walk, there will be periods during which there will be very little displacement, as in the Quaternary, and periods of rapid displacement, such as the Carboniferous.—*J. R. B.*

174–254. Hahn, A. Erfahrungen mit dem Torsions–Magnetometer *Gfz* der Askaniawerke, Berlin [Experiences with the Askania *GFZ* torsion magnetometer]: Zeitschr. Geophysik, v. 24, no. 2, p. 106–112, 1958.

A new magnetometer for measuring the vertical component of the earth's magnetic field ($z$) has been tested in the field. The magnet system is fixed to a horizontal torsion fiber and is brought into a horizontal direction for measuring its moment. Hence the reading becomes independent of the orientation of the magnetometer and a compass can be dispensed with. About one measurement could be made per minute, with an error not generally exceeding $\pm$ 2$\gamma$. Calibration remained constant for two months.—*D. B. V.*

174–255. Burkhardt, K[urt]. Zur Messung der Inklination mit Kippspule und langperiodischem Galvanometer [On the measurement of inclination with tilted coil and long-period galvanometer]: Zeitschr. Geophysik, v. 23, no. 1, p. 41–45, 1957.

The older of the two methods of measuring magnetic inclination with the earth inductor is tilting of the coil about 180°; this does not require commutation

of the current as for the rotating coil, but requires the use of long-period or ballistic galvanometers. The theory is outlined and examples calculated for one tilting of the coil and for the "multiplication method", using a galvanometer of 5-sec period in both cases.—*D. B. V.*

174–256. Norinelli, A[rmando]. Sulla "correzione per la gravità" nelle misure con bilance magnetiche [On the "gravity correction" in measurements with magnetic balances]: Annali Geofisica, v. 10, no. 1–2, p. 129–132, 1957.

Mathematical expressions are derived for the corrections for the effect of gravity that should be applied to measurements of vertical and horizontal geomagnetic components using Schmidt balances.—*D. B. V.*

174–257. Oguti, Takasi, and Momose, Kanichi. Report on geomagnetic observations of the Japanese Antarctic research expedition, 1956–57 (in Japanese with English abstract): Antarctic Rec., no. 3, p. 1–11, 1958.

Geomagnetic observations were made by the Japanese Antarctic expedition in the neighborhood of Prince Harald Coast from January 16 through February 15, 1957. An E. R. I.-type magnetometer was used for absolute measurements of the geomagnetic field on the pack ice, on the fast ice, and on East Ongul Island. For observation of geomagnetic variations a direct-vision magnetograph was placed in a non-magnetic tent pitched 250 meters north of the ship anchored at Ongul Island.

Detailed results are shown in tables, maps, and graphs. The intensity of the geomagnetic field was found to be extraordinarily small in the area investigated. Absolute values at Syowa Base are about 10 percent smaller than those of Vestine's chart; the magnetic chart of eastern Antarctica should be revised. The small geomagnetic force might be due to an extensive mass of rock magnetized downwards beneath Prince Harald Coast.

The occurrence of magnetic bays corresponded closely with an abnormal increase of the critical frequency of the $E_s$-layer and in extreme cases with the blackout of reflected waves. No one-to-one correspondence was found, however, between geomagnetic pulsations and ionospheric disturbances.—*V. S. N.*

174–258. Nagata, Takesi; Oguti, Takasi; and Kakinuma, Seiiti. Geomagnetic anomaly between South Africa and Antarctic continent roughly along 40° E meridian line: Acad. Japan Proc., v. 34, no. 7, p. 427–431, 1958.

The marked discrepancy in geomagnetic total intensity in the Lützow-Holm Bay region between values observed on the first Japanese Antarctic expedition in 1956–1957, and values of Vestine's world geomagnetic chart (see Geophys. Abs. 130–9372) were investigated further by the second expedition in 1957–1958. Preliminary results indicate that the secular change in geomagnetic intensity here is about $-220\gamma$ per yr, or 18 times as large as the average rate of secular variation due to the earth's dipole. This great rate of secular variation occurs over a region about $10^3$ km in linear extent; the regional anomaly in the area some hundreds of km south from Africa, remarked by Bullard in connection with the dynamo theory of the geomagnetic non-dipole field, seems to extend to the coast of the Antarctic, the rate of secular change becoming much greater near that continent.—*D. B. V.*

174–259. Bucha, Václav. Normální geomagnetické pole vertikální složky v českých žemích k epoše 1950,0 [The normal geomagnetic field of the vertical component in the Czech lands for epoch 1950.0 (with English and Russian summaries)]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 51, p. 577–600, 1956 (1957).

The normal geomagnetic field of the vertical component in Bohemia, Moravia and Silesia (Czechoslovakia) was calculated for epoch 1950.0 by four independent methods. The first method is based on the methods of calculus of errors using the Taylor expansion to second order terms; the second is a graphic method of comparing isolines; the third is a combination of the method of calculus of errors and the statistical method of collective calculus; and the fourth, purely statistical, is based on the assumption that the normal values arrange themselves statistically into a plane. The third and fourth methods are original, starting from equations for Gauss' expansion in spherical harmonics to the first order. The results are presented in a table and map of vertical intensities.—*D. B. V.*

174–260. Bucha, Václav. Výsledky magnetichých měření na stanovištích II. řádu v českých zemích k epoše 1955,0 [Results of magnetic measurements at second order points in the Czech lands for the epoch 1955.0 (with English and Russian summaries)]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sbornik, no. 50, p. 559–576, 1956 (1957).

The results of determination of the geomagnetic elements of 149 second order points in Bohemia, Moravia and Silesia (Czechoslovakia) for epoch 1955.0 are presented in the form of tables giving latitude, longitude, and $D$, $H$, and $Z$ for each station, and maps of declination and horizontal and vertical intensity.—*D. B. V.*

174–261. Janáčková, Alena. Sekulární variace deklinace na území Čech a Moravy [Secular variation of declination in the territory of Bohemia and Moravia (with English and Russian summaries)]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník no. 52, p. 601–607, 1956 (1957).

A map showing secular variation of geomagnetic declination in Bohemia and Moravia, Czechoslovakia, is presented, based on measurements made for epoch 1925.5 and 1949.5. Regions of unmetamorphosed sediments are foci of rapid changes; in regions of metomorphic rocks the course of the isopors is very complicated, and no general rule of behavior could be established.—*D. B. V.*

174–262. Watanabe, Naotune. Secular variation in the direction of geomagnetism as the standard scale for geomagnetochronology in Japan: Nature, v. 182, no. 4632, p. 383–384, 1958.

Curves of the magnetic secular variation have been developed from old records of geomagnetic observations (back to 864 A. D.), and measurements on the remanent magnetization of dated lava flows. These curves are extended back to about 200 A. D. by measurement of the remanent magnetization of 65 sets of samples of baked earth from old hearths, furnaces, and kilns. These arche-

ologically consistent results confirm a thousand-yr cycle in the variation of inclination and a 450-yr cycle in the variation of declination. Some 50 samples of baked earth collected from archeological sites between 4,400 and 5,600 yrs old show essentially the same patterns. These latter archeological dates are confirmed by two carbon-14 dates of 4,546 ±220 and 5,100 ±400 yrs B. P.—*J. R. B.*

174–263. Kertz, W[alter]. Erdmagnetismus [Geomagnetism]: Umschau, v. 58, no. 17, p. 527–530, 1958.

A review of geomagnetic research being carried on during the International Geophysical Year. Investigation of magnetic storms is the main object; a dense and extensive network of stations reaching to the poles has been established to determine the geographic distribution of the ionospheric current system that produces magnetic variations; rockets and earth satellites will obtain information on its height. In addition, observations of local differences in the magnetic variations, which must be attributed to internal causes, should throw light on the structure of the earth's crust.—*D. B. V.*

174–264. Rikitake, Tsuneji; Yokoyama, Izumi; Uyeda, Seiya; Yukutake, Takesi; and Nakagawa, Eiko. The anomalous behaviour of geomagnetic variations of short period in Japan and its relation to the subterranean structure. The 7th report: Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 1, p. 1–20, 1958.

Analysis of the phases of the magnetic storm of March 10, 1957, based on simultaneous observations of the geomagnetic components at four stations in central Japan together with magnetograms from five observatories in other parts of Japan, shows that the anomalous behavior of the vertical component in central Japan noted in the case of the short period variations has no counterpart in the cases of *SC* and bay. It is concluded that the distribution of electrical conductivity in the ground which seems to influence the short period variation is nearly transparent for slower variations such as $D_{st}$ or $S_q$.

Summarizing the results of all the papers in this series (see also Geophys. Abs. 162–39 through 43, 166–36) it may be said that the mantle beneath Japan seems to differ greatly from the mean state of the earth with regard to conductivity. At a depth of several hundred km conductivity is probably very low, of the order of $10^{-15}$ electromagnetic units compared to $10^{-12}$ electromagnetic units for the average value of the whole earth. The boundaries of this low-conductivity region are not known. Above it there is probably a highly conductive layer; strong currents in this layer, flowing in a roughly elliptical circuit of more than several hundred km diameter, would account for the geomagnetic anomalies observed and perhaps can even be correlated with volcanism and seismicity in Japan.—*D. B. V.*

174–265. Dessler, A. J. The propagation velocity of world-wide sudden commencements of magnetic storms: Jour. Geophys. Research, v. 63, no. 2, p. 405–408, 1958.

The following model is presented for the propagation of a worldwide sudden commencement of a magnetic storm: A longitudinal hydromagnetic wave will be generated by the impact between a plasma cloud ejected from the sun and the earth's magnetic field. This wave will travel from the point of impact both east and west around the geomagnetic equator and carry the magnetic

effect of the impact to the back side of the earth. It is shown that this hydromagnetic wave will be stable at an altitude of about 400 km and travel with a velocity of about 130 km per sec. Thus, it is proposed that sudden commencements do not occur simultaneously over the earth. Rather, about two minutes are required for a sudden commencement to be propagated around the world.—*Author's abstract*

174–266. Bureau, Jean-Louis. Débuts brusques d'orages magnétiques à Tamanrasset [Sudden commencements of magnetic storms at Tamanrasset]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 1, p. 112–114, 1958.

An analysis of records at Tamanrasset, Algeria, of definite sudden commencements in the years 1950 to 1956, inclusive. Three are negative, four consist of a principal positive impulse preceded by a small negative displacement (*SSC**) and 89 are essentially positive.—*D. B. V.*

174–267. Duclaux, F[rançoise], and Leprêtre, B[ernard]. Étude statistique des crochets magnétiques à Tamanrasset [Statistical study of magnetic bays at Tamanrasset]: Geofisica Pura e Appl., v. 40, p. 127–144, 1958.

Of the magnetic bays recorded at the Tamanrasset magnetic observatory in Algeria between 1949 and 1957, 33 percent are also reported in the international bulletin. Statistical study of the frequency of these undoubted bays shows that they follow the solar cycle, having a minimum in winter and being more frequent in afternoon than in morning. There does not seem to be any obedience in the McNish law. Most probable amplitude is 7 $\gamma$. "False bays" characterized by well defined $dH/dt$ and $dD/dt$, do not follow the solar cycle, having a minimum at equinox and no diurnal maximum; their most probable amplitude is between 7 and 10 $\gamma$, and their development lasts about 5 minutes; direction of disturbance vector is northnorthwest or (predominantly) southsoutheast, which should correspond to a westsouthwest-eastnortheast ionospheric stream. The existence of false bays may explain some of the confusion in identifying magnetic bays. (See also Geophys. Abs. 172–161.)—*D. B. V.*

174–268. Kato, Yoshio, and Saito, Takao. Investigation of the magnetic disturbance by the induction magnetograph, Part VII. On the damped type rapid pulsation accompanying ssc: Tōhōku Univ. Sci. Repts. 5th ser., v. 9, no. 9, p. 99–112, 1958.

The pure single train of *pt* type of geomagnetic pulsations appearing on sudden commencement is investigated and found to appear not only with *SSC*'s but also with some small abrupt increases of geomagnetic field intensity; this is attributed to hydromagnetic oscillation of the outer atmosphere excited by steep frontal corpuscular flow.—*D. B. V.*

174–269. Bednářova, Bohumila, and Kárník, Milan. Pozorování slunečních protuberancí a jejich použití při studiu změn vnějšího pole geomagnetického [Observations of solar prominences and their use in study of changes in the external geomagnetic field]: Československá Akad. Věd Geofys. Ústav. Práce, Geofys. Sborník, no. 19, p. 215–222, 1954.

