Geophysical Abstracts 179 October-December 1959

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

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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. Abstracts of papers in Japanese and Chinese are based on abstracts or summaries in a western language accompanying the paper.

LIST OF JOURNALS

Lists of journals published in Geophysical Abstracts 160 (January–March 1955, Bulletin 1033–A) and subsequent issues through 175 (October-December 1958, Bulletin 1086–D) have been compiled into a single list which may be obtained by writing to the U.S. Geological Survey, Washington 25, D.C.

The following references cited in Geophysical Abstracts 179 are not included in this master list:

Akad. Nauk Azerbaydzhan. SSR Inst. Geologii Trudy—Akademiya Nauk Azerbaydzhanskoy SSR, Trudy Instituta Geologii [Academy of Sciences of the SSR, Papers of the Institute of Geology]. Baku, Azerbaijan.

Akad. Nauk Beloruss. SSR Vestsi, ser. fiz.-tekh. nauk—Vestsi Akademii Navuk Belorusskoy SSR, seryya fizika-tekhnichnykh navuk [Bulletin of the Akademy of Sciences of the Belorussian SSR, physical-technical science series]. Minsk, B.S.S.R.

Akad. Nauk SSSR Voprosy Kosmogonii—Akademiya Nauk SSSR, Voprosy Kosmogonii [Academy of Sciences of the U.S.S.R., Problems of cosmogony]. Moscow, U.S.S.R.

Avtomobil'nyye Dorogi—Avtomobil'nyye Dorogi. Organ glavnogo upravleniya shosseynykh dorog. Nauchno-tekhnicheskoe izdatel'stvo avtotransportnoy literatury [Automobile Roads. Organ of the chief board of paved roads. Scientific-technical press of auto-transport literature]. Moskva (Moscow) U.S.S.R.

Braunkohle Wärme und Energie—Braunkohle Wärme und Energie. Düsseldorf, Germany.

Eesti NVS Teaduste Akad. Geol. Inst. Uurimused—Eesti NSV Teaduste Akadiemia, Geologia Instituudi Uurimused [Academy of Sciences of the Estonian SSR, Institute of Geology, Proceedings]. Talinn, Estonia.

Geol. Survey Japan Rept.—Report of the Geological Survey of Japan. Kawasaki-shi, Japan.

Geotimes—Geotimes. American Geological Institute. Washington, D.C.

Jour. Sci. Eng. Research [India]—Journal of Science and Engineering Research. Indian Institute of Technology (Midnapore District). Kharagpur, India.

L'vov. Geol. Obshch. Geol. sbornik—L'vovskoye Geologicheskoye Obshchestvo pri L'vovskom Gosudarstvennom Universitete im. Iv. Franko, Sbornik [Collected papers L'vov Geological Society at Ivan Franko State University in L'vov]. Lvov, Ukrainian S.S.R.

Maine Geol. Survey—Maine Geological Survey, Department of Economic Development. Augusta, Maine.

Meteorologiya i gidrologiya—Meteorologiya y gidrologiya. Gidrometeorologicheskoy izdatel'stvo. Leningrad, U.S.S.R.

Naš rad—Naš rad, Glasilo Radne Zajednice "Zavoda za Geological Instrazivanja N.R.H." Geofizike i Geoistrazivanja [Our Work, Organ of the Workers' Union of Geological Exploration of the Croatian People's Republic, Geophysics and Geological Prospecting]. Zagreb, Yugoslavia.

Royal Soc. Western Australia Jour.—Journal of the Royal Society of Western Australia. Perth, Western Australia.

[Rumania] Com. Geol., Dări de Seamă ale Şed.—Republica Populară Romîne, Comitelul Geologic, Dări de Seamă ale Şedinţelar [Rumanian People's Republic, Geologic Committee, Reports of Sessions]. Bucureşti [Bucharest], Rumania.

Slovenská Akad. Vied Geol. Sbornik—Slovenská Akadémia Vied, Geologický Sborník [Slovakian Akademy of Sciences, Collected Geological Papers]. Bratislava, Czechoslovakia.

Sovet. Antarkt. Exped., Informatsionnyy Byull.—Sovetskaya Antarkticheskaya Expeditsiya. Informatsionnyy Byullein'. Arkticheskii i Antarkticheskiy Nauchno-Issledovatel'skiy Institut Glavnogo Upravleniya Severnogo Morskogo Puti Ministerstva Morskogo Flota, SSSR. Informatsionnyy Byulleten Sovetskoy Antarkticheskoy Ekspeditsii [Arctic and Antarctic Scientific Research Institut of the Main Administration of the Northern Seaway of the Ministry of Navy of the U.S.S.R. Information Bulletin of the Soviet Antarctic Expedition]. Leningrad, U.S.S.R.

Univ. Sci. Budapestinensis Eötvös Annales, sec. geol.—Annales Universitatis Scientiarum Budapestinensis de Rolando Eötvös nominatae, sectio geologica. [Annals of the University of Sciences at Budapest in the name of Roland Eötvös, geologic section]. Budapest, Hungary.

Vses. Geog. Obshch. Izv.—Izvestiya Vsesoyuznogo Geograficheskogo Obshchestva. Izdatel'stvo Akademii Nauk SSSR [Bulletin of the All-Union Geographical Society. Press of the Academy of Sciences of the U.S.S.R.]. Leningrad, U.S.S.R.

FORM OF CITATION

The abbreviations of journal titles used are those used in the U.S. Geological Survey publications and 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 of Geographic Names. This system of transliteration for Russian is given in Geophysical Abstracts 148 (January–March 1952, Bulletin 991–A) and in new "List of Journals" announced above. Titles of papers in Japanese and Chinese are given in translation only.

ABSTRACTORS

Abstracts in this issue have been prepared by J. W. Clarke, Wanda L. Grimes, Anna Jespersen, Virginia S. Neuschel, and A. J. Shneiderov, as well as by the principal authors. Authors' abstracts are used in many instances. The initials of an abstractor following the notation "Author's abstract" indicates a translation from the original language.

AGE DETERMINATIONS

179–1. Davidson, C. F. How old is the Cambrian system?: Nature v. 183, no. 4663, p. 768–769, 1959.
Mayne, K. I., Lambert, R. St. J., and York, D. How old is the Cambrian system?: Nature, v. 183, no. 4663, p. 769–770, 1959.

Davidson objects to the drastic version of the age of the base of the Cambrian proposed by Mayne, Lambert, and York (see Geophys. Abs. 176–1). The usefulness for dating purposes of the Swedish kolm on which the dating of the Cambrian has largely rested, depends wholly on the hitherto undebated assumption that its uranium content was acquired when the associated trilobites were alive; but there is much evidence to refute this assumption. On the basis of new determinations from Russia and the Belgian Congo, the base of the Cambrian should be dated at about 600×10^6 yr, about halfway between the Holmes B scale ($500–520\times10^6$ yr) and the new proposal (750×10^6 yr).

Mayne, Lambert, and York reply that they had considered and rejected the evidence cited by Davidson in support of his argument. Most of the Russian determinations are based on average percentage argon loss for the whole rock that may not be valid for the separated mineral on which the determinations were made. The only Rusian measurements which are relevant to the argument are those on micas from granite pebbles in Lower Cambrian rocks. Two values are given (566×10^6 and 763×10^6 yr); there is no reason to prefer the first, as Davidson has done, or indeed, with such disagreement, either of them. As for the Belgian Congo, the stratigraphic position of the deposit in question (Shinkolobwe) is not as certain as the age value obtained for it.—*D. B. V.*

179–2. Kulp, J. Laurence, Cobb, James C., Long, Leon E., and Miller, Donald S. The geological time-scale: Nature, v. 184, no. 4688, p. 62–63, 1959.

Most of the cases cited for secondary support by Mayne, Lambert, and York for their extended geological time scale (Geophys. Abs. 176–1, 179–1) are shown to be either incorrect or not definitive to the argument. It is concluded that the extended time scale proposed by Mayne and his colleagues is based on limited data and is not supported by measurements other than their own. Current investigations in a number of laboratories on the age of stratigraphically well-defined rocks will permit a much closer definition of the geologic time scale in the near future.—*D. B. V.*

179–3. Baranov, V[ladimir] I. Posledniye dannyye po opredeleniyu absolyutnogo vozrasta Zemli [Recent data on the determination of the absolute age of the earth]: Akad. Nauk SSSR Voprosy Kosmogonii, v. 4, p. 39–55, 1958.

Recent data on radioactive determination of the absolute age of terrestrial minerals, meteorites, and chemical elements give an average of 4–5 billion years for the earth's absolute age. The age of the most ancient geological processes is about 3 billion years; the age of the earth's crust is about 4 billion years; the age of the terrestrial and meteoritic substances is 4.5 billion years; and the age of chemical elements, since the beginning of the irreversible process of radioactive decay, is 5–6 billion years. Baranov considers that prior to the beginning of radioactive decay the opposite process of nucleogenesis (the process of radioactive synthesis, and the evolution of chemical elements) operated for about 1 billion years. During this time the substance of the earth was formed; this was before it was separated as a planet.—*A. J. S.*

179–4. Voytkevich, G. V. Tektonicheskiye tsikly dokembriya [Tectonic cycles of the Precambrian]: Ministerstvo Vyssh. Obrazovaniya SSSR Nauch. Doklady Vyssh. Shkoly, Geol.-geog. nauki, no. 1, p. 64–71, 1959.

The ages of Precambrian rocks determined by radioactivity methods fall into 13 separate groups: These ages are 550; 630; 735; 820; 1,040; 1,400; 1,630; 1,850; 2,060; 2,300; 2,650; 2,900; and 3,100 million years. The representatives of any one group are generally worldwide in distribution, and the spacing of the groups in time is markedly regular.—*J. W. C.*

179–5. Long, Leon E., Kulp, J. Laurence, and Eckelmann, F. Donald. Chronology of major metamorphic events in the southeastern United States: Am. Jour. Sci., v. 257, no. 8, p. 585–603, 1959.

Potassium-argon and rubidium-strontium age measurements have been made on a variety of granites, pegmatites, gneisses, and schists which comprise the plutonic-metamorphic complexes of the Piedmont and Blue Ridge of the southeastern United States. Large portions of the area appear to have been metamorphosed initially approximately at the same time as the Grenville Province, i.e., about 900–1,000 million years ago. Superimposed on this older metamorphic province was a major orogenic event culminating at about 350 million years with widespread recrystallization of existing rocks and intrusion of pegmatites in the Spruce Pine, Franklin-Sylva, and Bryson City districts, and granites in the Virginia and North Carolina Piedmont. There is strong evidence of an additional metamorphic epoch between 350 and 1,000 million years, but its effects have been largely obliterated by the 350 million years event.

In western North Carolina a transition of apparent ages from 355 to 890 million years occurs in the same rock unit (Cranberry gneiss) over a distance of about 10 miles across the strike of the border of the 350 million years event.

In the southeastern Piedmont of Georgia and South Carolina a younger metamorphic event or events can be detected producing rocks of apparent age ranging from 230 to 310 million years. The time of these orogenies is compared with those in the Central and Northern Appalachians.

Evidence is accumulating that the Holmes' time scale will have to be considerably lengthened.—*Authors' abstract*

179–6. Komlev, L. V. Danilevich, S. I., Ivanova, K. S., Kuchina, G. N., Savonenkov, V. G., Filippov, M S., and Chupakhin, M. S. O vozraste granitov krivograd-zhitomirskogo magmaticheskogo kompleksa Ukrainy [On the age of granites of the Krivograd-Zhitomir magmatic complex of the Ukraine]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 159–175, 1958.

After a geological description of the granites of the Krivograd-Zhitomir magmatic complex in the Ukraine and associated migmatites, the results of absolute age determinations on the granites are reported. The ages established by radioactive methods were found to be: Pb^{208}/Th^{232}—1,710–2,100$\times 10^6$ yr; Pb^{206}/U^{238}—1,780–2,240$\times 10^6$ yr; total lead—1,730–2,150$\times 10^6$ yr; and A^{40}/K^{40}—1,720–1,970$\times 10^6$ yr.—*A. J. S.*

179–7. Komlev, L. V., Danilevich, S. I., Ivanova, K. S., Mikhalevskaya, A. D., Filippov, M. S., and Chupakhin, M. S. O vozraste charnokitov i chudnovo-berdichevskikh granitov Ukrainy [On the age of charnockites and the Chudnovo-Berdichev granites of the Ukraine]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 176–193, 1958.

The absolute age of the two distinct hybrid rock groups representative of the Precambrian strata of the Ukraine massif is reported. Both the charnockites along the Bug River and the Chudnovo-Berdichev granites contain monazite. The monazites from the two formations show a marked difference in age. By the total lead method the charnockites are 1,880–2,600$\times 10^6$ yr old, and the Chudnovo-Berdichev granites are 2,150–2,400$\times 10^6$ yr old. The lead-isotope method gave 2,920$\times 10^6$ for the maximum age of the charnockites. By the argon method (on biotite) the charnockites and the Chudnovo-Berdichev granites were found to be 1,400–1,630 and 1,310–1,610$\times 10^6$ yr, respectively. A map of absolute ages of rocks in the Ukraine is given.—*A. J. S.*

179–8. Gamkrelidze, P. D. Geologicheskoye stroyeniye Gruzii i primeneniye metodiki opredeleniya absolyutnogo vozrasta [Geology of the Georgia S.S.R. and application of methods for determination of absolute age]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 11–26, 1958.

Part 1 of this paper describes the basic geological features of the Georgian S.S.R. Part 2 describes localities and geologic strata for which radioactive age determinations have been made or are desirable.—*A. J. S.*

179–9. Ozima, Minoru. Some experiments in potassium-argon dating: Jour. Geophys. Research, v. 64, no. 11, p. 2033–2034, 1959.

The distillation method originally devised by Edwards and Urey (1955) to liberate alkalis from minerals has been modified so that both potassium and argon can be liberated from the same sample. This eliminates a source of error due to possible inhomogeneity of distribution of those elements in minerals. The procedure is described briefly.

In determining radiogenic argon–40, the sensitivity of a mass spectrometric analysis is greatly reduced by the presence of a small background of mass–36. A sweeping method has been devised to remove this source of error. The impurities that cause this background are trapped in a liquid air cold trap during the recycling; this gives a constant background level in the mass spectrogram,

and consequently the slopes of the lines give the A^{38}/A^{36} and A^{40}/A^{38} ratios regardless of the presence of a background of mass-36.—*D. B. V.*

179–10. Polevaya, N. I., and Murina, G. A. Vliyaniye nekotorykh nalozhennykh protsessov na resul'taty opredeleniya vozrasta argonovym metodom [Effect of some superimposed processes on the results of age determination by the argon method]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 247–253, 1958.

Divergences in ages obtained by radiometric and geological methods, even on different minerals from the same rock sample, are greatest and most frequent in Precambrian rocks. Polevaya and Murina attribute these divergences, in most cases, to secondary processes during the long history of Precambrian units rather than to defects in the radiometric methods themselves. The fact that the argon ages of mica and feldspar in some metasomatic granites and pegmatites differ by as much as 40 percent is explained by the hypothesis that the mica and accessory minerals represent the original rock (1,980–2,000 million years), whereas the feldspar indicates subsequent metasomatism (1,650 million years).—*A. J. S.*

179–11. Kashkay, M. A. Intruzivnyye porody Azerbaydzhana i ikh vozrastnyye sootnosheniya [Instrusive rocks of Azerbaijan and their age correlation]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 77–85, 1958.

Potassium-argon age determinations made on intrusive rocks in the Azerbaijan S.S.R. are correlated with stratigraphic and paleontologic observations. The absolute ages were found to be as follows: quartz porphyry, 165×10^6 yr; gabbro-diorite, 135×10^6 yr; granodiorite, 130×10^6 yr; "grano-aplite," 115×10^6 yr; quartz diorite, 125×10^6 yr; grano-syenite, 45×10^6 yr; and granites, 50, 55×10^6 yr.—*A. J. S.*

179–12. Afanas'yev, G. D. Novyye dannyye po opredeleniyu absolyutnogo vozrasta gornykh porod i mineralov Severnogo Kavkaza [New data on determination of the absolute age of rocks and minerals of the North Caucasus]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 44–63, 1958.

More than 200 samples of rocks from the North Caucasus have been processed for argon dating. Most of the samples were analyzed by two laboratories independently. The data of the absolute ages obtained indicate repeated magmatic cycles and regularities in spatial and temporal distribution of igneous rocks in the Greater Caucasus. The records of the samples used and their absolute ages are given in tables.—*A. J. S.*

179–13. Amirkhanov, Kh. I., Magatayev, K. S., and Timofeyeva, G. I. Rezul'taty opredeleniya absolyutnogo vozrasta osadochnykh porod neftenosnykh provintsiy Dagestana [Results of determination of the absolute age of sedimentary rocks of the oil-bearing provinces of Dagestan]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 69–76, 1958.

In this preliminary report, data on the radioactive argon and potassium in sedimentary rocks of Dagestan in the North Caucasus are given, and their argon ages are compared with the geological time scale (Marble and Starik). Complete agreement was found in the ages determined by both methods ($60–100\times10^6$ yr).—*A. J. S.*

179–14. Kantor, Ján. Vek niektorych Vysokotatranských granitoidov a kryštalických bridlíc podlá rádioaktívneno rozpadu K^{40} [Age of some granitic and crystalline rocks of the High Tatra according to the radioactive disintegration of K^{40} (with German summary)]: Slovenská Akad. Vied Geol. Sbornik, v. 10, no. 1, p. 89–96, 1959.

The High Tatra is a typical core massif composed of schists and granitic plutons. These rocks have been systematically studied, and their age has been the subject of speculation. Several radioactive age determinations were made at the Stúr Geological Institute in Bratislava using the potassium-argon method for biotite concentrates. A biotite paragneiss from the Jamnická valley yielded an age of 260×10^{-6} yr, and an oligoclase-biotite granite from the Batizovská valley gave 226×10^{-5} yr. The latter value may be too low inasmuch as the biotite is somewhat chloritized in places. Both the granite and the metamorphism of the gneiss are referred to the Variscan orogeny.—*Author's German Summary, J. W. C.*

179–15. Komlev L. V. Filippov, M. S. Danilevich, S. I. Ivanova, K. S. Kryukova, N. F., Kuchina, G. N., and Mikhalevskaya, A. D. Vozrastnyye dannyye argonovogo i svintsovoizotopnogo metodov dlya nekotorykh granitov i pegmatitov Srednego Pridneprov'ya [Age data of the argon and lead isotope method for some granites and pegmatites of the central Dneiper region (with English summary)]: Geokhimiya, no. 2, p. 110–115, 1959.

The argon ages have been determined on micas from a series of Precambrian rocks from the central Dneiper region. The oldest value, 2.9×10^9 yr, was obtained on a biotite mixed with amphibole, from granodiorite on the Mokraya Sura River, and on phlogopite from pegmatites cutting the granodiorite. Other values obtained for plagiogranites, granodiorites, and granites, range from 1.83×10^9 to 2.28×10^9 yr. The Korbin allanite pegmatites give ages of $2.1–2.61\times10^9$ yr by both the lead isotope and argon methods. Allanite from the Podstepensk quarry is $2.4–3.^0\times10^6$ yr old.—*D. B. V.*

179.16. Starik, I. Ye., Shats, M. M., and Sobotovich, E. V. O vozraste meteoritov [On the age of meteorites]: Akad. Nauk SSSR Doklady, v. 123, no. 3, p. 424–426, 1958.

The ages of seven stony meteorites have been determined by the lead method. A table gives the Pb^{206}/Pb^{238}, Pb^{207}/Pb^{235}, and Pb^{207}/Pb^{206} isotope ratios and the ages as calculated for each ratio. The results show no significant anomalies in the isotopic content of the lead. The ages calculated are in agreement with recent determinations.—*D. B. V.*

179–17. Gentner, W., and Zähringer, J. Kalium-Argon-Alter einiger Tektite [Potassium-argon age of some tektites]: Zeitschr. Naturforschung., v. 14a, no. 7, p. 686–687, 1959.

The potassium-argon ages have been determined for 4 tektites as follows: australite, 0.58×10^6 yr; billitonite, 0.53×10^6 yr; indochinite, 0.56×10^6 yr; and

moldavite, 8.5×10^6 yr. These ages correspond roughly with the ages of the formations in which they are found (Pleistocene and Upper Miocene).—*D. B. V.*

179–18. Venkatasubramanian, V. S., and Sivaramakrishnan, V. Studies on the lead alpha method of geochronology: Jour. Sci. Indus. Research [India], v. 18B, no. 8, p. 311–313, 1959.

Lead-alpha ages have been determined for zircons from Manavalakurchi, (Travancore) and cyrtolites from the Nellore mica belt in India. The age of the cyrtolites is found to be $1{,}490\times10^6$ yr, which is in agreement with determinations made on samarskite and allanite from the same igneous cycle. The picture is less clear in the case of the zircons. As the concentrates are from placer deposits, they are possibly of mixed origin. Their age values range from 950 to $1{,}050\times10^6$ yr.—*D. B. V.*

179–19. Barker, Harold. Radiocarbon dating: Nature, v. 184, no. 4687, p. 672–674, 1959.

This is a report on contributions made by representatives of each of the three English laboratories actively engaged in radiocarbon dating to a joint session of the physics and anthropology-archeology sections of the British Association at a recent meeting in York. They provide a picture of the basis of the method and its limitations, the trend of future development in instrumentation, and the capabilities of the method as applied to individual problems in the late Quaternary history of the British Isles.—*D. B. V.*

179–20. Reber, Grote. Age of lava flows on Haleakala, Hawaii: Geol. Soc. America Bull., v. 70, no. 9, p. 1245–1246, 1959.

Five lava flows on the southwest side of Haleakala, on the island of Maui, Hawaii, have been dated by means of carbon-14 determinations on charcoal from tree molds. The range in age from less than 100 yr to 890 ± 170 yr.—*D. B. V.*

179–21. Churchill, D. M. Late Quaternary eustatic changes in the Swan River district: Royal Soc. Western Australia Jour., v. 42, pt. 2, p. 53–55, 1959.

Pollen analyses have been made on a sample of fresh-water peat now submerged 68 ft below sea level at the narrows of the Swan River near Perth, Western Australia. The radiocarbon age of this sample was determined as $9{,}850\pm130$ yr. Mapping of Late Quaternary shorelines to the west of Fremantle show that Rottnest and Garden Islands have been isolated from the mainland since about 5,000 B.C.—*V. S. N.*

179–22. Tatsumoto, Mitsunobu, and Goldberg, E. D. Some aspects of the marine geochemistry of uranium: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 201–208, 1959.

The uranium concentrations in marine calcareous material of biological origin have been found to vary between 0.0X and 0.X ppm except for coral; these, like aragonitic oolites and aragonite precipitated from sea water, contain several parts per million. A geochronology based on the growth of ionium (thorium–230) from uranium is applicable not only to corals but also to oolites. Several examples of "oolite ages" are tabulated. The uranium content of ferromanganese minerals from pelagic deposits is of the order of 4–5 ppm.—*D. B. V.*

179–23. Deutsch, Sarah. Application de l'étude quantitative des halos pléochroiques à l'estimation de l'âge des roches [Application of the quantitative study of pleochroic haloes to estimation of the age of rocks]: Internat. Electronic and Nuclear Cong., Rome, 1958, Proc., v. 1, p. 309–314, 1958.

The quantitative relationships between coloration of biotite in granites and total exposure to α-particles received by the mineral have been investigated in thin sections of natural samples of known age and in artificially irradiated cleavage lamellae, and the results applied to dating of rocks (see Geophys. Abs. 169–22, 170–26, 171–35, 173–15, –16, 175–18, 176–19, 178–23). The method is particularly well suited to rocks less than 600 million years old; the precision, 20–40 percent, is sufficient to assign a massif to a particular orogeny without ambiguity. As subsequent metamorphism affects pleochroic haloes, results must be interpreted with care.—*D. B. V.*

COSMOGONY

179–24. Allan, D. W. The moon as clue to the earth's early history: Royal Astron. Soc. Canada Jour., v. 52, no. 1, p. 17–18, 1959.

Studies of the dynamic and tectonic evolution of the moon may help in understanding some geophysical and geological problems, particularly concerning the very early history of the earth. As erosion is largely absent on the moon, its surface structures probably date from the beginning of its history. The thermal histories of earth and moon are closely related, and the effect of tidal friction on the moon's motion has been used to date the earth-moon system.

If the craters of the moon are due to meteoritic impacts it must be concluded either that both the moon and earth suffered intense bombardment early in their history, all traces now being gone from the earth, or else that the moon somehow suffered more intense bombardment. If there has been volcanism on the moon and the maria are explained as lava flows, then another billion years must be added to its age for radioactive heating to have taken place, and there are difficulties in understanding the age relationships of the earth and the moon.—*D. B. V.*

179–25. Kuiper, Gerard P. The moon: Jour. Geophys. Research, v. 64, no. 11, p. 1713–1719, 1959.

This is a review of the principal empirical data bearing on the processes of lunar development. A working hypothesis of the general development of the moon is outlined: by a process of accretion in a protoplanet, the earth and moon together formed a binary planet whose common envelope was dissipated when the sun attained full brightness; as radioactive decay was about 10 times more intense at that time (some 5.5 billion years ago), the accreted mass was partially remelted some 4.5 billion years ago; this heating led to changes on the lunar surface; freezing and cooling, with contraction, followed. The surface features of the moon are interpreted in this light of the hypothesis.—*D. B. V.*

179–26. Green, Jack. Lunar and terrestrial features: Geotimes, v. 4, no. 4, p. 22–23, 1959.

"Serpentine Ridge" in the moon's Mare Serenitatis is shown to be analogous to the pressure ridge in the Sierra Negra Caldera in the Galapagos Islands; and the straight wall on the west side of the moon's Mare Nubium to be analogous to a subsidence fault on the southwest side of Darwin Caldera in the Galapagos

Islands. Although the scales are very different, it is suggested that these lunar features can be explained more plausibly by volcanism than by meteorite impact.—*D. B. V.*

179–27. Bülow, K[urd] von. Meteoritischer oder vulkanischer Ursprung der Mondkrater? [Meteoritic or volcanic origin of the moon craters?]: Umschau, v. 50, no. 14, p. 430–433, 1959.

The meteoritic and volcanic explanations of the craters of the moon are compared. No lunar features can be explained solely in terms of meteor impact, but all show parallels with terrestrial volcanism and can be explained by volcanism alone.—*D. B. V.*

179–28. Press, Frank. The geological aspects of the interior of the moon: Proceedings of Lunar and Planetary Exploration Colloquium, Missile Div., North American Aviation, Inc., v. 1, no. 1, p. 15–18, 1958.

Problems involved in seismic exploration of the moon are discussed. An unmanned seismograph seems practical, and 100-lb shots of TNT properly tamped should be effective. Noise would not be present on the moon. Knowledge of the moons' interior would furnish basic data on the cause of the earth's magnetic field; it would also throw light on the relationship of heat flow to earthquakes.—*J. W. C.*

179–29. Alter, Dinsmore. The Alphonsus story. Proceedings of Lunar and Planetary Exploration Colloquium, Missile Div., North American Aviation, Inc., v. 1, no. 4, p. 19–22, 1959.

The events are described that lead up to the photographing on October 26, 1956, of a haze on the floor of Alphonsus by the 60-inch reflector at Mount Wilson. A rilled area of Alphonsus appeared to be more obscured on the blue-violet plates than on infrared ones. These photographs caused N. A. Kozyrev, in the U.S.S.R., to make a systematic spectrographic search of the lunar surface, which led to his observations of a gas emission at Alphonsus on November 3, 1958. In the discussion H. R. Poppendick, an amateur astronomer, reported that he observed a cloud in Alphonsus on November 18, 1958.—*J. W. C.*

179–30. Urey, Harold C. Primary and secondary objects: Jour. Geophys. Research, v. 64, no. 11, p. 1721–1737, 1959.

Recent and older observations of meteorites are discussed and tentative conclusions drawn. Two sets of objects are required to account for the properties of chondritic meteorites. The primary objects are about lunar size, and it is suggested that the moon is one such object. The secondary have often been identified with the asteroids, but they may possibly be the surface regions of the primary objects; in fact, the surface of the moon may be the immediate place of origin of the stone meteorites. There is evidence that the stones and irons do not come from the same region of space, and that they definitely have quite different histories.—*D. B. V.*

179–31. Urey, H[arold] C., and Mayeda, Toshiko. The metallic particles of some chondrites: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 113–124, 1959.

A study of the metal particles of eleven chondrites and one achondrite of a unique kind has been made. It is concluded that the metal particles secured their principal characteristics by a slowly cooling process in a primary object. This body was broken up and the materials reaccumulated into a secondary

object. Reheating to about 500° C occurred during the break-up process. This took place in their history starting some 4.5×10^9 yr ago. A few glass chondrules may owe their origin to heating to high temperatures in very limited volumes.

Abee is an achondrite containing substantial amounts of iron and troilite. It is not a conglomerate and may be a stony iron in which the mixtures of metal and silicate are on a microscopic scale. No evidence of reheating of this object has been found. Crystalline silicates are suspended in the metallic phase, indicating that the body was formed in a low gravitational field.

The observed corrosion in all meteorites studied is probably of terrestrial origin.—*Authors' conclusion*

179–32. Honda, Masatake. Cosmogenic potassium-40 in iron meteorites: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 148–156, 1959.

The radioactivity of potassium isolated from three samples of iron meteorite has been measured using a low-level β-counter. An excess of activity corresponding to 1.3×10^{-10} g K^{40} per g, due to cosmic-ray bombardment, was expected. The amount of this excess potassium activity was estimated by comparison with a laboratory potassium sample of the same size. The counting data, tabulated in counts per minute above background, were consistent with expectations.—*D. B. V.*

179–33. Ehmann, W. D., and Huizenga, J. R. Bismuth, thallium and mercury in stone meteorites by activation analysis: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 125–135, 1959.

The radiochemical procedures for the assay of bismuth, thallium, and mercury in stone meteorites following neutron activation are described in detail. A bismuth-209 abundance of 2.2×10^{-9} g per g meteorite leading to a cosmic abundance of 0.0016 (per 10^6 Si atoms) was determined from the analysis of six stone meteorites. A thallium-203 abundance of 0.40×10^{-9} g per g meteorite and a mercury-202 abundance of 30×10^{-9} g per g meteorite corresponding to cosmic abundances of 0.00030 and 0.023 (per 10^6 Si atoms), respectively, were determined from analysis of five stone meteorites. Implications of these data as pertaining to the life history of meteorites are discussed.—*Authors' abstract*

Starik, I. Ye., Shats, M. M., and Sobotovich, E. V. On the age of meteorites. See Geophys. Abs. 179–16.

Voshage, H., and Hintenberger, H. Potassium as a cosmic radiation reaction product in iron meteorites. See Geophys. Abs. 179–282.

179–34. Dietz, Robert S. Shatter cones in cryptoexplosion structures (Meteorite impact?): Jour. Geology, v. 67, no. 5, p. 496–505, 1959.

Shatter cones (striated percussion fracture cones), apparently formed by explosive percussion, are known only from four cryptoexplosion (i.e., "cryptovolcanic") structures, viz., Steinheim Basin, Wells Creek Basin, the Kentland deformation, and the Crooked Creek structure. The nature of these shatter cones and their orientation at these four localities are described. It is concluded that the shatter cones may be a useful criterion for establishing that cryptoexplosion structures of the damped-wave type are probably formed by the hypervelocity and explosive impact of large meteorites. In any event, it is hoped that this paper will draw attention to these unusual structures so that geologists will be on the lookout for them in small, highly deformed, circular structures.—*Author's abstract*

179–35. O'Keefe, John A. Origin of tektites: Science, v. 130, no. 3367, p. 97–98, 1959.

The theory that tektites originated as secondary bodies from the infall of meteorites on the moon has been criticized on the grounds that tektites could not have arrived as a compact mass. If they fell from nearly circular orbits, however, this difficulty largely disappears.

A nearly circular orbit will have 1 or 2 sections, so-called active regions, from which falls are likely to occur. At any instant the falls will occur along the arc of a great circle, where the orbit reaches its lowest point in the atmosphere. Because in a few minutes the earth turns perceptibly under the active region, the strewn field will be widened in longitude. This also explains the fact that in the Indo-Malayan fall the tektites of Cambodia are much larger than those of the Philippines. The larger tektites should have a smaller ratio of drag to mass; therefore, they would be found west of the smaller tektites because they stayed up longer.

Objections are raised to explanations of tektites proposed by Barnes, Urey, and Kohman (see Geophys. Abs. 175–390 through 408).—*D. B. V.*

179–36. Mason, Brian. Chemical composition of tektites: Nature v. 183, no. 4656, p. 254–255, 1959.

Urey, Harold C. Chemical composition of tektites: ibid no. 4668, p. 1114, 1959.

A rapid survey of published analyses shows the existence of igneous rocks of composition closely comparable to each of the principal tektite types; therefore, Mason claims that even if as close a correlation can be established between tektites and sedimentary rocks, the argument that the chemical composition indicates that tektites have originated by fusion of sedimentary rocks is unwarranted.

Urey answers by referring to analyses of sedimentary rocks which show fair agreement except in water content (which is a real puzzle). He suggests that some of the granites listed by Mason may be fused sediments, and stresses the fact that the comparison should be made with the sediments of the general area in which particular tektites are found, not with average sedimentary rocks—*D. B. V.*

179–37. Eiby, G. A. A survey of the tektite problem: New Zealand Jour. Geology and Geophysics, v. 2, no. 1, p. 183–194, 1959.

Present knowledge of the occurrence, properties, and composition of tektites is reviewed; and the principal theories which have been advanced to explain their origin are critically discussed. Nininger's lunar impactite theory, modified in accordance with suggestions of Varsavsky, is most free from objection; but if Kopal's contention that tektites must have had an origin closer to the earth is well founded, Hardcastle's plastic sweeping theory seems likely to repay closer attention than it has so far received.—*Author's summary*

179–38. Taylor, S. R., and Ahrens, Louis H. The significance of K/Rb ratios for theories of tektite origin: Geochim. et Cosmochim. Acta, v. 15, no. 4, p. 370–372, 1959.

The similarity of K/Rb ratios for the earth, chondrites, and tektites is supporting evidence for an origin of tektites within the solar system. Alternatively, if they formed from a different stellar dust cloud, it must have had the same

relative proportions of K and Rb as the solar system. Examination of the latter possibility leads to the conclusion that the K/Rb ratio is not constant throughout the universe and that the solar-system ratio of about 220 is possibly unique. The ratio is evidently sensitively dependent on conditions of element formation; since the ratio in tektites is the same as in the earth and in chondrites, the case for an origin of tektites within the solar system is strengthened.—*D. B. V.*

179–39. Cherry, R. D., and Taylor, S. R. Origin of Be^{10} and Al^{26} in tektites: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 176–185, 1959.

The amounts of beryllium-10 and aluminum-26 recently reported in tektites (see Geophys. Abs. 174–330) can possibly be explained in terms of Urey's "comet" hypothesis of tektite origin (see Geophys. Abs. 175–390, –397). On the basis of a comet model, a similar level of beryllium-10 activity and a somewhat lower aluminum-26 activity are obtained. By mixing 1 part of chondritic silicate, which is assumed to represent the nonvolatile comet material and to contain the radioactive nuclides, with 13 parts of arkoselike material, the overall tektite composition can be accounted for rather satisfactorily.—*D. B. V.*

179–40. Starik, I. Ye., Sobotovich, E. V., and Shats, M. M. K voprosu o vozraste tektitov [On the question of the age of tektites]: Akad. Nauk SSSR Izv. ser. geol., no. 9, p. 90–91, 1959.