Comparison of observations of solar prominences on the eastern and western edges of the sun with geomagnetic *K*-indices indicates that some of the smaller

geomagnetic storms are related to prominences in the central meridian region. Prominences observed on the eastern edge forecast to a certain degree the occurence of magnetic storms, and those observed on the western edge serve to control such prognoses. The abnormally high prominence observed on March 26, 1953, on the eastern edge was followed on April 2 by a relatively small magnetic disturbance. This prominence was of the spot type and a spot was observed near it; this seems to confirm Waldmeier's hypothesis that spots have a negative effect on emission of corpucles from prominences.—*D. B. V.*

174–270. Bednářová, Bohumila, and Kárník, Milan. Pozrování slunečních protuberancí a jejich použití při studiu změn vnějšího pole geomagnetického [Observations of solar prominences and their use in their use in the study of changes in the external geomagnetic field in 1955 (with English and Russian summaries)]: Československá Akad. Věd Geofys. Ústav Práce, Geofys, Sborník, no. 53, p. 609–624, 1956 (1957).

Study of solar prominences in 1955 and comparison with geomagnetic *K*-indices shows that in that year, a period of increasing solar activity, most of the prominences were in eruptive regions where activity precedes an increase in geomagnetic activity.—*D. B. V.*

174–271. Grafe, Armin. Einige charakteristische Besonderheiten des geomagnetischen Sonneneruptionseffekts [Some characteristic features of the geomagnetic effect of solar eruptions]: Geofisica Pura e Appl., v. 40, p. 172–179, 1958.

Statistical analysis of the records of geomagnetic solar flare effects at Potsdam, Seddin, and Niemegk observatories from 1890 to 1956 shows that the frequency of *SFE*'s follows the sunspot period of 70 to 80 yrs, and varies seasonally with two equinoctial maximums and an extreme summer minimum. The east-west asymmetry of sunspots and eruptions is true also of the eruptions producing *SFE*'s. A phase lag between *Sq* and *SFE* current vectors was also found.—*D. B. V.*

Shuleykin, V. V. Telluric currents in the ocean and magnetic declination. See Geophys. Abs. 174–10.

## MAGNETIC PROPERTIES AND PALEOMAGNETISM

174–272. Kawai, Naoto. Magnetism of the earth crust: Jour. Geomagnetism and Geoelectricity, v. 9, no. 3, p. 140–156, 1957.

On the basis of experimental measurements of the effect of temperature (up to 700° C) and pressure (up to 19,000 atm) on samples of plutonic, metamorphic, and volcanic rocks (1,828 samples), it is concluded that pressure and temperature conditions under which rocks have been formed can be deduced from measurements of the magnetic state of rock-forming minerals. The interpretation is based on observations of piezothermal equilibria of titaniferous ferrites and silicates abundant in the lithosphere.

It is concluded that the crust consists of three magnetically different layers, an outer ferromagnetic layer due to ferrites, a middle paramagnetic layer due to titaniferous ferrites and a lower paramagnetic layer without titaniferous

ferrites. The temperature-pressure conditions at any point determine whether thermoremanent magnetization can develop. If the Curie point of a rock sample is determined from observations of its magnetization, and the composition of the ferrite contained in it by X-ray analysis, the depth of formation can be inferred from curves of Curie point versus depth. So far, field observations are consistent with the suggested depth rule.—*D. B. V.*

174–273. Burlatskaya, S. P. O metodike izmereniya magnitnykh svoystv gornykh porod na astaticheskom magnitometre [On a method of measuring the magnetic properties of rocks with an astatic magnetometer]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 1000–1007, 1957.

The effect of the three components of remanent magnetization of specimens of magnetic rocks on a Dolginov magnetometer has been studied. It was found that error can be as high as 20–25 percent of the measured bus bar values of susceptibility and remanent magnetization if the components perpendicular to the bus bar are disregarded. Formulas for determination of the values of all three components of remanent magnetization of a rectangular prism show that the error is smaller in the case of an oblong specimen and up to 8 percent for a cubic block. The Dolginov combination magnetometer reduced the effect of the vertical component to ±3.5 percent.—*S. T. V., A. J. S.*

174–274. Nagata, Takesi, and Kobayashi, Kazuo. Experimental studies on the generation of remanent magnetization of ferromagnetic minerals by chemical reactions: Acad. Japan Proc., v. 34, no. 5, p. 269–273, 1958.

By heating $\alpha$ $Fe_2O_3$ powder of mean diameter less than one micron at 340° for 20 hours in the atmosphere of hydrogen gas and under the influence of magnetic field, a magnetically stable remanent magnetization is developed in the resulting $Fe_3O_4$. This chemical remanent magnetization is intermediate in intensity between the isothermal remanent magnetization and thermoremanent magnetization. The behavior of the chemical remanent magnetization in an alternating demagnetizing magnetic field is quite similar to that of thermoremanent magnetization and is much more stable than the isothermal remanent magnetization. It was also found that the chemical remanent magnetization has about the same thermal stability as thermoremanent magnetization.—*J. R. B.*

174–275. Ponomarev, V. N. Krivaya namagnichevaniya obraztsa magnetita kontaktovo–metasomaticheskogo proiskhozhdeniya [The magnetization curve of a magnetite specimen of contact–metasomatic origin]: Akad. Nauk SSSR Ural otdel gorno-geol. Inst. Trudy no. 30, geofiz. Sbornik, no. 2, p. 84–86, 1957.

The curve of magnetization of a cylindrical specimen 4.5 cm long and 6 $cm^2$ basal area, taken from a chunk of magnetite ore (96 percent magnetite, 7 percent chalcopyrite, 3 percent nonmetallic mineral) from a contact zone of a deposit in the Krasnotur'insky region in the Urals, was measured in the field ($H_e$) produced by a solenoid. Its coercive force $H_c$ was determined from the known equality of $H_c$ with the adjusted external field $H_e$. The curves of magnetization and susceptibility were found to be as expected, but the coercive force was 35.7 oersteds instead of the usual 10 to 15 oersteds. The cause of this discrepancy was not established.—*S. T. V.*

174–276. Stacey, F. D. Effect of stress on the remanent magnetism of magnetite-bearing rocks: Jour. Geophys. Research, v. 63, no. 2, p. 361–368, 1958.

Measurements of the magnetostriction made by Heap for a single magnetite crystal in high magnetic fields are used in estimating whether a rock acquiring thermoremanent magnetization under a stress from which it is subsequently released has a moment differing in direction from the field in which it cooled. Assuming that an assembly of multidomain magnetite grains behaves isotropically and has magnetostriction constants $C_L = +10 \times 10^{-6}$, $C_t = -5 \times 10^{-6}$, referred to pure magnetite, it is shown that vectorial changes of magnetization through 90° are possible with a force of 500 atmospheres. Moments parallel to the direction of compression are reduced and those perpendicular to it are increased. Provided permanent deformation or fracture does not occur, the effect may be reversible. More quantitative results concerning reversibility are needed to show that paleomagnetic measurements do not reflect magnetostrictive effects.—*W. J. D.*

174–277. Stavrou, A[ngelos]. Untersuchungen über die magnetischen Eigenschaften der griechischen Roterde [Investigations of the magnetic properties of the Greek red soils]: Gerlands Beitr. Geophysik, v. 66, no. 3, p. 214–255, 1957.

The magnetic properties of 11 samples of the red soils of Greece, which cause local geomagnetic anomalies, have been investigated in the laboratory by means of apparatus consisting essentially of a magnetic coil and ballistic galvanometer. The results are tabulated, and the hysteresis loop and susceptibility curve drawn for the various samples.

The small amount of magnetite in all samples were separated in order to determine its effect on the magnetic properties. Another ferromagnetic component present in finely dispersed form could not be identified from X-rays. Percentages of FeO and $Fe_2O_3$ were determined by chemical analysis. A quantitative relationship was found between magnetic susceptibility and $Fe_2O_3$ content; the latter is probably in the form of $\gamma$—$Fe_2O_3$.—*D. B. V.*

174–278. Mamedov, M. Magnitnyye svoistva porod Krasnovodskogo rayona [Magnetic properties of rocks in the Krasnovodsk district]: Akad. Nauk Turkmen, SSR Izv., no. 2, p. 23–29, 1957.

Igneous rocks found in the outcrops of the Krasnovodsk district are described, and a table of their magnetic susceptibilities is given. Vectors of remanent magnetization are measured in 22 oriented igneous rock specimens, and the measurement results are given. The importance of the remanent magnetization and susceptibility study of the Krasnovodsk igneous rocks for magnetic mapping is emphasized, since the intrusives there are covered with sedimentary rocks which, for all practical purposes, are nonmagnetic.—*Author's abstract, A. J. S.*

174–279. Mikhaylova, N. P. K voprosu o magnitnosti gornykh porod Srednego Pridneprov'ya [On the magnetism of rocks of the central Pre-Dnieper region]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 176–182, 1958.

Numerous determination were made of magnetic susceptibility of specimens of magnetic rocks and of their content of iron oxides. The tabulated results

show that it is impossible to establish a relationship between the magnetic susceptibility and the content of ferric and ferrous oxides, even in petrographically similar specimens. The proportionality coefficient $K=\frac{Fe_2O_3}{FeO}$ ($Fe_2O_3$+FeO) recently suggested by Bronshteyn is shown to be valid in a few cases only. When the magnetite, probably of magmatic origin, occurs as separate grains scattered throughout the rock, the magnetic susceptibility is higher than when it occurs as rims around serpentine cores or as fine-grained cementing powder (less than 6,000 to $7{,}000\times10^{-6}$ cgs units in the latter case). It is concluded that there is no simple proportionality between the magnetic susceptibility of a rock and its content of magnetitie; the susceptibiilty depends on the position of the magnetite in the structure of the rock and on its origin.—*S. T. V.*

174–280. Ponomarev, V. N. O primenimosti magnitometrii dlya poiskov sul'fidnykh mestorozhdeniy v yuzhnoy chasti Zaural'ya [On the application of magnetometry in prospecting for sulfide deposits in the southern portion of the Trans-Ural region]: Akad. Nauk SSSR Ural Branch gorno-geol. Inst. Trudy no. 30, geofiz. Sbornik, no. 2, p. 93–96, 1957.

For a fuller utilization of the potentialities of the magnetic method of exploration in the Ural Mountains, the magnetic susceptibility $K$ was determined for some 50 different ores from a boring in a known deposit and for numerous rocks from the surrounding area, some 50 km$^2$ in all. Results are tabulated. To facilitate interpretation of the data obtained, determination of the vertical gradient of the magnetic field is recommended and the necessary formulas are given.—*S. T. V.*

174–281. Muehlberger, William R., and Baldwin, Brewster. Field method for determining direction of magnetization as applied to late Cenozoic basalts, northeastern New Mexico: Jour. Geophys. Research, v. 63, no. 2, p. 353–360, 1958.

The ambient magnetic field vector can be reduced almost to zero by placing a bar magnet parallel to the compass poles at an empirically determined distance. With such an arrangement, small field differences due to the remanent magnetization of rock samples can be detected qualitatively. The direction of the remanent magnetization vector, whether normal (near the present magnetic field azimuth and inclination) or reverse (near 180° from the present field) was determined for specimens of Pliocene to Pleistocene basalts in northeastern New Mexico. The objectives of field stratigraphic correlation or subdivision could not be attained because of inconsistencies in the observed remanent magnetization not associated with recognizable changes in the rock.—*W. J. D.*

174–282. Roche, Alexandre. Sur les variations de direction du champ magnétique terrestre au cours du Quaternaire [On the variations in direction of the earth's magnetic field during the Quaternary]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 24, p. 3364–3366, 1958.

The directions of magnetization observed in the lavas of the Auvergne and Velay, France, show that aside from possible secular variations, the geomagnetic field in the early Quaternary differed substantially from the present direction and that of the upper Pliocene. Pole positions are calculated for six lavas from the upper Pleistocene and early Quaternary.—*D. B. V.*

174–283. Roche, Alexandre, Cattala, Louis, and Boulanger, Jacques. Sur l'aimantation de basaltes de Madagascar [On the magnetization of the basalts of Madagascar]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 20, p. 2922–2944, 1958.

Fifteen oriented specimens of basalts were collected from six places in Madagascar, two in Quaternary and four in Cretaceous (Turonian) flows. The magnetization of the Quaternary specimens was found to be of complex origin and unsuitable for paleomagnetic purposes, but that of the Cretaceous specimens was found to be thermoremanent and stable. The direction indicated for Turonian time corresponds rather closely to that of the present geomagnetic field—*D. B. V.*

174–284. Asami, Eizo. Positional intermixing of the normal and reverse magnetizations of the Kawajiri-misaki basalt lavas: Jour. Geomagnetism and Geoelectricity, v. 9, no. 3, p. 162–164, 1957.

Examination of 43 samples from one square meter of outcrop, in continuation of the investigation of the paleomagnetism of the Kawajiri-misaki basalts of Japan (see Geophys. Abs. 171–270), reconfirms the fact that normal and reverse magnetizations are closely intermixed in a single block of rock. Seven specimens showed normal magnetization, one intermediate, and 35 reversed. Seven specimens closely spaced in place and having mixed directions show very weak magnetization and nearly intermediate directions; this seems to be the natural consequence of self-reversal, as the opposite magnetization thus produced is not always exactly antiparallel to the original direction.—*D. B. V.*

Watanabe, Naotune. Secular variation in the direction of geomagnetism as the standard scale for geomagnetochronology in Japan. See Geophys. Abs. 174–262.

Green, G. Polar wandering, a random walk problem. See Geophys. Abs. 174–253.

## MAGNETIC SURVEYS

174–285. Henderson, Roland G., and Zietz, Isidore. Magnetic-doublet theory in the analysis of total-intensity anomalies: U. S. Geol. Survey Bull. 1052–D, p. 159–186, 1958.

Analysis of horizontal- or vertical-intensity magnetic anomalies in terms of equivalent magnetic doublets has been extensively used for rough estimates of depth and depth extent of disturbing rocks. In this investigation, factors have been theoretically determined by which appropriate total-intensity anomalies can also be analyzed in terms of their magnetic-doublet equivalents. The effectiveness and limitations of the method have been checked by application to anomalies derived from model experiments and to observed anomalies. For satisfactory results the effective radius of the disturbing body must be less than its depth of burial. The calculation of doublet length is not so reliable as the calculation of depth; however, the former is better at low magnetic latitudes.—*Authors' abstract*

174–286. Köhler, Karl. Grundlagen für die Auswertung von magnetischen Anomalien (insbesondere *Z*–Komponente) [Principles of interpretation of magnetic anomalies (especially *Z*–component)]: Freiberger Forschungshefte C 41 Geophysik, 128 p., 1958.

A review of methods of evaluating local geomagnetic anomalies. First the general problem is posed, and the concept of geomagnetic anomalies and their relation to geologic structure explained. The various methods proposed for solution of the direct problem are summarized. Many diagrams and tables are available for practical use here. The advantages of the experimental versus mathematical solution are pointed out. A unique solution cannot be obtained for the inverse problem on the basis of magnetic data alone; additional geological or geophysical data are needed to narrow down the possibilities. The calculation of higher derivatives and gradients to clarify anomalies, and calculation of basement relief are also considered. A bibliography of 182 items is appended.—*D. B. V.*

174–287. Timofeyev, A. N. Ob interpretatsii geofizicheskikh anomaliy graficheskim sposobom po kasatel'nym [The interpretation of geophysical anomalies by the graphic method of tangents]: Akad. Nauk SSSR Ural Branch gorno-geol. Inst. Trudy no. 30, geofiz. Sbornik no. 2, p. 189–208, 1957.

The theoretical basis and the method of interpretation of gravitational and magnetic anomalies are presented. Using a graphic method based on the construction of tangents drawn to given points on the curves of the anomalies, the following problems are solved: finding the vertical and horizontal components; finding the apex and the maximum gradient of the anomaly produced by a magnetic pole, by a sphere (dipole), by a line of poles, by an infinite horizontal cylinder, by a vertical layer of infinite depth, by a vertical fault, and by a horizontal half-plane. A table is given containing numerical values of different characteristic parameters met with in many problems.—*S. T. V.*

Bulakh, Ye. G. Some criteria for checking interpretations of gravitational and magnetic anomalies. See Geophys. Abs. 174–184.

174–288. Blinstrubas, S. I. Naklonnaya nit' polyusov [Inclined line of poles]: Akad. Nauk Litovsk. SSR Trudy, ser. B, v. 3 (15), p. 183–202, 1958.

A solution of the direct problem of magnetometry is given and the methods of determining the space orientation of the surface of the upper magnetic poles of thin, inclined, infinitely descending layers, uniformly magnetized along the dip are discussed. It is shown that if a unique solution of the inverse problem is required, the profile curves of the vertical ($Z_a$) and horizontal ($H_a$) components of the magnetic field must be considered along the spread but not across it. The characteristic points used in deriving the three equations and the three unknowns sought are: point $Z_a=Z_{max}$; point $H_a=O$; and point $Z_a=H_a$. The points $Z_a=H_a$ are symmetrical with respect to the coordinates origin. The peculiar form of the isodynes of the vertical component makes it easy to distinguish case treated here from others met in practice. The equation derived is used for plotting isodynes and permits determination of $Z_a$ values for any point on the graph.—*A. J. S.*

174–289. Mašín, Jan. The magnetic field of an infinite parabolic cylinder: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 54, p. 625–637, 1956 (1957).

Equations are derived for the horizontal and vertical components of the magnetic field of an infinite parabolic cylinder (a body of infinite horizontal extent

having parabolic cross-section) in an arbitrary position for oblique magnetization, and the direct and inverse problems are solved. An alinement chart is compiled for determining the angle of inclination of the axis from the known relation $Z_o/H_o$. The method is applicable in magnetic surveying of anticlines and some igneous bodies, but the parabolic cylinder is not usually suitable for ore bodies.—*D. B. V.*

174–290. Mokhova, Ye. N. Pryamougol'naya prizma postoyannoy vospriimchivosti v odnorodnom magnitnom pole [A rectangular prism of constant susceptibility in a homogeneous magnetic field]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 3, p. 387–390, 1958.

This paper presents the results of a study of the distribution of induced magnetization and the structure of the magnetic field of rectangular prisms in the earth's field. The specimens used were mainly cubic, made of powdered titanomagnetite mixed with glue or plastic to give magnetic susceptibilities of 0.07 and 0.03 cgs units, respectively. The magnetic field over the specimens was measured by a Kalachnikov field meter. A coil 3 x 3 x 3 mm was used. The frequency of the field was 23 cycles per sec. The horizontal component of the geomagnetic field was compensated by Helmholtz coils. The field of a magnetized body having constant susceptibility was computed theoretically and compared with the experimental results. The experimental curve agrees rather well with the theoretical curve computed on the assumption of homogeneous magnetization, although at each end the experimental curve is flatter. (See also Geophys. Abs. 170–236.)—*S. T. V.*

174–291. Oilweek. Spartan Air Services introduces in Canada Varian nuclear precision magnetometer: Oilweek, v. 9, no. 24, p. 24, 1958.

The Varian nuclear precision magnetometer is a simple device whose sensing element is basically a coil of wire immersed in a bottle of water or other liquid containing hydrogen atoms. The hydrogen atoms are made to oscillate under the influence of the earth's magnetic field, and the frequency of oscillation is proportional to the earth's magnetic field at any point. This frequency is recorded on punched tape for computer processing. Information concerning the presence of ferrous type minerals, basement topography and thickness of overlying sediments, and general information on structural geology are obtainable from computer results. The instrument, already used by the U. S. Navy in the Vanguard satellite program and in the Aerobee rocket, has been introduced into Canada as an airborne prospecting tool for oil and mineral exploration. The advantage of this magnetometer is the fact that measurements are based on the unchangeable hydrogen proton and are not affected by changes in temperature, humidity, pressure or mechanical shocks; it is calibrated on a constant nature, and measurements are independent of orientation of the instrument with respect to the earth's magnetic field.—*V. S. N.*

174–292. Bouška, Jan, Bucha, Václav, Fröhlich, Bedřich, Gross, Karel, Markes, Ladislav, and Pl'shek, Vladimir. Metod geomagnitnoy razvedki s primeneniyem polevogo magnitometra novogo tipa [A method of geomagnetic prospecting using a new type of field magnetometer (with English and Czech summaries)]: Československá Akad. Věd

Geofys. Ústav. Práce Geofys. Sborník no. 55, p. 639–652, 1956 (1957).

Continuous measurement of the geomagnetic field while the observer is walking would offer the advantage of providing more complete data than static measurements with field balances and guarantee reliable results for interpretation. A new type of magnetometer operating on the principle of an electromagnetic probe (GM–1) has been developed for this purpose. The device, developed and tested in Czechoslovakia in 1954, has been applied in the field in 1955–1956. The instrument operates from two soft iron probes inserted vertically into the ground and magnetized by both the natural and the induced alternating fields. The three main parts of the magnetometer are an oscillator, a selective amplifier, and a compensator. The last compensates for the most of the field, and the electronic part measures only the difference between the compensated and the actual parts of the vertical component $Z$ of geomagnetic intensity. A nickel-iron storage battery which supplies the current and rather bulky electronic equipment make the device rather heavy for continuous field work. Use of transistors is planned for future models of the apparatus, the functions of which can be extended to include measurement of magnetic gradients and magnetite logging. A general diagram of GM–1 is given and the results of its use on a skarn-type magnetic bed near Vlastějovice, Czechoslovakia, are reported, with a partial interpretation based on measurements at various heights.—*A. J. S., D. B. V.*

174–293. Reich, H[ermann]. Über die Nachprüfung von magnetischen Messungen mit dem Lokal–Variometer von J. Wüst und die Feststellung der Ursachen der gefundenen magnetischen Störungen [On the reexamination of magnetic measurements with the Wüst local–variometer and determination of the causes of the magnetic anomalies found]: Zeitschr. Geophysik, v. 23, no. 4, p. 169–181, 1957.

Control measurements made at three places with Askania field balances show that Wüst's magnetic local–variometer is capable of delineating local anomalies in the geomagnetic horizontal component. The anomalies in question were all due either to iron objects or to magnetite-bearing slag, and had nothing to do with ground water as proponents of divining rods supposed. These tests point up the desirability of developing a convenient, light, and cheap magnetometer for field geologists that would be as indispensible, in regions of magnetic rocks, as pick and compass.—*D. B. V.*

Janakiramaiah, B., and Ramana, E. V. Geophysical investigations near the old workings for copper in Yanambail area, Khamman district, Andhra Pradesh. See Geophys. Abs. 174–129.

Suyama, Junji; Saitō, Tomosaburō; and Futsukaichi, Hiroshi. Report on the electric and magnetic investigations for titanic iron–sand deposits, in the Kaimon–onsen District, Ibusuki-gun, Kagoshima Prefecture. See Geophys. Abs. 174–127.

174–294. Skopichenko, M. F. Nekotoryye osobennosti geomagnitnogo i gravitatsionnogo anomal'nykh poley tsentral'noy chasti Prichernomorskoy vpadiny i ikh geologicheskoye istolkovaniye [Some peculiarities of

the geomagnetic and gravitational anomalous fields of the central part of the Black Sea marginal depression and their geologic interpretation]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy ser. geofiz., no. 2, p. 62–68, 1958.

The central part of the Black Sea marginal depression (long 32.5 to 36.0° E, lat 45° to 47° N) is filled with a thick layer of young sediments. Geophysical surveys were begun here as early as 1926. The results of geomagnetic and gravity surveys are presented in the form of maps of vertical magnetic intensity and Bouguer anomalies. The geomagnetic field reflects the structure and relief of the Precambrian crystalline basement which deepens southward. Local magnetic minima and maxima are caused either by local modifications in composition of the basement, in the north, or by local changes in its relief, in the south. The gravity anomalies also depend on topographic or petrographic inhomogeneities in the basement. They are positive, except in an area south of the Sea of Azov and another in the neck of the Crimean peninsula. More detailed geological and geophysical investigation of the anomalies is recommended.—*S. T. V.*

Krzivanek, G. A. Some data on the deep structure of the central portion of the Black Sea marginal depression. See Geophys. Abs. 174–210.

Lebedev, T. S. The gravitational and magnetic anomalies of the Pripet River basin and their relation to geologic structure. See Geophys. Abs. 174–211.

## MICROSEISMS

174–295. Kishinouye, Fuyuhiko. Microseisms (in Japanese with English abstract): Jour. Geography (Tokyo), v. 66, no. 2 (704), p. 1–7, 1957.

A general discussion of microseisms and their application to meteorology and earthquake engineering.—*V. S. N.*

174–296. Darbyshire, J., and Iyer, H. M. Some recent developments in the study of microseisms in Great Britain and the United States: Royal Astron. Soc. Geophys. Jour., v. 1, no. 2, p. 180–184, 1958.

A review, contrasting the development of research on microseisms in Great Britain and in the United States.—*D. B. V.*

174–297. Jensen, Henry. A procedure for the determination of direction of approach of microseismic waves: Denmark Geod. Inst. Medd. no. 36, 18 p., 1958.