Gerling and Yashchenko (1952) and Suess, Hayden and Inghram (1951) have dated various tektites by the argon method as ranging from 1.7×10^7 to 7.3×10^6 yr, considerably younger than stony meteorites. Analysis of a tektite (indochinite) shows that its uranium content is about 1.7×10^{-6} *g* per *g;* lead content is 7.6×10^{-6} *g* per *g;* and isotopic composition is $Pb^{204}=1$, $Pb^{206}=28.91$, $Pb^{207}=17.53$, and $Pb^{208}=41.87$.

If it is assumed that tektites are of cosmic origin, and correction is made for primary lead according to its isotopic composition in iron meteorites, then the age obtained is $Pb^{206}/Pb^{238}=4.7\times10^9$ yr, $Pb^{207}/^{235}=4.2\times10^9$ yr, $Pb^{207}/Pb^{206}=3.7\times10^9$ yr. Assuming that tektites are derived from terrestrial sedimentary rocks, and correcting for tertiary and quaternary lead, the age according to all 3 isotope ratios is about 3×10^9 yr instead of a few million years; the correction for tertiary lead is therefore meaningless, and the tektite evidently cannot be of terrestrial origin.

Although results based on a single sample are not conclusive, this analysis is additional evidence in support of a cosmic origin of tektites.—*D. B. V.*

Gentner, W., and Zähringer, J. Potassium-argon age of some tektites. See Geophys. Abs. 179–17.

179–41. Senftle, F[rank] E., and Thorpe, A[rthur]. Magnetic susceptibility of tektites and some other glasses: Geochim. et Cosmochim. Acta, v. 17, no. 3/4, p. 234–247, 1959.

The magnetic susceptibility at several magnetic field strengths of about 30 tektites has been found to range from 2×10^{-6} to about 7.9×10^{-6} emu per g. Tektites of similar provenance have similar susceptibilities; intensity of magnetization of all those measured is zero or small. Similar measurements on about 30 obsidians show approximately the same range of susceptibilities, but much higher intensity of magnetization; heating to 1,450° C reduced this intensity to zero.

It is concluded that the tektites must have been heated well above 1,400° C and all their iron was in solution, whereas the obsidians have not been heated

much above that temperature and there is a significant amount of undissolved iron in the glass, probably as magnetite. Further, if tektites are extraterrestrial, they probably entered the atmosphere as glass.—*D. B. V.*

179–42. Barnes, Virgil E., and Bruce, George A. Tektites in Georgia: Geotimes, v. 3, no. 7, p. 18, 1959.

The occurrence of tektites in Georgia is confirmed in areas of Miocene rocks. They resemble Czechoslovakian moldavites but with some differences; the Georgia tektites may thus represent a completely new shower.—*D. B. V.*

179–43. Cohen, A[lvin] J. Moldavites and similar tektites from Georgia, U.S.A.: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 150–153, 1959.

Trace element analyses and physical properties indicate that there is a strong similarity among the newly discovered Georgia tektites (see Geophys. Abs. 179–42) moldavites, and bediasites. Although it is impossible to determine from known geological considerations whether they all represent one and the same widespread tektite fall of hemispheric proportions, it is suggested that tektite falls other than the Australian may be very widespread. If wide distribution is confirmed by new discoveries of locale and age, it would greatly strengthen the case for lunar origin of tektites.—*D. B. V.*

179–44. Roe, F. W. Tektites in Brunei: Overseas Geology and Mineral Resources, v. 7, no. 2, p. 193–194, 1958.

Six tektites have been found in raised Quaternary alluvial deposits, locally known as the Butir gravel deposits, near Brunei, Borneo. They are well rounded, generally ovate or ellipsoidal, jet black, glassy stones, mostly less than 1 inch in diameter. The only tektites previously reported from Borneo are those found by Mueller in 1915 in Quatenary marine deposits at Tutong.—*V. S. N.*

179–45. Cohen, Alvin J. Origin of Libyan Desert silica-glass: Nature, v. 183, no. 4674, p. 1548–1549, 1959.

Results of trace analyses for germanium are given on silica glass, sandstone, quartzite, 2 sands from the Libyan Desert, the Aouelloul crater "impacite" glass, 2 obsidians, the average for tektites from 11 different localities, and the range for the nonmagnetic portions of 6 meteoritic stones. The germanium content of the silica-glass is 0.80, close to the average (0.77) for the other four materials from the Libyan Desert and not very different from the impactite (0.64); obsidian has twice as much germanium, tektites all have less, but stony meteorites bracket the value of 0.80. Trace-element contents also match the sandstone most closely and are quite different from the tektite. It is concluded that the Libyan Desert glass is terrestrial in origin, being formed from local materials probably by impact of some cosmic body.—*D. B. V.*

EARTHQUAKES AND EARTHQUAKE WAVES

179–46. Press, Frank, Oliver, Jack, and Romney, Carl. The need for fundamental research in seismology: Am. Geophys. Union Trans., v. 40, no. 3, p. 212–221, 1959.

This is a summary of the report of the panel on seismic improvement appointed by the President's Special Assistant for Science to reassess the Geneva seismic-monitoring system and to report on the possibility of improvements stemming

from an intensive-research program in seismology. This report reviews the current status of seismology and the directions that seismological research might profitably take in the next few years. Recommendation is made for studies of the mechanisms of natural earthquakes and explosions and of seismic-wave propagation for improvement of detection through increased knowledge of microseismic noise and through better instruments, and for improvement of data-processing methods.—*D. B. V.*

179–47. Dué Rojo, Antonio. Notas sísmicas de 1957 [Seismic notes of 1957]: Rev. Geofísica, v. 17, no. 66, p. 213–220, 1958; *reprinted in* Observatorio de Cartuja (Granada) Trabajos cient., ser. B, v. 12, no. 108, 1958.

This is a brief review of worldwide earthquake activity in 1957. The total number of earthquakes catalogued by the U.S. Coast and Geodetic Survey in Washington was 1,297, somewhat more than in 1956. The Aleutian earthquake of March 9 was particularly violent, and that archipelago suffered 357 earthquakes in the course of the year. Tables show the number of earthquakes per month for the world and for the Aleutians, the number of earthquakes of magnitudes 6 or more (broken down by quarter magnitudes), and the number of earthquakes at various focal depths ranging from 60 to 700 km. Macroseismic data are summarized briefly by area (Europe, Asia, Africa, America, Oceania) and a map of epicenters is presented.—*D. B. V.*

179–48. U.S. Coast and Geodetic Survey. Hebgen Lake, Montana earthquake, August 1959: U.S. Coast and Geod. Survey Prelim. Rept., 15 p., 1959.

This preliminary report on the Hebgen Lake, Mont., earthquake of August 17, 1959, was prepared early in September on the basis of reports from various geologists, physicists, and engineers. The earthquake occurred near the Montana-Wyoming border at lat 44°50′ N. and long 111°05′ W., had a magnitude of 7.1 (Pasadena), was felt over an area of 550,000 sq mi, and was followed by more than 200 aftershocks. Included in the report are discussions of the effects on local geology and engineering structures, the epicenters as determined from instrumental data, the seismic history and geology of the Hebgen Lake area, and results of special surveys by the Coast and Geodetic Survey.—*V. S. N.*

179–49. Tillotson, E[rnest]. Yellowstone Park earthquake: Nature v. 184, no. 4691, p. 955–956, 1959.

The earthquake of August 18, 1959, occurred at $06^h37^m13^s$ G.m.t. with an epicenter at lat 44.5° N., long 111° W., near the west boundary of Yellowstone National Park. Magnitude was 7.1 or more on the Richter scale and depth of focus was normal. Ten were killed and 60 injured. Provisional readings at Kew Observatory of *eP*, *iS*, *MH*, and *F* arrivals are given, and principal aftershocks on August 18–20 are tabulated. Notable earthquakes also occurred in this general vicinity in 1925, 1930, and 1947.—*D. B. V.*

179–50. Comité del Año Geofísico Internacional del Ecuador. Breve historia de los principales terremotos en la Republica del Ecuador. [Brief history of the principal earthquakes in the Republic of Ecuador]: Quito, Observatorio Astronómico de Quito, 25 p. and appendix, 1959.

This is a compilation of information on the strongest earthquakes that have occurred in Ecuador from 1534 to 1958. The first part of this publication describes briefly 32 of the most notable of these. A second part, by Claudio Molina Serrano, is the explanatory text for the accompanying 1:1,000,000-scale seismic and tectonic map of the country. The third part is a short description

by Pedro Salazar of the tectonic framework of Ecuador; the relationship of earthquakes to structure, and even to volcanoes, is intimate. The nine-page appendix lists statistics for 315 earthquakes, giving date, intensity and magnitude, epicentral coordinates and name of province, origin time, and observations (mainly on damage).—*D. B. V.*

179–51. Tryggvason, Eysteinn. Jarðskjálftar á Íslandi árin 1956, 1957 og 1958 [Earthquakes in Iceland during 1956, 1957, and 1958 (with English summary)]: Náttúrufraeðingurinn, v. 29, no. 2, p. 84–91, 1959.

This is a catalog of earthquakes recorded during 1956–58 at Iceland's seismograph stations at Reykjavík, Akureyri, Vík, and Kirkjuaejarklaustur. The last began operation in 1958, with one vertical Willmore seismograph. Seismic activity was low in south Iceland during these years, higher in the north. Shocks were felt on 6 days in 1956, 11 days in 1957, and 9 days in 1958; of these, the most intense occurred on June 1, 1956 (southwest, intensity 6, felt-area radius, 70 km), October 29, 1956 (north coast, intensity 5, felt-area radius 200 km), September 27, 1958 (north, intensity 6, felt-area radius 80 km), and December 6, 1958 (north coast, intensity 4, felt-area radius 100 km). About 25–30 percent of all Icelandic earthquakes in 1954–58 occurred in northwestern Vatnajokull, about 10 percent around Torfajökull; these two epicentral regions were unknown as such until recently.—*D. B. V.*

Tryggvason, Eysteinn. Velocity of earthquake waves and the earth's crust under Iceland. See Geophys. Abs. 179–260.

179–52. Florinescu, A. Regiunile cu focare de cutremure din ţara noastră [Regions of Rumania having earthquake foci]: Acad. Romîne Studii şi cercetări de astromonie şi seismologie, v. 4, no. 1, p. 281–289, 1959.

Using material collected for a catalogue of earthquakes felt in Rumania, Florinescu selected the earthquakes that originated within Rumania and determined their epicenters. The epicenters were found to be concentrated in 10 regions, which are indicated on a map.—*A. J. S.*

179–53. de Bremaecker, J. Cl. Seismicity of the West African Rift Valley: Jour. Geophys. Research, v. 64, no. 11, p. 1961–1966, 1959.

All the epicenters determined in the central part of the West African Rift Valley up to the middle of 1958 have been plotted on a map. Most of them are on the faults which border the Rift; a few are on faults which crosscut it. The eastern Virunga extinct volcanoes show a fairly strong seismic activity. The most important discovery is that of a transverse zone stretching west from Lake Kivu to the Congo River (450 km); extinct or active volcanoes are located at the intersection of this zone with the Rift Valley.

Diagrams show the amount of seismic energy liberated per year within 500 km of Lwiro. The mean value is 3.5×10^{20} ergs per year, which is about 0.03 percent of that of the earth as a whole.—*Author's abstract*

179–54. Herrinck, P. Séismicité du Congo belge. Compilation des séismes observés aux stations climatologiques entre 1909 et 1954 [Seismicity of the Belgian Congo. Compilation of earthquakes observed at the climatological stations between 1909 and 1954]: Acad. royale Sci. coloniales, Cl. Sci. nat. et médicales Mém., v. 9, no. 5, 55 p., 1959.

This list of earthquakes felt in the Belgian Congo and Ruanda Urundi was compiled from the monthly bulletins of the climatological stations in those

territories for the years 1909–54. They are based on macroseismic evidence and, therefore, are neither ideally complete nor accurate. A map of epicenters based on these observations shows two regions of fairly high seismicity, where instability of the rift valley is marked, and two of lesser importance—one on Lake Tanganyika and the other, surprisingly, in a part of the Kasai lying between, rather than on, known faults.

Tables give the location, date, and time of each shock, and the number of shocks per 1° quadrangle.—*D. B. V.*

179–55. Tvaltvadze, G[uri] K. K voprosu postroyeniya godografov dlya zemletryaseniy Kavkaza [On the problem of construction of traveltime curves for earthquakes in the Caucasus]: Akad. Nauk Gruzin. SSR Inst. Geofiziki Trudy, v. 15, p. 131–160, 1956.

Taking into consideration the specific seismogeologic structure of the Caucasus, and assuming the mean thicknesses (H) of the crustal layers and the mean velocities of longitudinal and transverse waves (v_p and v_s) in them to be as given below, Tvaltvadze discusses the derivation and graphic construction of traveltime curves for earthquakes focuses at different depths. For the sedimentary layer, he assumes H=10 km, v_p=4,500 m per sec, v_s=2,600 m per sec; for the granitic layer H=15 km, v_p=6,000 m per sec, v_s=3,400 m per sec; for the basaltic layer H=25 km, v_p=7,000 m per sec, v_s=4,000 m per sec; and for the subcrust v_p=7,900–8,000 m per sec, v_s=4,600–4,700 m per sec. Travel times of P_1, S_1, P_{121}, S_{121}, P_{131}, S_{131}, P_{141}, S_{141}, for focal depths h=0, 3, 6, 9, 15, 20, 25, 30, 35, 40, and 45 km in terms of epicentral distances from 0 to 400 km; and S—P intervals are given in tables and graphs. Several local earthquakes in the Caucasus are analyzed on the basis of these traveltime curves, and their epicenters and focuses are determined.—*A. J. S.*

179–56. Levitskaya, A. Ya., and Muratov, M. V. O svyazi seysmichnosti s tektonicheskoy strukturoy Chernomorskoy vpadiny i okruzhayushchikh oblastey [On the relation of seismicity to structure of the Black Sea depression and surrounding regions]: Akad, Nauk SSSR Izv. ser. geofiz., no. 4, p. 538–546, 1959.

A seismological description of the Black Sea depression and surrounding regions is compiled from the records of Russian, Bulgarian, and Turkish seismic stations; from the work of Gutenberg and Richter on the seismicity of the earth; and from the bulletins of the International Central Bureau of Seismology for 1923–57. The strongest earthquakes in the area have been observed on the Turkish side of the Black Sea. These include the Gallipoli earthquake on August 9, 1912, (M=7¾) and the shock on December 26, 1939, (M=8). The epicenters of most of the Turkish and Caucasus earthquakes have been on the mainland, whereas to the north of the Black Sea and in the Crimea, almost all earthquakes observed originated under the Black Sea. Earthquakes of M=6¾ have been recorded on the west coast of the Black Sea in southern Bulgaria (June 14, 1913 and April 18, 1928). On the northwestern coast several deep focus earthquakes with M=6½ and M=7¼ occurred in the Carpathians during the period of study. The absence of focuses in the bottom of the depression and high seismicity of its flanks have been explained by continual subsidence of the depression with crumbling of the periphery. The article contains many seismological data on the regions discussed, but absence of geological and seismological studies makes the theories advanced on the earthquakes speculative.—*S. T. V.*

179–57. Riznichenko, J. V. [Yu. V.]. On quantitative determination and mapping of seismic activity: Annali Geofisica, v. 12, no. 2, p. 227–237, 1959.

Determinations of seismicity based on simple summation of seismic energy of all earthquakes occuring in a given area in a given time cannot be applied to detailed mapping of seismicity; widely varying values result because most of the total energy is released in strong earthquakes that occur infrequently. The average level of frequency of numerous earthquakes in a wide range is proposed as a more stable value. This level may be determined by the number of earthquakes of a given energy class, related to a unit space-time region. The possibility of such determination is due to the existence of an approximately constant relationship between the relative number of earthquakes and their energy.

A detailed map is presented of the seismicity of the highly active Garm-Stalinabad region in the Tadzhik S.S.R., where many thousands of earthquakes, particularly weak ones, have been recorded by a network of highly sensitive seismic stations.—*D. B. V.*

Shirokova, Ye. I. Certain data on the character of the change of velocities in the upper layers of the earth's mantle. See Geophys. Abs. 179–255.

179–58. Kharin, D. A. Razvitiye seysmologii v KNR [Development of seismology in the People's Republic of China]: Akad, Nauk SSSR Vestnik, no. 8, p. 59–61, 1959.

The paper is an outline of recent progress in seismology in China. A seismicity map of China has been made based on the data collected for the great catalog of earthquakes that occurred during many centuries of China's history. Establishment of a base network of 18–20 seismic stations equipped with Kirnos seismographs is near completion. The Gan'suy Corridor and adjacent areas, noted for their high seismicity (up to $M=8.5$), are being investigated in the neighborhood of the Yangtse dam. Vibrographs, electromagnetic oscillographs, and other instruments are being manufactured in China to observe the seismic waves from kiloton blasts in the extension of the sluice of the dam. Seismogeological investigations are being carried out in the diverse and complex terrain near Lanchjou, Bastau, and Sian. The low sensitivity of the four seismic stations there has prevented Chinese seismologists from obtaining conclusive results. A group of 9 or 10 stations have been added to the project in 1959, and a total of 40–60 is planned for seismic observations of the region under the newly organized Lanchjou branch of the Chinese Geophysical Institute.—*A. J. S.*

179–59. Kodama, R. Distribution of earthquake foci in and near Kinki and Chubu districts [in Japanese with English summary]: Quart. Jour. Seismology [Tokyo], v. 24, no. 2, p. 41–43, 1959.

The distribution of earthquake epicenters and the relationship between their occurrences were investigated for earthquakes in and near Kinki and Chubu districts for the period 1926 through 1956. The general distribution and the distribution of epicenters according to focal depth are shown on maps; a study of these shows that earthquakes do not occur quite at random.—*V. S. N.*

179–60. Miyamura, Setumi. Local earthquakes in Kii Peninsula, central Japan. Part 1. Reconnaissance observation of minor shocks at Gobo, Wakayama Prefecture [in Japanese with English summary]: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 347–358, 1959.

Local seismic activity in Wakayama Prefecture, Japan, was renewed in the latter half of 1949. Reconnaissance observations were carried out at Gobo in January and February 1952 by means of sensitive-electronic horizontal seismographs having natural frequencies of 3 and 10 cycles per sec. Owing to the high level of ground noise at the station, observations were made only during the middle of calm nights in order to keep the magnification as high as 50,000–80,000 at cycles per sec frequency.

A total of 82 shocks was recorded during the 46 hr of effective observation. Of these, 37 gave $S-P$ times; comparison with $S-P$ intervals of earthquakes felt at Wakayama and Sionomisake observatories shows that the seismic center lies north of Gobo, nearer to Wakayama City. Comparison of seismograms obtained with higher and lower frequency characteristics clearly indicates the differences in spectral nature of the P- and S-wave groups.—*D. B. V.*

179–61. Yoshimura, J. Seismicity in Kyushu district [in Japanese with English summary]: Quart. Jour. Seismology [Tokyo], v. 24, no. 2, p. 35–39, 1959.

Data accumulated since 1885 were used to study the seismicity of the Kyushu district of Japan. The most active areas were those showing a negative Bouguer anomaly: the Setouchi-Hyuganada area, the western part of Mount Aso in the Daisen volcanic belt, the inner earthquake zone, and the Kirishima volcanic zone. In general, the district was most active seismically from 1889 through 1912; the number and energy of earthquakes show a close relationship to solar activity.—*V. S. N.*

De Noyer, John. Crustal structure of the North Pacific from Love-wave dispersion. See Geophys. Abs. 179–264.

179–62. Hayes, R. C. Earthquakes in New Zealand during the year 1954: New Zealand Dept. Sci. Indus. Research Seismol. Observatory Bull., no. S–106, 5 p., 1959.

Ninety-four shocks were reported felt in New Zealand during 1954. Although overall seismic activity in the area was abnormally low for the year, it was greater than usual for South Island. All earthquakes whose epicenters were located are listed in a table giving origin time, epicenter position, instrumental magnitude, and maximum felt intensity. The epicenters are also plotted on a map, except for 29 which were outside the immediate boundaries of North and South Islands.—*V. S. N.*

Sytinskiy, A. D. Seismic observations at Mirnyy Observatory. See Geophys. Abs. 179–356.

179–63. Gorshkov, G. P., and Shenkareva, G. A. O korrelatsii seysmicheskikh shkal [The correlation of seismic scales]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 1(168), p. 44–64, 1958.

The history of compilation of various scales for the determination of the intensity of seismic waves is reviewed, and different scales are compared. The first attempt to construct a seismic scale dates from 1564, and some 50 scales have been suggested since then in different countries for the description and evaluation of the intensity of earthquakes. In studying seismicity of various regions, it is absolutely necessary to establish a correlation between different

scales. Such an attempt is made here. A table presents 44 scales with numerical coefficients that relate them to make their correlation possible.—*S. T. V.*

179–64. Glivenko, Ye. V. Opredeleniye izmeryayemoy velichiny po izbytochnym nablyudeniyam v zadachakh seysmologii [The determination of a measured value in seismic problems by excess observations]: Akad. Nauk SSSR Izv. ser. geofiz., no. 7, p. 981–987, 1959.

Glivenko discusses the method of determining the most probable value of an unknown quantity in the case of an excess number of observations. This method can be applied to seismic problems such as determination of the focus of an earthquake or of energy at the focus. The method is applied to the determination of the epicenter of an earthquake from the observations of many stations, and the result is compared with the result obtained by the method of medians. The accuracy of the first method was found to be higher. Glivenko also discusses the conditions under which this method can be used (see also Geophys. Abs. 178–62).—*S. T. V.*

179–65. Bisztricsány, E[de]. On the determination of earthquake magnitudes: Univ. Sci. Budapestinensis Eötvös, Annales sec. geol., v. 2, p. 39–51, 1958.

The paper consists of two parts. In the first part the magnitude equation for Budapest is derived for 229 shallow-focus shocks. This equation is good for epicentral distances of $10° < \Delta° < 180°$. The mean error of magnitude determination is 0.34 *M*. In the second part a new approach to magnitude determination is treated. According to this new method there is a linear relationship between the magnitude of the shock and the logarithm of its decay time. The mean error of magnitude determination using this relationship is 0.32 *M*. (See also Geophys. Abs. 175–46.)—*J. W. C.*

179–66. Matumoto, Tosimatu. On the spectral structure of earthquake waves—its influence on magnitude scale: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 265–277, 1959.

The relation between earthquake magnitude and the spectral characteristics of seismic waves are considered. It is found that the amplitude-distance curves do not parallel magnitude; therefore, Richter's assumption fits only a limited range of magnitude, and extrapolation can lead to distortion. It is found that the characteristics of the seismometer may also lead to distortion of the magnitude scale. The formula for magnitude-energy transformation may be altered for the magnitude ranges above and below 6, because of the assumption of $A-\Delta$ curves (A=maximum ground motion, Δ=epicentral distance) and because of the natural period of the standard torsion seismometer.—*D. B. V.*

179–67. Tsuboi, Chuji. A new formula connecting magnitude and number of earthquakes: Jour. Physics of Earth [Tokyo], v. 6, no. 2, p. 55–57, 1958.

A new formula $\log n = (1 - M/M_s) \log n_o$ relating magnitude (M) and number (n) of earthquakes is proposed, where n_o is the number of earthquakes having a magnitude O and M_s is magnitude of the largest conceivable earthquake. The formula represents observed facts very nicely. It involves only one constant, $\log n_o$, in contrast to Gutenberg and Richter's formula, $\log N = a + b(8 - M)$, which

involves two. The new formula implies that $n(M)=n_0^{f(M)}$ rather than $n(M)=n_0 \cdot \phi(M)$.—*D. B. V.*

179–68. Suzuki, Ziro. A statistical study on the occurrence of small earthquakes (fourth paper): Tohoku Univ. Sci. Repts., ser. 5, v. 11, no. 1, p. 10–54, 1959.

This is a continuation of the detailed study of the magnitude distribution of small earthquakes (see Geophys. Abs. 158–143, 163–106, 175–37). The magnitude distribution for small independent earthquakes, for small earthquakes in different seismic regions, and for microearthquakes is investigated and compared with that for larger earthquakes. It is concluded that the magnitude distribution found in the present study conforms to a very general principle irrespective of location and of magnitude. It is remarkable that all earthquakes are governed by a single magnitude distribution with a single value of this parameter.

Volcanic earthquakes are also examined. It is found that noneruptive shocks can be expressed by the same form with the numerical value of m being within the limit of error; but for earthquakes accompanying eruptions the numerical value of m is far larger, although the functional form of the distribution is similar.

The implications of earthquake magnitude distribution are considered from two points of view: generation of a crack, and emission of elastic energy accumulated in a volume fraction of a seismic region. It may be possible to decide which alternative is valid by considering magnitude distribution together with space and time distribution of earthquakes.—*D. B. V.*

179–69. Kurimoto, Hiroshi. A statistical study of some aftershock problems [in Japanese with English summary]: Zisin, ser. 2, v. 12, no. 1, p. 1–10, 1959.

The experimental results obtained by Utsu and by Bath concerning the magnitude of the largest shock in the aftershock sequence of an earthquake are checked by the theory of probability. Results show that the largest aftershock is 1–1.4 smaller in magnitude than the main shock.

An attempt is also made to explain the statistical fact that the percentage of earthquakes accompanied by aftershocks decreases as magnitudes become smaller. Percentages are calculated according to the extreme-value theory and good agreement is found between the calculated and actual percentages—*V. S. N.*

179–70. Nagamune, Tomeo. On the azimuthal deviation of earthquake magnitudes [in Japanese with English summary]: Zisin, ser. 2, v. 11, no. 4, p. 180–184, 1958.

The instrumental magnitude of any one earthquake often differs considerably at different stations. To investigate this discrepancy, seismograms of the earthquake occurring off Boso Peninsula, Japan, November 25, 1953, recorded at 29 stations in various azimuths were studied, and the energies of Rayleigh waves corresponding to the respective stations were computed. The relation between the energy of Rayleight waves and the azimuth is expressed by a formula. The maximum discrepancy in magnitudes resulting from difference in azimuth is about 0.7.—*V. S. N.*

179–71. Scheidegger, A[drian] E. Statistical analysis of recent fault-plane solutions of earthquakes: Seismol. Soc. America Bull., v. 49, no. 4, p. 337–347, 1959.

The large number of fault-plane solutions at present available in the literature permit one to calculate several statistical averages that have an important bearing upon geotectonics. The present paper represents a continuation of earlier work in this direction: 101 new fault-plane solutions are listed and the ratio of pressure to tension, strike slip to dip slip, and the average slip angle have been calculated for nine earthquake areas. Some of the older results are thereby corroborated, viz., that the "normal" character of earthquakes is to represent strike-slip faulting, and that the central Asian regions constitute an exception to this rule. In addition, it is now possible to make a breakdown with regard to depth.. In this, a peculiar situation is found at 0.03 R-depth, where the slip angle reaches a maximum. If the relationship between shallow and deep earthquakes be considered for any one area, however, it turns out that they are on the whole of the same character. Thus, whatever it is that causes earthquakes, acts in a similar fashion at all depths in any one area, but differs from one area to another.—*Author's abstract*

179–72. Schäffner, Hans-Joachim. Die Grundlagen und Auswerteverfahren zur seismischen Bestimmung von Erdbebenmechanismen [The principles and evaluation procedures for seismic determination of earthquake mechanisms]: Freiberger Forschungshefte C63 Geophysik, 183 p., 1959.

This review of the present state of methods of earthquake fault-plane solutions has two purposes: to show the effectiveness and limitations of the procedures and to apply these to rock-burst investigations. The introductory chapter gives a brief outline of the development of methods of determining focal mechanism. The second is devoted to theoretical principles. The third discusses fault-plane solutions from a regional point of view, showing the relation to tectonics and ending with a discussion of geotectonic hypotheses. The fourth chapter contains a short discussion of the application of fault-plane solutions in rockburst investigations; this should not only be of practical value to miners but also of great significance in tectonic research. A bibliography of 171 items is given, and a 40-page appendix tabulates all available fault-plane solutions.—*D. B. V.*

179–73. Keylis-Borok, V. [I.] On estimation of the displacement in an earthquake source and of source dimensions: Annali Geofisica, v. 12, no. 2, p. 205–214, 1959.

An ellipsoid of rotation—a round fault plane surrounded by a crush zone—is taken as a model of an earthquake focus. The fault plane area S and displacement V along it can be estimated from the formulas $E=\frac{p^2}{\mu} S^{3/2} R_s$ and $V=\frac{p}{\mu}\sqrt{S}\,L_s$, where energy E is known, μ is shear modulus, R_s and L_s are coefficients whose values are given in a graph, and p=mean stress before the earthquake. Comparison of these formulas with the fact that the frequency of occurrence of earthquakes is proportional to $E^{0.5}$–$E^{0.6}$ shows that numerous weak earthquakes may play a considerable part in the formation of large faults and movement along them, although their total role in energy release is negligible.—*D. B. V.*

179–74. Jobert, G[eorges]. Étude du mouvement du sol au voisinage d'une faille [Study of the ground movement in the vicinity of a fault (with English and Esperanto summaries)]: Geofisica Pura e Appl., v. 43, p. 75–82, 1959.

The schemer of an earthquake shock caused by slipping on a transcurrent fault is examined mathematically and the law of variation of surface displacement as a function of distance from the fault is given, assuming that no extra stress is produced at the base of the broken layer. Taking a simple example of preearthquake strain, the order of magnitude of the extent of the fault in depth can be obtained. For the San Francisco earthquake of 1906 this is calculated as about 13 km.—*D. B. V.*

179–75. Kasahara, Keichi. Physical conditions of earthquake faults II, (A model of strike-slip faults with various dip angles): Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 39–51, 1959.

A strike-slip fault model is presented that is based on the assumptions made in a previous paper (see Geophys. Abs. 176–56; also 172–41 and 174–47) but with no assumption as to dip angle. The problem is reduced to the Laplace equation and solved by the relaxation method and also by model experiments based on the electric-elastic analogy.

It is shown that the deformation pattern is no more symmetrical with respect to the fault than in the previous model, but the deformation on the down-dip side of the fault appears systematically larger than that on the other side. The more the dip angle departs from 90°, the greater the asymmetry.—*D. B. V.*

179–76. Enescu, D[umitru]. Contribuţii la problema mecanismului şi energiei surselor seismice combinate [A contribution to the problem of the mechanism and energy of compound seismic sources (with Russian abstract)]: Acad. Romîne Studii şi cercetări de astronomie şi seismologie, v. 4, no. 1, p. 220–229, 1959.

Using the general equation of displacement of the focus, Enescu derives partial equations for a seismic source consisting of a double dipole, one component of which has angular momentum and the other has not. The nodal planes for this type of compound seismic source are investigated, and their possible distributions on a Wulff net are indicated. In the second part of this paper Enescu presents Claypeyron's equation for the case of a source of this type and derives an equation for the flux and density of energy. A calculation of the density of the energy for different azimuths for a double force without angular momentum combined with an ordinary force is presented graphically by isolines.—*Author's abstract, A. J. S.*

179–77. Galanopoulos, A. G. Macroseismic evidence for the fault plane: Annali Geofisica, v. 12, no. 2, p. 189–196, 1959.

The minimum radius of the felt area of an earthquake should coincide with the direction of the fault plane, because the amplitudes of longitudinal and transverse waves are zero in all directions in the fault plane (see Geophys. Abs. 170–74). The asymmetrical distribution from the focus is strong enough not to be masked by the effect of inhomogeneity of the medium, especially of the upper layers, on the isoseismal pattern. Therefore the minimum radius of the macroseismic area can be used in fault-plane solutions in cases where other evidence, such as initial motion of transverse waves, is not sufficient to

determine which of the two nodal planes for longitudinal waves was the true fault plane. The macroseismic evidence presumably fails in the case of dipslip motion, but should be striking in the case of transcurrent motion.—*D. B. V.*

179–78. Scheidegger, A[drian] E. Note on the tectonics of Kern County, California as evidenced by the 1952 earthquakes: Jour. Geophys. Research, v. 64, no. 10, p. 1499–1501, 1959.

A statistical analysis has been made of the mechanisms of the aftershocks of the Kern County, Calif., earthquake of July 21, 1952. A method the writer developed earlier shows the direction of tectonic motion to be at N. 32° W., approximately normal to the strike of the White Wolf fault. This is in agreement with Gutenberg's fault-plane solution for the main Kern County earthquake which yielded an overthrust in a northwesterly direction. It therefore appears that the Kern County earthquake and its aftershocks were caused by the same tectonic effects.—*Author's abstract*

179–79. Veldkamp, J. Some Sumatra earthquakes: Annali Geofisica, v. 12, no. 2, p. 249–255, 1959.

Fault-plane mechanisms of a number of shallow earthquakes near the island of Sumatra, Indonesia, have been investigated, using initial motions of *P*-and *S*-waves. In general the strikes of the fault planes are either perpendicular or parallel to the seismic belt, and the dips are mostly large. Displacements are generally perpendicular to the seismic zone; transcurrent movements predominate.—*D. B. V.*

179–80. Scheidegger, A[drian] E. Seismic evidence for the tectonics of central and western Asia: Seismol. Soc. America Bull., v. 49, no. 4, p. 369–378, 1959.

A statistical analysis of the null axes of the fault-plane solutions of earthquakes in any one area permits determination of the average tectonic motion direction of that area. In the present paper this method has been applied to areas in central and western Asia for which several hundred fault-plane solutions are readily available in the literature. The investigation yields the result that (seismically) calculated tectonic-motion directions in a series of small areas that are part of a larger unit are consistent with each other and that there is in every case an excellent correlation with the tectonic motion of the area as postulated from geological studies. This appears to justify completely the seismic method.

The seismically determined tectonic motion in central Asia appears to be mainly in a north-south direction. The motion refers to the present time (since the earthquakes occur at the present time), but it is the same as that postulated in geology for an explanation of the folding of the central Asian mountain ranges. This demonstrates that the stress system which created the central Asian mountains is active at the present time.—*Author's abstract*

179–81. Brune, James N., and Oliver, Jack. The seismic noise of the earth's surface: Seismol. Soc. America Bull., v. 49, no. 4, p. 349–353, 1959.

Maximum, average, and minimum values of surface-particle displacement, velocity, and acceleration of earth noise as a function of period are illustrated in graphical form. For periods less than about 5 sec the amplitude curves rise rapidly with increasing period. The most prominent feature of the illustration

is the sharp peak in the 5- to 8-sec period range. There are virtually no data on noise in the range of periods between 20 sec and the earth-tide periods. With the exception of the 10- to 40-sec period range, the data used are taken from the existing literature.—*Authors' abstract*

179–82. Terashima, Tsutomu. A study of the relation between predominant period and maximum amplitude of earthquake-motions by means of a magnetic tape recorder [in Japanese with English summary]: Zisin, ser. 2, v. 11, no. 3, p. 145–150, 1958.