A method is developed for the determination of the direction of approach of microseismic waves. At the moments at which $Z$ is maximum the slopes of the two horizontal records are read. The ratio between those two slopes gives the velocity of the earth-particle. The mean of several velocity vectors gives the direction of approach. The method is applied in some cases by use of the Swedish stations together with København.—*Author's summary*

Hardtwig, E[rwin]. Large explosions and microseismics. See Geophys. Abs. 174–103.

## RADIOACTIVITY

174–298. Waldron, Esther C., Schultz, Virginia A., and Kohman, Truman P. Natural alpha activity of neodymium: Phys. Rev., v. 93, no. 1, p. 254–255, 1954.

The natural $\alpha$-activity of neodymium has been investigated by nuclear emulsion techniques. The mean range of $\alpha$-particles is found to be 6.0 $\mu$; the energy of the group is calculated as 1.9 $\pm$0.1 MeV. The specific activity is estimated to be 0.015 $\alpha$ $sec^{-1}$ (gNd), corresponding to a half life of $Nd^{144}$ of 1.5 $\times$ $10^{15}$ yrs. These figures are uncertain by a factor of 2.—*D. B. V.*

174–299. Imbò, G[iuseppe]. Sul metodo fotografico per lo studio della radioattività delle rocce [On the photographic method of studying the radioactivity of rocks]: Annali Geofisica, v. 9, no. 3, p. 285–292, 1956.

On the basis of investigations of lavas from Vesuvius, a new formula is derived for calculating the radioactivity of rocks from $\alpha$-particle tracks on photographic emulsions:

$$n=\frac{NR\mu'}{4}\left(1+\frac{m}{\mu_2 R}r\right)\left(1-\frac{r}{\mu_2 R+mr}\right)^2$$

where $n$ is the number of tracks whose horizontal projection is greater than a given distance $r$, $N$ is the number of $\alpha$-particles emitted per $cm^3$ per sec, $R$ is their relative range in air, $\mu'$ and $\mu_2$ are the coefficients of their deceleration in the lava and in the emulsion, respectively, and $m$ is a proportionality constant.—*D. B. V.*

174–300. Hayase, Ichikazu. The radioactivity of rocks and minerals studied with nuclear emulsion V: Radioactive behavior of granites: Kyōto Univ. Coll. Sci. Mem., ser. B, v. 24, no. 2, p. 121–154, 1957.

Contact metamorphism of a rock by granite causes migration of the radioactive elements; the more advanced the crystallization in the hornfels, the more radioactive material it absorbs from the granite. At or near the contact the radioactive substances are concentrated in brecciated xenoliths and in the dusty parts and in biotite altered from cordierite, with the rock radioactivity gradually decreasing away from the contact.

In the minute radioactive minerals, the relation of quantity to radioactivity is in lognormal distribution; in general these minute grains are dependent both in mineralogical variety and in degree of radioactivity upon the form of granitic intrusion which contains them. In a batholith the minute radioactive minerals are feeble but in a stock they are strongly active. In contact rock and near xenoliths, however, grains of high as well as low radioactivity are found in both types of intrusions.

Thorium and uranium can be distinguished in the nucleus material on the basis of the pleochroic haloes in biotite, and the thorium-uranium ratio can be determined from the distribution of the alpha tracks emitted from the nucleus mineral. The later the stage of magmatic differentiation of the granite, the higher the thorium-uranium ratio.—*V. S. N.*

174–301. Vaňková, Věra. Determination of radioactivity of rocks by measurement of gamma ray activity: Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 1, p. 193–195, 1957.

A description of a method of determining gamma-ray activity of rocks using a Geiger–Müller counter. The results of measurements on three granodiorites, a diorite, a gneiss, a silty clay, a sandstone, and a limestone are tabulated. The minimum activity measurable with this device is $4\times10^{-6}$ g U per g of rock.—*D. B. V.*

174–302. Legrand, R. Brèches radioactives aux environs de Visé [Radioactive breccias in the vicinity of Visé]: Soc. belge Géologie Bull., v. 66, no. 2, p. 211–217, 1958.

Preliminary measurements of the radioactivity of the solution breccias underlying the Namurian in the vicinity of Visé, Belgium, show that the breccias contain the equivalent of up to one percent uranium. Radioactivity is lowest where silicification is most intense.—*D. B. V.*

174–303. Krylov, A. Ya. Radioaktivnost' razlichnykh kompleksov porod khrebta Terskey Ala–Tau [Radioactivity of various rock complexes of the Terskey Ala–Tau range (with English summary)]: Geokhimiya, no. 3, p. 191–196, 1958.

The uranium, thorium, and radioactive potassium contents of rocks from four series (Proterozoic and lower Paleozoic metamorphics, Caledonian granites and granodiorites, younger Caledonian leucocratic granites, and Cenozoic sediments) in the Terskey Ala–Tau range in northern and central Tyan-Shan, U. S. S. R., are tabulated, based on several thousand analyses. Average total chemical compositions are also given for each series. The results indicate that during the formation of granitic batholiths (where country rock is replaced) the radioactive elements are introduced mainly along with silicon and alkalis; at the same time calcium and magnesium are removed to a considerable extent and iron, manganese, and titanium to a somewhat lesser degree. This tendency increases in the second granite phase, which represents a further development of the magmatic process.—*D. B. V.*

174–304. Smyslov, A. A. Radioaktivnyye elementy v izverzhennykh porodakh severnogo Kazakhstana [Radioactive elements in igneous rocks of northern Kazakhstan]: Geokhimiya, no. 3, p. 197–205, 1958.

The contents of radioactive elements (U, Th, Ra), determined by means of luminescence and radiochemical analyses, in various intrusive and extrusive igneous rocks from the northern part of the Kazakh S. S. R. are tabulated. It is shown that the radioactivity can be used as a supplementary criterion in defining the intrusive complexes of this and other regions. The variations of the content of radioactive elements are related to differences in composition between intrusive and extrusive bodies and to the migration of uranium (and to a lesser extent of thorium) during magmatic activity; uranium may occur in easily soluble or in relatively insoluble forms, or both.—*D. B. V.*

174–305. Koczy, F[ritz] F. Geochemistry of the radioactive elements in the ocean. A critical summary: Deep-Sea Research, v. 3, no. 2, p. 93–103, 1956.

A discussion of the divergences between American workers (Urry, Holland, and Kulp), and the European workers (Pettersson, Koczy, Kröll, and others) in the geochemistry of radioactive elements in the ocean. Koczy agrees with Holland and Kulp that uranium seems to be enriched in shelf sediments and adds that the redox potential is apparently the cause, with biological processes playing an important part. Enrichment is great where mineralogic components settle very slowly. He disagrees with the Holland-Kulp method of removing ionium and radium. The rate of extraction of ionium from sea water seems to be of about the same order of magnitude as the rate of decay of uranium, and only a minor part need be supplied by river water. A theoretical estimate of ionium content in sea water is uncertain because of lack of knowledge of extraction of radium by animals and plants. Only further measurements can give correct answers.

The principles of calculation of the thorium and ionium contents of sea water are that the total addition of an element to the ocean, as given by the decay from the mother element and the supply by rivers, equals the decay into the daughter element and the precipitation; that fluctuations in the content of the elements in sea water are negligible for about 1,000 years; and that the isotopes are precipitated in the same ratio as their contents are found in solution.—*V. S. N.*

174–306. Kröll, Viktor S. The distribution of radium in deep-sea cores: Swedish Deep-Sea Exped. 1947–1948 Repts., v. 10, no. 1, p. 32, no date.

The radium concentration was measured for 13 deep-sea cores from the central and western Pacific and 4 from the Atlantic. The radium in the upper layers is probably ionium-supported. The vertical distribution of radium differs essentially from the theoretical distribution. This should be investigated further on as large a scale as possible. Three processes seem to affect the vertical distribution of radium in the sediment; variation of ionium supply with time due to variation in adsorption power of the depositing sediment for ionium or to variations of chemical conditions of the sea water (probably due to volcanic action); variation in rate of sedimentation by horizontal transport (possibly induced by volcanism); and diffusion and adsorption of radium in the sediment. Intense volcanic activity about 100,000 yrs ago in the Pacific is suggested.—*D. B. V.*

174–307. Kröll, Viktor S. Radium in manganese crusts: Göteborg Oceanog. Inst. Medd., no. 24, 10 p., 1955.

Measurements of the radium content of samples of manganese crusts from guyots in the northern Pacific show that the radium content seems to be governed by the chemical composition of the layers. There is never more than one Ra-maximum, whereas two such maximums is the rule in red clay. This may be attributed to the fact that the samples represent a relatively short time interval, and the Mn concentration, which probably determines the original radium concentration, does not show much variation. The increase in rate of sedimentation with depth as well as the increase of the $Ra/MnO_2$ ratio in some samples suggests that a certain amount of ionium-supported radium may be present, which can be disregarded in the uppermost layers but not for greater depths.—*D. B. V.*

174–308. de Vries, H. Atomic bomb effect: variation of radiocarbon in plants, shells and snails in the past 4 years: Science, v. 128, no. 3318, p. 250–251, 1958.

Measurements on the shells and flesh of marine, freshwater, and land mollusks and on a freshwater alga from Holland shows that there has been a noticeable increase in carbon-14 content in the last four years, which can be attributed to production of carbon-14 by atomic bombs.—*D. B. V.*

## RADIOACTIVITY SURVEYING AND LOGGING

174–309. Baranov, V[ladimir] I. Spravochnik po radiometrii [Handbook of radiometry]: Moscow, Gosudarstvennoye Nauchno-tekhnicheskoye Izdatel'stvo, 163 p., 1957.

This reference book of radioactivity surveying for geophysicists and geologists is a compendium of information on the nature of radioactivity; apparatus and methods of radioactivity surveying and logging used in the U. S. S. R.; distribution of radioactivity in the earth's crust, waters, and atmosphere; and radioactive methods of determining geologic age. Brief sections deal with rules for working with radioactive elements and with cosmic rays. The book includes 21 graphs and 94 tables of data and concludes with a bibliography of more than 180 items.—*D. B. V.*

174–310. Zuffardi, Piero. L'uranio: Cos'è–dov'è–come lo si cerca [Uranium: what it is, where it is, how it is sought]: Milano, Ulrico Hoepli, 218 p., 1957.

A guide to prospecting for natural radioactive substances.—*D. B. V.*

174–311. Voskoboynikov, G. M. Integral'nyye uravneniya i priblizhennyye formuly dlya rascheta intensivnosti γ-izlucheniya v odnorodnoy izuchayushchey srede [Integral equations and approximate formulas for the calculation of intensity of γ-radiation in a homogeneous radiating medium]: Akad. Nauk SSSR Ural Branch, gorno-geol. Inst. Trudy, no. 30, geofiz. Sbornik, no. 2, p. 152–161, 1957.

On the basis of the quantum theory and several theorems of theoretical physics, a new integral equation is derived for the equilibrium of γ -radiation in a homogeneous medium. Several approximate solutions are given. The formulas derived make it possible to obtain numerical values for the spectral and total intensity of radiation. Similar procedure can be used for the interpretation of the readings of any radioactivity counter. The results are sufficiently accurate for most practical problems, especially when the primary rays before dissipation have an energy not exceeding the value of 5 $mc^2$, (where $m$ is the mass of an electron, $c$ the velocity of light). The formuals can be applied for any medium.—*S. T. V.*

174–312. Jaki, Stanley L., and Hess, Victor F. A study of the distribution of radon, thoron, and their decay products above and below the ground: Jour. Geophys. Research, v. 63, no. 2, p. 373–390, 1958.

The distribution of radon and thoron and their decay products were determined experimentally at a height of one meter above the ground, at the ground surface, and beneath the surface at depths up to 75 cm.

An exhausted ionization chamber was filled with air at an elevation of one meter above the ground. By measuring the ionization produced in the shielded chamber by alpha particle emission it was possible to determine the relative amounts of radon and thoron. The experiments were conducted under various weather and ground conditions and it was found that wet, snow-covered, or frozen ground prohibits the escape of thoron into the air and greatly reduces the amount of radon emanated. The radon and radon decay products component of the total ionization ranged from 71 percent to 100 percent and averaged 87 percent.

An aluminum cylinder, charged to a potential of —600 volts, was used to determine the distribution of radon and thoron in soil gas at and beneath the surface of the ground. Alpha emission of radon and thoron produces positively charged RaA and ThA atoms which are attracted to the negatively charged cylinder wall. The ionization produced by these atoms and their decay products was used to calculate the distribution of the parent elements. The total ionization increased linearly with depth. However, the thoron component tended to approach a maximum at a depth of 75 cm, whereas the radon component showed no such tendency within the depth range of the experiments. At the ground surface the ionization produced by thoron and its decay products exceeds that of radon by a factor of five.—*R. G. B.*

174–313. Steiner, Ferenc. Mérési módszer kisméretű minták γ-aktivitásának és önelnyelési együtthatójának meghatározására [A measurement method for determining the gamma-activity and self-absorption coefficient of small samples]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, v. 7, no. 1, p. 57–62, 1958.

The number of gamma-quanta escaping each second from a sphere having a coefficient of self-absorption $\mu$, activity $n$, and radius $R$ is computed. Using a formula and diagram presented, $\mu$ can be determined from counts on two samples of different radii. The activity is determined by measurement against a radiation standard. The method can be applied to small samples. Use of a greater solid angle or of scintillation counter can extend the efficiency of the method to cover very small or very weakly radioactive samples.—*D. B. V.*

174–314. Budde, E. Bestimmung des Beweglichkeits-koeffizienten der Radiumemanation in Lockergesteinen [Determinatien of the coefficient of diffusion of radon in unconsolidated rocks]: Zeitschr. Geophysik, v. 24, no. 2, p. 96–105, 1958.

In order to establish the possibility of locating uranium enrichments or faults by measurements of radon concentration near the surface of the ground, it is necessary to know the diffusion coefficient of radon in unconsolidated material. Comparison of the results of laboratory measurements in a diffusion column with a theoretical model shows that there is no measurable difference between the diffusion coefficient in a dry unconsolidated soil and that in the open air, but that the diffusion coefficient depends to a great extent on the finest grain-size fraction in moist material. Therefore, it is not possible to measure any radon anomaly in soil-air even a short distance from a strong source in fine-grained soil under natural conditions, because hardly any radon would migrate.—*D. B. V.*

174–315. Yakovlev, A. F. O forme deystvuyushchikh i registriruyemykh anomaliy pri aero-gamma-s"yemke [On the form of true and recorded anomalies in airborne gamma surveying]: Akad. Nauk SSSR Izv. ser. geofiz., no. 5, p. 594–604, 1958.

An approximate equation is derived for the curves of the anomalies of the gamma-ray field in the atmosphere near the earth's surface. The solution is later extended to the problem of determination of these anomalies in the case of measurement by an airborne radiometer provided with an integrating element. Proof is presented that many types of anomalies often met in airborne gamma surveying are well approximated by the Gauss curve, which contains a parameter determined by the dimensions of the line of observation and its position with respect to the surveyed profile. This analysis permits solutions of the inverse problem.—*S. T. V.*

174–316. Roubault, Marcel, and Coppens, René. Sur une variation brusque et limitée de la radioactivité d'un massif granitique [On an abrupt localized change in the radioactivity of a granitic massif]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 21, p. 3086–3089, 1958.

A sharp increase in radioactivity (up to 140 counts per sec) in a Y-shaped band three to four meters wide in the granitic massif near Vannes (Morbihan, France) is found to be due mainly to a concentration of monazite, occurring as inclusions in biotite, rather than to a vein of uranium ore.—*D. B. V.*

174–317. Teuscher, Ernst Otto, and Budde, Ernst. Emanationsmessungen im Nabburger Flussspätrevier. I. Geologischer Teil (Neuere Untersuchungen auf Bayerischen Flussapätvorkommen; II. Geophysikalischer Teil (Rn-Messungen auf Flussspätgängen) [Emanation measurements in the Nabburger fluorspar district. 1. Geological part (New investigations on the Bavarian fluorspar occurrences) 2. Geophysical part (Radon measurements on fluorspar veins)]: Geol. Bavarica, no. 35, 59 p., 1957.

Radioactivity observed in different fluorspar veins in Bavaria stimulated intensive soil-gas emanation surveys in which more than 60 profiles between 40 and 100 m long were made across 24 different fluorspar zones. The geology of the various fluorspar districts and the interpretation of the results of the survey in the Nabburger district are presented in the first part of the paper. The results appear to be correlated with physical properties; thus the method is found suitable for fine-scale surveying, such as tracing known fractures and veins, particularly when overburden and vegetation cover are of uniform and moderate thickness. Best results were obtained when samples were taken at least one meter apart and at equal depths. Although accuracy is not as great as that of trenching or boring, further refinement of the method would hardly pay. The second part of the paper gives details of the measurements and describes examples typical of different combinations of vein and country rock: light veins (inactive zones) in active country rock; dark veins (stained by radioactivity) in more active country rock; and fractures filled with dark spar in active country rock.—*D. B. V.*

174–318. Iwasaki, Shoji; Sano, Sun'ichi; Obi, Nakamaru; and Ujiiē, Akira. On car-borne radiometric surveys (in Japanese with English abstract): Geol. Survey Japan Bull., v. 8, no. 12, p. 15–26, 1957.

Results of car-borne radiometric surveys in southern Okayama and central Tottori and Yamanashi Prefectures in Japan, were as follows: anomalous zones with activity up to 10,000 counts per minute were found in the granites in the vicinity of the Miyoshi and Ogamo uranium mines; high counts were also detected in the Hirose district and Ningyō Pass (subsequent areal surveys found torbernite at Hirose and a sedimentary autunite deposit at Ningyō Pass); radioactivity was high in the vicinity of Masutomi Spring, Yamanashi Prefecture. Further study is necessary to analyze the variations in count due to outcrops, overburden, and architecture (stone walls, bridges, tunnels, etc).—*V. S. N.*

174–319. Horikawa, Yoshio; Ujiiē, Akira; Nakai, Junji; Murayama, Masarō; Katada, Masato; and Yamada, Naotoshi. Radiometric survey with car-mounted instrument in the southern region of central Japan (in Japanese with English abstract): Geol. Survey Japan Bull., v. 9, no. 1, p. 1–10, 1958.

Results of a reconnaissance radiometric survey of 3,500 km$^2$ in central Japan indicate that acid igneous rocks are more radioactive than basic; the younger Naegi–Agematsu granite shows higher radioactivity than the older granites related to the Ryoke metamorphic zone; in the Ryoke zone, radioactivity is stronger in hornblende-biotite granite than in biotite granite or two-mica granite and is stronger in the hornfels and gneiss than in the crystalline schist and phyllite of the Sambagawa and Mikabu series.—*V. S. N.*

174–320. Kaneko, Tetsuichi; Ujiiē, Akira; Horikawa, Yoshio; and Anzai, Toshio. Radiometric survey with car-mounted instrument in the northern part of Okayama Prefecture (in Japanese with English abstract): Geol. Survey Japan Bull., v. 9, no. 1, p. 11–20, 1958.

Granitic rocks, abundant in the northern part of Okayama Prefecture, Japan, generally show anomalous radioactivity, and it is possible that a car-borne radiometric survey can be used for rapid identification of different types of granite. Route maps of radiometric intensity, on a scale of 1:50,000, will be useful in prospecting for radioactive minerals.—*V. S. N.*

174–321. Nakai, Junji; Muraoka, Hideki; Kobayashi, Takeshi. Radiometric survey with car-mounted instrument in southern part of Okayama Prefecture (in Japanese with English abstract): Geol. Survey Japan Bull., v. 9, no. 1, p. 21–30, 1958.

A radiometric survey in southern Okayama Prefecture in Japan showed an area of high radioactivity in the Chūgoku region, with intensities up to 17,000 counts per minute recorded over biotite granites of the Ihara area and Kojima Peninsula. The radioactivity of igenous rocks tends to increase with silica content except in the case of porphyrite, which exhibits strong activity. The sedimentary rocks of the area, regardless of age, showed 4,000–6,000 counts per

minute dropping to 1,000–3,000 counts per minute in the case of limestone and "schalstein." A detailed geological and geophysical study is recommended for the Ihara and Kojima Peninsula areas.—*V. S. N.*

174–322. Horikawa, Yoshio, and Ujiiē, Akira. Radiometric survey with car-mounted instrument in the southwestern part of Yamaguchi Prefecture (in Japanese with English abstract): Geol. Survey Japan Bull., v. 9, no. 1, p. 31–34, 1958.

A radiometric survey of southwestern Yamaguchi Prefecture, Japan, in an area of acidic rocks ranging in age from Paleozoic to Cenozoic, showed two anomalous areas of high radioactive intensity, one north of Bōfu–shi and the other between Ogori and Funaki. A detailed geological and geophysical study is recommended for the Bōfu–shi area.—*V. S. N.*

174–323. Storseth, B. J. Radioactivity logging in carbonate reservoirs: Oklahoma Univ., 5th biennial, Symposium on subsurface geology Proc., p. 29–48, 1957.

Radioactivity surveys of carbonate reservoirs are more easily interpreted than those of sand reservoirs because of the general homogeneity of the carbonate rock. Four methods of interpreting radioactivity logs of carbonate reservoirs are described in detail, ranging from the simple interpretative method as a measurement check to locate pay sections accurately to the more complex method of evaluating fundamental reservoir data and subsurface structures. The log interpreter must be familiar with instrumentation problems met in this type of logging and must have some means of checking the calibration of the log. With true calibration of values acquired from radioactivity logs, information from reservoir studies in the field may be used for definite comparison between wells.—*V. S. N.*

174–324. Northcote, K. E. A preliminary investigation of the density log as a porosity log: Canadian Oil and Gas Industries, v. 11, no. 4, p. 97–106, 1958.

The McCullough density log tool and the Lane Wells Densilog are both in use in Canada. The McCullough tool uses a scintillometer; through use of a collimated source and detector opening and a discriminator, only source gamma rays which have penetrated the formation are recorded. In theory, all natural gamma radiation and gamma rays which have experienced several collisions or have traveled through the mud cake are eliminated. The density log records a combination of bulk density of the formation with density of the fluid in the pores. If the logarithm of gamma intensity is plotted against density the result is a straight line and the log can be calibrated for density if density is known for one point on the log. The log can be calibrated for porosity where lithology is known: $\phi\% = 100\ \frac{\rho_G - \rho_B}{\rho_G - \rho_{FL}}$ where $\rho_G$ is grain density, $\rho_B$ bulk density, and $\rho_{FL}$ is density of the fluid pores. The "Densilog" has a collimated source opening with a window as a detector opening to the Geiger counter. The number of gamma rays scattered back to the detector depends on the density of the formation; there is no discriminator. Natural gamma rays are

thought to be shielded from the detector by a lead plug. The log can be calibrated for density by means of a series of transparent charts, one chart for each mud weight. If lithology ($l_o$) is known, porosity can be read from the chart. Examples of four well logs showing density and neutron logs are given.—*V. S. N.*

## SEISMIC EXPLORATION

174–325. Menzel, Heinz, and Rosenbach, Otto. Bemerkungen über den Einfluss der Verwitterungsschicht auf das Spektrum seismischer Wellen [Remarks on the effect of the weathered layer on the spectrum of seismic waves]: Geofisica Pura e Appl., v. 40, p. 36–40, 1958.

A continuation of an earlier paper (see Geophys. Abs. 171–324). Further theoretical investigations are made of the effect of the weathered layer on seismic waves. The discrepancy between theory and observation is diminished by modifying assumptions as to the elasticity of the weathered layer. It is shown that if the layer is acted upon by a momentary impulse (needle impulse) the frequency of the seismic wave is determined by the gradient of acoustical resistance, not by the velocity gradient; therefore it is necessary to measure not only velocity but also density as a function of depth.—*D. B. V.*

174–326. Caloi, P[ietro]. Sulla dispersione delle onde sismiche nell'ambito delle altissime frequenze [On the dispersion of seismic waves in the very high frequency range]: Annali Geofisica, v. 10, no. 3–4, p. 193–208, 1957.

Vibrograph registration of seismic waves from near explosions in a number of Alpine valleys confirms the fact that dispersion exists in all seismic waves, body as well as surface, because the earth's crust is not perfectly elastic. Maximum velocity is associated with maximum frequency, and as in optics, dispersion is intimately associated with absorption. The maximum limit of disperson for the media in these experiments (limestones and dolomites) is above 8 kmps, and for periods greater than 0.02 sec it is greatly reduced. Absorption is connected with a dissipation of energy, analogous to friction phenomena, that transforms part of the seismic energy into heat.—*D. B. V.*

174–327. Knudsen, William C. Elimination of secondary pressure pulses in offshore exploration (a model study): Geophysics, v. 23, no. 3, p. 440–458, 1958.