An analysis was made of earthquake waves recorded by a velocity seismometer equipped with a magnetic tape recorder operated intermittently at Mount Tsukuba from November 30 to December 9, 1957. Since the tape records were reproducible, various characteristics of the seismic waves other than velocity could be investigated by means of an electric-circuit device. The relationship between predominant periods and maximum trace amplitudes was studied, and acceleration seismograms and the frequency distributions of maximum acceleration and maximum velocity amplitudes were compared and expressed mathematically.—*V. S. N.*

179–83. Kanai, Kiyoshi, Tanaka, Teiji, and Yoshizawa, Shizuyo. Comparative studies of earthquake motions on the ground and underground. (Multiple reflection problem): Tokoyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 53–87, 1959.

A spectral analysis has been made of seismograms of earthquake motions obtained at the surface and underground at Hitachi mine and Tokai village, Ibaraki Prefecture, Japan. Comparison of observational with theoretical results shows that the amplitude at the surface grows very large depending on the multiple reflection of seismic waves in the superficial layer.—*D. B. V.*

179–84. Miyamura, Setumi, and Tsujiura, Masaru. Direction of approach and apparent velocity of near earthquake initial motion [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 359–374, 1959.

Direction of approach and apparent velocities of initial motions of more than 50 near earthquakes were determined by tripartite observations at Mount Tukuba, Japan. The stations were spaced several hundred meters apart; instrumentation included two UHF 3-channel radio telerecording seismographs (RTS–2) and a double-track commercial magnetic tape recorder with endless reel.

Azimuthal distribution of epicenters around Tukuba agrees fairly well with the geographic distribution of epicenters in the Kwanto district and suggests that the seismic regime of the region is stationary in time. The relation of apparent velocity obtained from a near earthquake and its S—P time (taken as a substitute for epicentral distance) is clearly consistent with the crustal layering deduced from explosion seismology. Accuracy in determination of direction of approach and apparent velocity is discussed.—*D. B. V.*

179–85. Iida, Kumizi, and Aoki, Harumi. Phases in the preliminary tremors of seismograms and crustal structure in Nagoya District [in Japanese with English summary]: Zisin, ser. 2, v. 12, no. 2, p. 75–81, 1959.

Seismograms of the aftershocks following the Mikawa, Japan, earthquake of 1945 are used to investigate some phases of the preliminary tremors recorded

at Nagoya and Gifu. Two distinct phases, P_1 and P_2 are recognized in the Nagoya seismograms. The first phase is independent of the duration of the preliminary tremors (τ), whereas the second phase is related to it. The times from commencement of phase P to P_1 and P_2 are: P_1=0.46 sec and P_2=0.53 τ+1.417 sec. Only one distinct phase is recognized in the Gifu seismograms and the time from P to this phase (P_2=1.48 sec) is independent of the duration of preliminary tremors. Using these data, the upper central structure in the Nagoya district is discussed.—*V. S. N.*

179–86. Ritsema, A. R. Note on the azimuth deviations of *P*-waves recorded at Djakarta station: Geofisica Pura e Appl., v. 43, p. 159–166, 1959.

Differences between epicentral azimuths and directions of arrival of first *P*-waves are determined from horizontal seismograms at the Djakarta station in Indonesia. Systematic deviations of more than 15° are encountered in the northwest through north to southeast azimuths. Azimuth deviations caused by discontinuities dipping 5°, 10°, and 15° and with ratios of longitudinal wave velocities on either side of the discontinuity of 1.23, 1.38, and 1.52 are calculated. The model that best fits the observed data is that of a discontinuity with a velocity ratio of about 1.5, dipping 8–10° in a N. 10° E. direction. No dipping discontinuity in the south and west directions for Djakarta is necessary to account for the few observed data in these quadrants.—*D. B. V.*

179–87. Vaněk, J[iri]. Die Amplituden von *PP*- und *SS*-Wellen in der Nähe von 40° und die Struktur des äusseren Erdmantels [The amplitudes of *PP*- and *SS*-waves in the vicinity of 40° and the structure of the outer mantle of the earth]: Annali Geofisica, v. 12, no. 2, p. 239–247, 1959.

The amplitude variation of *PPH*-, *PPV*-, and *SSH*-waves at epicentral distances between 25° and 52° was studied on the basis of seismological records from Jena and Prague. A distinct minimum at distance Δ_{min} and a distinct maximum at distance Δ_2 were found for both *PP*- and *SS*-waves. Results are tabulated, together with those of Ruprechtova for *PH*- and *SH*-waves (see Geophys. Abs. 176–58).

The observed asymmetry in Δ_2 for *PP* and *SS* can be explained by regional variations in the structure of the upper mantle.—*D. B. V.*

179–88. Bolt, B. A. Travel-times of PKP up to 145°: Royal Astron. Soc. Geophys. Jour., v. 2, no. 3, p. 190–198, 1959.

Examination of some 900 *PKP* readings in the range $110° < \Delta° < 145°$, as recorded in the International Seismological Summary for 24 southern earthquakes, provides new evidence that the Jeffreys-Bullen times for the *DE*-branch before 140° need an increase of about 1 sec. In this range there is no evidence of significant differences between *PKP* times to Europe and North America. In the range $135° < \Delta° < 145°$ a concentration of *PKP* observations preceding the *DE*-branch is found that fits the form t=19 min 29.1 sec+2.69 (Δ—141.6°); this possibly corresponds to the *BC*-branch of *PKP* and its extension for the diffracted waves associated with the caustic at *B*.—*D. B. V.*

179–89. Gutenberg, B[eno]. Earthquake waves reflected at the inside of the core boundary: Jour. Geophys. Research, v. 64, no. 10, p. 1503–1508, 1959.

Travel times of waves generated by an earthquake at a depth of 600 km and reflected from the inside of the core boundary as well as the epicentral distances

of the caustics of *PKKP*, *SKKP*, and *PKKS* agree within the limits of error with those calculated on the basis of velocity-depth curves. This applies also to the travel times of *SKKS* and *SKKKS* for which poor agreement was reported before the inner core was established. The periods of all waves traveling through the outer core seem to be shortened. In the outer core the attentuation is possibly smaller than in the mantle.—*Author's abstract*

179–90. Aki, Keiiti, and Tsujiura, Masaru. Correlational study of near earthquake waves: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 207–232, 1959.

This is the second report on this study. The first part gave the results of tripartite investigations at Kamakura, Japan, with a small net having an average span of 100 m set up on relatively soft sandstone (see Geophys. Abs. 175–56). In the present study the spacing was increased to 500 m and the net was set up on exposed granitic rocks near Mount Tukuba.

Despite differences in geology, the results agreed in most respects. It was found that a plane wave coming from the general direction of the origin of the earthquake has an average power comparable to irregular noises in the wave portion for the first few seconds after the initial motion. The fraction of the average power carried by the plane wave is greatest in the initial wave portion; it then decreases, becomes slightly larger on the arrival of the *S*-wave, and is very small after the *S*-wave.

The low-velocity plane waves (several hundred m per sec) recorded at Kamakura were not observed at Mount Tukuba; this may be due to the difference in geology.—*D. B. V.*

179–91. Sato, Ryosuke. On the determination of crustal structure by the dispersion curves of surface waves (II) [in Japanese with English summary]: Zisin, ser. 2, v. 11, no. 3, p. 121–134, 1958.

Sato assumes a simplified dispersion curve similar to a rigorous one for some seismic surface waves and investigates the method of analyzing observed results that will give the best agreement with the true dispersion curve of surface waves in the crust under consideration. It was found that at a certain epicentral distance the duration of oscillations of seismic waves is independent of the thickness of the layer; the greater the thickness, however, the longer the periods of the waves. If thickness is constant, the duration becomes longer as the epicentral distance increases. Where distance and thickness are the same, the periods of the waves decrease as the velocity or rigidity ratio of the lower and upper mediums increases. Formulas are presented for the relationship between group velocity and period and between phase velocity and period. (For part 1 see Geophys. Abs. 175–62).—*V. S. N.*

179–92. Shlanger (Ben-Menahem), Ari. Free non-radial vibrations of the earth: Geofisica Pura e Appl., v. 43, p. 23–35, 1959.

Earthquake shear waves with periods of about 12.2 minutes have been reported by Båth (see Geophys. Abs. 177–69), who suggests that these might be due to torsional vibrations of the whole mantle on some axis through the center of the earth. An attempt is made here to explain such vibrations theoretically. The general elastokinetic equation for a heterogeneous isotropic medium is solved for a free spherical shell overlying a liquid core, and the solution is investigated for the first two modes. The frequency equation is solved for a shell and for

the limiting cases of a full sphere and an infinitely thin shell. Application to various mantle models shows fair agreement of theoretical with observed periods. Closer agreement might be obtained if rigidity of the core is taken into account.—*D. B. V.*

179–93. Oliver, Jack, Dorman, James, and Sutton, George H. The second shear mode of continental Rayleigh waves: Seismol. Soc. America Bull., v. 49, no. 4, p. 379–389, 1959.

Waves of the Rayleigh type corresponding to the fundamental and first shear modes for the continental crust-mantle system have been identified on seismograms previously. In this paper, waves corresponding to the second shear mode are identified for two paths, one from the Belgian Congo to Pietermaritzburg, South Africa; the other from Oklahoma to Palisades, N.Y. Comparison of the dispersion of these waves with theoretical dispersion for several crust-mantle models demonstrates the increase in resolving power of this method of obtaining crustal structure when data for several modes are available. There are small but measurable differences in the velocity structures averaged along these two paths.—*Authors' abstract*

Takeuchi, H[itoshi], Press, F[rank], and Kobayashi, N[atoa]. Rayleigh wave evidence for the low-velocity zone in the mantle. See Geophys. Abs. 179–254.

Takeuchi, H[itoshi]. A comment on the flattening of the group velocity curve of mantle Rayleigh waves with periods about 500 sec. See Geophys. Abs. 179–253.

179–94. Sikhuradze, D. I. Izucheniye dispersii voln Lyava pri blizkikh zemletryaseniyakh [The study of the dispersion of Love waves in near earthquakes]: Akad. Nauk SSSR Izv. ser. geofiz., no. 4, p. 593–597, 1959.

Surface waves, especially Love waves, produced by earthquakes in the Dzhavakhet Highlands (Caucasus) have been studied in the records of 15 earthquakes obtained at the seismic stations at Tbilisi and Yerevan.

Epicentral distances were 125–150 km at Yerevan and 85–104 km at Tbilisi; the $S-P$ intervals were 15–19 sec at Yerevan and 11–13 sec at Tbilisi. Foci were determined on the basis of some 10–15 other stations in addition to Tbilisi and Yerevan. The thickness of the sedimentary section is calculated to be 4 km at Tbilisi and 5 km at Yerevan. The group velocity of the Love waves was found to vary with the frequency from 2.6 to 3.0 kmps; periods ranged from 4 to 10 sec.—*S. T. V.*

179–95. Milne, Allen R. Comparison of spectra of an earthquake *T*-phase with similar signals from nuclear explosions: Seismol. Soc. America Bull., v. 49, no. 4, p. 317–329, 1959.

Hydrophones from a surface vessel in 1,300 fathoms of water off Juan de Fuca Strait detected, in the course of the "Hardtack" series of tests in the Marshall Islands, three acoustic signals which had peaks in their energy spectra at frequencies less than 20 cycles per sec. Two of these appear to have originated from nuclear explosions; the third, though having a similar energy spectrum, was apparently a *T*-phase from an earthquake near Cape Mendocino with its epicenter at 40°16′ N., 124°12′ W., and an origin time of $23^h04^m46^s$ on May 24, 1958.

Travel-time measurements and signal spectra indicate that the nuclear explosions originated within Eniwetok Atoll. The coupling of their signals to the water path apparently was similar in nature to that of the earthquake *T*-phase, but the duration of the signals from the nuclear explosions was considerably less.—*Author's abstract*

179–96. Tomaschek, R[udolf]. Great earthquakes and the astronomical position of Uranus: Nature, v. 184 no. 4861, supp. 4, p. 177–178, 1959.

Statistical study (based on Gutenberg and Richter's data) of the effect of the astronomical positions of the planets on earthquakes shows a remarkable correlation between the positions of Uranus and the moment of great earthquakes for a certain period. In the 134 earthquakes investigated, a fairly significant number of cases were found where Uranus was very near its upper or lower transit of the meridian of the epicenter at the time of great earthquakes; this occurred especially in 1904 (when the compilation of data started) and also in 1905 and 1906. These years correspond to a conspicuous maximum of energy release. The correlation cannot be explained by a tidal effect; it therefore may not be a relationship of cause and effect in the usual mechanical sense.—*D. B. V.*

Szemerédy, P. On the magnetoelastic property of the earth's crust. See Geophys. Abs. 179–311.

179–97. Robel, Franz. Die Erdbebenstation Bensberg bei Köln [The Bensberg seismic station near Cologne]: Zeitschr. Geophysik v. 25, no. 1, p. 16-32, 1959.

The location, physical plant, and instrumentation of the Bensberg seismic station, established in 1955 near Cologne, Germany, are described briefly. The station is equipped with a horizontal Wiechert-type seismograph with mechanical recording for N-S and E-W components, and a uniform set of electroinductive seismographs with galvanometric-optical recording for N-S, E-W, and vertical components. These are illustrated in photographs and schematic diagrams, and their calibration discussed. Several earthquake seismograms are reproduced.—*D. B. V.*

179–98. Lehner, Francis E. An ultra-long-period seismograph galvanometer: Seismol. Soc. America Bull., v. 49, no. 4, p. 399–401, 1959.

A brief description is given of a galvanometer of longer than ordinary period (480 sec). The instrument is basically a scaled-up version of Lehner's 90-sec galvanometer currently in use in many long-period seismograph installations. Mention is made of some of the details, precautions, and techniques pertaining to its construction, testing, and operation. The discussions are applicable to galvanometers of extended period in general.—*D. B. V.*

179–99. Båth, Markus. Development of instrumental seismology in Sweden in 1949–1958; Geofisica Pura e Appl., v. 43, p. 108–130, 1959.

The present seismological stations in Sweden (Uppsala, Kiruna, Skalstugan, Göteborg) and older stations no longer operating (Vassijaure, Abisko, Lund) are reviewed; all pertinent information is given, including location, nature of ground, physical plant and instrumentation, methods of time measurement, elimination of disturbances, and determination of ground amplitude. Typical magnification curves are given. Ground amplitudes are compared from simul-

taneous records of Benioff E and N and Wiechert E and N, and of Benioff Z^1 and Grenet Z^1 instruments. The comparison between Benioff and Wiechert instruments gives a new estimate of the effect of friction (particularly of the recording pen against the paper) in the latter.—*D. B. V.*

179–100. Droste, Zofiya [Zofia], Gibovich, Slavomir [Gibowicz, Sławomir], and Gordeyuk, Yusef [Hordejuk, Józef]. Analiz pervykh smeshcheniy seysmicheskoy volny na seysmogrammakh [Analysis of first motions of seismic waves on seismograms (with English translation)]: Acta Geophys. Polonica, v. 7, no. 2, p. 136–164, 1959.

The distortions of periods and first amplitudes caused by different types of seismographs (mechanical and galvanometric recording) are calculated, on the assumption that the ground vibrations are sinusoidal.—*D. B. V.*

179–101. Prosvirnin, V. M., and Rykunov, L. N. O kharaktere svobodnykh kolebaniy p'yezodatchikov, ispol'zuyemykh pri modelirovanii seysmicheskikh yavleniy [On the mode of the free vibrations of piezoelectric emitters used in the modeling of seismic phenomena]: Akad. Nauk SSSR Izv. ser. geofiz., no. 5, p. 752–755, 1959.

In modeling the sources of elastic waves occurring in nature, it is necessary to produce both short impulses, imitating earthquake shocks, and relatively long trains of almost sinusoidal vibrations, imitating microseisms. Prosvirnin and Rykunov have experimented with a packet of 10 sheets of Seignette's salt cut at 45°, excited by rectangular electric impulses of a duration which could be varied from 2×10^{-6} sec to 40×10^{-6} sec, and having a frequency of 50 cycles per sec. Use of two diode vacuum tubes made it possible to send into the tested packet only impulses of negative sign. By varying the frequency of the impulses and observing on an oscillograph the deformations and the electric effect (due to the piezoelectricity) produced, it was possible to determine the natural frequency of oscillations, when the effect reached its maximum. To reduce the oscillations to only one mode, it was necessary to prevent the generation of other modes by clamping the packet along the corresponding edge.

Using this procedure Prosvirnin and Rykunov succeeded in determining the frequency of natural vibrations of the tested packet. Three possible modes were calculated: $f_1=68\times10^3$, and $f_2=88\times10^3$, and $f_3=103\times10^3$ cycles per sec. The third, f_3, is of impulse character and would be excited only under initial conditions not fulfilled in the model. The character of the vibrations corresponding to the frequencies f_1 and f_2 is illustrated. Knowledge of natural vibrations of various modes often can be of great importance in application of piezoelectric arrangements.—*S. T. V.*

179–102. Hordejuk, J[ózef], Uchman, J.[an], Wojtczak, B. A new type of short-period seismograph SK–58: Acta Geophys. Polonica, v. 7, no. 2, p. 165–175, 1959.

The new short-period seismograph SK–58 comprises 1 vertical and 2 horizontal components, galvanometers, and optical recording apparatus. The seismograph period can be adjusted within the range 1–3.5 sec for the horizontal seismographs and from 1–1.5 or 1.7 to 3.5 sec (depending on thickness of springs) for the vertical. The description of the various parts of the installation is accompanied by photographs, schematic diagrams, graphs of different characteristics, and reproductions of seismograms.—*D. B. V.*

179–103. Hagihara, Yukio. A rotation seismometer [in Japanese with English summary]: Zisin, ser. 2, v. 11, no. 3, p. 141–144, 1958.

Two reliable rotation seismometers were successfully constructed for the observation of rotational movements of the ground around the vertical axis. The sensitivity of the seismometers is such that a rotation of 0.1 sec. produces a deflection of 1 cm on the recording paper.—*V. S. N.*

179–104. Matumoto, Hideteru. Simple electronic seismographs supplied only with commercial A.C. source [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 375–380, 1959.

Two types of simple electronic seismographs designed for study of local earthquakes are described. One, HFSA (M–1), is for observation of extremely near shocks ($\Delta <$ about 20 km); the others, MFSA (M–2), is for ordinary near shocks. The circuits and characteristics of each are presented. These instruments have been in use since 1955 at a few stations on the Kii Peninsula, Japan. They have been operated continuously without trouble by high school pupils or power station staff; therefore, it is concluded that such seismographs, with several stages of valve circuit fed by commercial a-c current only, are usable for routine operation. Examples of seismograms of small earthquakes that can be recorded only by highly sensitive seismographs are reproduced.—*D. B. V.*

179–105. Matumoto, Hideteru. Logarithmic wide amplitude range electronic seismograph [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 381–388, 1959.

A logarithmic wide-amplitude-range seismograph is described. The amplitude range was extended by using a suppression character in the amplifier circuit. In order to get logarithmic suppression, potentiometers composed of a resistor and a network with 4 rectifier elements were put in the amplifier circuit at 3 stages. An equalizing device introduced between transducer and amplifier increased the accuracy. A satisfactory velocity-frequency characteristic was thus obtained, and verified by experimental observations at Tukuba, Japan, using the logarithmic and ordinary seismographs. Schematic diagrams, several graphs of frequency characteristics, and examples of seismographs are given.—*D. B. V.*

179–106. Tsujiura, Masaru, and Miyamura, Setumi. UHF multi-channel radio tele-recording seismograph. Part II [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 193–206, 1959.

Results of tests of the ultra-high frequency multichannel radiotelerecording seismograph RTS–2 (described in detail in the first part—see Geophys. Abs. 172–45) are outlined. Characteristics of the component parts and overall characteristics are given with schematic diagrams and graphs (all figures have English captions. The results are tabulated in English for experiments on simultaneous separate receiving of two radio waves of identical frequency and perpendicular or parallel polarization from two transmitters of different azimuths by means of the directional character of aerials.—*D. B. V.*

179–107. Matuzawa, Takeo. Movements of a galvanometer directly coupled to an electromagnetic seismographic pendulum [in Japanese with English summary]: Zisin, ser. 2, v. 11, no. 4, p. 185–191, 1958.

The free vibration of the coupled system is discussed, and it is mathematically proved that the vibration is always damped. The necessary conditions for

the extreme case of undamped harmonic vibrations are that the coupling factor $\sigma^2=1$ and that the natural period of the pendulum equal that of the galvanometer. The solution is presented for the case where the galvanometer and pendulum respectively are critically damped, and movements of a galvanometer in the early stage of forced vibration are given. An example is discussed, and an illustration is presented that shows an incident wave, the free vibration, forced vibration, and finally the movements of the galvanometer.—*V. S. N.*

179–108. Belotelov, V. L., Veshnyakov, N. V., and Zhilyayev, I. I. Seysmicheskiy energometr [A seismic energometer]: Akad. Nauk SSSR Izv. ser. geofiz., no. 4, p. 611–616, 1959.

A new type of instrument developed by Belotelov and his associates for the purpose of measuring earthquake energy is described. It consists of three independent elements: a velocimeter, a functional converter, and an integrator. The velocimeter has 1 vertical and 2 horizontal seismographs. The seismographs are strongly damped. Their coefficient of damping D must satisfy the conditions $D \geqq \frac{1}{\sqrt{8\delta}} \left(\sqrt{\frac{T_{p\,max}}{T_{p\,min}}} - \sqrt{\frac{T_{p\,min}}{T_{p\,max}}} \right)$; here $T_{p\,min}$ is the shortest period and $T_{p\,max}$ is the greatest period of the seismic waves, and δ is the admissible error. An example illustrating the operation of the energometer is given, and the results are compared with similar calculations for a seismogram.—*S. T. V.*

ELASTICITY

179–109. Stilke, G. On elastic surface waves at a cylindrical hole in an infinite solid: Geophys. Prosp., v. 7, no. 3, p. 273–286, 1959.

Solutions for the propagation of elastic waves at the surface of a cylindrical hole of infinite length are derived from the wave equation for a perfectly elastic and isotropic medium. It is found that the phase and group velocities depend on the ratio between the wave length and the circumference of the cylindrical hole. These surface waves can be classified into different orders. They differ in the calculated dispersion curves, in the range of possible wave lengths (cut-off-frequencies), and in the amplitude proportion of the components of the displacement vector. For very short wave lengths these waves converge to normal Rayleigh waves.

These results are used to explain some of the multiple onsets and disturbances on seismograms, obtained in practical seismic investigations in the mines of Siegerland. The conformity of theoretical and practical results is limited, because the idealised suppositions on which the computation is based, such as perfect elasticity, homogeneous and isotropic medium, and circular cross section of the mine gallery are met only approximately in practice.—*Author's abstract*

179–110. Kobayashi, Naota. Wave generation from a line source within the ground [in Japanese with English summary]: Zisin, ser. 2, v. 12, no. 2, p. 49–60, 1959.

As a continuation of two earlier papers (see Geophys. Abs. 170–75, 173–126), a study of wave generation from a distortional line source within the ground

is presented. Calculation of wave displacements for a distortional origin of step-function type in time showed that, in contrast to surface displacements, no displacement corresponding to the Rayleigh wave appears at deep points in the ground; three distinct pulses corresponding to the direct S, reflected S, and reflected P do appear.

Wave profiles at the surface are also calculated for an impulse origin. The mechanism of generation of Rayleigh waves for a distortional origin is like that for a dilatational origin.—*V. S. N.*

179–111. Gassman, Fritz. Elastische Multipolwellen in einem Medium, das aus homogenen, isotropen, planparallelen Schichten besteht [Elastic multiplet waves in a medium consisting of homogenous isotropic plane parallel layers (with English summary)]: Geofisicia Pura e Appl., v. 43, p. 83–107, 1959; reprinted in Zürich Inst. Geophysik Mitt., no. 36, 27 p., 1959.

By means of Laplace transformation, "exponential coefficients" and "transmission factors" are calculated according to Cagniard's method (see Geophys. Abs. 102–5700) for the case of an infinite elastic solid consisting of homogenous isotropic layers separated by plane parallel boundaries, when a point in the interior of one layer is a multiple source of elastic waves, beginning at time $t=0$. By means of the "transmission factors" the elastic displacements of the waves reflected and refracted at the boundaries can be determined.—*D. B. V.*

179–112. Das Gupta, Sushil Chandra. On coda waves of earthquakes: Geofisica Pura e Appl., v. 43, p. 45–74, 1959.

Coda waves, the tail portion of an earthquake record, have been observed and analyzed by several workers. Omote (see Geophys. Abs. 159–129) showed that coda waves contain three periods T_1, T_2, and T_3; T_1 increases with epicentral distance, but T_2 and T_3 are constant for all earthquakes from different epicentral distances. Das Gupta attempts here to explain the T_2 and T_3 periods mathematically in terms of passage of cracks at the focal region.

It is concluded that coda waves may originate due to flow at the source; that the rate of fracture due to compression bears a definite ratio to velocity of flow of compressional or distortional sources; and that the Rayleigh type of wave will be prominent but its velocity will be small.—*D. B. V.*

170–113. Tazime, Kyozi. Transition from solid to liquid superficial waves in a plate: Jour. Physics of Earth [Tokyo]), v. 6, no. 2, p. 91–99, 1958.

Even if Poisson's ratio reaches 0.5, first order $M^{(1)}$ or $M^{(2)}$ waves cannot coincide with the first order of superficial liquid waves in a plate. Each branch of dispersive Rayleigh waves should correspond respectively to $\sin \alpha H=0$ or $\sin \beta H=0$ (α and β are displacement potentials, H is thickness of the plate). The former is none other than the dispersion curve of liquid waves, but in the latter, amplitude must be zero. The first order of dispersive Rayleigh waves does not always correspond to the first order of $\sin \alpha H=0$.—*D. B. V.*

179–114. Liu, D. T. Wave propagation in a liquid layer: Geophysics, v. 24, no. 4, p. 658–666, 1959.

The oscillatory phenomenon observed in seismic records in many areas in offshore surveying has been ascribed by Burg and others (see Geophys. Abs. 147–13221), in a wave-theory treatment, to guided energy traveling in the water

layer. Liu has obtained a solution of the pressure-wave equation for a point source in the water layer that allows examination not only of the frequency dependence on depth, but also of the transient amplitude response with depth and time. It is concluded that in most actual situations the phenomenon cannot be wholly explained by the assumed mechanisms because the theory indicates too rapid a decay of the energy.—*D. B. V.*

179–115. Knopoff, L[eon]. The seismic pulse in materials possessing solid friction, II: Lamb's problem: Seismol. Soc. America Bull., v. 49, no. 4, p. 403–413, 1959.

The study of the propagation of seismic waves through a medium having attenuation factors varying as the first power of the frequency has been extended to the geometry used by Lamb for the perfectly elastic case. The results show three pulse groups corresponding to *P*-, *S*-, and *R*-events. For high *Q*, all three pulses are very sharp; these pulses broaden at rates proportional to the product of the distance and $1/Q$. For symmetric pulse input and high *Q*, the *R*-pulse is noticeably asymmetric, the *P*-pulse only weakly so.—*Author's abstract*

179–116. Szendrei, M. E. An experimental investigation of the propagation of a sonic pulse along the surface of a semi-infinite medium: Geofisica Pura e Appl., v. 43, p. 36–44, 1959.

The waveform of a sonic pulse along the surface of a semi-infinite medium is investigated for short distances from the source. The velocities of the various modes are compared and used to deduce the elastic constants of the medium. The breadth of the Rayleigh wavelets is used to verify the wavelet theory and deduce the law of absorption of the medium. Direct attenuation measurements are somewhat scattered and do not agree exactly with wavelet breadth results.—*Author's summary*

179–117. Horton, C. W. A loss mechanism for the Pierre shale: Geophysics, v. 24, no. 4, p. 667–680, 1959.

A theoretical study is made of a fairly simple model of an elastic solid in which losses are attributed to both the shear modulus and the bulk modulus. Each of these elastic parameters is represented by a circuit containing 2 springs and 1 dashpot. This is a modification of the usual Kelvin solid that has finite stiffness at infinite frequency. The four relaxation times introduced in the model are determined to fit the experimental data presented by McDonal and others (1958) [see Geophys. Abs. 174–337]. It is shown that one can obtain a very good representation of their experimental data with the model described above. The wave equation for an elastic solid is given in an canonical form so that one can compare easily the behavoir of different models of the elastic parameters.—*Author's abstract*

179–118. Rocard, Yves. Sur l'absorption des ondes séismiques longitudinales [On the absorption of longitudinal seismic waves]: Acad. Sci [Paris] Comptes Rendus, v. 249, no. 13, p. 1130–1132, 1959.

The coefficient of absorption (α) of *P*-waves at mean depths in the earth has been calculated on the basis of French records of an impact 3.5 km distant, a nuclear explosion in Nevada (8,550 km), and the Lake Nègre explosions (781 km). A rather consistent picture of absorption coefficients is obtained if

a=1/1,200 km in the mantle and a=1/840 km at about 25–30 km depth, at 1 pulse per sec, assuming that a is proportional to frequency in the spectrum of the seismic waves.—*D. B. V.*

179–119. Parkhomenko, I. S. Ob intensivnosti volny proshedshey cherez seriyu sloyev s povyshennoy skorost'yu [The intensity of a wave that traverses a series of layers with higher velocity]: Akad. Nauk SSSR Izv. ser. geofiz., no. 5, p. 676–683 (part 1) and no. 6, p. 827–835 (part 2), 1959.

In the first part, results are presented of a study of the intensity of head waves traversing a series of higher velocity layers spaced widely enough apart that there is no interference from multiple reflections between these layers. The investigations was made on models consisting of solid and liquid elements, using an ultrasonic-impulse seismoscope. The results show that the amplitude of the waves traversing such a series of layers (A_N) may be either greater or less than the amplitude of waves traversing a single layer having a thickness equal to the sum of the individual layers in the series (A_0). The ratio of the thickness of an individual layer in the series to wavelength in that layer (d_2/λ_2) is a determining factor. When the wave traverses a very thin layer ($d_2/\lambda_2<0.02$ —0.14), $A_N>A_0$; with increasing thickness of layers the ratio A_N/A_0 decreases and A_N becomes smaller than A_0. The effect becomes more marked as the number of layers increases. These relationships hold for any velocity ratios between the interstitial and basal higher velocity layers.

In the second part, theoretical approximate calculations are made of the intensity of plane stationary waves propagating across a series of higher velocity layers of finite thickness, which were investigated experimentally in the first part. The theoretical results agree with the experimental.—*S. T. V.*

179–120. Weber, Max. Das ebene n-Schichtenproblem der Reflexions-seismik mit Konstanten Frontgeschwindigkeiten, beliebigen Neigungen und beliebiger Lage der Quelle [The plane n-layer seismic reflection problem with constant front velocities, arbitrary dips, and arbitrary position of the source]: Geofisica Pura e Appl., v. 43, p. 12–22, 1959; reprinted in Zürich Inst. Geophysik Mitt., no. 36, 12 p., 1959.

A general mathematical treatment is given for the problem of seismic reflection in n plane layers for the case where velocities are constant and dips and position of the source are arbitrary. Finally a simple method of treatment of inclined layers is developed by generalization of the $t\Delta t$ method; the n-layer problem is split up into n—1 two-layer problems.—*D. B. V.*

179–121. Sato, Ryosuke. Reflection and transmission of elastic waves at a discontinuity with an intervenient transient layer [in Japanese with English summary]: Zisin, ser. 2 v. 10, no. 3–4, p. 141–153, 1957.

In studies of the reflection and refraction of elastic waves at a discontinuous boundary, most authors have assumed that the density or elastic constants of the mediums vary discontinuously (mathematically) at the boundary. It may be better to consider that the physical properties of materials in the immediate vicinity of a discontinuity in the earth vary continuously in actuality. In such cases, the most pertinent transfer of energy among the waves takes place near the boundary, and no theory can be adequate without referring to the sharpness of the discontinuity as compared with the wavelength.

Sato has investigated the reflection and transmission of elastic waves at a discontinuity for the incidence of SH-waves at various glancing angles when

an intervenient layer of thickness H exists between the two different media. Both density and rigidity of the intervenient layer vary continuously but steeply from the corresponding values of the upper medium to those of the lower one. It was found that while the transmitter wave is not much affected, the reflected wave is considerably affected by the existence of the intervenient layer if the wavelength of the incident wave is very small compared with the thickness of the layer.—*V. S. N.*

179–122. Oguchi, Yuko. Reflection of elastic waves at a solid-fluid boundary (1)—On the case of *SH*-waves [in Japanese with English summary] : Zisin, ser. 2, v. 11, no. 4, p. 165–179, 1958.

The reflection of elastic waves at a solid-viscous fluid boundary is compared with the reflection at a solid-solid boundary, especially with respect to amplitudes. The results are as follows: if the incident waves are of the infinite coherence of sine waves, the amplitude of the reflected waves is not affected so much by the density ratio ρ^1/ρ as by the ratio $\rho'_{vp}/\rho\mu$ and is twice as much as that at a solid-solid boundary when the incident angle is small and the ratio $\rho'_{vp}/\rho\mu$ is not close to unity. If the incident waves are of the finite coherence of sine waves with zero-angle incidence, the reflected waves are deformed slightly at their heads and tails, but the amplitudes are the same in the first case.—*V. S. N.*

179–123. Weber, Max. Die Laufzeitfunktion und ihre Interpretation in der Refraktionseismik des einachsig inhomogenen Körpers [The travel time function and its interpretation in seismic refraction surveying of the uniaxial inhomogeneous body] : Geofisica Pura e Appl., v. 43, p. 167–181, 1959; reprinted in Zürich Inst. Geophysik Mitt., no. 36, 16 p., 1959.

The problem of interpreting seismic-refraction data in a uniaxial inhomogeneous medium is treated generally and an exact solution derived.—*D. B. V.*

179–124. Oguchi, Yuko. On refracted waves (I) [in Japanese with English summary] : Zisin, ser. 2, v. II no. 3, p. 135–140, 1958.

Oguchi investigates the character of refracted waves generated by a periodic *SH*-type line source situated in one of two homogeneous, isotropic, semi-infinite elastic mediums in horizontal contact. The displacement due to refracted waves is expressed mathematically. It was found that the waves are not much affected by the existence of the free surface.—*V. S. N.*

179–125. Tazime, Kyozi. Ray-theoretical construction of dispersive Rayleigh waves: Jour. Physics of Earth [Tokyo], v. 6, no. 2, p. 81–89, 1958.

Published studies of Rayleigh-wave dispersion have largely been confined to either dispersion curves or ratios of vertical to horizontal displacement where Poisson's ratio of the layer was assumed to be 0.25. This paper is a theoretical study of absolute amplitudes for various values of Poisson's ratio. For this purpose, displacement potentials have been expressed with reflecting coefficients where a useful operator has been derived from the characteristic equation of surface waves. The characteristic equation in general has been expressed by a hyperbola. The case of dispersive Rayleigh waves in a plate and in a surface layer resting on a perfectly rigid half-space are calculated.—*D. B. V.*

179–126. Jobert, Nelly. Calcul de la dispersion des ondes de Love de grande période à la surface de la Terre [Calculation of the dispersion of long-period Love waves at the surface of the earth]: Acad. Sci. [Paris] Comptes Rendus, v. 249, no. 11, p. 1014–1016, 1959.