The behavior of the gas bubble generated by explosive charges fired below the ocean's surface has been studied by means of a scale model. The motion of the bubble was recorded using a high-speed camera. A small pressure detector was used to record the pressure variation near the bubble. The behavior of the bubble generated by the equivalent of a 15 pound charge was studied with the bubble subjected to the following boundary conditions: a single charge at various depths below the liquid surface, two charges on a vertical axis at various separations and various depths, two charges on a horizontal axis at various separations, a single charge at various separations below a solid plate, and a single charge at various separations to the side of the solid cylinder. Of these methods, the only one which appeared promising was the location of two charges on a vertical axis with both charges within 20 feet of the surface.—*Author's abstract*

174–328. Opitz, D[ietrich]. Eine Methode zur Ermittlung der mittleren Geschwindigkeit elastischer Wellen in der Reflexionsseismik [A method of determining the average velocity of elastic waves in seismic reflection] : Gerland Beitr. Geophysik, v. 66, no. 3, p. 205–213, 1957.

Starting from the fact that the known formulas and methods of determining average velocity of seismic waves differ in the positioning of the seismographs, in number of measured values used, as well as in behavior of the reflectors, Heiland's method of evaluation of $t^2$—$x^2$ coordinates (here called the $\tau$–$\xi$ method) is generalized by using elementary geometrical relationships. The traveltime hyperbola is converted into a parabola by the transformation $x^2=\xi$, $t^2=\tau$. It is shown that with this transformation an evaluation is possible with symmetrical geophone spread or with the system of opposite shot points, in which the position of the reflector does not enter in. The procedure is simple and can easily be handled by a computer.—*Author's summary, D. B. V.*

174–329. Weber, Max. Die Interpretation von seismischen Reflexionsmessungen mit abgebrochenen Potenzriehen [The interpretation of seismic reflection measurements by a power series with a finite number of terms] : Geofisica Pura e Appl., v. 40, p. 19–35, 1958.

The problem of seismic reflection in a uniaxial inhomogeneous medium is treated, under the assumption that the traveltime function $\psi$ $(r)$ or $\psi^2$ $(r)$ can be represented by a power series with a finite number of terms. An approximate solution is given for inclined boundary surfaces. An example is given. (See also Geophys. Abs. 169–299.)—*D. B. V.*

174–330. Bugaylo, V. A. Uskorennyy sposob postroyeniya otrazhayushchikh granits metodom zasechek [A rapid method of constructing reflecting horizons using the method of intersections] : Akad. Nauk SSSR Ural Branch, gorno-geol. Inst. Trudy, no. 30, geofiz. Sbornik no. 2, p. 142–145, 1957.

A description is given of a new graphic method of determining reflecting horizons when the velocity in the cover formation is constant. The construction necessitates preliminary preparation of a templet and of a "rhombic divisor" of simple construction. The suggested method permits great saving in time, especially when three to five layers are involved. The method was tested in 1949 in seismic surveys in the Tyumen region, U. S. S. R.—*S. T. V.*

174–331. Kisłow, Afrikan. Wachlarowa metoda sejsmichna [The fan seismic method] : Nafta (Poland), v. 3, no. 5, p. 128–130, 1957.

A discussion of the basic principles of fan-shooting. The method is recommended particularly for the preliminary reconnaissance work. Several examples of its application in central and eastern Europe are described.—*S. T. V.*

174–332. Vasil'yev, Yu. I., Kovalev, O. I., and Parkhomenko, I. S. Issledovaniye kristallicheskogo fundamenta metodom prelomlennykh voln v usloviyakh nepolnogo ekranirovaniya. I. [An investigation of the crystalline basement by the method of refracted waves in conditions of incomplete screening. Part 1] : Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 317–329, 1958.

It is known that the propagation of seismic waves through geological strata meets a resistance proportional to the ratio of thickness to wave length $(d/\lambda)$.

Therefore, a lower frequency than usual has been used for the transmission of seismic waves and a low frequency (15 to 35 cycles per sec) modification of the correlation refraction method has been worked out. Its application to the surveying of the crystalline basement in several areas under conditions of incomplete screening is described in this paper. A detailed analysis of the apparatus is presented, and seismogram results are analyzed. These tests show that the use of low frequency equipment makes it possible to record longitudinal refracted waves corresponding to the surface of the basement even when this is covered with a thick layer of carbonate rocks having almost the same velocities, where use of medium-frequency equipment earlier had failed to give results. Essential differences between the waves refracted from intermediate layers in the carbonate complex and those refracted from the crystalline surface were found in the record form, frequency characteristics, and damping. The same equipment can be used also in studies of thick sedimentary rocks, especially in the case of strong absorption of seismic energy or in the presence of screening strata.—*S. T. V.*

174–333. Korovnichenko, Ye. G. O skorostyakh i glubinakh, opredelyayemykh pri sovmestnom ispol'zovanii godografov chisto prodol'nykh i odnogo iz tipov obmennykh prelomlennykh voln [On velocities and depths determined by combined use of the traveltime curves of longitudinal and of one of the types of transformed refracted waves] : Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 120–129, 1958.

In this paper Korovnichenko extends his method of determining seismic velocities and depths of refracting horizons using data on transformed waves $P_1S_2P_1$ together with those on longitudinal waves (see Geophys. Abs. 171–325), to the cases of a horizontal refracting boundary overlain by a horizontal layer, an inclined refracting boundary overlain by two homogeneous layers separated by a horizontal plane, and a horizontal refracting boundary overlain by a formation in which velocity increases with depth. It is concluded that when velocity does not change too abruptly and when the refracting horizon is inclined not more than 10°–15° from the horizontal, the error in the computations of approximate values is not more than three percent.—*S. T. V.*

174–334. Hameister, E[rnst]. Ein Diagramm zur Bestimmung der Tiefe beim 2-Schichten-problem in der Refraktionsseismik [A diagram for depth determination in the two-layer problem in seismic refraction] : Gerlands Beitr. Geophysik, v. 67, no. 2, p. 158–161, 1958.

A graph is developed for the determination of depth in a two-layer problem concerning refraction seismic or similar questions involving horizontal layering. No calculation is needed for this process.—*Author's summary*

174–335. Brewer, H. L., and Holtzscherer, J. Seismic detectors and deep bore holes : Geophys. Prosp., v. 6, no. 2, p. 81–100, 1958.

Investigations of subsurface conditions at the Parentis and Lugos oil field areas (France) were made by shooting shaped charges or primacord in wells at different levels and recording the returning waves with seismic detectors on the surface. From velocity data in each well, time-distance curves were calculated for several possibilities : horizontal layers, dipping layers, and fault. Comparison of the calculated and experimental curves shows anomalies which correspond to a sudden change of dip, a fault or a thickening of the section.

It is concluded that this method, although costly and difficult to interpret, could be used for subsurface investigations near wells where other methods cannot be used.—*L. P.*

174–336. Raykher, L. D. Seysmokarottazh skvazhin s ispol'zovaniyem udalennykh punktov vzryva [Seismic logging using remote shot points]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 183–186, 1958.

A method of determining the depth of refracting horizons, the seismic velocities in various layers, and the average velocity along the entire seismic ray is suggested, which uses the observations of the waves coming from remote shot points in addition to the usual readings. In the case of one refracting layer between homogeneous and isotropic layers, the traveltime curve consists of straight segments and the known relations to the angles and the vectors of any two adjoining elements can be applied. The cases of one refracting horizon with stratified overlying and underlying formations; of a refracting horizon between two formations in which the seismic properties vary with depth; and of several refracting horizons, are discussed.—*S. T. V.*

174–337. McDonal, F[rank] J., Angona, F. A., Mills, R[obert] L., Sengbush, R. L., Van Nostrand, R[obert] G., and White, J. E. Attenuation of shear and compressional waves in Pierre shale: Geophysics, v. 23, no. 3, p. 421–439, 1958.

Attenuation measurements were made near Limon, Colorado, where the Pierre shale is unusually uniform from depths of less than 100 ft. to approximately 4,000 ft. Particle velocity wave forms were measured at distances up to 750 ft from explosive and mechanical sources. Explosives gave a well-defined compressional pulse which was observed along vertical and horizontal travel paths. A weight dropped on the bottom of a borehole gave a horizontally-traveling shear wave with vertical particle motion. In each case, signals from three-component clusters of geophones rigidly clamped in boreholes were amplified by a calibrated, wide-band system and recorded oscillographically. The frequency content of each wave form was obtained by Fourier analysis, and attenuation as a function of frequency was computed from these spectra.

For vertically-traveling compressional waves, an average of six determinations over the frequency range of 50–450 cps gives $\alpha=0.12\ f$. For horizontally-traveling shear waves with vertical motion in the frequency range 20–125 cps, the results are expressed by $\alpha=1.0\ f$. In each case attenuation is expressed in decibels per 1,000 ft. of travel and $f$ is frequency in cps. These measurements indicate, therefore, that the Pierre shale does not behave as a visco-elastic material.—*Author's abstract*

174–338. Khalevin, N. I. Rezul'taty seysmokarottazha interval'nykh skorostey rasprostraneniya uprugikh voln [The results of the seismic logging of the interval velocities of propagation of elastic waves]: Akad. Nauk SSSR Ural Branch, gorno-geol. inst. Trudy no. 30, geofiz. Sbornik no. 2, p. 111–115, 1957.

A description is given of an experimental portable set-up for the determination of layer velocities in drill holes. Investigations carried out in 1953 have shown that the apparatus is fully adequate. The station is readily transportable, can be installed in a very short time, is efficient, and gives identical seismo-

grams under the same conditions. A disadvantage is its low sensitivity and inability to isolate longitudinal waves; this is due partly to the low natural frequency of the station, which makes it impossible to decrease the distance between the transmitter and the receiver. The nature of many recorded waves cannot as yet be interpreted. Identification of individual waves is based on the comparison of their velocities with the known average velocities in the observed profile. It was noted that an increase of amplitude corresponds to the sections of the waves of higher velocities, so that the relative anomalies of the amplitudes are much greater than the anomalies of the velocities. Use of a shorter distance between the transmitter and the receiver would improve the resolving power.—*S. T. V.*

174–339. Khalevin, N. I. Ob impul'snom interval'nom zvukovom karottazhe [On intermittent impulse acoustic logging]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 379–386, 1958.

A description of a new method of well-logging, in which the strata pierced by the drill hole are identified from observation of the velocities of elastic waves produced in the drill hole; the thickness of individual strata is determined together with the exact position of reflecting and refracting horizons. The apparatus consists of an elastic wave generator mounted in a hermetically sealed container, and a receiver at a fixed distance from the generator with an amplifier, a time recorder, and an oscillograph. The impulse which produces the shock in the wall of the container and reaches the walls of the drill hole is acted upon by an electromagnet controlled from the surface of the ground. Several waves of different velocities and frequencies were observed during tests in the sedimentary formations of the Chelyabinsk lignite fields, including the longitudinal, transverse, and Lamb waves. The recurrence of the same frequency spectrum was very good, so that the experiments could be repeated at different times. The spectrum of the waves produced was very much influenced by the elastic properties of the surrounding formations and the depth to which the probe was sunk. As a precaution against the short circuiting, the space between the transmitter and the receiver was filled with rubber. Numerous seismograms obtained during the experiments are reproduced and their geologic interpretation suggested. The most important advantage of the apparatus is the possibility of determining the characteristics of a much greater volume of rocks. It also decreases the effect of caverns or local heterogeneities. The nature of an unidentified elastic wave observed during the experiments is to be investigated in future tests.—*S. T. V.*

Förtsch, Otto, and Vidal, H. Seismic survey of the Grossen Gurgler Ferner in the Ötztaler Alps in late summer 1956. See Geophys. Abs. 174–175.

174–340. Beránek, Břetislav. A contribution of reflection seismic surveying for studying the structure of the Komárno basin: Československá Akad. Věd Studia Geophys. et Geod., v. 1, no. 2, p. 279–385, 1957.

The geology of the Komárno basin in Czechoslovakia is worked out on the basis of preliminary results of regional reflection surveys. The deepest part of the basin is filled entirely with Pliocene (Pannonian) sediments. It is separated from a high eastern block by the Žitava fault. Continued subsidence of the western block as a unit along this fault accounts for the high, localized seismicity (microtremors) in this area (see also Geophys. Abs. 174–18).—*D. B. V.*

174–341. Beránek, Břetislav, and Zounková, Milada. Ergebnisse der seismischen Refraktionsuntersuchung in der weiteren Umgebung von Rimavská Sobota [Results of seismic refraction investigation in the Rimavská Sobota region] Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 66, p. 367–379, 1957 (1958).

A seismic refraction survey was made in the Rimavská Sobota region in southeastern Slovakia in order to determine the depth and relief of the basement of the Oligocene basin. Basement contours show two highs in the northeast part of the area, and the lowest point in the southwest corner. Information from two boreholes shows errors of 7.2 and less than one percent, respectively.—*D. B. V.*

174–342. Brosse, P. Die seismische Bestimmung der Grundwassertiefe [The seismic determination of ground-water depth]: Zeitschr. Geophysik, v. 23, no. 5, p. 236–240, 1957.