The phase velocity of long-period Love waves has been obtained by integration of the differential equation of motion. The earth model used was Bullen's model A. The results are presently graphically. For wavelengths between 400 and 2,000 km the phase velocity is nearly a linear function of wavelength and the group velocity maintains a value of 4.5 kmps in this range, in agreement with experimental results concerning the *G*-wave (see Geophys. Abs. 174–61). The group velocity for the first harmonic varies much more rapidly. The presence of the crust modifies the form of both curves, particularly that of the harmonic, for short wavelengths. Displacements as a function of depth for different values of n are also shown graphically.—*D. B. V.*

179–127. Sata, Yasuo, and Yamaguchi, Rinzo. Velocity equation of Love waves propagated in multi-layered media [in Japanese with English summary]: Zisin, ser. 2, v. 12, no. 2, p. 61–67, 1959.

A simple and direct method is presented for the derivation of the velocity equations of surface waves propagating in a multilayered structure. Starting with the uppermost layer and adopting the solution satisfying the condition of the free surface, the displacement and the stress at the boundary between this and the next layer is obtained. The two boundary conditions, continuity of displacement and stress, give the solution for the next layer. The process is repeated for each layer until the solution is obtained for the last layers or semi-infinite medium; this solution converges at the point of infinite depth and gives the velocity equation for this case.

A table is presented showing the change of physical quantities necessary for modifying the above theory to solve the problem of sound waves in a liquid medium.—*V. S. N.*

179–128. Waniek, Ludvík, and Klíma, Karel. Zur Messung der Druckwellenamplituden [On the measurement of pressure-wave amplitudes]: Freiberger Forschungshefte C60 Geophysik, p. 57–67, 1959.

This report treats some methodological problems of measurement of pressure-wave amplitudes. Measurements in the immediate vicinity of the impact or explosions source are influenced by inertia and therefore by the size of the pressure indicator, as these must be calibrated statically. A new method of measuring pressure-wave amplitudes is developed, which uses as pressure indicators the silver-bromide crystals in a photographic plate on the order of 10^{-3} mm in size. The measurement of microscopic deformation is possible optically. A series of experiments shows that the new method gives better results than previous methods.

In conclusion, measurements of pressure-wave absorption on limestone and granite samples are presented. The apparatus used is described and illustrated schematically. It was assumed that the pressure waves are propagated in the sample as plane waves, that the amplitudes decrease according to the law $P=P_o e^{-\alpha d}$ (P_o is initial pressure, P the pressure in samples of length d and absorption coefficient α), and that the absorption mechanism is constant in the measured length of the specimen. The results for limestone are presented graphically.—*D. B. V.*

179–129. Iida, Kumizi, and Kumazawa, Mineo. Measurements of elastic wave velocities in rocks at high temperatures [in Japanese with English summary]: Zisin, ser. 2, v. 12, no. 1, p. 11–18, 1959.

This is essentially the same as the paper previously published in the Nagoya University Journal of Earth Sciences, v. 7, no. 1, 1959. (See Geophys. Abs. 178–103).—*V. S. N.*

179–130. Balakrishna, S. Effect of dimensional orientation on ultrasonic velocities in some rocks: Indian Acad. Sci. Proc., sec. A, v. 49, no. 6, p. 318–321, 1959.

The variation of ultrasonic velocities in gneisses, schists, limestones, and granites having a definite dimensional orientation of crystals composing the aggregate, has been investigated experimentally. Longitudinal and torsional velocities were measured by the pulse technique involving total internal reflection. Results are tabulated; they show that velocities vary considerably in directions perpendicular and parallel to the reference direction. This is attributed to the greater compaction and varying stress to which the rock has been subjected in that direction. Velocity values in the same lithological type depend on the structure and geologic history of the specimen.—*D. B. V.*

179–131. Balakrishna, S. Elastic wave velocities in Makrana marbles: Current Sci., v. 28, no. 7, p. 285, 1959.

Results of measurement of longitudinal and torsional ultrasonic wave velocities in marbles from Makrana (Rajasthan, India), ranging from fine to coarse in grain size, show that velocity decreases as grain size increases. As in previous studies (see Geophys. Abs. 168–74), it was also noted that absorption is high in coarse-grained rocks and low in fine-grained.—*D. B. V.*

179–132. Treitel, Sven. Discussion of internal friction of fine grained limestones: Geophysics, v. 24, no. 4, p. 823, 1959.

Zietz, Isidore, and Peselnick, Louis. Authors' reply: Geophysics, v. 24, no. 4, p. 824, 1959.

Treitel points out an ambiguity in Peselnick and Zietz's paper on internal friction in fine grained limestones (see Geophys. Abs. 177–94), claiming that their distance attenuation coefficient α_D is not identical with α, the classical attenuation coefficient.

Zietz and Peselnick, in reply, show mathematically that α_D does equal α.—*D. B. V.*

ELECTRICAL EXPLORATION

179–133. Alfano, L[uigi]. Introduction to the interpretation of resistivity measurements for complicated structural conditions: Geophys. Prosp., v. 7, no. 3, p. 311–366, 1959.

A study is made of the possibility of calculating electric potentials, and therefore of interpreting apparent resistivity measurements, when the ground presents structural conditions more complicated than plane, parallel stratification.

For this work a schematic type of structure has been chosen, in which the discontinuity planes for electric resistivity are both parallel and perpendicular to the level of the ground.

The problem has been examined in its general aspect, and then some criteria for the numerical calculation has been indicated.

Some calculated examples are presented, relevant to vertical electric soundings accomplished by conventional technique, for particular types of structure.—*Author's abstract*

179–134. Petrucci, Giuseppe. I sondaggi elettrici col metodo diretto di misura della resistenza del terreno. Teoria. Applicazioni pratiche [Electrical soundings with the direct method of measurement of electrical resistivity of the terrane. Theory. Practical applications]: [Italy] Servizio Geol. Boll., v. 78, no. 4–5, p. 797–810, 1956.

A formula for interpretation of the relative graphs of electric soundings to a depth of 48 m by the direct-resistivity method is presented, and an application of the formula is discussed and presented in graphs and tables. The case of an infinite homogeneous isotropic medium of two horizontal and parallel layers is treated. Some graphs commonly used in routine electric prospecting are drawn for various geologic terranes, and practical possibilities of the method are demonstrated.—*A. J. S.*

179–135. Petrucci, Giuseppe. Su alcuni casi pratici di applicazione del metodo Petrucci per l'esecuzione dei sondaggi elettrici [On some practical examples of application of the Petrucci method for executing electrical soundings (with English summary)]: [Italy] Servizio Geol. Boll., v. 80, no. 1, 9–37, 1959.

Petrucci's method of making electrical-resistivity soundings, based on the direct measurement of apparent resistivity of the terrane (see Geophys. Abs. 179–134) has been shown to possess certain advantages over the classic Wenner method and its developments—greater sensitivity; complete elimination of detrimental surface variations; sensitivity unaffected by distance between current electrodes, therefore by depth; greater depth penetration for a given electrode spacing; greater ease of measurement, as compensations and measurement of potential electrodes are omitted; less space needed; and easier calculation and interpretation. In this paper these advantages are illustrated by means of practical examples of cases of exploration for metallic ore (pyrite), study of a building foundation, ground-water exploration, and finally in a wide area with varied hydrologic and geologic conditions (from Isola delle Femmine to Punta Raisi, Palermo).

The results bear out earlier claims that impermeable strata can be determined within 3 percent error. For best results the spacing must be adapted in each case to local geologic and topographic conditions. In unconsolidated terranes and shallow hydrologic studies, where the topography is irregular the mean-electrode spacing should be reduced to 10–20 m.—*D. B. V.*

179–136. Nazarenko, O. V., Lipilin, V. A., and Frenkel, V. S. Ob interpretatsii rezul'tatov dipol'nykh zondirovaniy [On interpretation of the results of dipole soundings]: Razvedochnaya i Promyslovaya Geofizika, no. 18, p. 53–60, 1957.

In the usual procedure of dipole electric sounding, the measured values of apparent resistance are referred to the midpoint between the current and receiving dipoles. When the electrode separation is increased by moving only the receiving electrodes, the reference point is displaced toward the receiving dipole. This introduces an ambiguity in the position of the point to which the depth values obtained from the sounding can be referred. A master chart is proposed for reduction of displaced midpoint values of apparent resistance to a fixed point on

the profile. In this way the graphs of apparent resistance reflect the effect of displacement of the reference point along the profile, as well as the values of the resistance for different depths.—*A. J. S.*

179–137. Karandeyev, K. B., and Mizyuk, L. Ya. Electronnaya izmeritel'naya apparatura dlya geofizicheskoy razvedki metodami postoyannogo toka [Electronic measuring apparatus for geophysical prospecting by the direct current method]: Moscow, Gosgeoltekhizdat, 288 p., 1958.

This book deals with types of electronic equipment used for d-c electrical prospecting, as applied to petroleum, ore, and engineering geophysics. After an introductory instructional chapter, the methods of small constant potentials are analyzed, followed by a discussion of the theory and application of the electronic compensation systems EPO–5 and ESK–2 and the system KSP–5 for direct determination of apparent resistance. A two-channel autocompensator using an EPO–5 oscillograph is described, followed by a description and analysis of the single-recording electronic autocompensator EAK–3. Nomograms for each instrument are given on 10×13 inch sheets. The bibliography lists 89 titles, 79 of which are in Russian.—*A. J. S.*

179–138. Tokarev, A. K. Electrorazvedka gruntov pri izyskaniyakh dorog [Electric exploration of grounds in preliminary surveys for roads] Avtomobil'nyye Dorogi, no. 5, p. 13–15, 1958.

For electrical investigation of the ground in preliminary surveys for roads, the nonsinusoidal a-c current of low frequency is suggested in combination with the electrometers of MS–07 type manufactured by Energspribor plant near Moscow, U.S.S.R. The meter consists of a hand driven magnetoelectric device for measuring the potential to current ratio, and gives highly accurate recording within the ranges of 0–10, 0–100, and 0–1,000 ohms. It was found that the described a–c resistivity method is several times more efficient than a d-c method of exploration of equal accuracy. The weight of the apparatus is approximately 20 kg., and it is effective to a depth of 50 m.—*A. J. S.*

179–139. Marshall, Donald J., and Madden, Theodore R. Induced polarization, a study of its causes: Geophysics, v. 24, no. 4, p. 790–816, 1959.

The causes of induced electrical polarization include not only the polarization of metal-solution interfaces, but also effects associated with the coupling of different flows. Electro-osmotic, thermal electric, and ion diffusion effects are among such examples. A study of the physical properties of geologic materials indicates that only electrode interface and diffusion flow phenomena are important sources of induced polarization effects.

It was attempted to find characteristic differences between these two phenomena. Theoretical and experimental considerations show that the kinetic processes involved are quite similar in the two cases. This leads to difficulties in identifying the polarizing agent from electrical measurements although the effects of well-mineralized zones are easily recognized.—*Authors' abstract*

179–140. Šumi, F[ranć]. Geophysical exploration in mining by induced polarization: Geophys. Prosp., v. 7, no. 3, p. 300–310, 1959.

The electrochemical effect caused by flow of current across a boundary that separates a medium with electronic conductivity (metals, sulfides) from one with electrolytic conductivity (rocks, water) is the basis of induced-polarization

prospecting. Polarization may also be induced by flow of current across a boundary separating two media with different electrolytic conductivities (lithological differences, saturation); this effect must be eliminated in prospecting. In order to obtain the induced-polarization effect of ore bodies it is necessary to determine the effect of the barren rock and subtract it from the observed effect.

Results of field measurements by this method is the Idrija mercury mine and Mežica lead-zinc mine in Yugoslavia and in the Kankberg ore district in Sweden are in good agreement with the geologic data. It is concluded that the induced-polarization effect can be caused by sulfide ores, especially when they are fine grained; mercury ore of low metallic content can also be detected. The polarization effect depends on the depth penetration of the primary current; therefore, it is different for different electrode arrangements. The results of induced polarization can be interpreted quantitatively.—*D. B. V.*

179–141. Postel'nikov, A. F. K voprosu o prirode vyzvannoy polyarizatsii v osadochnykh gornykh porodakh [On the problem of the nature of induced polarization in sedimentary rocks]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 2, p. 126–136, 1959.

The close correlation between induced polarization of a rock and the specific area of the pores, and therefore its porosity, is challenged. An explanation of induced polarization is presented, discussed, and verified experimentally. A linear correlation between the electromotive force of induced polarization and the inductive field, an almost linear correlation between polarization capacity and the specific resistance of the electrolyte, and the form of dependence of polarization capacity on the degree of dispersion of the medium are established.—*A. J. S.*

179–142. Roy, A., and Chowdhury, D. K. Interpretation of self-potential data for tabular bodies: Jour. Sci. Eng. Research [India], v. 3, pt. 1, p. 35–54, 1959.

The problem of interpretation of self-potential data for ore bodies in the form of thin veins or sheets (more common in nature than rods or spheres) is treated. Four cases are considered: (1) infinite in both strike and depth; (2) infinite along strike but finite in depth; (3) finite in length but infinite in depth; and (4) finite in both strike and depth. The first three are solved theoretically, and master curves are presented for determination of location, depth, width, and dip of the ore body. For the fourth case, model-tank measurements were made; the data are represented by curves in suitable dimensionless form, against which field-anomaly profiles can be matched.—*D. B. V.*

179–143. Smirnov, A. A. O metodike izucheniya potentsialov fil'tratsii v ruslakh rek [Method of study of filtration potentials in beds of rivers]: Ministerstvo Vyssh. Obrazovaniya SSSR Nauch. Doklady Vyssh. Shkoly, Geol.-geog. nauki, no. 2, p. 114–121, 1959.

The potential and gradient of the natural electric field were successfully used in study of the flow of ground water directly adjacent to river channels in the bauxite fields of the northern Urals. Profiles were made first parallel and then transverse to the course of the river. Circumferential measurements were subsequently made around anomalous points. The direction of flow of ground water was determined by these measurements. (See also Geophys Abs. 175–111).—*J. W. C.*

179–144. Tikhonov, A. N., and Skugarevskaya, O. A. Ob asimpoticheskom povedenii protsessa stanovleniya elektromagnitnogo polya v sloistykh sredakh [On the asymptotic character of the process of building-up of the electromagnetic field in stratified media]: Akad. Nauk SSSR Izv. ser. geofiz., no. 7, p. 937–945, 1959.

This study is a continuation of the article on the build-up of the electromagnetic field as an asymptotic process (see Geophys. Abs. 178–124), and discusses the build-up of an electromagnetic field in a medium composed of a number of homogeneous and isotropic strata overlying a perfectly insulating basement. The process of the build-up of the electromagnetic field is considered to be an asymptotic process at points sufficiently distant from the source of the field. The source of the field is assumed to be an electric dipole of length dx, set at the zero point of the coordinate system and oriented in the direction of the x-axis. The receiving dipole is assumed to be placed either on the x-axis or on the y-axis parallel to the feeding dipole. Applying the results obtained in the first paper, it is possible to write the expressions for the field components directly. The expression for the summary conductivity S of the studied medium can also be determined.—*S. T. V.*

179–145. Dmitriyev, V. I. Vliyaniye neodnorodnostey zemli na pole pryamolineynogo beskonechno dlinnogo kabelya [The effect of heterogeneities of the ground on the field of a rectilinear cable of infinite length]: Akad. Nauk SSSR Izv. ser. geofiz., no. 4, p. 621–623, 1959.

The effect of a perfectly conducting thin vertical vein of finite depth on the electromagnetic field of an infinitely long cable laid on an otherwise homogeneous ground is analyzed mathematically. The results show that for shallow veins, the modulus anomaly is of the order of some tens of percents, and the phase anomaly some tens of degrees. Away from the vein the anomaly dies out rapidly, the modulus anomaly more rapidly than the phase anomaly. On the average, the width of the anomaly is of the order of 0.1–0.2 of the wavelength in the ground. With increasing depth the intensity of the anomaly decreases but its width increases.—*S. T. V.*

179–146. Tikhonov, A. N., Shakhsuvarov, D. N., and Rybakova, Ye. V. O vozmozhnostyakh razlicheniya ekvivalentnykh razrezov pri ispol'zovanii permennykh electromagnitnykh poley [On the possibility of distinguishing between equivalent profiles, using alternating electromagnetic fields]: Akad. Nauk SSSR Izv. ser. geofiz., no. 8, p. 1202–1205, 1959.

The method of vertical electric profiling with direct current fails to distinguish different layers in the case of equivalent sections. (Equivalent cross sections are those satisfying the relationship $\frac{h_1}{\rho_1}+\frac{h_2}{\rho_2}=$constant, where h_1 and h_2 are the layer thicknesses and ρ_1 and ρ_2 their resistivities.) Theoretical analysis and experiments show that by using alternating electromagnetic fields it is possible to obtain clearly distinguishable curves, using either the electrical or the magnetic component of the field. The curves in question are reproduced in the article.—*S. T. V.*

179–147. Tikhonov, A. N., and Shakhsuvarov, D. N. Elektromagnitnoye pole dipola v dal'ney zone [The electromagnetic field produced by a dipole in a distant zone]: Akad. Nauk SSSR Izv. ser. geofiz., no. 7, p. 946–955, 1959.

Conditions are analyzed concerning the treatment of the electromagnetic field produced by a dipole in a zone rather distant from the source. A general method is given for computing the electromagnetic field in a stratified half space acted upon by an alternating dipole set at the zero point of the coordinate system. If only distant points are taken into consideration, the amplitudes and phase angles of the field components can be determined as asymptotic values, which can be determined directly and simply by the theory of differential geometry for asymptotic relations. The case is treated in detail where the upper layer overlies a perfectly conducting medium. Graphs of the amplitudes of the field components are given in the article for 2-layer and 4-layer mediums.—*S. T. V.*

179–148. Molochnov, G. V. Eksperimental'noye issledovaniye elektromagnitnogo polya v neodnorodnykh sredakh [Experimental investigation of electromagnetic field in inhomogeneous media]: Leningrad Univ. Uchenyye Zapiski, no. 249, p. 63–70, 1958.

Integral expressions for the electromagnetic dipole field over layered mediums, which are arrived at theoretically, require a laborious numerical evaluation and in some cases present great mathematical difficulties. Molochnov proposes an experimental determination of the intensity vector of an electromagnetic field in layered mediums by means of electromagnetic models. The functional relationship between phase characteristics of the field and parameters of the medium is emphasized, and a method of determining the phase displacement in two mutually perpendicular components of the field using the apparatus usually applied in amplitude determination is suggested. Research carried out in 1953–56 at Leningrad University is described; its results, presented in graphs and a table, indicate that the experimental method proposed by Molochnov produces data on phase shift and amplitude variation in the induced electromagnetic field that agree within about 2 percent with theoretical values.—*A. J. S.*

179–149. Barret, William M. Radoil's approach to porosity-trend mapping: Oil and Gas Jour., v. 57, no. 35, p. 120–124, 1959.

Radoil surveys provide a worthwhile tool for aiding in the location and definition of oil accumulations that occur in porosity trends. The method makes use of radio waves to disclose the electrical contrast between oil and salt water, or between oil and sediments, at the boundaries of oil fields. With a fixed transmitter and a movable receiver, receiver reading-spread profiles are obtained along traverses overlying the prospect or field under investigation. These profiles may be neutral, indicating absence of oil, or anomalous, defining the margins of an oil pool. The depth may be determined within practical tolerances from the spread characteristics of the anomalies.

This method was successfully applied in mapping an important porosity trend in the lower Pettet section of the Sligo formation extending southeastward from Gregg County, Tex., into Caddo and Desoto Parishes, La. Exploration based on a radoil survey of this area has led to the development of an oil and gas field 50 miles long and averaging 3 miles in width.—*V. S. N.*

179–150. Dayev, D. S. Ob obrabotke i istolkovanii dannykh radiovolnovogo prosvechivaniya [Processing and interpretation of data of radiowave transmission] : Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 6, p. 104–109, 1959.

The problem commonly arises of distinguishing anomalies on the radiowave graph that are caused by a disturbing body. This problem can be solved by comparing observed experimental curves with theoretically calculated curves. Formulas are presented for the calculation of such curves, and two examples from mine workings are given. The method gives satisfactory results where the host rock of a disturbing ore body is more or less uniform.—*J. W. C.*

179–151. Ward, S[tanley] H. AFMAG—airborne and ground: Geophysics, v. 24, no. 4, p. 761–789, 1959.

A new development in electromagnetic surveying, AFMAG, essentially eliminates the time variance in recording the natural magnetic field in the audio and subaudio frequency range that are considered to be provoked by distant and local thunderstorms. As the space variance can be correlated with geologic features, AFMAG provides a method of exploration with particular application to prospecting for conductive mineral deposits. AFMAG instrumentation is currently available for both ground and airborne operations; the tilt of the plane of polarization of the natural magnetic fields is recorded simultaneously at two frequencies. Examples drawn from airborne and ground surveys show that the method has a greater depth of penetration than the conventional induction-electromagnetic method. Other advantages include the possibility of choosing discrete operating frequencies over a broad band (from 1 to 1,000 cycles per sec). The chief disadvantage is a sometimes restricted daily measuring period during which the fields are of an amplitude too low to be measured with current instrumentation; improvements are being made in this direction.—*D. B. V.*

179–152. Friedl, Karl, and Kántás, Karl. Geophysical results in Austria and special regard to telluric measurements: Geofisica Pura e Appl., v. 43, p. 195–208, 1959.

Comparison of the results of telluric measurements in the Austrian-Molasse zone and in the Vienna Basin with those of other geophysical methods and deep drilling shows that the telluric method is useful not only in reconnaissance, in which it can serve as a basis especially for more detailed seismic work, but also in solving detailed problems. The results of model experiments concerning the influence of anisotropy confirm the theory of the telluric effect.

Seismic interpretation is more complete in the light of telluric data, especially in faulted regions. Structures can be followed in regions topographically unsuited to seismic methods. Telluric surveys are interpretable in areas of deep basement overlain by anisotropic sedimentary layers.—*D. B. V.*

179–153. Berdichevskiy, M. N., and Bryunelli, B. Ye. Teoreticheskiye predposylki magnito-tellurichеskogo profilirovaniya [The theoretical prerequisites of magneto-telluric profiling] : Akad. Nauk SSSR Izv. ser. geofiz., no. 7, p. 1061–1069, 1959.

In this article the relationships between the electric and magnetic components of a plane-monochromatic wave in horizontally-homogeneous media are analyzed for horizontal and for inclined layers. These relationships are con-

sidered as the first step leading to a new method of geophysical exploration, namely, the method of magnetotelluric profiling (MTP). MTP method is considered to be superior to the telluric-current method (MTC) because it eliminates the necessity of simultaneous observation of the electromagnetic field at two different points of the area surveyed, and because there is no need for a base-station network in regional investigations. These two factors make the MTP method more economical. The data processing is also simpler. From the measured values it is possible to determine the absolute value of the total longitudinal conductivity, not relative resistivity as in the case of the MTC method. A theoretical study is presented based on Maxwell's fundamental equations of the ratio between the electric and magnetic components of the electromagnetic field. Special cases examined in the article are a homogeneous half-space and a two-layer profile.—*S. T. V.*

179–154. Kopelev, Yu. S. Zimniye raboty metodom tellurichеskikh tokov [Winter work by the telluric current method]: Razvedochnaya i Promyslovaya Geofizika, no. 29, p. 57–59, 1959.

Until very recently it was considered impossible to use the telluric-current method during winter months because the nonpolarizing electrodes usually employed contain copper-sulfate solution, which freezes and becomes inactive. In the Tyumen region in northwestern Siberia an electrical exploration party tried to use ordinary (polarizing) electrodes with simple iron electrodes driven into the frozen ground; the phenomenon of natural polarization was found to die out completely after several hours. Thus, if an interval of about 24 hr elapses between the setting up of the measuring line and the actual measurement, simple electrodes can be used with fully satisfactory results. It must be noted that the phenomenon of induced polarization of electrodes is not usually observed at temperatures below freezing. Repetition of the measurements at all stations after several days gave results differing from the first by only 2.1–2.3 percent.—*S. T. V.*

179–155. Gilbert, Ray E. Notes on geophysical work at Marysvale, Utah: U.S. Atomic Energy Comm. Rept., RME–2050, 24 p., 1958.

Direct-current resistivity methods were tested in two localities in the Marysvale area, a uranium district disposed in a region of volcanic and plutonic rocks of Tertiary age in south central Utah. An altered rhyolite dike was successfully traced by this method, and the information was used in planning a drilling program. There was less success in locating a contact between a quartz monzonite and a rhyolite conglomerate; this is attributed to lack of homogeneity in the basal section of the rhyolite.

Resistivity methods can be used to outline zones of intense alteration; data on the location of uranium deposits in altered rhyolite can thereby be obtained.—*J. W. C.*

179–156. Keunecke, O[tto]. Ergebnisse neuerer geophysikalischer Untersuchungen in Kohlefeldern der rheinischen Reviers zum Zwecke der Festlegung tektonischer Störungen [Results of recent geophysical investigations in coal fields of the Rhine district for the purpose of determination of tectonic dislocations]: Braunkohle Wärme und Energie, v. 11, no. 8, p. 314–318, 1959.

Of the various geophysical methods tested, electrical methods have proved the most practical for solving structure problems; they permit a direct deter-

mination of the attitude of subsurface strata. Several diagrams are given that show the relationship of electrical profiles to the geology. Use of these techniques reduces the number of drill holes necessary in these coal fields.—*J. W. C.*

179–157. Triglavčanin, Ante. Geoelektrična ispitivanja za rješenje mnogobrojnih pitanja [Geoelectric studies for solution of numerous problems] : Naš rad, no. 1, p. 7–8, 1955.

Geoelectric investigation for engineering purposes in Croatia is discussed in general, and examples of surveys are given for Zagradačka Rijeka, Maribor, Lijeviča Polje, and Rijeka Pliva. Resistivity curves of the profiles are presented and interpreted geologically.—*A. J. S.*

179–158. Yashchenko, Z. G. Oypt primeniniya elektrorazvedki dlya issledovaniya proyavleniy karsta v dolinakh rek Angary i Zapadnoy Dviny [Experience in the use of electrical exploration for investigation of the karst manifestations in the valleys of the Angara and West Dvina Rivers]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geologira i razvedka, no. 1, p. 104–110, 1959.

The area investigated in the Angara Valley is characterized by thick, massive karstic carbonate rocks, whereas the West Dvina Valley contains thinner karstic carbonate rocks at shallow depth. Electrical profiling was carried out to distinguish the degree of karstification of the rocks and the limits of its occurrence. Best results were obtained in profiles perpendicular to the river.

The zones of fracturing and karstification distinguished by the electrical survey were found to correspond to depressions in ground-water level. Maps and electrical profiles are presented.—*J. W. C.*

179–159. Bystritskiy, A. A., and Kukovyakin, A. A. Opyt primeneniya geofizicheskikh metodov pri razvedke mestorozhdeniya izvestnyakov [Experience in the use of geophysical methods in exploration of deposits of limestone] : Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geol. i razvedka, no. 7, p. 112–117, 1959.

Geophysical investigations of a limestone deposit in Primore (Maritime Territory, U.S.S.R.) are described in the hope that they will serve as an example of the use of geophysical methods in exploration for building materials in general.

The limestone has a karst surface and in places a deeper karstification. The cavities are filled with clay. Igneous dikes also cut the limestone. The geophysical work was designed to distinguish the dikes, establish contacts of the limestone with the surrounding schist, and to study the deep karst. Several methods were tried to distinguish the dikes: magnetic exploration, the self-potential method, and various modifications of electrical profiling. Only the electrical profiling was successful; an example is presented.

The contact between the limestone and the schist is marked by a sharp change in electrical resistivity from 3,000 to 3,500 ohm-m for the limestone to 600 ohm-m for the schist. Vertical electrical profiling was carried out in exploratory drill holes. Alluvium and surface karst yielded resistivity values of 100–500 ohm-m; crystalline limestone, 8,000 ohm-m; fractured limestone, more than 2,000 ohm-m; strongly fractured limestone, 500–1,000 ohm-m; and cavernous limestone, less than 500 ohm-m. The electrical data were used to construc geologic cross

sections, a structural map of the deposit, and an isopach map of the limestone. The limit of the karstification was also determined. The procedure recommended for such exploration is outlined.—*J. W. C.*

ELECTRICAL LOGGING

179–160. Kulinkovich, A. Ye. K teorii karotazha elektricheski anizotropnykh plastov [Theory of logging of electrically anisotropic strata]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 6, p. 83–94, 1958.

Oil reservoirs commonly consist of thin interbedded clays and oil-saturated sands. The apparent specific resistivity opposite such beds is small, and their recognition is difficult. The possibility exists, however, of distinguishing such beds by their anisotropy. Nomograms are presented by which the resistivity of the rock perpendicular to the bedding and parallel to the bedding can be obtained. These values are then used in a formula to determine the coefficient of anisotropy.—*J. W. C.*

179–161. Johnson, Hamilton M. Geologist's interpretation of drilling mud requirements: World Oil, v. 149, no. 6, p. 133–136, 1959.

New drilling muds interfere with the geologist's evaluation of formations. The most important factors that affect resistivity are temperature, salinity, and pH. Phosphate and caustic-quebracho muds yield entirely normal electric logs. Red mud (pH 11.5) produces a low resistivity, and the conventional electric log may not be effective. Salt-water muds also render conventional electric logs ineffectual; a combination of laterolog, microlaterolog, and gamma-logging must be used.—*J. W. C.*

179–162. Flock, D. L., and Kennedy, H. T. Drilling mud filtration and its effect on the electrical resistivity of porous media: Canadian Min. Metall. Bull., v. 52, no. 563, p. 178–185, 1959; *also in* Canadian Inst. Min. Metall. Trans., v. 62, p. 82–89, 1959.

This study was undertaken to provide a thorough understanding of the effect of contamination by drilling fluids on the electrical properties of porous systems. Filtration tests were made on both consolidated and unconsolidated sands, and their resistivity profiles determined with screen-type electrodes spaced at convenient intervals along the core. Four drilling fluids were used, ranging in resistivity from 447.0 ohm-cm to 5.76 ohm-cm; permeability of the 3 unconsolidated and 4 consolidated cores used varied from 1,257 to 4,560 md. Results showed that resistivity of an invated core is controlled by the resistivity of the filtrate, of the residual core water, and of the clay particles; and by the amount and distribution of filtrate, clays, residual oil, and brine. There was a significant increase in resistivity owing to the presence of clay solids invading the core; change in resistivity with the diffusion of salts was substantial after 5 hrs; and in some cases there is almost complete displacement of residual-oil and core-water from the unconsolidated cores by the invading fluid. Evidence also supports the buildup of a water bank in front of the invading fluid.

Tests of invasion on 6 unconsolidated and 3 consolidated cores show a decreasing volume of invasion with decreasing permeability of the cores.—*V. S. N.*

179–163. Brown, Albert A. Improved accuracy in porosity determination from the Microlaterolog: Canadian Oil and Gas Industries, v. 12, no. 9, p. 46–51, 1959.

Accuracy in porosity determination with the microlaterolog can be improved in two ways: using past experience in the area, the timing of the microlaterolog run should be chosen to ensure that sufficient invasion is present but that the mudcake is not too thick; for field areas, empirical F_a/ϕ charts should be constructed because they average out errors due to such factors as variable residual-oil saturation, changes in formation factor/porosity relationship, and effect of mudcake.—*V. S. N.*

179–164. Shevkunov, Ye. N. Opredeleniye poristosti porod po dannym mikrozondov [Determination of porosity of rocks according to microsonde data]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zadvedeniy, Neft' i gaz, no. 4, p. 11–14, 1958.

The equations for the determination of porosity according to microsonde data are presented and discussed. Porosity determined by this method is compared with that determined by core analysis for one well. The values are in comparatively good agreement. The microlog is compared with the caliper log and *SP*-log for this same well.

The microsonde method yields sufficiently detailed information on the porosity of water-bearing strata. The absence of data on the true value of the residual-oil saturation decreases the accuracy of determination of the porosity of oil-bearing beds.—*J. W. C.*

179–165. Neyman, Ye. A. Postroyeniye paletki mikrozondov po dannym elektricheskogo modelirovaniya [Construction of a nomogram for microsondes according to data of electrical modeling]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Neft' i gaz. no. 1, p. 13–20, 1959.

The methods and results of modeling tests with microsondes are described, and a nomogram is presented for quantitative interpretation of microsonde diagrams. A sketch and specifications of the model and of the sonde are given. The results of the measurements on the model are used to establish mathematical relationships which in turn are the basis for the nomogram. By means of the nomogram the specific resistance of the invaded zone and the porosity of the formation can be determined. A step-by-step example is given of such determinations.—*J. W. C.*

179–166. Ismet, A. R. Sposob utochneniya opredeleniya vidimoy moshchnosti plasta po mikrodiagrammam [Method of refinement of the determination of the apparent thickness of strata according to micrologs]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Neft' i gaz. no. 4, p. 15–18, 1958.

Rotation of the microsonde on its long axis during thickness measurements leads to errors. A formula is presented that contains a correction for such rotation.—*J. W. C.*

179–167. Ismet, A. R. Znacheniye voprosa opredeleniya glubiny plasta po osi skvazhiny dlya resheniya ryada geologicheskikh zadach [The importance of the problem of determination of the depth of a layer with respect to the axis of a borehole for solution of a number of geologic problems]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Neft' i gaz, no. 1, p. 23–30, 1958.

The use of micrologs to determine the thickness and attitude of beds in boreholes is described. Examples are illustrated and discussed, and the problems are treated trigonometrically.—*J. W. C.*

179–168. Bencze, Pál. Über die Weiterentwicklung des Induktionsbohrlochmessverfahrens [On the further development of the induction logging method]: Freiberger Forschungshefte C60 Geophysik, p. 7–12, 1959.

Some problems of construction of induction-logging instruments are discussed. The two most important sources of distortion are temperature and pressure. Inductivity can be made independent of temperature if the axial thermal-expansion coefficients of the coil are twice as great as the radial-expansion coefficient. A device for achieving this temperature compensation is described. The simplest way to avoid pressure effects is to surround the coil system with a protective covering.—*D. B. V.*

179–169. Hill, H. J., and Anderson, A. E. Streaming potential phenomena in *SP* log interpretation: Jour. Petroleum Technology, v. 11, no. 8, p. 203–208, 1959.

The empirical relationship between streaming potential, mud resistivity, and pressure differential for permeable beds and shales have been determined in the laboratory for various types of muds. The net streaming potential in a well is the algebraic difference between the permeable bed and shale streaming potentials; it is generally of sufficient magnitude to be of critical importance. This conclusion is confirmed by field experiments, and an evaluation of the streaming potential is necessary to obtain accurate estimates of the electrochemical component of the *SP*.

The electrochemical component of the *SP*-curve is related to formation water activity, or resistivity, and is an important parameter in the various methods of shaly-sand interpretation. Increased accuracy in estimation of streaming-potential corrections should result in increased applicability of *SP*-data to formation evaluation.—*J. W. C.*

179–170. Vilkov, N. V. Opyt opredeleniya poristosti plastov po parametru PS [Experience in the determination of porosity of strata according to the *SP*-parameters]: Geologiya Nefti, no. 12, p. 60–62, 1959.

Porosity values are plotted on a graph versus the ratio of the average *SP* to the maximum Δ *SP*. A linear relationship results. This opens the possibility of estimating the porosity of oil- and water-bearing strata according to the *SP*-curve. Comparison of the results of several investigators indicated that this method is more accurate.—*J. W. C.*

179–171. Tarkhov, A. G. O podzemnykh nablyudeniyakh yestestvennogo elektricheskogo polya v rudnykh rayonakh [On subsurface observations of the natural electric field in ore regions]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 12, p. 114–122, 1958.

Subsurface exploration of pyrite deposits in the Azerbaijan S.S.R. revealed a self-potential anomaly of 130 mv intensity in a drill hole; the logging curve is illustrated. The anomaly is attributed to ground water and not to the pyrite ore in the vicinity.

The variation of the field along a drill hole intersecting a polarizing ore body is treated. A strict mathematical solution is possible only with simplifications. The solution is sought in a model made of copper and iron disks. The self-potential curves obtained for the model differ from the theoretically calculated curves. There is no kick of the potential at the contact; the potential changes rather smoothly from extreme values near the contacts through zero at the middle. Examples of measurements in mine workings are also discussed. Oxidation appears to exert considerable effect on the natural field.—*J. W. C.*

179–172. True, H. W. Induction-electrical logging in Oklahoma: Shale Shaker Digest II (1955–1958), p. 418–423, 1958.

This paper was previously published in World Oil, v. 146, no. 4, 1958 (see Geophys. Abs. 176–123).—*V. S. N.*

179–173. Sebestyén, Károly, and László, Sajti. A vízkutató fúrások mélyfúrási geofizikai vizsgálata [Investigation of water wells by means of geophysical logging (with German summary)]: Geofiz. Közlemények, v. 8, no. 1–2, p. 33–52, 1959.

The application of well-logging methods to wells drilled for water in Hungary has led to the conclusions that the *SP*-curve is not only suitable for indicating possible aquifers, but also for approximate determination of the properties of the water they contain. Given enough data, porosity can be calculated from the apparent-restivity curves, and permeability can be estimated approximately. The natural gamma-ray profile can often be substituted to advantage for the *SP*-curve for distinguishing and delimiting sandy layers, as it is independent of the properties of the formation water and also can be used in cased wells.—*D. B. V.*

179–174. Sigal, L. A. K ispol'zovaniyu dannykh elektrometricheskikh issledovaniy v skvazhinakh dlya izucheniya nekotorykh voprosov tektoniki Zapadno-Sibirskoy nizmennosti [On the application of the data of electrical well-logging to the study of some tectonic problems in the West Siberian Lowland]: Sovetskaya Geologiya, no. 3, p. 114–115, 1959.

Sigal shows that self-potential logs clearly reflect the sand content of formations traversed. He introduces the coefficient of sandiness K_i, which can be determined from the formula $K_i=\frac{\Sigma h}{H_i}$, where Σh=sum of thicknesses of sandy layers in a segment H_i of the sedimentary column. Inasmuch as the tectonic history of a region is reflected in the grain size of the facies, electrical logs can

be applied to study of tectonic processes. The Meso-Cenozoic movements that have affected the West Siberian Lowland are interpreted on the basis of *SP*-logging data from a number of separate holes.—*S. T. V.*

GENERAL

179–175. Howell, Benjamin F., Jr. Introduction to geophysics: New York, McGraw-Hill, 399 p., 1959.

This is a beginning college textbook in geophysics designed to familiarize the reader with the scope of geophysics in relation to the other sciences, to give him insight into methods used by geophysicists to study the earth, and to outline the most important discoveries of these researches. Those using the book should be familiar with the terminology of geology and physics and have some knowledge of calculus. The text covers the following subjects: origin of the earth and the moon; geochronology; temperature of the earth; various aspects of seismology; mass, movement, shape, and size of the earth; density and elastic constants; gravity; isostasy; origin of continents; continental drift; tectonic forces, patterns, profiles, and causes of mountain building; geomagnetism; terrestrial electricity; and geomagnetic and geoelectric instruments. An excellent list of references is also included.—*V. S. N.*

179–176. Bruckshaw, J. M. Prospects of geophysical prospecting: Geophys. Prosp., v. 7, no. 3, p. 267–272, 1959.

This presidential address delivered at the 16th meeting of the European Association of Exploration Geophysicist (Munich, 1959) outlines past progress in gravity, magnetic, seismic, and electrical exploration methods and considers their possible future development. Gravity and magnetic techniques have already reached the limit beyond which increased sensitivity of instruments can contribute nothing to accuracy of interpretation. Seismic and electrical techniques are limited by the signal-to-noise problem. Great advances may yet be possible but it is inconceivable that the same basic ideas can be extended indefinitely. The main problem is now a matter of new ideas.—*D. B. V.*

179–177. Mollard, J. D. Photogeophysics—Its application in petroleum exploration over the glaciated plains of western Canada *in* Williston Basin Symposium, 2d Internat., Saskatchewan Geol. Soc. and North Dakota Geol. Soc.: Bismarck, N.Dak., Conrad Publishing Co., p. 109–117, 1958.

Suitably scaled high-resolution aerial mosaics reveal structurally controlled surface fracture patterns over extensive areas of the drift-covered Canadian prairies and in the heavily vegetated, muskeg-dotted northern region of northern Alberta and the Northwest Territories. Aerial fracture study is based on evidence that the earth's crust, particularly the sedimentary column, is systematically fractured over extensive regions; these fracture systems are believed to result from disturbances associated with recurrent structural adjustments in the deeper crust (see Geophys. Abs. 167–122). Anomalies in the surface-fracture data may reflect anomalous conditions in the underlying sedimentary rocks, even though bedrock surfaces are covered by drift or trees. In petroleum exploration, aerial fracture-pattern studies find greatest application over sedimentary basins possessing comparatively simple subsurface structure and stratigraphy. When the full potential of aerial fracture study is realized, after many more years of application, it is expected to play a principal role in the pre-

ground-geophysical stages of an integrated subsurface exploratory program.—*V. S. N.*

179–178. McCollum, E. V. Geology, a geophysical tool: Mines Mag. [Colorado], v. 49, no. 5, p. 27, 1959.

This is the same as the paper published in the Bulletin of the American Association of Petroleum Geologists, v. 43, no. 7, p. 1503–1504, 1959 (see Geophys. Abs. 178–189).—*V. S. N.*

179–179. Rawer, Karl. Correlation in geophysics: Geofisica Pura e Appl., v. 43, p. 218–226, 1959.

Difficulties in the geophysical application of the correlation coefficient r and with the definition of average or mean value are pointed out; the advantages of a new correlation measure based on a counting procedure are indicated. This "Rawer-Taubenheim correlation number" R is invariant with respect to monotonous transformations.—*D. B. V.*

179–180. Thirlaway, H. I. S. Geophysics in Pakistan: Royal Astron. Soc. Geophys. Jour., v. 2, no. 3, p. 241–247, 1959.

This article summarizes the results in earth physics (seismology, geomagnetism, physical geodesy, geodynamics, and applied geophysics) since the founding of the Geophysical Institute at Quetta in 1951, and introduces the personnel responsible.—*D. B. V.*

179–181. Canadian Well Logging Society. Logging techniques: Canadian Oil and Gas Industries, v. 12, no. 9, p. 52–53, 1959.

This paper summarizes a logging-program panel discussion held by the Canadian Well Logging Society in May 1959. It essentially involves a comparison of logging techniques for various areas in western Canada. The types of logs (such as induction-electric log, microlog, microlaterolog, gamma ray-sonic log or neutron log) to be used and the order of usage are discussed for Saskatchewan, northeastern British Columbia, central Alberta, the Swan-Hills-Whitecourt area, and the foothills.—*V. S. N.*

179–182. Komarov, S. G. Technika promyslovoy geofiziki [The technique of logging geophysics]: Moscow, Gostoptekhizdat, 562 p., 1957.

This is the second, revised edition of the book first published in 1947 (see Geophys. Abs. 135–10630). The length of the book is increased by about 47 percent. The chapter on principal measuring instruments of the first edition has been dropped and the chapter on electric logging increased from 84 to 228 pages. Discussion of logging methods other than electric is also increased from 11 pages in the first edition to 103 pages in the second. Descriptions of Russian geophysical instruments and apparatus replace those of foreign origin that appeared in the first edition. The second edition book is better edited and has no errata list. Of the 163 references given, 135 are in Russian.—*A. J. S.*

179–183. Hamilton, R. G. Supplemental geologic tools: Shale Shaker Digest II (1955–1958), p. 409–410, 1958.

This brief paper, discussing various well-logging tools, serves as an introduction to a group of papers on specific well-logging instruments and methods

presented in this volume of the Shale Shaker Digest (see Geophys. Abs. 179–182,–184–379).—*V. S. N.*

179–184. Franks, Curtis, and White, Bill. More from your dip-log surveys: Shale Shaker Digest II (1955–1958), p. 414–417, 1958.

This paper was previously published in the Oil and Gas Journal, v. 55, no. 14, 1957, and in Shale Shaker, v. 8, no. 8, 1958 (see Geophys. Abs. 175–152).—*V. S. N.*

179–185. Hammond, Rolt. Tunnel engineering: New York, Macmillan Co., 332 p., 1959.

The chapter entitled "Tunnelling through difficult ground" contains sections on resistivity measurements, seismic methods, gravity surveys, and magnetic surveys. These are discussed with respect to their application to tunnel engineering.—*J. W. C.*

179–186. Vitásek, František. Fysicky Zeměpis [Physical geography]: Praha, Nakladatelstvi Československá Akad. Věd, 598 p., 1954.

This is the third edition of the second volume of a textbook by Professor Vitásek on physical geography, published by the Czechoslovakian Akademy of Sciences. The book contains several chapters of interest to geophysicists. Among them are a discussion of the figure of the earth and the methods of investigation of its gravitational field; the thermal properties of the earth; and discussion of geomagnetic phenomena and their variations. Volcanic phenomena (volcanoes, geysers, mud volcanoes) are discussed in a separate chapter. Subsequent chapters treat seismic phenomena, including earthquake energy, wave propagation, and the geographic distribution of seismic centers. This is followed by a discussion of vertical and horizontal displacements of the ground, continental drift, and polar wandering.—*S. T. V.*

GEOTECTONICS

179–187. Kennedy, George C. The origin of continents, mountain ranges, and ocean basins: Am. Scientist, v. 47, no. 4, p. 491–504, 1959.

Four major observations—persistence of continents and mountain ranges in spite of high erosion rates, relatively uniform heat-flow values in continents and ocean basins, subsidence of marginal troughs in response to loading by low-density sediments, and uplift of plateaus once worn to sea level—suggest the inadequacy of the traditional view that continents represent masses of low density sial floating in denser sima. Theoretical considerations, largely confirmed by recent experimental work in the field of high pressures, suggest that the Mohorovičić (M) discontinuity is the result of a phase change from gabbroic to eclogitic material. Differences in depth of the M discontinuity under mountains and under oceans can be explained by the fact that the phase change takes place at a different pressure for a different temperature.

The uplift of continents from sea level to high plateaus is the consequence of warming of the rocks near the M discontinuity a few tens of degrees, so that the phase change migrates downward; convection currents are no longer needed to explain the uplift. As mountains are eroded, the pressure underneath decreases and dense rock at the discontinuity is converted to light rock which rises, keeping the mountains high. Rapid sedimentation in troughs at first increases the pressure with little change in temperature; light rock is converted into dense rock at the discontinuity, and the resulting decrease in volume causes

subsidence. Given sufficient time, however, the temperature rises at the bottom of the trough and the discontinuity ultimately migrates upward. This implies that mountains are generated largely because of vertical motion; major faults and folds are gravitational in origin, although concomitant lateral thrust of other origin is not excluded.

If the bulk composition of continental rocks is the same as that of oceanic rocks, the uniform heat flow is accounted for. Minor variations from place to place are necessary to account for the existence of ocean basins, continents, and mountains on the basis of a phase change. This change must take place over a considerable depth interval.—*D. B. V.*

179–188. Magnitskiy, V. A. K voprosu o proiskhozhdenii i putyakh razvitiya kontinentov i okeanov [On the problem of the origin and course of evolution of the continents and oceans]: Akad. Nauk SSSR Voprosy Kosmogonii, v. 4, p. 5–38, 1958.

The problem of origin of the oceanic and the continental parts of the earth's crust is discussed, and the hypotheses of ocean expansion due to the subsidence of continents and of continental growth at the expense of oceanic areas are analyzed and compared. At present neither hypothesis can be proved nor disproved; Magnitskiy favors the second, which finds support in recent investigations and coring of the ocean floors. Bibliography consists of 85 titles.—*A. J. S.*

179–189. Bubnov [Bubnoff], S[erge] N. Tektonicheskiye fazy i kharakter protsessov deformatsii Zemli, svyazannykh s eye vnutrenney dinamikoy [Tectonic phases and the nature of deformation processes of the earth related to its internal dynamics]: Moskov. Obshch. Ispytateley Prirody Byull., v. 63, Otdel. geol., v. 33, no. 1, p. 3–6, 1958.

Bubnoff discusses the continuity and duration of tectonic phases and concludes that they are not isolated impulses but the sum of successive impulses grouped in spectrumlike geochronological bands, concentrated toward the center of the phase. It is very possible that the impulsive (orogenic) movements are accompanied by continuous (epirogenic) movements. The duration of a phase depends on the stresses and strains involved as well as on the properties of the material.—*A. J. S.*

179–190. Aubouin, Jean. À propos d'un centenaire: les aventures de la notion de géosynclinal [Apropos of a centenary: the adventures of the geosyncline concept]: Rev. Géographie phys. et Géologie dynam., v. 2, no. 3, p. 135–188, 1959.

This is a comprehensive review of the geosyncline concept. Its historical development is traced. The classifications of Schuchert, Stille, Kay, and Peyve and Sinitsyna are compared; a new classification is proposed that is essentially the same as Peyve and Sinitsyna's but uses classical terminology. The second part of the paper is a detailed description of the characteristics of geosynclines, including discussion of their sedimentation, tectonics and orogenesis, metamorphism and magmatism, evolution, and location. An extensive bibliography is appended.—*D. B. V.*

Grossling, B. F. Temperature variations due to the formation of a geosyncline. See Geophys. Abs. 179–237.

179–191. Eygenson, M. S. Solnechnaya aktivnost', geodinamika i geotektonika [Solar activity, geodynamics, and geotectonics] : L'vov. Geol. Obshch. Geol. sbornik, no. 5–6, p. 433–446, 1958.

The problem discussed in this paper concerns the assumed correlation between solar activity and geotectonics via geodynamics. The effect of variation in solar activity on the circulation of the atmosphere and hydrosphere of the earth is discussed. This affects the angular velocity vector of the earth's rotation and the direction of its axis, resulting in tectophysical phenomena, geomagnetic activity, and variation in seismicity (see Geophys. Abs. 154–14624, –14684). A correlation coefficient of 0.9 has been established between the values A, P, and T of the earth's rotation (A=amplitude and P=duration of the 14-month Chandler period, and T=year-to-year variation in the period of the earth's rotation) and the seismicity index of the earth.—*A. J. S.*

179–192. Stovas, M. V. Neravnomernost' vrashcheniya zemli kak geotektonicheskiy faktor [Variation of the earth's rotation as a geotectonic factor] : Vses. Geog. Obshch. Izv., v. 91, no. 4, p. 336–341, 1959.

The three types of variation in the angular velocity of the earth (monotonic decrease due to tidal friction amounting to 0.0024 sec per 100 yr; the sporadic variation different in magnitude and sign, reaching 1.6 sec per yr; and seasonal variation due to changes in atmospheric circulation) are discussed, and their geotectonic influence is evaluated qualitatively. Any change in the rate of the earth's rotation causes a corresponding change in the deformation potential, which determines the figure of the earth. This results in a variation in the values of the inertial deformation forces (see Geophys. Abs. 178–206), and consequently causes tectonic movements of the earth's interior and the crust. Stovas arrives at a distribution of deformation forces due to the conservation of angular momentum working against the change in angular velocity of the earth, and finds that latitudes $\pm 35°$ are critical (see Geophys. Abs. 178–52, 207), as derived previously by A. Veronnet (1912). These are the parallels of maximum seismic and tectonic activity; San Francisco, Mexico, Lisbon, Sicily, Calabria, Iran, and Japan are crossed by the $+35°$ parallel, and Cape Ridge, Melbourne, and Buenos Aires are on the $-35°$ parallel. Data confirming the correlation of tectonic movements with changes in rate of rotation are discussed, and a graph shows the principal tectonic movements and large oceanic transgressions during the geologic past.—*A. J. S.*

179–193. Menard, H[enry] W. Minor lineations in the Pacific Basin: Geol. Soc. America Bull., v. 70, no. 11, p. 1491–1496, 1959.

Two patterns of minor lineations are identified in the Pacific basin: a pinnate pattern centered on major lineations and a less definite herringbone pattern extending across crustal blocks and changing direction at the fracture zones in the northeastern Pacific. Both major and minor lineations have a relatively constant trend in very large areas near the continental margins of North and South America.

The scale of crustal distortion implied by the common association of minor- with major-lineation patterns merits attention. If a mirror image of the Hawaiian Islands lineation is compared with the San Andreas fault, the minor lineations associated with Hawaii lie in the same area as the Basin and Range province and have about the same trends, spacing, and lengths as individual ranges; this may be coincidence, but the scale is significant. Horizontal displacement along the San Andreas fault implies major crustal shortening and

stretching somewhere. The distribution of major and minor lineations on the sea floor suggests that the secondary effects of large-scale wrench faulting may be looked for far afield.—*D. B. V.*

179–194. Belousov, V. V. Tektonofizika—novoye perspectivnoye napravleniye v geologii [Tectophysics—a new prospective outlook in geology]: Akad. Nauk SSSR Vestnik, no. 9, p. 3–10, 1958.

After a historical review of physical hypotheses and theories of the mechanism of faulting, folding, and other tectonic deformations in the earth's crust, Belousov describes the developments in this field of dynamic geology and experimental tectonics in the U.S.S.R. since 1944. Studies of the physicomechanical properties of rocks, the physical-similitude method, and tectophysical modeling are discussed.—*A. J. S.*

179–195. Ma, Ting Ying H., and Pan, Chia-Lin. Development of volcanic belts together with zones of deficient gravity along the margin of shifted crustal masses: Bull. volcanol., v. 21, p. 103–107, 1959.

The relationship between zones of negative gravity anomalies and volcanic and seismic belts can be explained in terms of sudden total displacement of the solid earth shell. Gravity deficiency results only on the forward edge of shifted crustal masses; therefore, a zone of negative gravity anomaly is always accompanied by a zone of active or dwindling volcanism. Since sudden total displacement of the solid earth shell has occurred repeatedly during geologic times, traces of old volcanic belts with no coexisting gravity anomalies mean that the gravity deficiency has been removed. (See also Geophys. Abs. 174–172.)—*D. B. V.*

179–196. Yamaguti, Seiti. On the change in the heights of bench marks between Tokyo and Misaki at Kanagawa Prefecture. Change in the heights of fixed plane inside the mareographic station at Aburatubo: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 33–37, 1959.

Comparison of results of the precise-levelling survey of 1957 between Tokyo and Misaki, Japan, with earlier survey results (1952 and 1955) suggests the existence of block motions of the crust in this district. Analysis of mareograph records from the Aburatubo station shows a variation having an 18-year period; this may be a result of the earth's tide due to the motion of the moon's ascending node, or to change of the mode of rotation of the earth. The change in sea level is of the same order as the change in the earth's crust.—*D. B. V.*

GRAVITY

179–197. Barta, G[yörgy]. On the secular variation of the level surface of gravity: Univ. Sci. Budapestinensis Eötvös Annales, sec. geol., v. 2, p. 15–19, 1958.

A 50-year pulsation can be observed in the secular variation of the geomagnetic field as well as in the angular velocity of the earth. These phenomena are explained by movement in the earth's core. It is concluded that a similar oscillation must be present also in the secular variation of the observed average sea level. Using data of different distant mareograph stations, a 50-year undulation in the trend of the curves can be established. The above phenomena are related to a general worldwide process.—*J. W. C.*

179–198. Pawłowski, Stanisław. Valeur de la pesanteur pour le point fondamental de Varsovie [Value of gravity for the base point of Warsaw] : Bull. géod., no. 53, p. 75–86, 1959.

Provisional gravimetric measurements in Poland have established the gravity value at Warsaw as g=981.2412 cm per sec^{-2}. Analysis of results obtained in a system of gravity ties with Potsdam shows that the more probable value of gravity at Warsaw is g=981.2400±0.0002 cm per sec^{-2}. This value has been verified by analysis of indirect ties through the pendulum points of Kielce, Krakow, and Racibórz, and through Ciechanów, Goldap, Susz, and Szczytno.

In the last part, the results of recent absolute gravity measurements at Washington and Teddington are reported; these show that there is a difference of 15–20 mgal between the absolute system and that of Potsdam.—*D. B. V.*

179–199. Vajk, Raoul. How to correct and interpret gravity data : World Oil, v. 149, no. 6, p. 143–145, 1959.

The most important corrections of gravity data in exploration are latitude correction, elevation correction (free-air and Bouguer) and, to some extent, terrain and regional corrections. The Bouguer gravity may commonly shows a regional-gravity effect, which is a dominant, deep-seated geologic feature that veils gravity anomalies caused by geologic structures of possible economic interest. No other field of gravity interpretation has caused so much controversy as correction for the regional effect. The difficulty stems from attempting to determine the components of a sum when it is not known how many numbers were added. Preference is expressed for a method whereby the gravity anomalies are analyzed and broken up into components on a basis of geological and geophysical consideration.—*J. W. C.*

179–200. Balabushevich, I. A. Rashenne pramoy i advarotnay zadachy gravimetryi pa drugoy vertykal'nay vytvornay sily tsyazharu dlya uzbudzhal'nykh tsel prastseyshay formy (artykul 1-y) [Solution of the direct and inverse gravimetric problems of vertical gradient for simple form disturbing bodies (part 1) (in White Russian)] : Akad. Nauk Beloruss. SSR Vestsi, ser. fiz.-tekh. nauk, no. 2, p. 96–110, 1958.

The methods of calculation of higher derivatives of gravity on the axis z—$(\partial g/\partial z)$ and $\partial^2 g/\partial^2$ are regarded as effective but subject to the influence of regional anomalies that conceal the local anomalies sought for. Balabushevich presents solutions of the direct and inverse problems of determination of the derivative $\partial^2 g/\partial z^2 = g_{zz}$, aiming at criteria for a qualitative (and under favorable conditions quantitative) interpretation of maps of the second vertical derivative constructed according to Elkins (see Geophys. Abs. 144–12620) and Rosenbach (see Geophys. Abs. 155–14811). Solutions are given for a sphere, vertical and horizontal circular cylinder, horizontal half plane, horizontal half-layer (ledge) with vertical cutoff, a horizontal plane strip, a horizontal infinite parallelepiped, a vertical plane strip, vertical half plane, and a vertical layer.—*A. J. S.*

179–201. Zidarov, D., and Sakalian, K. Experimental-model solution of the inverse gravimetric and magnetometric problems: Bolgar. Akad. Nauk Doklady, v. 12, no. 1, p. 29–32, 1959.

A device is described for modelling gravity anomalies. A transparent-walled cube W filled with inert gas contains a large number of electrode couples arranged

so that their centers form a cubic lattice. By means of a switchboard, voltage from a generator can be applied to any of the couples, producing luminous gas discharge in the space between them. Any space $T^{(n)}$ can be filled with light sources of equal intensity. The illumination E_z $(x'_1\ y')$ cast by the sources uniformly filling the region $T^{(n)}$ onto the plane $x'y'$ at a certain distance from the cube is proportional to the vertical gradient V_z $(x'_1\ y')$ of the gravitational field of the same region $T^{(n)}$, with homogeneous density of the masses contained in $T^{(n)}$. The obtained function is electronically modelled by means of a television camera.

A suitably illuminated light-coded map of $V_z(x,y)$ obtained from gravity measurements is placed before a second television camera, and the form of the disturbing body is found by varying the body model $T^{(n)}$ until a comparable image is produced.

The inverse magnetic problem is solved by an analogous model.—*D. B. V.*

179–202. Nedialkov (Nedyalkov), I. P., Stainov (Staynov), G. L. Ormandjiev (Ormandzhiyev), S. I., and Iliev (Iliyev), I. D. High speed computing device for interpretation of gravity anomalies: Bolgar. Akad. Nauk Doklady, v. 12, no. 1, p. 37–40, 1959.

A device for high-speed computation of the direct and indirect gravimetric problem for the two-dimensional case (ore veins) is described; it consists of an electrolytic tank model (see Geophys. Abs. 177–114) with an auxiliary device for computing errors. The function of the latter is to solve the inverse problem on the basis of the solution of the direct problem by applying the method of consecutive approximation.—*D. B. V.*

179–203. Dimitrov, L. V. Graficheskiy sposob vychisleniya znacheniy vtoroy vertikal'noy proisvodnoy potentsiala sily tyazhesti [A graphic method of the evaluation of the second vertical derivative of the gravity potential] : Akad. Nauk SSSR Izv. ser. geofiz., no. 4, p. 617–620, 1959.

A graphic method of evaluating the second vertical derivative of gravity, U_{zz}, is suggested. The procedure is explained and illustrated by several figures and lengthy computations.—*S. T. V.*

179–204. Zagonov, A. V. Logarifmicheskiye paletki Δg dlya polusfery i beskonechnogo polutsilindra [Logarithmic nomograms of Δg for a hemisphere and an infinite half-cylinder] : Prikladnaya Geofizika, v. 20, p. 101–108, 1958.

The use of known formulas for the attraction of a hemisphere and of an infinite half cylinder make possible an approximate evaluation of the gravitational effect of salt domes and of anticlines. This procedure is very time consuming and the inverse problem is still more time consuming; therefore, it is very important to have a set of theoretically computed curves constructed in logarithmic scale. The use of such nomograms makes it possible to use not only individual characteristic points of the curve but also its entirety. Examples of such curves are reproduced.—*S. T. V.*

179–205. Raspopov, O. M. Povedeniye vertikal'nogo gradienta sily tyazhesti v gornom rayone [The behavior of the vertical gradient of gravity in a mountainous region]: Akad. Nauk SSSR Izv. ser. geofiz., no. 8, p. 1231–1234, 1959.

Gravity anomalies Δg and the gravity gradient $\Delta\Theta$ were measured at 38 stations, located at different heights from deep in a valley to the highest ridges of the Caucasus. As expected, the lowest values of Δg were found on the tops of ridges; $\Delta\Theta$ was computed using Numerov's formula (see Geophys. Abs. 178–222). Geographic coordinates of the stations, measured values of Δg, and computed values of $\Delta\Theta$ are given in a table. It is concluded that the field of the vertical gradient of gravity is determined primarily by near-surface masses.—*S. T. V.*

179–206. Murphy, Thomas. The changes of sensitivity and drift rate of a Worden gravimeter with time and temperature: Geofisica Pura e Appl., v. 43, p. 209–217, 1959.

Comparison of readings made during 4 years of fieldwork with laboratory tests shows that the behavior of a Worden gravimeter is not dependent on vibration and that drift can be separated into two distinct parts, isothermal and thermal. The isothermal drift is remarkably constant over short and long periods of time and is of the order of 0.01 mgal per hr. The thermal drift is complicated and depends on the fact that the rate of change of the ambient temperature is different in size and sign for rapid and slow changes of temperature. Sensitivity changes slowly with time, 0.1 percent per yr, and is only slightly affected by temperature. Tares or jumps in the readings are very rare. The inclusion of a rheostat in the lighting circuit and attachment of a thermometer to the outside of the instrument are recommended. To keep drift correction small and increase accuracy, returns to base station should be made according to changes in ambient temperature rathen than at fixed time intervals.—*D. B. V.*

179–207. Petrova, Ye. M. Opyt primeneniya gravimetrov GAK–3M [Experience in application of gravimeters GAK–3M]: Razvedochnaya i Promyslovaya Geofizika, no. 16, p. 52–57, 1956.

The performance of quartz-astatic gravimeters of the type GAK–3M introduced in 1954 is discussed. This Russian gravimeter is distinct in its comparatively small dimensions and the absence of thermostats. It is stable and simple in operaton. Elimination of storage batteries from the design makes the apparatus light and portable and convenient for surveys in rough terrains. The studies of the gravimeter GAK–3M and its performance by five field expeditions of Glavneftegeofizika and of the Siberian Airborne Expedition (see Geophys. Abs. 179–208) under varying climatic and terrain conditions of central Asia, the far north, the Siberian taiga (forests), and central U.S.S.R. showed an accuracy of ± 0.4 mgal. This accuracy was increased to ± 0.15 mgal when the gravimeter was used in an ice thermostat. In order to obtain these accuracies the instrument requires field adjustment for the temperature correction.—*A. J. S.*

179–208. Smirnov, L. P. Opyt regional'noy s"yemki s gravimetrami GAK–3M na vertolete [Experience of regional surveying with GAK–3M gravimeter in helicopters]: Razvedochnaya i Promyslovaya Geofizika, no. 16, p. 44–52, 1956.

The GAK–3M gravimeter and its performance in an airborne gravimetric survey in Siberia in 1954 are described. Three GAK–3M, a North American

SAGO, a GKA–3, and a SN–3 were used in the survey; they were transported in helicopters because of the rough terrain. The gravity difference on the Tara-Omsk traverse was found to be 175.50±0.18 mgal between terminals; this value is 1.3 mgals greater than previously determined. The GAK–3M proved to be the best of the Russian-manufactured gravimeters used in the survey; however, considerable nonlinear (approximately parabolic) temperature variation is a disadvantage in its performance.—*A. J. S.*

179–209. Gladkiy, K. V. Vychisleniye popravki za smeshcheniye nul'-punkta pri nablyudeniyakh s gravimetrom [Calculation of the correction for zero point drift in observations with a gravimeter]: Razvedochnaya i Promyslovaya Geofizika, no. 17, p. 65–67, 1957.

Gladkiy derives a formula for zero point drift of a gravimeter: $\Delta g_H = K\Delta T$, where Δg_H is the correction, K is a coefficient that can be calculated, and ΔT is the time elapsed from the beginning of observations to the observation at a given point. He considers the formula to be more accurate than present methods used in repeated gravity observations.—*A. J. S.*

179–210. Veselov, K. E., and Panteleyev, V. L. O vliyanii vozmushchayushchikh uskoremy pri izmerenii sily tyazhesti staticheskim gravimetrom na more [On the effect of disturbing accelerations in gravity measurements with a static gravimeter at sea]: Prikladnaya Geofizika, no. 20, p. 86–100, 1958.

Veselov and Panteleyev analyze the theory of the measurements of gravity force at sea using the static method suggested by Vening Meinesz. The static method consists in the introduction of very strong damping in the moving element of the gravimeter. This change in construction eliminates the high-frequency accelerations produced by movement of the ship, but does not affect low-frequency accelerations caused by the changes in the force of gravity. The effectiveness of this change in construction is measured by the "dynamicity" of the instrument, that is, by the ratio of dynamic deflection to static deflection. The coefficient of dynamicity can be determined from records of the displacements of the moving part of the instrument. This theoretical analysis was tested in numerous experiments, which gave satisfactory agreement with theoretical data. Certain suggestions as to further improvement of the marine gravimeter are also made.—*S. T. V.*

179–211. Harrison, J[ohn] C. Tests of the LaCoste-Romberg surface-ship gravity meter I: Jour. Geophys. Research, v. 64, no. 11, p. 1875–1881, 1959.

Gravity measurements made with a LaCoste-Romberg surface-ship gravity meter on board the M.V. *Horizon* along a 300 mile track off southern California are compared with submarine measurements near the track. The agreement (±5 mgal) is considered to be as close as can be expected from this type of comparison.—*Author's abstract*

179–212. Lejay, Pierre. Rapport sur l'activité du Bureau Gravimétrique International. L'établissment d'un réseau nondial homogène [Report on the activity of the International Gravimetric Bureau. The establishment of a uniform worldwide network]: Bull. géod., no. 53, p. 21–26, 1959.

At present the stations of the first-order worldwide gravimetric network form a coherent basis for national networks, except for high-latitude points

where calibration is still a problem. Considerable progress has been made regarding the European calibration base and its tie to the American base. The Bureau has collaborated effectively in the reduction of certain networks by doing part or all of the topographic or isostatic reduction. Worldwide maps of Bouguer and isostatic anomalies (Airy, T–30 km) are in course of preparation.—*D. B. V.*

179–213. Innes, M. J. S. The establishment of a calibration standard for gravimeters in eastern Canada and the United States: Bull. géod., no. 53, p. 53–73, 1959.

This is the same as the paper published in Transactions of the American Geophysical Union, v. 39, no. 2, p. 195–207, 1958 (see Geophys. Abs. 173–198).—*D. B. V.*

179–214. Kneissl, M[ax]. Rapport sur les bases gravimétriques d'étalonnage en Europe [Report on the gravimetric calibration bases in Europe]: Bull. géod., no. 53, p. 27–51, 1959.

The values of the Morelli-Martin gravimetric network, transformed by means of constants calculated on the basis of comparison of this network with a network of 13 principal pendulum stations, are recommended as the calibration values for the principal points of the gravimetric calibration lines of Europe. The variation of constant is annuled by maintaining the fundamental gravity value of 981,180.4 mgal for Harzburg.—*D. B. V.*

179–215. Marzahn, Kurt. Ergebnisse der Pendelmessungen des Deutschen Geodätischen Forschungsinstitutes auf den Stationen der europäischen Gravimetereichlinien [Results of the pendulum measurements of of the German Geodetic Research Institute at the Stations of the European gravimeter calibration lines]: Deutsche Geod. Komm. Veröffentl., ser. B, no. 44, 17 p., 1958.

After discussion of the period of oscillation of the pendulum, the compensation procedure, the partial compensation of the four individual measurement tours, and total compensation, the results of pendulum measurements along the European gravimeter calibration lines are tabulated.—*D. B. V.*

179–216. Marzahn, Kurt. Ausgleichung des Deutschen Schweregrundnetzes (Gravimeter und Pendelmessungen) [Adjustment of the German gravity base network (gravimeter and pendulum measurements)]: Deutsche Geod. Komm. Veröffentl., ser. B, no. 54, 45 p., 1959.

Measurements in the German gravity base network, completed in 1957, have been treated in order to provide a basis for incorporation of the network into an overall European network. The methods and results of the adjustment of pendulum and gravimeter measurements are described. Adjustment of the pendulum network was carried on simultaneously with determination of the scale factor for the gravimeter network. The gravimeter network was checked against pendulum measurements made in 1934–43. An appendix gives the gravity values of the function points of the German gravity base network in the preliminary uniform scale.—*D. B. V.*

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179–217. Hinze, William J. A gravity investigation of the Baraboo syncline region: Jour. Geology, v. 67, no. 4, p. 417–446, 1959.

This paper reports on a gravity investigation of the Baraboo syncline, an inlier of folded Precambrian rocks in flat-lying Paleozoic sediments of south-central Wisconsin. The regional gravity anomaly represents the southern terminus of a gravity minimum that is centered over Wisconsin and in this area ranges from —40 mgal in the south to —70 mgal in the north with local minimums of —90 mgal. This minimum is interpreted in the light of seismic crustal studies as a result of thickening of the granitic layer and also of the crust as a whole.