During seismic measurements in a petroleum concession in the Upper Rhine Valley graben, ground-water levels were calculated at more than 400 points from the seismically recorded "uphole" time and drilling depth. From this data conclusions can be drawn as to the presence and course of ground-water currents.—*D. B. V.*

174–343. Schulz, G. Reflexionen aus dem kristallinem Untergrund im Gebiet des Pfalzer Berglandes [Reflections from the crystalline basement in the region of the Pfalzer Bergland]: Zeitschr. Geophysik, v. 23, no. 5, p. 225–235, 1957.

Depth of a deep reflecting horizon (travel time 5.365 sec) observed in a seismic survey of the Pfalzer Bergland ("Palatine mountain land") area in Germany is determined to be about 13,000 m; this is probably the Conrad discontinuity.—*D. B. V.*

174–344. Mori, Kiyoshi, and Kojima, Seishi. Seismic prospecting at Abuta mine, Hokkaidō: Geol. Survey Japan Bull., v. 8, no. 11, p. 49–57, 1957.

An experimental refraction seismic survey was made at the Abuta mine in Japan to determine the adaptability of seismic methods to the mapping of minute structure in mineral deposits. Velocity distribution from seismic data corresponded with reasonable accuracy to geologic structure but the characteristic velocity of the pyrite vein could not always be recognized when the vein thickness was small in comparison with seismic wave length. The depth of each refracted boundary appeared greater than that found in borings. Errors due to time lag and other instrumental distortion could not be considered as negligible in fine-structure mapping.—*V. S. N.*

174–345. Chereau, J[ean] Y[ves]. Étude des vitesses du Karroo à Madagascar [Study of the velocities of the Karroo in Madagascar]: Geophys. Prosp., v. 6, no. 2, p. 101–111, 1958.

The Karroo system in Madagascar is a thick continental deposit of sandstone with some shale, with no characteristic beds. Where it outcrops, velocities were measured in boreholes, and where it is covered by Jurassic beds velocity profiles

were made. Velocities depend mainly on age, but long refraction soundings show a progressive increase in velocity with depth and weak differentiation of key beds. The laws of Faust (see Geophys. Abs. 145–12825 and 153–14495) are good first approximations of conditions in the Karroo if the maximum depth attained by each layer and invasions by fresh water are taken into account. A systematic departure of the Karroo from Faust's average argillaceous-sandy series could be due to an erosional hiatus, the presence of limestone beds, or fresh water invasions. An angular unconformity exists between the Sakamena and the Isalo formations.—*D. B. V.*

174–346. Pieuchot, M[aurice], and Richard, H[enri]. Some technical aspects of reflection seismic prospecting in the Sahara: Geophysics, v. 23, no. 3, p. 557–573, 1958.

The small signal-to-noise ratio encountered in the Sahara required the development of special techniques. The gentle dips and low frequencies permitted the use of a pattern of 100 shot holes recorded by an array of 100 or more geophones per trace with the linear dimensions of the arrays of the order of 100 m. The large structural dimensions allowed the compositing of as many as five records into a single trace. Seismic reflection exploration was made economically feasible by the use of pneumatic hammers for drilling and the less expensive nitrates for explosives. The experimental procedures leading to the selection of the techniques are described.—*Authors' abstract*

174–347. Khalevin, N. I. O primenenii korrelyatsionnogo metoda prelomlennykh voln pri poiskakh *i* razvedke uglenosnykh otlozheniy na vostochnom sklone Urala [On the use of the correlation refraction method in prospecting and exploration of coal deposits on the eastern slope of the Urals]: Akad. Nauk SSSR Ural Branch, gorno-geol. inst. Trudy, no. 30, geofiz. Sbornik no. 2, p. 116–120, 1957.

Coal bearing strata interbedded in lower Carboniferous and lower Mesozoic formations on the east slope of the Urals have boundary velocities of 2,000 to 4,000 m per sec. These velocities are sufficiently distinct from those of the surrounding strata, which ordinarily have a velocity greater than 4,500 m per sec, that the correlation refraction method can be effectively applied to coal exploration in this area. To the present time the correlation refraction method has been applied in few such cases but always with complete success; in Khalevin's opinion it will become a leading geophysical method of exploration.—*S. T. V.*

174–348. Khalevin, N. I. O skorosti rasprostraneniya uprugikh voln v osadochnykh porodakh [On the velocity of propagation of elastic waves in sedimentary rocks]: Akad. Nauk SSSR Ural Branch gorno-geol. Inst. Trudy no. 30, geofiz. Sbornik no. 2, p. 121–132, 1957.

By comparison of the seismic velocities obtained from extensive exploration of drill holes in different parts of the Turgay depression in the Urals during the years 1952–1953 with those obtained by others in the Chelyabinsk coal basin and in the Trans-Ural region, Khalevin derives several regularities in the variation of these velocities with depth. As the first approximation it can be assumed that the average seismic velocity in the Mesozoic varies linearly with depth. For greater depths the variation of the average velocity can be more accurately represented by a "saturation" curve, asymptotically approaching a

constant limit. A number of empirical equations of velocity have been determined.—*S. T. V.*

174–349. Sollogub, V. B. Uprugiye svoystva gornykh porod v rayone peredovykh progibov Al'piyskoy geosinklinal'noy oblasti Evropeyskoy chasti SSSR [Elastic properties of rocks in the region of the forward depressions of the Alpine geosyncline of the European part of the USSR] : Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 1, p. 93–126, 1956.

The lithology and seismic velocities were investigated in 113 holes drilled during an intensive petroleum exploration campaign in the Ukraine and adjacent parts of European Russia. Depths ranged from 1,800 to 3,200 m. Analysis of the results leads to the conclusion that seismic velocity is determined by three factors: static load of the overburden, lithology of the stratum, and the degree of dynamic metamorphism to which it has been subjected. Static load always increases the velocity, so that other things being equal, velocity increases with depth; the effect of static load is greater on younger deposits than on older ones. In intensely deformed regions velocities may be higher by 1,000 m per sec or more than in undeformed rocks of the same lithologic composition. Variations in lithology may produce horizontal as well as vertical variation in velocity. The paper is illustrated by a map, 25 sets of curves and numerous tables of data.—*S. T. V.*

174–350. Kravets, V. V. Primeneniye seysmorazvedki dlya izucheniya tectonicheskogo stroyeniya zapadnoy okrainy Ovruchskogo Massiva [The use of seismic surveys in the investigation of the geologic structure of the western border of the Ovruch massif] : Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy ser. geofiz., no. 2, p. 43–56, 1958.

During 1955–56 the Ukrainian Institute of Geological Sciences conducted investigations in the northern part of the Zhitomir area which belongs to the northwestern part of the Ukrainian shield and is bounded on the south by the Korosten pluton, on the north by the Pripet basin, on the east by the Ovruch massif (quartzites and pyrophyllite schists) and on the west by the Osnits intrusive complex. The object of the investigation was to determine whether the high frequency refraction method could be used to locate vertical contacts and crush zones in crystalline rocks.—*S. T. V.*

## STRENGTH AND PLASTICITY

174–351. Jeffreys, Harold. Rock creep, tidal friction and the moon's ellipticities: Royal Astron. Soc. Monthly Notices, v. 118, no. 1, p. 14–17, 1958.

In the form of the law specifying creep of rocks under small long-term stress proposed by Lomnitz (see Geophys. Abs. 167–270), it is possible to avoid the complication of an infinite initial strain rate and yet satisfy experimental data. In a more generalized form, $\epsilon\cdot=\frac{P}{\mu}\left[1+\frac{q}{\alpha}\left\{(1+at)^{\alpha}-1\right\}\right]$ where $\epsilon$ is the strain, $P$ is the stress, $\mu$ the rigidity, $t$ is time, and $\alpha$, $q$, and $a$ are constants, this law may be applied successfully to the sharpness of seismic pulses and the damp-

ing of the variation of latitude; creep is proportional to $t^{0.17}$ rather than $t^{0.33}$ or log $(at)$. Also, the modified law easily accounts for the rotations of Mercury and the satellites of the Earth and Mars; it is consistent with the existence of the Moon's excess ellipticities. However, the law seems to indicate that creep is not important in isostatic adjustment; so presumably fracture or flow near the elastic limit is dominant.—*E. C. R.*

174–352. Jeffreys, Harold. Rock creep and thermal instability: Royal Astron. Soc. Geophys. Jour., v. 1, no. 2, p. 162–163, 1958.

The theory of instability of a fluid heated below can be adapted without difficulty to a rock satisfying the modified Lomnitz law of creep. It is found that instability is impossible and therefore that steady convection currents would not arise.—*Author's summary*

Uhlmann, Manfred. On the investigation of the strain relations in supporting pillars of potash and rock salt mines by means of acoustics. See Geophys. Abs. 174–95.

## SUBMARINE GEOLOGY

174–353. Crary, A. P., and Goldstein, Norman: Geophysical studies in the Arctic Ocean: Deep-Sea Research, v. 4, no. 3, p. 185–201, 1957.

Bathymetric, seismic reflection, seismic refraction, and gravity studies were made along the path of the floating ice-island T–3, by the United States Air Force. The island was occupied at two different times and during those times drifted from 88°00′ N, 156° W to 84°40′ N, 81° W and from 83°37′ N, 88° W to 82°19′ N. 98° W. Except for one area of rough bottom topography including a prominent ridge extending parallel to Lomonosov Ridge, the depths in the vicinity of the 90° meridian are between 1,500 and 2,700 meters with some scattered peaks. The continental slope was crossed 100 km off the coast of northwestern Ellesmere Island.

Seismic reflection data were used to determine water depths and the character of the reflection horizons a few kilometers below ocean bottom. In the southern half of the area a widespread quiet reflecting zone, showing remarkably constant thickness, was encountered from 100 to 300 meters below the ocean floor. The velocity of bottom sediments ranges from 1.6 to 2.4 kmps with one high velocity of 3.77 kmps at a site on the slope of the prominent ridge. A velocity of 5.96 kmps was found in one area at 1,320 meters below the ocean bottom. Gravity values obtained along the path of T–3 gave free-air anomalies of −40 to +54 mgal. An attempt was made to compute the average densities of special bottom features but lack of sufficient depth data for accurate bottom contours made results unreliable.—*V. S. N.*

174–354. Menard, H[enry] W., and Fisher, Robert L. Clipperton fracture zone in the northeastern equatorial Pacific: Jour. Geology, v. 66, no. 3, p. 239–253, 1958.

The Clipperton fracture zone, trending roughly east-west for 3,300 miles between 127° W long and 96° W long, is divisible into four zones from west to east: a broad, low welt 900 miles long with central trough 10–30 miles wide; a volcano-studded ridge, here called Clipperton Ridge, 60 miles wide and 330 miles long with local relief of 18,000 feet; a low welt with central trough transecting the Albatross Plateau which is the northernmost part of the great

East Pacific rise; and a zone of bifurcation east of Albatross Plateau the major branch of which, Tehuantepec Ridge, trends to the northeast and thus deviates from the great circle trend followed by the four great fracture zones so far discovered in the northeastern Pacific. Three of the known great ridges, similar to Clipperton Ridge in size, relief, and position within east-trending fracture zones of the northeastern Pacific, occur at an intersection with northwesterly trending zones; thus it is possible that some northwesterly-trending lineation intersects the Clipperton fracture zone near Clipperton Island. Throughout the Pacific basin transcurrent faults and submarine fracture zones are associated with and limit most oceanic trenches and island arcs. No causative relation is suggested between the two, however, because many of the transcurrent or linear features such as the Clipperton are too long to be of local origin and lie at all angles to the trenches and island arcs. It is probable that the lineations are a part of a pattern of faults which broke the crust of the Pacific Basin and China into large blocks in early geological history. Forces which formed the island arcs and trenches may possibly act on an area larger than one of these older blocks but the structures which they produce are discontinuous at the edges of the blocks.—*V. S. N.*

## VOLCANOLOGY

Ma, Ting Ying H., and Pan, Chia-Lin. Development of volcanic belts together with zones of deficient gravity along the margin of crustal masses. See Geophys. Abs. 174–172.

Contini, Camillo. Earthquakes, volcanoes and natural steam deposits. See Geophys. Abs. 174–218.

174–355. Markhinin, E. K. Ob energii obrazovaniya yuvenil 'nogo vulkanicheskogo pepla [Energy of formation of juvenile volcanic ash]: Akad. Nauk SSSR Doklady, v. 116, no. 5, p. 826–829, 1957.