A dominant residual minimum with an amplitude of —18 mgal correlates with the Baraboo syncline. As there are no density contrasts in the surface Paleozoic and Precambrian rocks to explain this differential, it is interpreted as a local thickening of the granitic layer to 7.7 km in contrast to the normal 2.8 km. This residual-gravity minimum also suggests that the syncline closes some 5 miles south and west of where previous workers have placed the boundary.

A magnetic study of the Baraboo syncline (Ostenso, 1953) substantiates the conclusions reached from the gravity investigation.—*V. S. N.*

179–218. Bakkelid, Sivert. Gravity observations in a submarine along the Norwegian coast: Norges Geog. Oppmåling, Geod. pub. no. 11, 30 p., 1959.

Gravity observations made in 1957 and 1958 in a submarine at stations along about 1,000 miles of the Norwegian coast are described. A Vening Meinesz pendulum apparatus was used, and observations were made at depths of 100–150 ft. The stations are plotted on a map, and the gravity data are compiled in a table.—*J. W. C.*

179–219. Inghilleri, Giuseppe. Completamento del rilievo gravimetrico nell' Italia Nord Occidentale [Completion of the gravimetric survey of northwestern Italy]: Boll. Geodesia e Sci. aff., v. 18, no. 3, p. 339–370, 1959.

The methods used and data obtained in a gravimetric survey of northwestern Italy are presented. The 276 stations occupied, together with the 248 stations of Cunietti's survey and 39 of the AGIP Mineraria, increase the average station density for the area to 1 per 100 km^2, as required for the construction of the gravimetric map of Italy. Inghilleri's values were referred to Milan (g=980.-5640 mgal), and the AGIP Mineraria measurements to Padua (g=980.65855 mgal). Complete data for 315 stations (station number, latitude and longitude, altitude, observed and normal gravity, and Bouguer anomaly) are given. Two maps show the gravity network and Bouguer anomalies of the area.—*D. B. V.*

Dąbrowski, Adam. The structure of the deep underground of western Poland according to data of geophysical investigations. See Geophys. Abs. 179–341.

179–220. Socolescu, M. [M.], Bișir, D., Georgescu, M., Popovici, D[orin], and Visarion M[arius] Determinarea anomaliilor reziduale din datele măsurătorilor gravimetrice [Determination of residual anomalies from gravimetric survey data (with French summary)]: Acad. Romîne Studii și cercetări de fizică, v. 9, no. 1, p. 115–126, 1958.

Geological reductions, based on an assumed density of 2.67, are applied to the isostatic map of Rumania to obtain residual anomalies caused by structures

or bodies in the sial not accounted for previously. Gravity-anomaly maps are constructed and interpreted.—*A. J. S.*

179–221. Botezatu, Radu. Cercetări gravimetrice în regiunea Fringhîeşti-Valea Gardurilor Pieptănari [Gravimetric investigations in the region of Fringhîeşti-Valea Gardurilor-Pieptănari (in Rumanian, with Russian and French summaries)]: [Rumania] Com. Geol. Dări de Seamă ale Şed., v. 42, p. 159–170, 1954–55 (1959).

The results of detailed gravity studies are presented and interpreted. The gravity anomalies in general are in accord with the major tectonic and stratigraphic elements of the area. The gravity map shows many possible structures and salt concentrations.—*Author's summary, J. W. C.*

179–222. Popovici, Dorin. Prospecţiune gravimetrică în regiunea Ocnele Mari (Vîlcea) [Gravity exploration in the region of Ocnele Mari (Vîlcea) (in Rumanian with Russian and French summaries)]: [Rumania] Com. Geol. Dări de Seamă ale Şed., v. 42, p. 171–189, 1954–55 (1959).

This gravity survey of 1952 was designed for locating salt domes. The density of stations on the gravity net was about 30 per km^2, and 95 km^2 were surveyed. A Bouguer-anomaly map is presented; the value of the contour interval is 0.5 mgal. Three large areas are distinguished on the gravity map.—*Author's summary, J. W. C.*

179–223. Botezatu, Radu. Cercetări gravimetrice în regiunea Vrancea de Nord [Gravity research in the region of North Vrancea (in Rumanian, with Russian and French summaries)] [Rumania] Com. Geol. Dări de Seamă ale Şed., v. 42, p. 203–214, 1959–55 (1959).

Gravity measurements in this region have revealed a number of gravity anomalies which are interpreted according to the known and the probable geological data. A large fault is marked by a gravity minimum. Other gravity minimums are associated with salt deposits. The gravity maximums are related to facies changes where salt is not involved.—*Author's summary, J. W. C.*

179–224. Visarion, Marius. Cercetări gravimetrice în Transilvania de NNE, cu privire specială asupra regiunii Bistriţa [Gravimetric measurements in the NNE part of Transylvania with a special survey of the Bistriţa region (in Rumanian, with Russian and French summaries)]: [Rumania] Com. Geol. Dări de Seamă ale Şed., v. 42, p. 215–229, 1954–55 (1959).

The relationship between gravity anomalies and the geologic structure in the north-northeast part of Transylvania is examined. The fieldwork was done in 1952–53. The Bouguer map shows a positive anomaly that separates two gravity lows; this corresponds to a horst in the basement flanked by thick low-density sediments.

Application of the gravity method in this region is favored by the presence of salt masses flanked by rocks of higher density. The anticlines thus correlate with negative anomalies and the synclines with positive.—*Author's summary, J. W. C.*

179–225. Airinei, Şt[efan]. Cercetări gravimetrice si magnetice în regiunea Singeorgiul de Padure-Miercurea Nirajului [Gravimetric and magnetic research in the region of Singeorgiul de Padure-Miercurea Nirajului (in Rumanian, with Russian and French summaries)]: [Rumania] Com. Geol. Dări de Seamă ale Şed., v. 42, p. 231–244, 1954–55 (1959).

Gravimetric and magnetic investigations were carried out in 1954 in the Transylvanian Basin of Rumania. An area of 800 km^2 was covered, and 1,267 stations were occupied. The Bouguer anomalies are contoured on a gravity map, and the ΔZ values on a magnetic map. In the north the gravity picture is controlled by the basement, and the magnetic field shows steeper gradients. In the south the gravity and magnetic fields correspond to and are attributed to the presence of salt masses.—*Author's summary, J. W. C.*

179–226. Botezatu, Radu. Cercetări gravimetrice de-a lungul vaii Carierii (reg. Constanta) [Gravity investigations along the valley of the Carierii (Constanta region) (in Rumanian, with Russian and French summaries)]: [Rumania] Com. Geol. Dări de Seamă ale Şed., v. 42, p. 245–250, 1954–55 (1959).

The results are presented of experimental local gravity surveying in an area where a fault is known from drilling. The gravity data reveal the fault, and its slip is estimated. A gradual change in gravity value across the area is attributed to the relief of dense Mesozoic and Paleozoic rocks that lie beneath Quaternary material.—*Author's summary, J. W. C.*

179–227. Kozlov, P. T. K voprosu ob ekonomicheskom effekte razvitiya gravitatsionnoy razvedochnoy apparatury [Question of the economic effect of development of gravity exploration apparatus]: Razvedochnaya i Promyslovaya Geofizika, no. 27, p. 90–106, 1959.

Gravity surveying parties in the U.S.S.R. in 1955 numbered 107 of a total of 435 geophysical parties involved in oil exploration; this method stands second to seismic surveying in number of parties and accounted for one-seventh of the expense for geophysical exploration. Gravity surveying occupies first place in area covered; 506,000 km^2 were surveyed in 1955.

The technique of gravity investigations has passed through two stages. The first of these extended from the first use of gravity exploration in the 1920's until the early 1940's. A pendulum instrument was used for general regional study, and the variometer for detailed work in individual areas. The second stage, which began with the 1940's, was marked by the introduction of static gravimeters of different kinds.

The cost of gravity surveys is broken down according to unit area and points for different instruments. A complaint is recorded that research on gravity meters is handled by one agency and construction by another; there is no coordination between the two agencies.—*J. W. C.*

178–228. Borisov, A. A. Anomalii sily tyazhesti i genezis struktur Russkoy platformy [Gravity anomalies and the genesis of structures of the Russian platform]: Geologiya Nefti, no. 9, p. 43–49, 1957.

The gravity field of the Russian platform has been studied in detail by pendulum and gravimeter surveys. The average Bouguer anomaly of this territory is close to zero. Most of the anomalies do not exceed 30 to 40 mgal, and only a few are 60 to 80 mgal. There is no relationship between shield areas and

type of anomaly; the Baltic shield is weakly negative and the Ukrainian is positive. The Donets Basin is negative and the Black Sea depression is positive. After correcting for lack of mass of the sedimentary cover, however, the syneclises turn out to be positive and the uplifts are negative.

There is an intimate relation between the anisotropy in the deep zones of the earth and the structural forms of the platform. The syneclises occur where there is an excess of mass at depth. The downward movement of the syneclises leave the intervening areas at a less subsided level; these are the anteclises. An anteclise may have subsided greatly, but with respect to the syneclises it is in an uplifted position.—*J. W. C.*

179–229. Tsimel'zon, I. O. O sootnosheniyakh mezhdu lokal'nymi anomaliyami sily tyazhesti i tektonikoy neftegazonosnykh oblastey [Relationship between local gravity anomalies and the structure of oil and gas districts]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Neft' i gaz, no. 8 p. 13–16, 1959.

Gravity maximums have generally been associated with uplifts; exceptions have been few. In the area of the Apsheron Peninsula and Kobystan, however, individual structures and even whole structural zones are not recorded on the gravity maps by clear anomalies. Reinterpretation of the gravity data of these areas has demonstrated that in areas of discontinuous and intermediate Tertiary folding, the most intensive local minimums represent zones of fractured, less dense rocks; these generally occur at the crest of domes. The strongest minimums in west Apsheron and in Kobystan are over areas of mud volcanoes. Other examples of the coincidence of gravity minimums and uplifts are cited from the literature. (See also Geophys. Abs. 166–227.)—*J. W. C.*

179–230. Moiseyenko, F. S. O znachenii malykh gravitatsionnykh anomaliy dlya poiskov redkometal'nykh mestorozhdeniy v Tsentral'nom Kazakhstane [On the significance of small gravity anomalies for the prospecting of rare metal deposits in central Kazakhstan]: Akad. Nauk SSSR Doklady, v. 128, no. 1, p. 144–147, 1959.

The results of gravimetric surveys on a scale of 1:500,000 of several deposits of tungsten or molybdenum (or both) in the central Kazakh S.S.R. support Emmons' idea of preferred concentration of ores in areas of intrusive cupolas and the like, also Kropotkin's concept of a direct relationship of mineralization to granite intrusions rather than to hypothetical deeper sources.

The procedure involves 2 or 3 intersecting ("asterisk") profiles with station intervals of 1–2 km; the length of the profiles should be at least 10–30 km. The observed Δg curves are interpreted strictly in the light of geologic data.—*D. B. V.*

179–231. Mudaliar, S. K. S. The Indian programme for the International Geophysical Year, pt. 2 of Survey of India's contribution: Jour. Sci. Indus. Research [India], v. 18A, no. 8, p. 343–346, 1959.

Gravity research in India during the International Geophysical Year consisted of observations of earth tide and of deflections of the plumbline. Geomagnetic work comprised a general survey and detailed surveys of several magnetically disturbed areas; absolute observations of dip, horizontal intensity, and declination were made at 52 old repeat stations in various parts of India, and 6 new repeat stations.—*D. B. V.*

179–232. Yokoyama, Izumi. Gravity survey on Kuttyaro caldera lake: Jour. Physics of Earth [Tokyo], v. 6, no. 2, p. 75–79, 1958.

A condensed version of this paper has been published by Yokoyama and Tajima in Nature, v. 183, no. 4663, p. 739–740, 1959 (see Geophys. Abs. 176–198).—*D. B. V.*

179–233. Thiel, Edward, and Behrendt, John C. Gravity and magnetic measurements on the Ellsworth oversnow traverse, 1957–1958, *in* Seismology, gravity, and magnetism: Am. Geog. Soc., IGY World Data Center A, Glaciol. Rept. Ser. no. 2, p. 1–21, 1959.

Gravity and vertical magnetic intensity observations were made at 5-mile intervals on the Ellsworth oversnow traverse of 1957–1958, which covered unexplored portions of the Filchner Ice Shelf, adjacent islands, and land. Reduced data for the measurements is presented without interpretations.—*V. S. N.*

179–234. Thiel, Edward. Gravity base stations, Antarctica *in* Seismology, gravity, and magnetism: Am. Geog. Soc., IGY World Data Center A, Glaciol. Rept. Ser. no. 2, p. 1–10, 1959.

Gravity bases on the Pacific and Atlantic sides of the Antarctic continent are described, and observed gravity values given. All American and some foreign gravity measurements on the Pacific side of the continent are tied to the McMurdo station, the only pendulum station to date in Antarctica. Gravity measurements on the Atlantic side are tied to the Ellsworth base station; because of the lack of a pendulum tie here, the Ellsworth value is less certain than the McMurdo value.—*V. S. N.*

179–235. Ostenso, Ned A., and Bentley, Charles R. Gravity and magnetic studies on the Marie Byrd Land traverses, 1957–1958, *in* Seismology, gravity, and magnetism: Am Geog. Soc., IGY World Data Center A, Glaciol, Rept. Ser. no. 2, p. 1–47, 1959.

This report covers the results of the gravity and magnetic program conducted by the Byrd Station Traverse Party on the two seismic traverses in Marie Byrd Land. Preliminary interpretations are discussed and the results of traverse measurements are given in three appendixes.—*V. S. N.*

HEAT AND HEAT FLOW

179–236. MacDonald, Gordon, J. F. Calculations on the thermal history of the earth: Jour. Geophys. Research. v. 64, no. 11, p. 1967–2000, 1959.

The possible thermal history of a spherically symmetrical earth is studied by comparing numerical calculations of the development of temperature within a number of models with observations on the present thermal state of the earth. The average surface heat flow is taken as 50 ergs per cm^2 per sec, and it is assumed that the mantle is solid and that electrical conductivity increases rapidly in the outer few hundred kilometers of the earth.

Models incorporating a wide range of initial conditions reproduce qualitatively the electrical conductivity of the earth. Chondritic models reproduce the present surface heat flow to within a factor of 2. Variability in heat flow among models is due to varying contributions of "initial heat," higher radio-

genic heat in the past, and depth of burial of heat sources. The general features of temperature-depth curves are similar for many models in which energy is transmitted by radiation as well as by ordinary lattice conduction. The temperature gradient is high near the surface but decreases within the earth as effective conductivity increases with increasing temperature. Melting temperature is most closely approached or exceeded in the outer few hundred kilometers of the earth. Surface heat flow is found to be constant in time for a wide range of models, provided that heat is transmitted solely by radiation and conduction.—*D. B. V.*

179–237. Grossling, B. F. Temperature variations due to the formation of a geosyncline: Geol. Soc. America Bull., v. 70, no. 10, p. 1253–1282, 1959.

The perturbation of thermal equilibrium produced by subsidence and sedimentation in the earth's outer layers has been investigated by means of two models. In the first the heat reaching the surface is generated in the interior, in the second, in the crust. Each model consists of three horizontal layers representing the sedimentary layer, the crystalline continental crust, and the plastic substratum. It is assumed that at a particular instant the thickness of the top layer is increased. A theory is developed to determine the subsequent temperature variations. Also, asymptotic values are found for large times. The temperature variations are evaluated for subsidences of 6 and 13 km, assuming thickness of 2 and 30 km for the sedimentary and crystalline layers respectively.

It is concluded that rapid subsidence and sedimentation produce important temperature variations in the earth's outer layers. Similar results are obtained for both models. The variations are practically the same up to about 5 million years in the sedimentary layer and upper crust; after that, the increase is more rapid in the first model. Temperatures in the lower crust are built up more rapidly from the beginning in the first model. Temperature increases rapidly for about the first 20 million years, thereafter increases much less rapidly. For large times the deviation from the steady state is a linear function of depth and varies as $t^{-3/2}$, if heat comes from the interior, or as $t^{-1/2}$, if it is generated in the crust.

The times required for the adjustment are large enough to be significant in geological processes. The decrease in crustal strength (due to increase in temperature) after the subsiding stage in the evolution of a geosyncline may control the time at which folding begins; the folding stage would take place 15–20 million years after subsidence.—*D. B. V.*

179–238. Egyed, L[ászló]. On the origin of terrestrial heat flow: Univ. Sci. Budapestinensis, Eötvös Annales, sec. geol., v. 2, p. 89–92, 1958.

It is proposed that at least part of the heat being transferred in terrestrial heat flow is due to a plastic release of the elastic stresses caused by the expansion of the earth. This mechanism at the same time makes understandable the fact that terrestrial heat flow is independent of crustal structure.—*Author's summary*

179–239. Rikitake, Tsuneji. Studies of the thermal state of the earth. The second paper: Heat flow associated with magma intrusion: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 233–243, 1959.

The conduction of heat within and outside of a magma suddenly intruded into a spherical cavity in the earth's crust is discussed, and the changes in geothermal gradient and in heat flow at the earth's surface directly above the magma are calculated. It is assumed that the initial temperatures within and without the sphere are constant and zero, respectively, and that the temperature of the earth's surface is kept at zero.

It is found that the geothermal gradient at the surface increases gradually to a maximum, then slowly diminishes. The maximum depends on the size and depth of the sphere. If the radius and depth of the center of the sphere are 2 and 5 km respectively, the gradient corresponding to an initial temperature of 1,300° C reaches a maximum of about 40° C per km, for a usual thermal diffusivity of rocks, some 6×10^4 yr after the intrusion. As this is only about twice the gradient due to general crustal heat flow, it would not be easy to detect a magma mass of this size and depth by surface geothermal-gradient measurements. The large geothermal gradients observed in some volcanic areas probably are caused by high-temperature masses permeated with hot gases at a depth of 1 km or less.—*D. B. V.*

179–240. Boldizsár, Tibor. Geothermisches Temperaturfeld und die Aufwärmung der Grubenwetter [Geothermal temperature field and the heating up of mine damp]: Freiberger Forschungshefte C60 Geophysik, p. 76–85, 1959.

The temperature field of the earth's crust depends on the terrestrial heat flow and on the heat conductivity of rocks; therefore, the heat-flow value is of fundamental importance to miners in calculations of the heating of mine damp. The so-called geothermal step (reciprocal of geothermal gradient) is not suitable for this purpose. The term "geothermal step" has been incorrectly used until now in the technical literature; the correct definition is given as $gg=H/(T_H-T_o)$, where gg=geothermal gradient, H=depth, T_H=temperature at the depth, T_o=amplitude of the temperature wave. T_o can be obtained approximately from the many-year average of mean temperature of the ground surface.

In conclusion the concept of geothermal gradient is considered. The average geothermal gradient, used until now for characterizing the temperature field in the earth's crust, is not suitable for that purpose and meets neither theoretical nor practical (mining) requirements. Without knowledge of heat flow and the thermal values of individual layers, neither theoretical nor practical investigations rest on adequate foundations.—*D. B. V.*

179–241. Lachenbruch, Arthur H. Periodic heat flow in a stratified medium with application to permafrost problems: U.S. Geol. Survey Bull. 1083–A, p. 1–36, 1959.

Solutions to the Fourier heat equation for quasi-steady periodic flow in a stratified semi-infinite medium can be obtained readily by standard methods. The results have wide application to studies of earth-temperature variations induced by diurnal, annual, and other periodic variations in ground-surface temperature. Much of the previous work on this subject has been interpreted with reference to the solution for the homogeneous case; this can be seriously in error when applied to stratified earth materials.

One application of the theory is to the important problem of determining the minimum thickness of gravel fill required to maintain the material on which it rests (the subgrade) in a perennially frozen state in permafrost areas. The results indicate that the required fill thickness is very sensitive to the thermal properties of the subgrade. If a thin layer of material with a low thermal contact coefficient, such as spruce logs, is placed between the fill and subgrade, the thickness of fill required to maintain undisturbed permafrost can be greatly reduced.

The thermal properties of the soil beneath the layer supporting plant growth can have an important influence on the temperature in that layer. This effect, which cannot be explained by studies of the ground surface and the surficial layer, is likely to have important application to plant ecology in the arctic.

The theory yields an approximate method of estimating the effect of winter snow cover on the mean annual temperature of the ground surface.—*Author's abstract*

179–242. Lachenbruch, Arthur H., and Brewer, Max C. Dissipation of the temperature effect of drilling a well in Arctic Alaska: U.S. Geol. Survey Bull. 1083–C, p. 73–109, 1959.

Temperature measurements to a depth of 595 feet were made during a period of 6 years after the drilling of a 2,900-foot well near the Arctic coast at Barrow, Alaska. The temperature-time curves for depths from 295 to 595 feet fit a simple 2-parameter logarithmic formula within instrumental error (±0.01° C) for data taken during the last 4½ years. This formula, which is of the type proposed by Bullard, is based upon a highly simplified theoretical model of the thermal history of the well. The general features of the temperature-time curves for earlier times can be explained in terms of the various physical factors neglected in the simplified model. The analysis indicates that the thermal disturbance decreased from about 20° C to about 0.1° C in the 6-year period following drilling. It is estimated that about 50 years will elapse between the time of drilling and the time the temperature disturbance caused by drilling diminishes to 0.01° C in the depth range studied.

This work probably forms an adequate basis for the study of secular changes in ground temperature that are measurable during the period of observation. Such changes have been observed at all depths from 75 to 275 feet.—*Authors' abstract*

179–243. Mekhtiyev, Sh. F. Geotermicheskiye nablyudeniya na Apsheronskom poluostrove [Geothermal observations on the Apsheron Peninsula]: Akad. Nauk Azerbaydzhan. SSR Inst. Geol. Trudy, v. 14, p. 16–69, 1951.

In this monograph Mekhtiyev reports on geothermal observations conducted on the Apsheron Peninsula in the Caspian Sea from 1880 to 1944–45 and discusses the measurement procedures and the values obtained for geothermal gradients at different locations on the peninsula. Electric thermometric and maximum thermometer measurements were carried out at five separate oil well locations; the causes of the divergence in results are discussed. The observed distribution of temperatures is considered to depend on tectonic, petroliferous, and other conditions in the strata. Special consideration is given to the sources of heat in the earth's crust and to the temperature distribution in the strata of oil-bearing areas. Geothermal "steps" of 30.09 m, 25.4 m, 32.9 m, and 27.5 m per °C were established for four places. The variation of the mean values of geo-

thermal step for one of these—the Ordzonikidze oil wells—was found to be 26–27 m per °C up to 500 m depth, 29–30 m per °C to 1,000 m, 30–31 m per °C to 1,500 m, 31–32 m per °C to 2,000 m, and 32–33 m per °C to a depth of 2,500 m. The boiling point of water is reached at 2,800 m, and the critical temperature of water at an estimated 12,000 m.—*A. J. S.*

179–244. Arbolishvili, D. Z. Geotermicheskiy rezhim nekotorykh rayonov Gruzinskoy SSR [Geothermal regime of some regions of the Georgian SSR] : Geologiya Nefti, no. 12, p. 43–47, 1958.

Measurements were made of the geothermal gradient in boreholes at a number of localities in the Georgian S.S.R. The intervals tested, temperature values, geothermal gradients, and duration of observations are presented in a table. The geothermal gradient in this region ranges from 1.8° C to 3.0° C per 100 m. The temperature of a particular stratigraphic unit may be the same in wells located in similar tectonic environments, although the depth of the unit may vary.—*J. W. C.*

179–245. Von Herzen., R., and Maxwell, A[rthur] E. The measurement of thermal conductivity of deep-sea sediments by a needle-probe method : Jour. Geophys. Research, v. 64, no. 10, p. 1557–1563, 1959.

The transient heating of a needle probe is used to measure the thermal conductivity of deep-sea sediments in 10 minutes or less. An accuracy of 3–4 percent compares favorably with steady-state methods, and measurements by both methods on the same sediments show good agreement. Thermal diffusivity of deep-sea sediments is shown to be proportional to thermal conductivity, in agreement with theoretical expectations.—*Authors' abstract*

179–246. Roy, Rustum, Majumdar, A. J., and Hulbe, C. W. The Ag_2S and Ag_2Se transitions as geologic thermometers: Econ. Geology, v. 54, no. 7, p. 1278–1280, 1959.

The pressure dependence of the argentite-acanthite (Ag_2S) and high-low naumannite (Ag_2Se) transitions has been studied beyond 1,000 atm. The inversion temperatures, 176° C and 128° C, are both raised less than 10° C by an increase of pressure of 1,000 atm. The usefulness of the presence of argentite and of high naumannite as indicators of certain minimum temperatures is therefore enhanced, especially in analyzed samples.—*Authors' abstract*

179–247. Angino, Ernest E. Some effects of pressure on the thermoluminescence of limestone: Jour. Geophys, Research, v. 64, no. 10, p. 1638–1640, 1959.

In order to ascertain the effects of pressure alone on thermoluminescence of limestones, a preliminary study was made on seven limestones of different geologic age. After heat treatment to drain the thermoluminescence occurring naturally in the 0° C–400° C range, the samples were pressed at 7,720 bars for increasing lengths of time (2, 5, 10, 15, 30 min) and a glow curve was plotted for each. Pressure was applied vertically by a 50-ton hydraulic press and was not truly hydrostatic. Three of the samples showed no thermoluminescence after pressure, but in the other four it was considerable. Further work showed that the duration of pressure is more critical than amount of pressure. Over a long period, pressure resulting from burial at 10,000 ft, for instance, may be sufficient to develop a relatively large percentage of the observed natural thermoluminescence of a limestone sample.

The general shape of the pressure-induced glow curve is similar to that of a crystallization-induced curve; what we observe may actually be a crystallization effect induced by pressure. Peak temperatures of the pressure-induced glow curves do not coincide with the peaks of natural thermoluminescence of the sample, the former being 15° C–20° C higher; evidently the same trapping mechanism is not at work in the two instances.—*D. B. V.*

179–248. Angino, Ernest E., and Siegel, Frederic R. The effects of trace elements on natural thermoluminescence: Compass, v. 36, no. 4, p. 296–303, 1959.

An investigation of the effects of magnesium, strontium, and iron on natural thermoluminescence of limestones was made to obtain new data that could be used in furthering the theory of the thermoluminescence method of age determination. Interpretations cannot be accepted as definitive because they were based on observations of only 10 samples from 2 limestone units in Kansas. Results, however, warrant further research. Magnesium and strontium appeared to increase the area under the middle- and high-temperature thermoluminescence peaks, respectively; conversely, iron acted as an inhibitor and lowered the total thermoluminescense of the samples.—*V. S. N.*

179–249. Malyuga, V. P. Usovershenstvovannyy glubinnyy elektrotermometr [An improved electric thermometer for deep measurements]: Razvedochnaya i Promyslovaya Geofizika, no. 17, p. 93–97, 1957.

The SBY–46 electrometer cannot operate under high temperature and pressure and has a thermal inertia of the order of 7 sec. Therefore, a new type of electrometer, ETMI–55 (electrometer of small inertia 1955 model) has been designed and tested. The thermometer operates with a triple-core cable and consists of a Wheatstone bridge with three manganine arms (resistance 200 ohms each) and a fourth copper arm (resistance about 200 ohms at 20° C). This thermometer can operate under pressures up to 800 kg per cm^2 and temperatures up to 160° C. The maximum thermal inertia (time constant) is less than 0.5 sec, which allows a speed in measuring borehole temperature up to 2,000–3,000 m per hr. Malyuga describes the construction of the thermometer and its assemblage. Nonlinearity of the new thermometer, however, introduces an error of approximately 0.01 $(T-T_0)$.—*A. J. S.*

INTERNAL CONSTITUTION OF THE EARTH

179–250. Jeffreys, Harold. The earth—Its origin, history and physical constitution (4th edition): Cambridge, England, The University Press, 420 p., 1959.

The basic plan of this book has remained unchanged although much new material has been added to take account of recent developments. The principle change in this edition is in the treatment of tidal friction resulting from recent information that makes it possible to estmate the amount of tidal friction by the damping of the 14-monthly variation of latitude. Recent investigations of the thermal history of the earth, implying a rising temperature and an alltime solid state, are discussed; Jeffreys still believes that the granitic layer and the concentration of radioactivity toward the surface are decisive evidence for former fluidity. The section on the moon's surface has been expanded.

The book has 12 chapters, 5 appendices, and a considerably lengthened bibliography.—*V. S. N.*

179–251. Kapustinsk[i]y, A. F. To a new conception of the internal constitution of the earth: Experientia, v. 14, no. 2, p. 429–434, 1959.

This is an English version of Kapustinskiy's theory that the earth consists of three geospheres: the perisphere or crust (50–120 km) with normal chemistry; the intersphere, an eclogitic shell (120–2,900 km) in which chemical reactions are degenerate; and the centrisphere, a "metalized" core (2,900–6,370 km) devoid of chemical properties. Because of the ultra-high pressure, matter in the centrisphere behaves as though the temperature were absolute zero. (See also Geophys. Abs. 171–201, 175–237, 176–221, 178–260.)—*D. B. V.*

179–252. Popov, V. I. O tsentrobezhnom i stupenchatom razvitii obolochek litosfery [On the centrifugal and step-by-step development of the layers of the lithosphere]: L'vov. Geol. Obshch. Geol. sbornik, no. 5–6, p. 409–432, 1958.

Popov considers that the development of the earth's shells, including crust, should be looked at from the point of view of complex physicochemical and chemical changes of the earth's substance, not as a result of mechanical deformations alone. He suggests the term "paleogeophysics" for the study of such processes in historical perspective. After a brief review of the differentiation hypotheses of Belousov (see Geophys. Abs. 148–13425) and others, Popov presents his hypothesis of the centrifugal differentiation in stages of the earth's substance. After a primary differentiation of the earth into the iron core and the peridotite mantle, the latter differentiated at its top into the basaltic and granitic layers, and decomposition of these two produced the sedimentary layers. The differentiation of the core from the peridotite mantle took place 5.2–4.5 billion years ago while they were liquid. The basaltic and then the granitic layers were formed at the surface of the mantle and the basalt foundations of the continents were established 3.5–2.0 billion years ago. About 2 billion years ago the granitic nuclei of the continents began to develop. The granitic layer continues to grow at the edges of the continents, tending to unite them eventually into a single continental stratum. This process has not yet affected the Pacific Ocean basin to any significant degree. A bibliography of 96 titles is included.—*A. J. S.*

179–253. Takeuchi, H[itoshi]. A comment on the flattening of the group velocity curve of mantle Rayleigh waves with periods about 500 sec: Seismol. Soc. America Bull., v. 49, no. 4, p. 365–368, 1959.

A scale-ratio consideration and a calculation on statical deformations of the earth by surface loads suggest that the flattening of the group velocity curve of mantle Rayleigh waves with periods about 500 sec is not due to the existence of the earth's core, as has been suggested.—*Author's abstract*

179–254. Takeuchi, H[itoshi], Press, F[rank], and Kobayashi, N[aota]. Rayleigh-wave evidence for the low-velocity zone in the mantle: Seismol. Soc. America Bull., v. 49, no. 4, p. 355–364, 1959.

Variational calculus methods are applied to the problem of dispersion of mantle Rayleigh waves. In the present paper we have worked two models. One is Gutenberg's model with a low-velocity layer around 150 km depth. The other is a Jeffreys-Bullen model modified above 200 km depth so as to join smoothly to the explosion-determined velocities just under the Mohorovičić dis-

continuity. No low-velocity layer is assumed in this model. Both models give almost identical theoretical dispersion curves which agree well with the Ewing-Press observations of mantle Rayleigh waves for periods longer than 250 sec. This result means that the minimum group velocity at about 250 sec is mainly due to a sharp increase of shear velocity at about 400 km depth, which is a common feature for the two models. For periods shorter than 250 sec Gutenberg's model gives results concordant with the observations. The modified Jeffreys-Bullen model disagrees significantly with the observations. This demonstrates the existence of a low-velocity layer in the upper mantle.—*Authors' abstract*

179–255. Shirokova, Ye. I. Nekotoryye dannyye o kharaktere izmeneniya skorostey v verkhnikh sloyakh obolochki zemli [Certain data on the character of the change of velocities in the upper layers of the earth's mantle]: Akad. Nauk SSSR Izv. ser. geofiz., no. 8, p. 1127–1137, 1959.

Examination of amplitudes of longitudinal waves from deep earthquakes in the Hindu-Kush Mountains region shows that the low-velocity layer, which begins at a depth of 60–100 km, extends to a depth of at least 200 km. The boundaries of this layer are relatively sharp. The change in velocity at its upper boundary is about 10 percent and at the lower boundary somewhat smaller.—*S. T. V.*

179–256. Lill, Gordon, and Bascom, Willard. A bore-hole to the earth's mantle: AMSOC's Mohole: Nature, v. 184, no. 4681, p. 140–144, 1959.

This is a discussion of the contribution to science of the "Mohole" project to drill to the mantle, and a progress report on the project. Direct knowledge of the exact mineralogical and rock composition of the mantle, its density, strength, temperature, amount of radioactivity, and thermal and electrical conductivity would contribute immeasurably to understanding of the earth and its origin and would enhance the value of indirect geophysical measurements. Some new and unexpected evidence might be unearthed that could substantially revise existing concepts.

The idea of drilling from an oceanic island has been abandoned because the mantle has been found to be as deep as 17 km under islands recently studied, and in any event developments in floating drilling platforms make deep-water drilling appear to be more feasible. The project will be divided into two phases. The first involves modification of existing drilling equipment; the objectives of this phase would be to obtain the best possible samples of the upper layers (down to 6 km) while testing out deep-water drilling methods. The second phase, drilling the remaining 3–5 km to the Mohorovičić discontinuity, will probably require a completely new engineering design because the total length of drill pipe would be well over a mile more than the deepest oil well to date.

As the feasibility study progresses, the original cost estimates have shrunk and it now appears that the entire project might be carried out for about $15 million; this is much less than the cost of a rocket-propelled moon probe. AMSOC believes that this series of holes which will eventually sample the mantle is likely to produce the greatest advances in man's knowledge of the earth in our time.—*D. B. V.*

179–257. Woollard, G[eorge] P[rior]. Crustal structure from gravity and seismic measurements: Jour. Geophys. Research, v. 64, no. 10, p. 1521–1544, 1959.

Seismic refraction measurements have not agreed everywhere with gravity- and surface-wave indications of crustal structure, probably because of masking of crustal layering. The slope of the curve that describes the relationship between seismic depth to the Mohorovičić discontinuity and Bouguer anomalies suggests that the density difference between crust and mantle decreases as crustal thickness increases. Assuming that the mantle has a constant mean density of 3.32 g per cm^3, mean crustal density would appear to increase from a minimum of 2.86 g per cm^3 in the oceans to about 3.08 g per cm^3 under high plateaus and mountains. If mean crustal density is essentially constant, the effective density of the mantle must decrease by a comparable amount. The existence of a low-density zone in the upper mantle, as suggested by the velocity dispersion of very long-period Rayleigh waves, would explain the relationships observed.

Isostatic relationships suggest that the mean density of the continental crust is essentially constant (2.85–2.88 g per cm^3); these values imply that the basaltic layer is present everywhere. Seismic studies in Central Asia have shown that the basaltic layer usually is thicker beneath areas of uplift. Its general inhomogeneity (shown by velocity variations from 6.4 to 7.3 kmps) and varying thickness suggest that it may be a zone of phase transition within the mantle. Despite lack of homogeneity in the crust, it appears possible that empirical relationships may be used to predict approximate crustal thickness from regional Bouguer anomalies or from surface elevations with a reliability approaching that for seismic measurements.—*D. B. V.*

Sato, Ryosuke. On the determination of crustal structure by the dispersion curves of surface waves (II). See Geophys. Abs. 179–91.

179–258. Båth, Markus. Seismic surface wave dispersion—a world-wide survey: Geofisica Pura e Appl., v. 43, p. 131–147, 1959.

The Love and Rayleigh wave dispersion is determined for all oceans and all continents except South America on the basis of long-period records of 13 selected earthquakes at Uppsala and Kiruna. The results give information on crustal structure along several paths not heretofore investigated and confirm earlier results on others. The central Arctic is oceanic in structure, and the Atlantic and Pacific ocean bottoms are completely similar in structure. The Eurasiatic crustal path is 10–15 km thicker than the North American path, and there is perfect agreement between North America and Africa. A shear-wave velocity of 4.3–4.4 kmps is obtained from the upper mantle under the continents.—*D. B. V.*

179–259. Talwani, Manik, Sutton, George H., and Worzel, J. Lamar. A crustal section across the Puerto Rico Trench: Jour. Geophys. Research, v. 64, no. 10, p. 1545–1555, 1959.

A crustal section across the Puerto Rico Trench, from 450 km north to 250 km south of San Juan, was deduced from seismic refraction and gravity data. The crust was divided into 5 layers having compressional-wave velocities of 1.54, 2.1, 3.8, 5.6, and 7.0 kmps. Densities of 1.03, 2.0, 2.4, 2.7, and 3.0 g per cm^3, respectively, were taken from a density-velocity curve compiled by Nafe and Drake (unpublished). Depths to the Mohorovičić discontinuity were com-

puted from the gravity data using a subcrustal density of 3.4 g per cm^3, corresponding to a velocity of 8.2 kmps.

Depth to *M* under the trench is about 20 km, decreasing sharply on both sides. Northwards, it reaches a minimum of about 10 km under the Outer Ridge, then deepens gradually to about 13 km beneath the south margin of the Nares Basin; south of the trench *M* rises under the Puerto Rico Shelf to about 17 km, then deepens sharply to about 30 km beneath Puerto Rico. South of Puerto Rico the crust thins again to about 14 km under the Venezuelan Basin. Depths to *M* were also obtained using Airy isostatic anomalies and assuming constant crustal density of 2.67 g per cm^3 over a mantle of density 3.27 g per cm^3. The section thus deduced differs significantly from that obtained when density structure within the crust was considered.—*D. B. V.*

179–260. Tryggvason, Eysteinn. Hraði jarðskjalftabylgja í jarðskorpunni undir Íslandi [Velocity of earthquake waves and the earth's crust under Iceland (with English summary)]: Náttúrufraeðingurinn v. 29, no. 2, p. 80–84, 1959.

The apparent *P*-wave velocities between Icelandic seismograph stations were investigated for earthquakes with epicentral distances less than 800 km. A distinct P_b phase with a velocity of about 6.7 kmps was seen on almost all records. On the best records a small-amplitude phase, called P_x; is seen before the P_b; it has an apparent velocity of 7.3–7.6 kmps and is the first phase on most seismograms if epicentral distance is between 150 and 800 km. The P_n phase, with a velocity of about 8 kmps, is rarely recorded.

The observed phase velocities can be explained by two-layer crust in which the upper layer, with a *P*-wave velocity of about 6.7 kmps, is about 15 km thick; thickness of the lower layer, in which velocity is about 7.5 kmps is undetermined.—*D. B. V.*

179–261. Savarenskiy, Ye F., Solov'yeva, O. N., and Shechkov, B. N. O nablyudeniyakh voln Lyava na Moskovskoy seysmicheskoy stantsii i stroyenii zemnoy kory [On the observations of Love waves at the Moscow seismic station and the structure of the earth's crust]: Akad. Nauk SSSR Izv. ser. geofiz., no. 5, p. 669–675, 1959.

The determination of crustal thickness from Love-wave data is examined mathematically for one-and two-layered models, and then the thickness of the crust is calculated from records obtained at Moscow of earthquakes in the vicinity of Japan. It is found that the crust along this path is 30–40 km thick, the basaltic layer being about half as thick as the granitic layer.—*D. B. V.*

179–262. Gagel'gants, A. A., Gal'perin, Ye. I., Kosminskaya, I. P., and Krakshina, P. M. Stroyeniye zemnoy kory tsentral'noy chasti Kaspiyskogo more po dannym glubinnogo seysmicheskogo zondirovaniya [Structure of the earth's crust in the central part of the Caspian Sea according to the data of deep seismic sounding]: Akad. Nauk SSSR Doklady, v. 123, no. 3, p. 520–522, 1958.

The results of deep-reflection surveys in the central Caspian Sea, in which 2,500 km of profile were measured, are presented in the form of a map showing contours on the Mohorovičić discontinuity, on the basalt layer, and on the basement, together with a northeast-southwest cross section. In the platform area on the northeast the basement is shallow and the discontinuities are almost horizontal. In the transitional area between the platform and the Caspian

depression, the basement surface and surface of the basalt layer descend abruptly, the Mohorovičić surface more gradually. In the platform 3 crustal layers can be distinguished: a sedimentary layer 2–3 km thick, with a velocity of about 3 kmps; a granitic layer about 10–15 km thick; and a basaltic layer about 20–25 km thick. Total thickness of the crust is about 30–35 km. In the transitional area the sedimentary layer thickens considerably and the granitic layer thins. In the depression itself the crust consists of a thick sedimentary layer (20 km) with average velocities of 3.5–4 kmps and a basaltic layer with a velocity of 6.6 kmps; total crustal thickness here is 40–45 km. Reflections corresponding to the granitic layer are absent in the depression; this means either that the granitic layer is missing in the usual sense, or that it is so thin its reflections cannot be distinguished among other groups of waves.—*D. B. V.*

179–263. Matuzawa, Takeo. On the crustal structure in north-east Japan by explosion seismic observations: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 123–154, 1959.

This is the complete version of a report on explosion seismologic investigations of crustal structure in northeast Japan; a summary report appeared earlier in the Publications du Bureau Central Séismologique International, Travaux scientifiques no. 19, p. 229–242, 1956 (see Geophys. Abs. 173–256).—*D. B. V.*

179–264. De Noyer, John. Crustal structure of the North Pacific from Love-wave dispersion: Seismol. Soc. America Bull., v. 49, no. 4, p. 331–336, 1959.

Short-period Love-wave dispersion from the Kurile Islands earthquake (June 22, 1952; $O=21^h41^m53^s$; $\phi=46°$ N.; $\lambda=153.5°$ E.) can be explained with a two-layer crustal model in which the upper 2 km of material has a shear-wave velocity of 2.31 kmps. The second layer has a thickness of 4 km and a shear-wave velocity of 3.71–3.86 kmps. Shear-wave velocities of 4.50–4.52 kmps are used for the material immediately below the crust. This crustal model is compared with structures obtained from short-period Love-wave dispersion across other Pacific paths and with results of refraction studies.—*Author's abstract*

ISOTOPE GEOLOGY

179–265. Rankama, Kalervo. Aplicaciones geológicas de la radioactividad y de los nucleidos estables [Geologic applications of radioactivity and the stable nuclides] *in* Cursillos y conferencias del Instituto "Lucas Mallada," no. 5: Inst. Lucas Mallada Inv. Geol., p. 3–15, 1958.

The subject of radioactive and stable nuclides is reviewed in general. The historical development is outlined, and the isotope fractionation, radioactive age determinations, and the geochemistry of carbon, oxygen, and sulphur are discussed.—*J. W. C.*

179–266. Green, Jack. Geochemical table of the elements for 1959: Geol. Soc. America Bull., v. 70, no. 9, p. 1127–1184, 1959.

A geochemical table of the elements for 1959 is given (with French, German, Russian, and Spanish keys), cast in the framework of the conventional periodic table. The following data are given for each element: geochemical character; weight and structure; size and charge; natural isotopes (with percent abundance, half lives, and type of radiation decay); nuclear; thermodynamic; min-

eralogic; value in dollars; abundances in grams per metric ton; and series of geochemical interest. A post-1953 bibliography of nonradiogenic isotope abundance data and a list of abundances of elements in soils and igneous rocks are included in the text.—*D. B. V.*

179–267. Polański, Antoni. Problem argonu atmosferycznego [The problem of atmospheric argon]: Archiwum Mineralogiczne, v. 20, no. 1–2, p. 259–295, 1956.

This is a critical analysis of various calculations that have been based on the amount of argon-40 in the atmosphere. Several parameters enter into these calculations: (1) thickness of the crust, (2) average potassium content of the crust, (3) present potassium-40 content in the potassium of the earth, (4) time elapsed since argon-40 began to escape into the atmosphere, (5) rate of escape of argon-40, and (6) decay constant of potassium-40; only the third and sixth of these are fairly accurately known.

Polański attempts to establish to what degree change of some of these values influences the values of the other parameters by calculating various quantities (such as the age of atmospheric argon) on the basis of different assumptions. It is concluded that it is premature to undertake calculations based on the argon-40 content of the atmosphere; therefore, the results of all existing calculations should be considered unreliable.—*D. B. V.*

179–268. Turekian, K. K. The terrestrial economy of helium and argon: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 37–43, 1959.

Using a model of continuous degassing of the earth and recent data on the chemical composition of chondritic meteorites, a "degassing constant," α, is determined from the argon-40 economy of the earth. The value of α, assuming an earth 4.55×10^{9} yr old, is 2.81×10^{-11} yr^{-1}. On the assumption that α is constant for all volatiles escaping from the earth, the helium economy of the earth is discussed. On the same premise the primordial water concentration of the solid earth, devoid of a hydrosphere, is determined to be 2,300 ppm which compares favorably with 2,650 ppm for chondrites. The small size of α indicates that the rate of water release from the earth has been sensibly constant over the past 4.55×10^{9} yr.—*Author's abstract*

179–269. Gerling, E. K., and Levskiy, L. K. Produkty kosmicheskoy radiatsii v meteorite Sikhote-Alin' [Products of cosmic radiation in the Sikhote-Alin meteorite]: Akad. Nauk SSSR Doklady, v. 123, no. 3, p. 420–423, 1958.

The relative abundances of the helium, neon, and argon isotopes in individual samples of the Sikhote-Alin meteorite and the changes in the amount of their cosmogenic isotopes with distance from the surface of a large specimen have been investigated. The results are tabulated under the following headings: sample number; distance from surface in cm; A^{40}, A^{38}, and A^{36} content; A^{38} and A^{36} in 10^{-7} cm^3 per g; A^{38}/A^{36} ratio; He, He^4, and He^3 in 10^{-6} cm^3 per g; He^3/He^4 ratio; Ne, Ne^{20}, Ne^{21}, and Ne^{22} in 10^{-8} cm^3 per g; A^{38}/Ne^{21}; He^3/A^{38}; and He^3/Ne^{21}. No uniform change with depth and no direct quantitative relationship between content of light nuclei and content of cosmogenic isotopes are evident. These results cast doubt on work done by others on the effects of depth on meteorites.—*D. B. V.*

179–270. Allais, G., and Curien, H. Mesure de la teneur en bore–10 des minéraux [Measurement of the boron–10 content of minerals]: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 108–112, 1959.

A method of analysis of boron-10 is described; it is based on the absorption properties of thermal neutrons. Precision is of the order of 2 percent. The procedure is simple and rapid. The boron-10 contents of five very different minerals (kernite, ascharite, inoite, tourmaline, and datolite) were measured by this method; none shows any deviation within limits of error from the isotopic composition of a reference standard.—*D. B. V.*

179–271. Hoffman, J. H., and Nier, A.[lfred] O. The cosmogenic He^3 and He^4 distribution in the meteorite Carbo: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 32–36, 1959.

The cosmogenic helium-3 and helium-4 distribution in a cross section of the iron meteorite, Carbo, has been made with a mass spectrometer. The He^3/He^4 ratio is approximately constant throughout most of the cross section and has a value of 0.239. The amount of helium-3 varies between the approximate limits of 3.2 and 4.6×10^{-6} std cm^3 per g of meteorite. Contours of constant helium-3 and helium-4 were plotted. These are open curves indicating the meteorite was either split in half late in its lifetime or eroded away on one side since its fall to earth.—*Authors' abstract*

179–272. Begemann, F., Eberhardt, P., and Hess, D. C. ^3He - ^3H - Strahlungsalter eines Steinmeteorites [He^3-H^3 radiation age of a stone meteorite (with English abstract)]: Zeitschr. Naturforschung, v. 14a. no. 5/6, p. 500–503, 1959.

The tritium and helium-3 content of three samples of the Abee stone meteorite have been measured. Within limits of experimental error, both are found to be the same at the surface and near the center of the meteorite. The amount of helium-3 accumulated and the tritium decay rate yield a maximum age of 30×10^6 yr. Assuming that equal amounts of helium-3 and tritium are produced by cosmic ray interaction with the meteoritic matter, the radiation age is 13×10^6 yr.

The He^4/U age of the meteorite is more than 3.8×10^9 yr. The two most probable explanations of this discrepancy are either that up to 13 million years ago the meteorite was shielded from cosmic radiation as part of a larger mass, which subsequently broke up without heating; or it attained its present size by steady loss of mass due to breaking off of small pieces. A third possible explanation, that cosmic radiation was temporally and spatially not constant, is dismissed as unlikely on the basis of other evidence.—*D. B. V.*

179–273. Zykov, S. I., and Stupnikova, N. I. Ob opredelenii izotopnogo sostava svintsa [On determination of the isotopic composition of lead]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 243–246, 1958.

Determination of the isotopic composition of lead by the usual method for geochronological purposes is difficult when the lead content is of the order of 10^{-2}–10^{-4} percent. The isotope-dilution technique described by Tilton and others (see Geophys. Abs. 162–163) is described and discussed. Error may reach 30 percent in exceptional cases, but ordinarily does not exceed 1 percent.—*A. J. S.*

179–274. Malinovskiy, F. M. Izotopnyy sostav svintsa iz sul'fidonosnykh fosforitov Podolii [Isotopic composition of lead from the sulfide-bearing phosphorites of Podolia]: Geokhimiya, no. 2, p. 191–192, 1959.

The isotopic composition of lead from the Podolsk phosphorites (Ukrainian S.S.R.) has been determined as follows: $Pb^{204}=1$, $Pb^{206}=20.18\pm0.1$, $Pb^{207}=15.98\pm0.1$, and $Pb^{208}=38.09\pm0.2$. The lead is therefore anomalous.—*D. B. V.*

179–275. Tugarinov, A. I., Zykov, S. I., and Zmeyenkova, A. V. O vozraste nekotorykh svintsovykh mestorozhdeniy Kavkaza [On the age of certain lead deposits of the Caucasus]: Akad. Nauk SSSR, Kom. opredeleniyu absolyut. vozrasta geol. formatsiy, 5th sess. Trudy, p. 64–68, 1958.

Measurements of the isotopic composition of lead from deposits in the Azerbaijan S.S.R., the North Caucasus, the Kuban' River valley, and Armenian S.S.R. are discussed, and ages of the deposits determined. It was found possible to subdivide the Caucasus leads into three groups: the Variscan (Hercynian) hydrothermal; the Jurassic deposits regenerated through leaching and erosion of Variscan rocks; and the post-Jurassic hydrothermal deposits. The Pb^{206}/Pb^{204}, Pb^{207}/Pb^{204}, and Pb^{208}/Pb^{204} ratios are tabulated for the lead of each deposit.—*A. J. S.*

179–276. Chow, Tsaihwa J., and Patterson, C[laire] C. Lead isotopes in manganese nodules: Geochim. et Cosmochim. Acta, v. 17, no. 1/2, p. 21–31, 1959.

The isotopic compositions of leads which were isolated from manganese nodules of the Atlantic and the Pacific Oceans were determined. The Atlantic leads were more radiogenic than those of the Pacific. The Pacific samples showed a trend of increasing radiogenic leads from the northwest toward the southeast Pacific. The relationship between the collecting sites and the isotopic compositions of leads can be used to trace the circulation patterns of deep-water masses. The oceanic leads originated from rock systems whose uranium and lead contents have differentiated at various times appreciably later than 4.5×10^9 yr.—*Author's abstract*

179–277. Samuel, David, and Steckel, Fritz. Bibliography of the stable isotopes of oxygen (O^{17} and O^{18}): Pergamon Press, New York, 224 p., 1959.

Papers published through 1957 on the oxygen-17 and oxygen-18 isotopes are compiled. They are arranged according to author and indexed according to subject. Much of the book covers work done on preparation and use of oxygen-18.—*J. W. C.*

179–278. Teys, R. V. Izotopnyy sostav kisloroda prirodnykh sul'fatov [Isotopic composition of oxygen of natural sulfates]: Geokhimiya, no. 3, p. 28–32, 1956.

Experiments show that the oxygen isotopic composition of sulfates derived from marine waters cannot be used to determine isotopic composition of the marine waters at the time when the mineral was being deposited. The isotopic composition of the oxygen of natural sulfates reaches an equilibrium with the oxygen of marine waters only after several hundred years. (See also Geophys. Abs. 179–279).—*J. W. C.*

179–279. Teys, R. V., Gromova, T. S., and Kochetkova, S. N. Isotopnyy sostav prirodnykh fosfatov [Isotopic composition of natural phosphates]: Akad. Nauk SSSR Doklady, v. 122, no. 6, p. 1057–1060, 1958.

The isotopic composition of oxygen in natural apatites and phosphorites and in a skate's tooth was analyzed. The apatites and phosphorites were found to be deficient in oxygen-18 with respect to river water. The oxygen-18 content of the tooth was essentially the same as that of the river water; this is not necessarily an indication of equilibrium conditions, for a more significant comparison in this case would be one made against sea water.

Comparison of these measurements with determinations of the oxygen isotopic composition of sulfates and of sea water (see Geophys Abs. 179–278) suggests that the sulfates are more nearly in equilibrium with sea water than are the phosphates. In some samples this is due to genetic factors unrelated to the water. In other cases where a relationship with the water could be established, the difference appears to depend first on the greater difficulty of exchange in the case of phosphates and second on the lesser solubility of calcium-phosphate salts.—*D. B. V.*

179–280. Dorman, F. H., and Gill, Edmund D. Oxygen isotope paleotemperature determinations of Australian Cainozoic fossils: Science, v. 130, no. 3388, p. 1576, 1959.

Fossil marine shells collected in southern Victoria, Australia, within half a degree of lat 38.5° S. have been analyzed for O^{18}/O^{16} by mass spectrometry, and their paleotemperatures have been determined. A distinct maximum in mid-Tertiary time is shown by the genera *Glycimeris*, *Ostrea*, and *Chlamys*. This is in keeping with the biological evidence.—*D. B. V.*

179–281. Sharp, Robert P., and Epstein, Samuel. Oxygen-isotope ratios and glacier movement: California Inst. Tech., Div. Geol. Sci. Contr., no. 875, p. 359–369, 1959.

Variations in oxygen-isotope ratios appear to constitute a parameter of considerable potential value for investigation of glaciers. Analyses of firn from the Saskatchewan Glacier in Canada and from the Greenland ice sheet show that individual strata composing an annual firn layer have distinctly different oxygen-isotope ratios which reflect the altitude of accumulation, seasonal influences, differences among individual storms, and subsequent diagenetic changes.

Samples of ice taken from Saskatchewan Glacier along a centerline profile from a firn limit to terminus show a trend toward lower O^{18}/O^{16} ratios downglacier, a reverse of normal precipitation pattern that could be due to the fact that ice at progressively lower positions on the tongue originated at successively higher sites in the accumulation area. This would confirm Reid's deduction concerning flow lines in a valley glacier. Ratios in samples from a transverse profile 6.75 km above the terminus of Saskatchewan Glacier indicate that the marginal ice comes from higher parts of the firn area than the center ice. The generally higher O^{18}/O^{16} ratios in the ice tongue compared to those in the firn is an unsolved problem, possibly involving diagenetic changes in the firn or alterations associated with flowage; it is unlikely that they reflect major climatological change.

Isotope ratios in samples from the Malaspina Glacier in Alaska show that deformed bands of clean and debris-rich ice probably represent original valley

glaciers and medial moraines from far back in the accumulation area and confirm that one of the major ice units consists of material accumulated in the large basin of the upper Seward Glacier.—*V. S. N.*

179–282. Voshage, H., and Hintenberger, H. Kalium als Reaktionsprodukt der kosmischen Strahlung in Eisenmeteoriten [Potassium as a cosmic radiation reaction product in iron meteorites]: Zeitschr. Naturforschung, v. 14a, no. 9, p. 828–838, 1959.

The potassium isotope abundances were determined for three iron meteorites. Three types of potassium are present: cosmogenic, resulting from spallation from iron nuclei due to cosmic-ray reaction and with a more uniform isotope distribution than common terrestrial potassium; common potassium, originally present in the iron of the meteorites with at least approximately the same isotope distribution as terrestrial potassium; and terrestrial potassium, resulting from contamination. The relative abundances are as follows: Carbo, K^{39}=79.5, K^{40}=4.8, and K^{41}=15.7 percent; Treysa, K^{39}=85.35, K^{40}=3.10, and K^{41}=11.55 percent; and Clark County, K^{39}=90.8, K^{40}=0.8, and K^{41}=8.4 percent. Surprisingly, the Treysa meteorite, with a higher content of cosmogenic noble gases, gives a smaller cosmic-ray age than the Carbo. This difference can be explained if the Treysa specimen was exposed for a shorter time to less intensive radiation than the Carbo. The age of the latter is at least several hundred million years, in agreement with other estimates for iron meteorites (see also Geophys. Abs. 169–2, 171–3, 177–265, 179–271).—*D. B. V.*

Honda, Masatake. Cosmogenic potassium-40 in iron meteorites. See Geophys. Abs. 179–32.

179–283. Chalov, P. I. Izotopnoye otnosheniye U^{234}/U^{238} v nekotorykh vtorichnykh mineralakh [The U^{234}/U^{238} isotope ratio in some secondary minerals]: Geokhimiya, no. 2, p. 165–170, 1959.

The U^{234}/U^{238} isotope ratios have been determined for 44 samples of minerals from the oxidation zone, the oxidation subzone of the cementation zone, and the cementation zone. It is shown that in natural conditions the result of alteration is a disturbance of isotopic equilibrium toward relative impoverishment in uranium-234.—*D. B. V.*

MAGNETIC FIELD OF THE EARTH

179–284. Rikitake, Tsuneji. Forced oscillations of the earth's dynamo: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, 245–264, 1959.

The possibility that geomagnetic secular variations are caused by forced oscillations of small amplitude superposed on the steady state of the earth's dynamo is investigated mathematically on the basis of magneto-hydrodynamic principles.

With drastic simplification, the driving force due to buoyancy is obtained for hypothetical variations of a 100-year period. The time-dependent thermal field responsible for such a force field is also obtained. It is shown that a field amplitude of 10^{-4} ° C would account for the S_1^0 field, assuming that the amplitude of the latter is 1,000γ at the pole.—*D. B. V.*

179–285. Maeda, Ken-ichi. Distortion of the magnetic field in the outer atmosphere due to the rotation of the earth: Annales Géophysique, v. 14, no. 2, p. 154–166, 1959.

The possibility of shearing distortion of the magnetic equator in the outer atmosphere is investigated mathematically. The magnetohydrodynamic wave equation is deduced and some approximations of the wave equation discussed. Assuming that the earth is surrounded by a cavity formed by rotation, the fields generated inside and outside this cavity by the nonasymmetric component of the earth's dipole moment rotating with the earth are obtained. It is shown that these fields will produce a westward shift of the dip equator in the outer atmosphere.—*D. B. V.*

179–286. Rochester, Michael G. Geomagnetic westward drift and irregularities in the earth's rotation: La Jolla, University of California, 53 p., 1959.

Bullard's (1950) rigid-sphere model for the steady westward drift of the earth's nondipole magnetic field is extended to included the magnetic coupling provided by the presence of the higher multipole fields at the core-mantle boundary. If the first six harmonics of the observed surface field are taken into account, the retarding couple on the mantle is increased by a factor of 1.6. Using this result it would follow from Bullard's specialized model of the core that the geomagnetic dynamo mechanism generates a toroidal field of several hundred gauss in the deep interior of the core. Time-dependent perturbations of the mantle-core coupling are investigated rigorously, and it is shown that reasonable fluctuations of the fields at the core-mantle boundary are capable of explaining changes in the length of day at the rate of order 1 millisecond in 10 years. The tightness of the coupling is increased by 60 percent over that afforded by Bullard's model. The argument provides additional evidence that the mean electrical conductivity in the bottom 2,000 km of the mantle is at least 10^{-9} emu. A summary of knowledge of the distribution of electrical conductivity with depth in the earth is given in the introduction.—*Author's abstract*

179–287. Barta, György. A föld mágneses sarkainak és középpontjának időbeli vándorlásáról [The wandering of the geomagnetic poles and of the middle point of the earth (with German summary)]: Geofiz. Közlemények, v. 8, no. 1–2, p. 3–17, 1959.

Using the magnetic spherical function presentation derived back to 1550 by Fritsch, Barta has calculated the secular wandering of the locus of the eccentric dipole, of the intersection of the centric and eccentric dipoles with the earth's surface, and of the "inclination-pole" in relation to the eccentric dipole. The results indicate that a fairly regular ¾-circle has been described around the theoretical inclination-pole since 1550; this fact is in good agreement with the 480-year period determined on the basis of the "London variation."

The effect of the dipole of known intensity, position, and direction for London was determined; the period and phase of the theoretical dipole wandering thereby obtained correspond to the observed wandering, but the amplitude is only a third as much. From this it can be concluded that the "London variation" can be considered to be a result of wandering of the middle point and of the pole, and both phenomena have a common cause.—*D. B. V.*

179–288. Yukutake, Takesi. Attenuation of geomagnetic secular variation through the conducting mantle of the earth: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 13–32, 1959.

The decrease in amplitudes of secular variation through the mantle is discussed, taking into account the existence of the conducting core and assuming that the source of geomagnetic secular variations is a time-dependent electric-current sheet at the core boundary that has magnetic potential equivalent to that due to randomly distributed magnetic dipoles. The lower harmonic components damp out more conspicuously than the higher ones. To cause an attenuation compatible with that inferred from observation, the electrical conductivity of the mantle would range between 4.5×10^{-10} and 2.0×10^{-9} emu at a depth of 2,500 km.—*D. B. V.*

179–289. Przypkowski, Tadeusz. On the magnetic declination obtained from observation by Martin Bylica of Olkucz around 1485: Acta Geophys. Polonica, v. 7, no. 2, p. 176–181, 1959.

Examination of old records of magnetic-declination measurements made in the 15th century gives 6 values of about 14° for the period 1480–85, 2 values of 12°30′, and 1, not very certain, of 11° for a later period. Probably 12°30′, as given on Bylica's globe, was the correct value for central Europe for 1485; this figure apparently resulted from a diminution of declination shortly before 1485 from the value of 14°, which it must have had immediately after the middle of the 15th century. Declination at Rome seems to have changed from 7°30′ to 6° E. from the mid-15th to mid-16th century.—*D. B. V.*

179–290. Oguti, Takasi, and Kakinuma, Seiichi. Preliminary report of geomagnetic survey during JARE the second: Antarctic Rec., no. 7, p. 17–25, 1959.

Two types of geomagnetic surveys were carried out during the second Japanese Antarctic Research Expedition: measurement of the geomagnetic field near Lutzow-Holm Bay using a three-component magnetometer on the ice-floes from December 23, 1957, to January 27, 1958, and observation of geomagnetic total intensity during the voyage (November 19, 1957, to April 27, 1958) through the East and South China Seas, the Indian Ocean, and the Antarctic Ocean, using a seaborne proton magnetometer.

The marked discrepancy in geomagnetic total intensity observed between South Africa and the Antarctic continent is discussed (see Geophys. Abs. 174–258). The regional anomaly in total intensity was observed to be markedly large in some areas, such as the southeast margin of the African continental shelf, the south bank of Madagascar, and the area just northwest of Izu-Osima, Japan. The latitude dependency of daily variation in total intensity along the course of the ship was estimated roughly, and a remarkable increase in amplitude and phase shift of daily variation was noted near the geomagnetic dip equator; the width of the zone of large amplitude of daily variation is about 5° on either side of the geomagnetic dip equator, and the range in daily variation in total intensity amounts to 200γ. This large range is caused by the equatorial jet current in the lower ionosphere. The effect of the solar eclipse of April 19 on the daily variations was observed in the zone of the dip equator. The maximum deviation in total intensity from the normal curve is about 80γ, or 60 percent of the normal deviation from the daily mean value. This too large amount is a problem to be studied in detail later.—*V. S. N.*

179–291. Jacobs, J. A. Magnetic storms: Royal Astron. Soc. Canada Jour., v. 53, no. 2, p. 85–90, 1959.

The development of knowledge of transient geomagnetic variations and theories to explain them are reviewed briefly. A dynamo theory to interpret the magnetic field at the time of sudden commencement (*SC*) of a magnetic storm has been developed by Obayashi and Jacobs, on the assumption that the main source of electromotive generation is due to an increase in electrical conductivity in the polar regions. Proof is still needed, however, that electric currents actually do flow in the upper atmosphere and that they are not just a mathematical model with which to explain the observed magnetic variations. Much information is hoped for from International Geophysical Year data.—*D. B. V.*

179–292. Bhargava, B. N., and Gopala Rao, U. V. Ionospheric disturbances associated with magnetic storms at Kodaikanal: Indian Jour. Meteorology and Geophysics, v. 10, no. 2, p. 203–208, 1959.

*F*2-layer disturbances at Kodaikanal have been analyzed for a study of the behavior of the critical frequency and the vertical height during geomagnetic storms. The disturbances have been classified for this purpose into two categories namely, the positive and negative. The characteristics of *Dst* and S_D variation of f_0F2 and the S_D variation of $h'F$ at night have been discussed. The results have been explained in terms of the quiet and disturbed day vertical drift velocities.—*Authors' abstract*

179–293. Lange, Heinz. Über Korpuskularstörungen der F_2-Schicht und die Südwärtsbewegung des Störungseinsatzes auf die Nordhalbkugel der Erde [On corpuscular disturbances of the F_2 layer and the southward movement of the onset of the disturbance in the northern hemisphere of the earth (with English and German summaries)]: Gerlands Beitr. Geophysik, v. 68, no. 4, p. 230–245, 1959.

Investigation of the times of beginning of corpuscular disturbances of the F_2 layer of the ionosphere shows that the southward movement is real, its velocity is about 500 km per hr, and the propagation is not concentric to the fictive magnetic pole of the earth.—*D. B. V.*

179–294. Piddington, J. H. The transmission of geomagnetic disturbances through the atmosphere and interplanetary space: Royal Astron. Soc. Geophys. Jour., v. 2, no. 3, p. 173–189, 1959.

The theory of the propagation of slowly varying electromagnetic disturbances through partially ionized gas is developed and applied to the earth's atmosphere and interplanetary space. The medium is regarded as two separate coexisting phases, an electron-ion plasma and neutral atoms which move to some extent independently. Quantitative results are given for a model atmosphere out to several earth radii.

Up to a few hundred km the medium behaves for waves of all periods between 1 sec and 10^4 sec, as a rigid conductor and as a dispersive medium. Above about 1,000 km the disturbances travel as hydromagnetic waves in the ion plasma alone. The currents responsible for all observed geomagnetic disturbances must flow at levels below about 1,000 km.

The problem of penetration of solar gas into the earth's field is discussed. An alternative to theories of the main phase of an *SC*-storm is suggested, whereby

lines of force of the earth's field are carried away along the sun-earth line. Some properties of micropulsations are explained in terms of the transmission of hydromagnetic waves.

The "effective" conductivity (σ_3) of the atmosphere out to several earth radii has its maximum at about 100 km, above which it rapidly falls to about 10^{-16} emu.—*D. B. V.*

179–295. Hatherton, T., and Midwinter, G. G. Diurnal variation of aurora and geomagnetic disturbance at New Zealand Antarctic stations: Nature, v. 184, no. 4690, p. 889–890, 1959.

The local diurnal variations of auroral frequency and of local geomagnetic disturbance recorded at Scott Base and Hallett Station in Antarctica appear to have no simple relationship.—*D. B. V.*

179–296. Kato, Yoshio, and Watanabe, Tomiya. Particles of aurorae and geomagnetic pulsations: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 4, p. 185–194, 1959.

It is shown that the geomagnetic pulsation is caused by hydromagnetic oscillation of the exosphere excited by solar-charged corpuscles impinging on the earth as predicted by Störmer. Pc-type pulsations are excited by auroral particles impinging on the 09–h impact zone, of which latitude is higher than the usual auroral zone and which gives rise to a second auroral zone as suggested by Nikolsky. Pt-type pulsations are excited by particles impinging on the 21–h zone, corresponding to the usual auroral zone. The L.M.T. dependence of the occurrence frequency of geomagnetic pulsations is well explained, assuming that the intensity of geomagnetic pulsations at a station will be lesser as it is more distant from the impact zone. On the other hand, the G.m.t. control in the occurrence frequency, as suggested by Troitskaya, is to be expected due to an inclination of the geomagnetic axis to the axis of rotation of the earth.—*Authors' abstract*

179–297. Bureau, Jean-Louis. Variations diurnes et annuelles des amplitudes normalisées des débuts brusques d'orages magnétique à Tamanrasset [Diurnal and annual variations of standarized amplitudes of sudden commencements of magnetic storms at Tamanrasset]: Acad. Sci. [Paris] Comptes Rendus, v. 249, no. 16, p. 1543–1545, 1959.

The amplitude of variations of sudden commencements at the Tamanrasset observatory for the years 1950–56 have been determined. Variations common to all stations were eliminated by determining the variations with respect to three other stations (Apia, Vassouras, and Elisabethville); for this purpose the ratios $\Delta D/\Delta H$, $\Delta Z/N$, $\Delta D/N$, *and* $\Delta H/N$ (where N is a number characterizing the storm on a worldwide scale) were calculated.

The diurnal variation of $\Delta Z/N$ shows a clear minimum at 14^h local time and is similar to the diurnal variation of Z, but 2 or 3 hr earlier. The diurnal variation of $\Delta D/N$ has a maximum toward 13^h and a minimum toward 19^h, and is opposite in sign to the variation of D. The diurnal variation of $\Delta H/N$ does not resemble the variation of H, but rather that of $\Delta D/N$. For $\Delta Z/N$ and $\Delta D/N$ there is no annual variation, strictly speaking. The annual variation of $\Delta H/N$, however, shows a larger amplitude than the diurnal variation, with a maximum in July and minimum in November; there is no similarity to the annual variation of magnetic disturbance. In the period studied, three sudden commencements were negative in ΔH.—*D. B. V.*

179–298. Abe, Siro. Morphology of SSC and SSC*: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 4, p. 153–163, 1959.

In general we may consider that it is very rare that *SSC** is not observed in any part of the world at the time of sudden commencement of magnetic storms. The electric current-systems for the world distribution of the preliminary impulse and the main impulse of the sudden-commencement vectors are derived. These current-systems will be situated in the earth's upper atmosphere except for the current representing the world-wide increase in the horizontal component of geomagnetic field of extra-terrestrial origin. The dependency of occurrence frequency of *SSC** on local time and latitude can reasonably be explained by the characteristic modes in these current-systems. A theoretical interpretation of *SSC* and *SSC** phenomena will be possible by combining the merits of various different theories.—*Author's abstract*

179–299. Kato, Yoshio, and Saito, Takao. Preliminary studies on the daily behavoir of rapid pulsation: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 4, p. 221–225, 1959.