Considering magma as a solution of water vapors in a silicate melt, Markhinin explains the origin of juvenile volcanic ash by the formation of steam bubbles in a magma supersaturated with gases when external pressure on the magma is reduced. A froth of steam bubbles may form in the magma if the process is rapid enough. The magma may explode and throw out a cloud of vitreous particles, juvenile volcanic ash, if the internal pressure in the bubbles of the froth is greater than the external. In an extrusive boss of andesite-dacite at the center of the Golovin caldera, a ratio of 3 to 7 was found for the volume of froth to total volume of rock; using an approximate mathematical analysis it is calculated that the energy necessary to transform 1 $km^3$ of lava into ash particles a few hundredths of a millimeter in diameter is $1.85\times10^{22}$ ergs, out of $2.5\times10^{25}$ available in the explosion.—*A. J. S.*

174–356. Verhaege, Marcel. L'éruption due volcan Mugogo au Kivu [The eruption of the volcano Mugogo in Kivu]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 20, p. 2917–2120, 1958.

A new volcano, Mugogo, appeared in August 1957 in the central part of the Virunga volcanic area (Kivu, Belgian Congo), in a sector thought to be dormant. The eruption, which began abruptly, was preceded by earthquakes; in 42 hours, 750,000 $m^3$ of solid material (lava and bombs) was emitted from

three craters alined in an east-west direction, to build a cone 120 m long and 40 m high. The lava and ejecta are ankaratrite, the first of this composition to be produced in historic time.—*D. B. V.*

174–357. Nemoto, Tadahiro; Hayakawa, Masami; Takahashi, Kiyoshi; and Oana, Shinya. Report on the geological, geophysical and geochemical studies of Usu Volcano (Shōwa-Shinzan) (in Japanese with English abstract): Geol. Survey Japan Rept., no. 170, 149 p., 1957.

Gravity, seismic, magnetic, electrical, and radioactivity surveys and temperature measurements were made to study underground structures and surface phenomena in the area of Shōwa-Shinzan, a parasitic cone on the east flank of Usu Volcano, southwestern Hokkaido, Japan. The cone, formed from 1943 through 1945, is a dome of viscous lava rising above a roof mountain which resulted from intrusion of lava into horizontal rock layers in the area causing a continuous uplifting of the land. Results from the gravity survey of the eastern part of Usu Volcano show a general tendency for anomalies in the northwestern part to be larger than in the southeastern part; values near Usu-somma are greater than elsewhere. In the vicinity of Shōwa-Shinzan, the largest anomaly is over the dome with another high gravity zone at the southern edge of the roof mountain; later seismic surveys confirmed the gravity results that the dome lava extends to the south under the uplifted zone near Yanagihara. Results from the magnetic survey could not be used to confirm the other surveys because of the topographic effect of Usu-somma.

Temperature measurements and electrical and radioactivity surveys were made to study near-surface physical phenomena. Comparison of present temperature data in the dome area with data obtained at the time of activity shows a very slow decrease, from 1,000° C to 800° C. It is demonstrated that present temperature distribution on the dome surface can be explained by heat conductivity under conditions of "no-heat supply." The distribution of alpha-ray and beta-ray emission, and the intensity of emission in relation to temperature and topography are discussed. A preliminary electrical survey, using the Wenner configuration, showed only that no formation of high resistivity such as andesite occurs in the shallow part of the roof mountain. Some geochemical studies were made of fumarole gases. The report is well illustrated with maps and tables.—*V. S. N.*

174–358. Mogi, Kiyoo. Relations between the eruptions of various volcanoes and the deformations of the ground surfaces around them: Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 2, p. 99–134, 1958.

Ground deformation resulting from eruptions of Sakurazima, (1914), Usu (1910 and 1943–45), Komagatake (1929), and Muyakesima (1940) in Japan and of Kilauea (1924) in Hawaii, determined from precise levelings and triangulation, are found to be of two types. One is the circular depression of a wide area, related to change of state of the magma reservoir; the other is uplift of a limited area near the crater due to lava extrusion. The relative magnitude of these two types of deformation depends on the character of the eruption. In the case of Sakurazima and Kilauea, the mechanics of deformation are explored in some detail.—*D. B. V.*

174–359. Shima, Michiyasu. On the second volcanic microtremor at the Volcano Aso: Kyōto Univ. Disaster Research Inst. Bull., no. 22, 6 p., 1958.

The radius of the magma chamber is calculated from the period of the second of four volcanic microtremors observed at Mt. Aso, Japan, as 696 to 1,392 m. This second microtremor has a long period (3.5–7 sec), and is believed to be generated by the explosive action of a gas-rich magma in a reservoir. As the reservoir begins to vibrate with the gas explosions, the mode vibrating in the direction of propagation of the wave is the one which appears in most cases; when the equations of wave motion of such a mode are solved, using *P* and *S* wave velocities and the sound velocities of the exploding magma calculated from records of volcanic earthquakes, the radius of the magma chamber can be derived from the period of the microtremor.—*V. S. N.*

174–360. Gorshkov, G. S. Deyatel'nost' vulkanologicheskoy stantsii v 1949 g [Activity of the vulcanological station in 1949]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 19, p. 32–37, 1953.

Activity of the Kamchatka volcanological station in 1949 consisted chiefly of observations of Sheveluch and Klyuchevskoy, but included journeys to Tolbachik volcano and the Kireynskiy hot springs. The seismic section recorded 262 earthquakes, of which 53 were distant, 97 near, and 112 local.—*D. B. V.*

174–361. Gorshkov, G. S. Sostoyaniye vulkanov Klyuchevskoy gruppy (s 30 avgusta po 31 dekabrya 1948 g.) [State of the volcanoes of the Klyuchevskoy group (from August 30 to December 31, 1948)]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 19, p. 7–13, 1953.

Gorshkov, G. S. Sostoyaniye vulkanov Klyuchevskoy gruppy v pervoy polovine 1949 g [State of the volcanoes of the Klyuchevskoy group in the first half of 1949]: ibid., p. 38–43, 1953.

Bylinkina, A. A. Sostoyaniye pobochnykh kraterov Klyuchevskogo vulkana v maye 1949 g [State of the lateral craters of Klyuchevskoy volcano in May, 1949]: ibid., p. 48–50, 1953.

Basharina, L. A. Nablyudeniya za sostoyaniyem fumarol pobochnykh kraterov vulkanov Klyuchevskogo i Shiveluchv 1948–1949 gg [Observations on the state of the fumaroles of the lateral craters of the volcanoes Klyuchevskoy and Sheveluch in 1948–1949]: ibid., p. 51–59, 1953.

Bylinkina, A. A. Poyezdka k krateram gruppi Tuyla v iyule 1950 g [Journey to the Tuyla crater group in July, 1950]: ibid., p. 60–61, 1953.

These reports give details of the activity of the summit and lateral craters of Klyuchevskoy volcano, of Tolbachik, of Sheveluch, and of the Tuyla group of craters (parasitic on Klyuchevskoy) at the times in question. Activity was mainly fumarolic; emission of gas clouds from the summit crater of Klyuchevskoy began in October 1948 and continued intermittently through the first half of 1949. Tolbachik remained in a fumarolic state.—*D. B. V.*

174–362. Gorshkov, G. S., and Bylinkina, A. A. Nablyudeniya nad izverzhenniyem vulkana Sheveluch v 1948–1950 gg [Observations on the eruption of Sheveluch volcano in the years 1948–1950] : Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 20, p. 8–31, 1954.

Bylinkina, A. A., and Gorshkov, G. S. Sostoyaniye vulkanov Klyuchevskoy gruppy vo vtoroy polovine 1949 g [State of the volcanoes of the Klyuchevskoy group in the second half of 1949] : ibid., p. 32–37, 1954.

Bylinkina, A. A., Gorshkov, G. S., and Ogorodov, N. V. Voskhozhdeniye na Klyuchevskoy vulkan 29 iyulya 1951 g [Ascent of Klyuchevskoy volcano on July 29, 1951] : ibid., p. 38–47, 1954.

Piyp, B. I. Izverzheniye kratera Bylinkinoy [Eruption of the Bylinkina crater] : ibid., p. 48–51, 1954.

Naboko, S. I. Vulkan Kikhpinych i yego sostoyaniye v avguste 1951 g [Kikhpinych volcano and its state in August 1951] : ibid., p. 52–59, 1954.

Gorshkov, G. S. Pik Krenitsyna [Krenitsyna Peak] : ibid., p. 60–63, 1954.

Pipy, B. I., and Svyatlovskiy, A. Ye. Izversheniye Pika Krenitsyna v 1952 g [Eruption of Krenitsyna Peak in 1952] : ibid., p. 64–68, 1954.

Piyp, B. I. Vulkan Tolbachik [Tolbachik volcano] : ibid., p. 69–71, 1954.

Reports on the activity of the various volcanoes of Kamchatka and of Krenitsyna Peak in the Kurile Islands at different times during the years 1948 to 1952. The strongest activity was that of Sheveluch, with emissions of lava and gas over a 20-month period; Klyuchevskoy emitted gas clouds in the last half of 1949, as did its side crater Bylinkina in November 1951 and Krenitsyna in November 1952; all other activity was fumarolic.—*D. B. V.*

174–363. Bylinkina, A. A., and Gorshkov, G. S. Sostoyaniye Klyuchevskogo vulkana v yanvare–aprele 1950 g [State of Klyuchevskoy volcano in January–April 1950] : Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 21, p. 3–5, 1954.

Piyp, B. I. Sostoyaniye deystvuyshchikh vulkanov severnoy Kamchatki s maya 1950 po oktyabr' 1951 g [State of the active volcanoes of northern Kamchatka from May 1950 to October 1951] : ibid., p. 6–10, 1594.

Piyp, B. I. Sostoyaniye deystvuyushchikh vulkanov severnoy Kamchatki s noyabrya 1951 po oktyabr' 1952 g [State of the active volcanoes of northern Kamchatka from November 1951 to October 1952] : ibid., p. 11–13, 1954.

Gonsovskaya, G. A. Sostoyaniye vulkana Kosheleva letom 1951 g [State of Koshelev volcano in the summer of 1951] : ibid., p. 14–18, 1954.

In these papers details are given of the activity of various Kamchatka volcanoes in the period 1950 through 1952. Activity was mainly solfataric with some local volcanic earthquakes. Temperature measurements and chemical compositions of emissions are given in many instances.—*D. B. V.*

174–364. Bylinkina, A. A. Pod"em na Suelich—deystvuyushchiy kupol vulkana Sheveluch v aprele 1949 g [Ascent of Suelich, active dome of Sheveluch volcano in April, 1949]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 19, p. 44–47, 1953.

A brief report on the Suelich dome in the summit crater of Sheveluch volcano in Kamchatka. Part of the dome is "dying," part actively rising.—*D. B. V.*

174–365. Ustinova, T. I. Vulkan Gamchen [Gamchen volcano]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 21, p. 47–55, 1954.

A detailed description of Gamchen volcano on the east coast of Kamchatka, hitherto not mentioned in the literature. Fumarolic activity reported in 1943 was not observed in 1946.—*D. B. V.*

174–366. Gorshkov, G. S. O nablyudenii naklonov v okrestnostyakh Klyuchevskogo vulkana [On observations of tilting in the vicinity of Klyuchevskoy volcano]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 21, p. 40-42, 1954.

Systematic inclinometer observations were begun at the Kamchatka station in 1949. During that year tilt was northward and amounted to approximately two minutes of arc, averaging 0.2 second per day. Such inclination is usually considered to be a real tilt of the earth's surface, but deflection of the pointer of the inclinometer could also be produced at least in part by change in the horizontal component of the earth's gravitational field, due to underground movement of volcanic material. Thus inclinometer observations offer a real possibility of long-range forecasting of eruptions.—*D. B. V.*

174–367. Fabre, René, and Chaigneau, Marcel. Sur les gaz volcaniques des fumerolles du Mont Pelée (Martinique) et de la Grande Soufrière de Basse-Terre (Guadeloupe) [On the volcanic gases of the fumaroles of Mount Pelée (Martinique) and the Grande Soufrière de Basse-Terre (Guadeloupe)]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 1, p. 15–19, 1958.

Analysis of the gases from fumaroles on Mt. Pelée on Martinique shows that a profound change in composition (increase in $CO_2$, oxygen, nitrogen; disappearance of hydrogen, hydrocarbons, CO, $H_2S$, HCl) has occurred since the eruption of 1902, whereas those from the Grande Soufrière on Guadeloupe have changed little in the same period. The composition of the gases seems clearly to be related to volcanic activity. To avoid secondary reactions, a quick-acting dehydrating agent was used in the collecting ampoules.—*D. B. V.*

# INDEX