Kato and Saito analyzed the daily variations of the period of rapid pulsation: *pc*, pulsation accompanying with *SSC* or *SI*, and a small short-period pulsation on the stormtime. It is found that the shortest period of these pulsations is long in the daytime and becomes apparently short in the nighttime, and shows clearly daily variations.—*Authors' abstract*

179–300. Srinivasamurthy, B. Sudden commencements and impulses in Kodaikanal magnetograms—their hourly frequency: Indian Jour. Meteorology and Geophysics, v. 10, no. 2, p. 209–212, 1959.

The diurnal variation in the frequencies of sudden commencements (*SC*'s) and sudden impulses (*SI*'s) at Kodaikanal (lat 10.2° N., long 77.5° E.) is analysed from the data for the period 1949-57. The hourly frequency curve of *SC*'s and *SI*'s (combined) has little resemblance to the curve obtained by Newton from his analysis of Greenwich-Abinger records. The results of harmonic analysis show a nearly semi-diurnal trend in the distribution of storm sudden commencements (*SSC*'s); this, however, is small. The hourly frequencies of *SI*'s show a significant diurnal variation with an afternoon maximum and a forenoon minimum and a secondary minimum around 18^h local time and a secondary maximum around 08^h. These results are also compared with those obtained by Ferraro, Parkinson, and Unthank.—*Author's abstract*

179–301. Troiskaya, V. A., and Mel'nikova, N. V. O kharakternikh intervalakh kolebaniy, ubyvayushchikh po periodu (10–1 sek.), v elektromagnitrom pole Zemli i ikh svyazi s yavleniyami v verkhney atmosfere [On characteristic intervals of pulsations of diminishing period (10–1 sec) in the electromagnetic field of the earth and their relation to phenomena in the upper atmosphere]: Akad. Nauk SSSR Doklady, v. 128, no. 5, p. 917–920, 1959.

Analysis of records of pulsations of diminishing period (10–1 sec) suggests that these pulsations correlate directly with abrupt disturbances in the ionosphere and with the development of auroras in low latitudes.—*D. B. V.*

179–302. Watanabe, Tomiya. Hydromagnetic oscillation of the outer ionosphere and geomagnetic pulsation: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 4, p. 195–202, 1959.

It is suggested that geomagnetic pulsations may be due to resonance in the hydromagnetic oscillation of the lower part of the exosphere. Hydromagnetic oscillation of the lower exosphere that gives rise to the *pt*-type of pulsations may be excited by solar charged particles impinging on the auroral zone. The *pc*-type of pulsation may be caused by corpuscles impinging on the second auroral zone at higher latitude. It is speculated that the *pc*-pulsation may be caused by a continuous solar corpuscular stream having a velocity of the order of 10^8 cm per sec, and that the *pt*-pulsation is due to corpuscles accelerated intermittently by magnetic clouds in a mean flow of corpuscles.—*D. B. V.*

179–303. Watanabe, Tomiya. Morphology of the geomagnetic pulsation: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 4, p. 177–184, 1959.

This is an abstract of a lecture read at the symposium on pulsations and rapid variations in geomagnetism and earth currents held in Tokyo on April 3–4, 1959. It is essentially a review of present knowledge of the *pc*, *pt*, *pg*, and very rapid pulsations.—*D. B. V.*

179–304. Yoshimatsu, T[akasaburo]. On the frequency of geomagnetic plusation *pc:* Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 4, p. 208–213, 1959.

Using a preliminary 3-month table of the International Association of Geomagnetism and Aeronomy, the hourly frequency of *pc* (*F*) is calculated for each of the 14 observatories in the Europe-Africa and Japan-Australia longitudinal zones, for each month and each season during the period October 1957–June 1958. For each season the maximum hour interval of the frequency falls around 9^h–11^h in local time for most observatories. The ratio of the maximum to the mean values of *F* for each season shows a remarkable dependence on geomagnetic latitude.

It is clarified by the superposed-epoch method that the principal maximum peaks of daily numbers of the observatories (*Kp*) appear 1 or 2 days after those of the daily sum of *Kp* during the whole period. The inverse relation is also checked.

These results suggest that the outer atmosphere may become most sensitive to the impinging solar agency to a greater depth than usual within 1 or 2 days after the geomagnetic disturbances, probably in the higher geomagnetic latitudes.—*D. B. V.*

179–305. Kato, Yoshio. Investigation on the geomagnetic rapid pulsation: Tohoku Univ. Sci. Repts., ser. 5, v. 11, supp., 28 p., 1959.

Rapid geomagnetic variations recorded at Onagawa Magnetic Observatory in Japan are reviewed statistically, and their character and cause are discussed. It is concluded that giant pulsation (*pg*) is caused by a toroidal hydromagnetic oscillation of the outer atmosphere that can be observed only in the auroral zone; that *pt*- and *pc*-pulsations are caused by poloidal hydromagnetic oscillations of the outer atmosphere; that the period of *pt* is the fundamental period of oscillation of the outer atmosphere at a radius of 6 earth's radii, contracted by the intermittent impingement of the corpuscular stream; and that *pc* is the standing oscillation in the lower boundary of the outer atmosphere

excited by the lower energy corpuscular beam which impinges on a somewhat higher latitude of the day hemisphere.—*D. B. V.*

179–306. Yanagihara, Kazuo. Some characters of geogmagnetic pulsation *pt* and accompanied oscillation *spt:* Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 4, p. 172–176, 1959.

Some characteristics of geomagnetic pulsations *pt* (night) and associated shorter period oscillations are examined. One of the most remarkable features of *pt* is that the 11 year variation of its activity is inversely proportional to solar activity. *Pt*'s are frequently accompanied by bays; they appear less often in periods of severe disturbance such as magnetic storms. The relationship of *pt* to possible outer atmospheric oscillation is examined.

A distinctive characteristic of most (179) of the 202 probable *pt*'s recorded at Memambetsu observatory during the International Geophysical Year are accompanied by secondary oscillations of 5–10 sec period, overlapping the main *pt*-oscillation; these are named *spt.* This *spt*-pulsation is considered to correspond to hydromagnetic oscillation in the region between the inner reflecting zone and the ionosphere, whereas the main *pt*-oscillation is considered to be one in the upper region. When reflection is effective in the inner reflecting zone, the *pt*-oscillation may not be transmitted to the earth; this is the case for the sunspot maximum period. In the same period, the *spt*-pulsation may develop more actively. Conversely, in a sunspot minimum, reflection may not be effective and *pt*'s are observed to be more active.—*D. B. V.*

179–307. Yoshimatsu, Takasaburo. On the frequency of geomagnetic pulsations observed in Japan during the IGY (1): Kakioka Magnetic Observatory Mem., v. 9, no. 1, p. 27–32, 1959.

Monthly frequencies observed during the International Geophysical Year in Japan are compared. The mean frequency of *pc* is found to be about twice that of *pt*, regardless of groups and stations. The ratio of mean monthly frequencies *pc/pt* shows a fairly good dependence on geomagnetic latitude. Seasonal variation of frequency of *pt*, related to that of the monthly means of the daily sum of *K*-indices at Kakioka, is so very different from that of *pc*, especially in spring and summer, that it would be desirable to check against data for other regions and other years. Comparison of pulsation data for various parts of the world would be facilitated by improvement of the international scaling standard. It is proposed that an index similar to the *K*-index be made in order to promote international cooperation more effectively in this field.—*D. B. V.*

179–308. Rikitake, Tsuneji; Uyeda, Seiya; Yukutake, Takesi; Tanaoka, Iwao; and Nakagawa, Eiko. The anomalous behavior of geomagnetic variations of short period in Japan and its relation to the subterranean structure. The 8th report: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 1–11, 1959.

As a result of magnetic observations made on Hachijo-shima and Aogashima, two islands roughly 270 and 340 km south of Tokyo, respectively, it is concluded that the area in which an anomalously large vertical component of short-period geomagnetic variations is observed does not extend as far as these islands. The area seems to be very narrow, covering only the southern part of central Japan. (See also Geophys. Abs. 158–50, 162–39 through –43, 163–27, 166–36, 174–264).—*D. B. V.*

179–309. Campbell, W. H., and Nebel, B. Micropulsation measurements in California and Alaska: Nature, v. 184, no. 4686, supp. 9, p. 628, 1959.

Geomagnetic micropulsations with periods of 10–30 sec have been studied at stations established at Borrego, Calif., and College, Alaska. The average diurnal behavior of 15-min r.m.s. amplitudes measured from March through September 1958 in California is shown graphically. Micropulsations at both stations for comparable times shows 23 coincident active groups in 6 days of operation. Large nighttime storms in Alaska gave oscillations 10–15 times larger than in California, but daytime activity amplitudes were similar at the 2 stations. Times of great micropulsation activity in Alaska were accompanied by shortwave blackouts and, in dark hours, by auroral displays.—*D. B. V.*

179–310. Campbell, W. H. Studies of magnetic field micropulsations with periods of 5 to 30 seconds: Jour. Geophys. Research, v. 64, no. 11, p. 1819–1826, 1959.

Magnetic field micropulsations with periods of 5–10 sec were studied for 7 months of 1958 at a station in southern California with a 2-m diameter coil antenna of 21,586 turns. The local diurnal amplitude fluctuation attained maximum at 0945 and 1400 hr. Twenty-seven-day solar dependence and correlations with magnetic and ionospheric *F*-layer disturbances were evident. The storm-time variation for micropulsation storms showed a secondary maximum at 65 min.—*Author's abstract*

MAGNETIC PROPERTIES AND PALEOMAGNETISM

179–311. Szemerédy, P. On the magnetoelastic property of the earth's crust: Univ Sci. Budapestinensis Eötvös Annales, sec. geol., v. 2, p. 107–115, 1958.

The shifts of magnetic anomalies caused by earthquakes can be satisfactorily explained by the magnetoelasticity of the earth's crust. Earthquakes bring about a rearrangement of elastic strain in parts of the crust, resulting in a lasting change of its average magnetic susceptibility. The calculations carried out in the present paper show that a change of susceptibility by several percent is sufficient to modify the earth's magnetic field by the observed amount. Moreover, an instantaneous-strain rearrangement in the crust can—according to the calculations presented—generate an electromotive force of considerable intensity. The probability of observing this electromotive force is slight, however, as it would be masked by telluric-current variations and by the electroseismic phenomenon.—*J. W. C.*

179–312. Nagata, T[akesi], and Uyeda, S[eiya]. Exchange interaction as a cause of reverse thermoremanent magnetism: Nature, v. 184, no. 4690, supp. 12, p. 890–891, 1959.

Recent evidence shows that the property of reverse thermoremanent magnetism is intrinisic to the ilmenite-hematite series and that the mechanism causing it should be of the nature of exchange interaction. In a series of synthetic ilmenite-hematite solutions, $x\mathrm{FeTiO_3} \cdot (1-x)\mathrm{Fe_2O_3}$, reversal of polarity takes place within a limited range $0.45 \leqq x \leqq 0.6$. The ability to produce reverse thermoremanent magnetism is peculiar to those members of the series that belong to the border region between the ferrimagnetic and antiferromagnetic regions, and the true mechanism of reversal should be closely related to the

same order-disorder phenomenon as that which causes the ferrimagnetic ⇌ antiferromagnetic transformation.

Whatever the detailed mechanism may be, it is possible to express the effective magnetic field that should be responsible for the production of reverse thermoremanent magnetism as $H_{eff}=H_{ex}-H_{int}$, where *eff*, *ex*, and *int* stand for effective, external, and interaction, respectively; $H_{eff}>0$ and $H_{eff}<0$ correspond to the cases of normal and reverse thermoremanent magnetism. (See also Geophys. Abs. 165–267, 175–291.)—*D. B. V.*

179–313. Hargraves, Robert B. Magnetic anisotropy and remanent magnetism in hemo-ilmenite from ore deposits at Allard Lake, Quebec: Jour. Geophys. Research, v. 64, no. 10, p. 1565–1578, 1959.

The anisotropism of magnetic susceptibility of nearly pure hemoilmenite ore from deposits in the Allard Lake area in Quebec consists of a distinct plane of maximum susceptibility with a minimum susceptibility axis at right angles. This plane coincides with a preferred crystallographic orientation indicated by parallelism of titanhematite lamellae which have exsolved on the basal plane of the ferrianilmenite host grains. The vectors of remanent magnetism (*RM*) show a striking tendency to lie in or near this preferred plane. On the assumption that hematite (if not ilmenite as well) is potentially ferromagnetic in the basal plane only, it was inferred that the *RM*-vectors could represent the resolved component of the magnetizing field which tended to lie in the plane of maximum susceptibility; this hypothesis can explain the broad spread of *RM*-vectors of samples from one deposit in terms of a single magnetizing field direction, and also the variation of intensity of *RM* of otherwise similar samples. In all but 1 of 47 samples of hemoilmenite the ore was reversely polarized (*N*-seeking pole up). This study provides additional "natural history" evidence bearing on the problem of self-reversal of thermoremanent magnetization.—*D. B. V.*

179–314. Ganguli, D. K., and Bhattacharyya, T. K. Some studies on susceptibility of ilmenite: Jour. Sci. Eng. Research [India], v. 3, pt. 1, p. 69–82, 1959.

The magnetic susceptibility of ilmenite and the effects of pulverization have been studied in detail in a magnetic field of the same order as that of the earth. Measurements were made on a large number of samples prepared by mixing different proportions of the magnetic material of various grain sizes with an inert material. Discrepancies between observed and theoretical susceptibility are less in the case of higher packing of particles, and they gradually increase with higher void ratios. The susceptibility also varies with percentage by weight of ilmenite. Powdering greatly diminishes magnetic susceptibility.

The susceptibility of ilmenite is about 10 times less than that of magnetite. If the amount of ilmenite is constant in the field and that of magnetite varies, magnetic prospecting can be used. Magnetic prospecting can also be used to advantage for concentrations of ilmenite such as in placer sands or contact-metamorphic deposits. On the other hand, an increase of ilmenite by 10 percent by volume in a magnetite sample with 50 percent void may influence the vertical anomalies significantly; small changes in susceptibility in the basement may mask completely anomalies caused by structural features.—*D. B. V.*

179–315. Vinokurov, V. M. Magnitnyye svoystva mineralov gruppy vol'framita [Magnetic properties of the minerals of the wolframite group]: Ministerstvo Vyssh. Obrazovanii SSSR Nauch. Doklady Vyssh. Shkoly, Geol-geog. nauki, no. 2, p. 62–65, 1959.

Magnetic susceptibility measurements were carried out on minerals of the wolframite group, which are paramagnetic and show anisotropy characterized by three unique directions. Two of these conform to crystallographic directions and the third forms an angle of 8°–13° to the (100) face normal. Data on 13 specimens are presented in a table.

The presence of the three directions of magnetic susceptibility is governed by deformation of the polyhedron (MO_6). The relatively small differences between the susceptibility for these three unique directions indicates that the polyhedron is not significantly deformed.—*J. W. C.*

179–316. Yefimov, F. N. Magnito-fraktsionno-mineralogicheskiy analiz [Magneto-fractionation-mineralogical analysis]: Geologiya Nefti, no. 1, p. 63–69, 1958.

The method of magneto-fractionation-mineralogical analysis is defined. It deals with the determination of the qualitative and quantitative relationship between magnetic parameters of a rock or ore and its mineral composition. More than 300 analyses were made, and the results are plotted on a graph; the ordinate represents percentage of ferromagnesium minerals present, and the abscissa represents the magnetic susceptibility of the rock. The points are distributed on a smooth curve.

The magnetic susceptibility of rocks containing more than 2 percent magnetic fraction depends on the content of ferromagnetic minerals, particularly magnetite. The influence of the latter decreases sharply, however, as its content drops from 2 to 0.1 percent, and the role of paramagnetic minerals becomes greater. (See also Geophys. Abs. 166–272).—*J. W. C.*

Senftle, F[rank] E., and Thorpe, A[rthur]. Magnetic susceptibility of tektites and some other glasses. See Geophys. Abs. 179–41.

179–317. Thorpe, Arthur, and Senftle, Frank E. Absolute method of measuring magnetic susceptibility: Rev. Sci. Instruments, v. 30, no. 11, p. 1006–1008, 1959.

An absolute method of standardization and measurement of the magnetic susceptibility of small samples is presented which can be applied to most techniques based on the Faraday method. The fact that the susceptibility is a function of the area under the curve of sample displacement versus distance of the magnet from the sample, offers a simple method of measuring the susceptibility without recourse to a standard sample. Typical results on a few substances are compared with reported values, and an error of less than 2 percent can be achieved.—*Authors' abstract*

179–318. Petrova, G. N., and Koroleva, V. A. Opredeleniye magnitnoy stabil'nosti gronykh porod v laboratornykh usloviyakh [The determination of magnetic stability of rocks in laboratory conditions]: Akad. Nauk SSSR Izv. ser. geofiz., no. 5, p. 703–709, 1959.

Investigation of the stability of the magnetization of different rocks is indispensable if data on remanent magnetization are to be used for the deter-

mination of the position of the magnetic pole during previous geologic epochs. Methods of determination of stability in natural environments as well as in laboratory conditions are discussed; attention is paid to Neel's theoretical premises. The results of experiments on the magnetic stability of Siberian traps in constant and alternating fields are presented. These results confirm Petrova's statement that magnetic stability is a more reliable characteristic of rock than the vector of remanent magnetism. It is concluded that for rocks stable in their natural conditions, the intensity of a demagnetizing constant field ranges from 20 to 100 oersted, whereas the intensity of demagnetizing alternating fields (reducing the value of I_n to ½ I_n) is 80–150 oersted. (See also Geophys. Abs. 169–229.)—*S. T. V.*

179–319. Girdler, R. W. Possible reversals of the earth's magnetic field in the Jurassic period: Nature, v. 184, no. 4685, supp. 8, p. 540–541, 1959.

In a recent study of the natural remanent magnetization of the Upper Lias Sands of western England, 17 samples collected from 2 sites (out of 14) were found to have reversed directions of magnetization; samples a little higher and lower in the section were normally magnetized. The sands are all lithologically similar. It would be surprising if a physical or chemical mechanism could be responsible for reversal of magnetization at just two sites, and it is suggested that there may have been a reversal of the geomagnetic field during deposition.

Using Arkell's subzone scheme and the geological time scale of Mayne, Lambert, and York (see Geophys. Abs. 176–1), it is possible to obtain an upper limit for the duration of the period of reversal. It is concluded that this possible reversal of the geomagnetic field in the Early Jurassic period must have lasted less than 6×10^5 yr. Evidence has been found for reversals a few million years later (Nairn, see Geophys. Abs. 170–242), and in Jurassic rocks from South Africa (Graham and Hales, see Geophys. Abs. 170–255) and South America (Creer, see Geophys. Abs. 179–321).

The estimate for the time of reversal compares favorably with Hospers' estimates of reversals in the Tertiary period (see Geophys. Abs. 167–196), and the results are consistent with a coupled-disk dynamo theory of the geomagnetic field (see Geophys. Abs. 175–270, –271).—*D. B. V.*

179–320. DuBois, P. M. Palaeomagnetism and rotation of Newfoundland: Nature, v. 184, no. 4688, p. 63–64, 1959.

The direction of magnetization was measured on 22 samples from the Bonaventure formation (Upper Mississippian or Lower Pennsylvanian) of the Gaspé Peninsula, 14 from the Kennebecasis formation (Mississippian) near St. John, New Brunswick, and 10 from the Bathurst formation (Pennsylvanian) near Dalhurst, New Brunswick. The mean direction of each sample has been plotted on a stereogram. As the rocks were collected from an extensive area their directions have been corrected to the geographic location lat 48° N., long 66° W., by assuming that the earth's average magnetic field is a dipole. The mean direction of the results of Nairn, Frost, and Light from the Codroy gypsum (Carboniferous) of Newfoundland (see Geophys. Abs. 177–296) has also been corrected to that location. There is no significant difference in declination between the Newfoundland samples and those reported here. This surmise is confirmed by a statistical analysis which gives a corrected mean direction of $D=160.5°$ and $I=+19.5°$ with a circle of confidence of 5.0° for these samples. Thus there is no evidence for any relative rotation between Newfoundland and the mainland

Maritime Provinces since Carboniferous time. If rotation occurred, these areas moved as a unit.—*D. B. V.*

179–321. Creer, K. M. Preliminary palaeomagnetic measurements from South America: Annales Géophysique, v. 14, no. 3, p. 373–390, 1958.

Measurements of the natural remanent magnetization of basaltic lavas of Early Quaternary age from Argentina, and of basalts and baked sandstones of the Early Jurassic Serra Geral formation from the Uruguay-Brazil border, show appreciable scatter. Precision is improved by treatment in alternating magnetic fields. Normal and reversed groups of magnetization are found in lavas of both formations and in the baked sediments. Comparisons with the directions of magnetization of the Karroo basalts (see Geophys. Abs. 170–242) suggests a clockwise rotation of 22° of Africa relative to South America since Early Jurassic times; this is about half the amount suggested by DuToit in his reconstruction of Gondwanaland and the two results are consistent with the view that the displacement of the southern continents to their present positions had reached a halfway stage in the Early Jurassic.—*D. B. V.*

179–322. Rutten, M. G. Paleomagnetic reconnaissance of mid-Italian volcanoes: Geologie en Mijnbouw, v. 21, no. 10, p. 373–374, 1959.

The direction of magnetization of the products of five Quaternary volcanoes of central Italy (Vulsini, Cimini, Vico, Sabatini, and Laziale) has been investigated in the field. Cimini, which is Villafranchian in age, shows reverse magnetization; the others, all younger, are magnetically normal. Potassium-argon dating of products of Sabatini gives a minimum duration of the present normal magnetic period as 470,000 year.

It was found possible to distinguish in the field between primary tuffs with pronounced magnetic orientation and redeposited tuffs, lahars, and such without orientation or with random orientation. This was checked against the historic Vesuvius eruption of A. D. 79; the mud flow which covered Herculaneum shows no magnetic orientation in the field, whereas small lava inclusion in the ash which destroyed Pompeii all have regular normal magnetization.—*D. B. V.*

179–323. Coombs, D. S., and Hatherton, T. Palaeomagnetic studies of Cenozoic volcanic rocks in New Zealand: Nature, v. 184, no. 4690, p. 883–884, 1959.

The direction of remanent magnetization has been determined for some New Zealand Cenozoic rocks of different ages. Reversals are found in the Lower Pleistocene, Upper Miocene-Lower Pliocene (or possibly within Miocene), and Upper Eocene rocks. No measurable polar wandering with respect to New Zealand has occurred since Late Eocene times.—*D. B. V.*

179–324. Turnbull, G. Some palaeomagnetic measurements in Antarctica: Arctic, v. 12, no. 3, p. 151–157, 1959.

Rock specimens for measurement of remanent magnetization were collected from two localities in Victoria Land, Antarctica: At Cape Hallett from Cenozoic volcanics, and in the Ferrar Glacier region from the Early Mesozoic Beacon sandstone series and the Mesozoic dolerite sills intruding the series.

Results of all measurements are given in a table. Results of measurements on the Cenozoic volcanics agree with earlier paleomagnetic evidence showing that the average geomagnetic poles have been alined along the present axis of rotation for the last 20 million years. Measurements on the dolerite sill samples

show a Mesozoic pole position of about lat. 58° S., long. 142° W. The Beacon sandstones are too weakly magnetized for significant measurements; the only exceptions are samples collected near the sills whose magnetization is obviously not original, and is significant only in that it lends support to results obtained for the dolerite formation.

Magnetization of the older rocks in a direction significantly different from that of the present mean magnetic field may be interpreted as evidence of polar wandering. The data are probably too sparse for a discussion of continental drift.—*V. S. N.*

MAGNETIC SURVEYS

179–325. Logachev, A. A. Metodicheskoye rukovodstvo po aeromagnitnoy s"yemke [Manual of aeromagnetic survey methods]: Moscow, Gosgeoltekhizdat, 146 p., 1955.

This is a professional manual on airborne magnetic surveying based on the experience of Logachev and others during the period 1936–54. The vertical component of the anomalistic magnetic field Z_a and the total field increment ΔT are discussed in chapter 1, and the analytical relationships between Z_a and ΔT, and Z_a and H_a (the horizontal component of the anomalistic field) are given in terms of the observation altitude. Chapter 2 deals with the interpretation of recorded magnetic anomalies in terms of the geometry and magnetic parameters of disturbing geological bodies. The methods of airborne magnetic surveying are discussed in the last chapter.—*A. J. S.*

179–326. Strakhov, V. N. Ob analyticheskom prodolzhenii dvukhmernykh magnitnykh poley [On the analytical extension of two-dimensional magnetic fields]: Akad. Nauk SSSR Doklady, v. 126, no. 5, p. 987–989, 1959.

The problem of an analytical extension of a two-dimensional magnetic field into the adjacent half plane along the real axis is discussed in terms of the complex field intensity. A mathematical method analogous to that used in the solution of an analytic extension of three-dimensional fields by the Fourier-Bessel integral is developed. The general solution, which was found technically difficult for evaluation, is transformed into an approximate solution which can be tabulated and expressed in master-chart form.—*A. J. S.*

179–327. Hall, Donald, H. Direction of polarization determined from magnetic anomalies: Jour. Geophys. Research, v. 64, no. 11, p. 1945–1959, 1959.

Recent research on remanent magnetization of rocks shows that the effects of permanent magnetization cannot be neglected in interpreting the results of magnetic surveys. With new techniques, components of the magnetic field are measured in directions other than those generally treated in earlier methods of interpretation. In this paper equations for the magnetic field over a point dipole, a horizontal line of dipoles, a thin dipping sheet, a thick dipping sheet, and a sloping step are derived in the case where directions of measurement and of polarization are both arbitrary.

It is found that these directions combine with other properties of the bodies to form parameters from which various features of the anomalies over the bodies can be determined. In terms of these combined parameters it is possible to obtain the higher derivatives of the expressions for the fields over these bodies and to develop methods of determining their unknown parameters when

magnetic profiles are given. From single profiles the depth, pole strength, and direction of polarization of a single dipole or horizontal line of dipoles can be determined; for dipping sheets or a sloping step the depth, pole strength per unit surface area, and a polarization function (combining direction of polarization and dip of the inclined faces) can be determined.

The equations for fields and their derivatives over infinite lines of dipoles, dipping sheets, and sloping steps are expressed as derivatives of a single function, and a general expression for derivatives of any order is given. Thus a single set of equations can be used to compute values of the fields and their derivatives over these bodies. Graphs are presented as an aid to their computation.

Methods of calculation of the unknown parameters of the line of dipoles and the thin, dipping sheet when their anomalies are given, are outlined, followed by examples of calculation in the case of theoretically calculated sample profiles.—*D. B. V.*

179–328. Logachev, A. A. Vychisleniye elementov zaleganiya namagnichennykh tel po materialam magnitnoy s"yemki v gornoy mestnosti [Calculation of position of elements of magnetized bodies from the data of a magnetic survey in mountainous terrain]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 3, p. 96–101, 1959.

The existing theory of calculating the position of magnetized bodies from the data of a magnetic survey has been developed for measurements on a horizontal plane only. For rough terrain, the survey data must be reduced to a horizontal plane. Using the total vectors $\vec{Z}$ and $\vec{H}$ as $f(x,z)$, Logachev derives a reduction formula and determines the depth h, the dip, and the axis of the deposit (perpendicular to the strike) with the aid of appropriately constructed master charts.—*A. J. S.*

Zidarov, D., and Sakalian, K. Experimental-model solution of the inverse gravimetric and magnetometric problems. See Geophys. Abs. 179–201.

179–329. Rotshteyn, A. Ya., and Tsirel, V. S. Nekotoryye itogi rabot s yadernym magnetometrom [Some results of work with a nuclear magnetometer]: Akad. Nauk SSSR Izv. ser. geofiz., no. 7, p. 1070–1072, 1959.

A description is given of the absolute nuclear precession magnetometer AYaPM–4–VITR designed and built in the U.S.S.R. This instrument operates on the principle of nuclear resonance and is designed for field use. It measures the absolute value of the total magnetic vector T with an accuracy of $\pm 2\lambda$. The time of one measurement is 2 sec, and measurements can be made every 10 sec. The total weight of the magnetometer, with a battery good for 1,000 measurements, is only 8.5 kg. The instrument consists of the following parts: an emitter, an electronic device, and a recorder. The emitter is a cylindrical glass container filled with a mixture of water and alcohol. The electronic device contains a set of standard quartz resonators, an amplifier, a divide detector, a filter, and an amplifier at the outlet. A storage battery and dry batteries are used. The characteristic curves of the instrument, obtained in field measurements, are reproduced. The magnetometer has been used in several parts of the U.S.S.R. with fully satisfactory results.—*S. T. V.*

179–330. Wing, Lawrence A[lvin]. An aeromagnetic and geologic reconnaissance survey of the Sidney-Augusta and Gardiner areas, Kennebec County, Maine: Maine Geol. Survey GP and G 5, 18 p., 1959.

A geologic and aeromagnetic reconnaissance survey was made of two small areas in the vicinity of Augusta and Gardiner, Maine. In the Augusta area the results of the aeromagnetic survey permit extending the geologic boundaries and rock units into the part with heavy overburden. In the Gardiner area the magnetic pattern outlines a mapped sulfide-bearing zone and permits the extension of that zone.—*A. J.*

179–331. Balsley, James R., Postel, A. W[illiams], and others. Aeromagnetic and geologic map of the Loon Lake quadrangle and part of the Chateaugay quadrangle, Franklin County, New York: U.S. Geol. Survey Geophys. Inv. Map GP 191, 1959.

This map, on a scale of 1:62,500 (1 inch=about 1 mile) and a contour interval of 100 and 500 gammas, is part of a series of maps showing the results of aeromagnetic surveys over an area of about 6,200 sq mi in the northwest part of the Adirondack Mountains. Contours of total magnetic intensity relative to an arbitrary datum are superposed on a reconnaissance geologic map.—*W. L. G.*

179–332. Balsley, James R., and Buddington, A. F., and others. Aeromagnetic and geologic maps of New York: U.S. Geol. Survey Geophys. Inv. Map GP 190, 192, and 193, 1959.

The following aeromagnetic and geologic maps have been published at a scale of 1:62,500 (1 inch=about 1 mile) and a contour interval of 100 and 500 gammas: 190, Santa Clara quadrangle and part of the St. Regis quadrangle, Franklin County; 192, Oswegatchie quadrangle, St. Lawrence, Herkimer, and Lewis Counties; and 193, Tupper Lake quadrangle, St. Lawrence, Hamilton, and Franklin Counties, N.Y. These maps are part of a series showing results of aeromagnetic surveys over an area of about 6,200 sq mi in the northwest part of the Adirondack Mountains. Contours of total magnetic intensity relative to an arbitrary datum are superposed on reconnaissance geologic maps.—*W. L. G.*

179–333. Bromery, Randolph W., Zandle, Gerald L., and others. Aeromagnetic maps of Pennsylvania: U.S. Geol. Survey Geophys. Inv. Map GP 200, 201, 203–208, 214. and 217–220, 1959.

Aeromagnetic maps that show by contour lines the total intensity at about 500 ft above ground level have been published for the following: 200, Valley Forge quadrangle, Chester, Montgomery, and Delaware Counties; 201, part of the Norristown quadrangle, Philadelphia, Chester, Delaware, and Montgomery Counties; 203, part of the West Chester quadrangle, Chester and Delaware Counties; 204, part of the Media quadrangle, Chester and Delaware Counties; 205, East Greenville quadrangle, Berks, Lehigh, and Montgomery Counties; 206, Milford Square quadrangle, Bucks, Lehigh, and Montgomery Counties; 207, Sassamansville quadrangle, Montgomery and Berks Counties; 208, Perkiomenville quadrangle, Montgomery and Bucks Counties; 214, Quakertown quadrangle, Bucks County; 217, Safe Harbor quadrangle, Lancaster and York Counties; 218, Conestoga quadrangle, Lancaster County; 219, Quarryville quadrangle, Lancaster County; and 220, Morgantown quadrangle, Berks, Lancaster, and Chester Counties.—*W. L. G.*

179–334. Bromery, Randolph W., Henderson, John R., Jr., Bennett, Bruce L., and others. Aeromagnetic map of parts of the Lambertville and Stockton quadrangles, Bucks County, Pennsylvania, and Hunterdon and Mercer Counties, New Jersey: U.S. Geol. Survey Geophys. Inv. Map GP 216, 1959.

This aeromagnetic map shows by contour lines the total intensity at about 500 ft above ground level for parts of the Lambertville and Stockton quadrangles, Bucks County, Pa., and Hunterdon and Mercer Counties, N.J.—*W. L. G.*

179–335. Bromery, Randolph W., Bennett, Bruce L., and others. Aeromagnetic maps of Pennsylvania: U.S. Geol. Survey Geophys. Inv. Map GP 202, 209, and 213, 1959.

Aeromagnetic maps that show by contour lines the total intensity at about 500 ft above ground level have been published for the following: 202, Malvern quadrangle, Chester County; 209, Phoenixville quadrangle, Chester and Montgomery Counties; and 213, Allentown quadrangle, Northampton, Lehigh, and Bucks Counties.—*W. L. G.*

179–336. Bromery, Randoph W., Henderson, John R. Jr., Zandle, Gerald L., and others. Aeromagnetic maps of Pennsylvania: U.S. Geol. Survey Geophys. Inv. Map GP 215 and 221, 1959.

Aeromagnetic maps that show by contour lines the total intensity at about 500 ft above ground level have been published for the following: 215, Buckingham quadrangle, Bucks County; and 221, Elverson quadrangle, Berks and Chester Counties.—*W. L. G.*

179–337. Canada Geological Survey. Aeromagnetic maps of the Province of New Brunswick: Dept. Mines and Tech. Surveys, Geophysics Papers 123, 133, 135, 136, 141, 593–595, 597–600, 750–753, 756, and 758, 1959.

Aeromagnetic maps that show by contour lines the total magnetic intensity at about 1,000 ft above ground level have been published for the following quadrangles: 123, McKendrick Lake; 133, Doaktown; 135, Napadogan; 136, McAdam; 141, Burtts Corner; 593, McDougall Lake; 594, Rolling Dam; 595, St. Stephen; 597, Codys; 598, Sussex; 599 Hamstead; 600, Saint John; 750, Fredericton Junction; 751, Fredericton; 752 Grand Lake; 753, Minto; 756, Boiestown; and 758, Newcastle.—*W. L. G.*

179–338. Canada Geological Survey. Aeromagnetic maps of Manitoba: Dept. Mines and Tech. Surveys, Geophysics Papers 726–732, 1959.

Aeromagnetic maps that show by contour lines the total magnetic intensity at about 1,000 ft above ground level have been published for the following quadrangles: 726, Gimby Lake; 727, Samson Lake; 728, Morand Lake; 729, Clisby Lake; 730, Sprott Lake; 731, Nicklin Lake; and 732, Bain Lake.—*W. L. G.*

179–339. Canada Geological Survey. Aeromagnetic maps of Northwest Territory: Dept. Mines and Tech. Surveys, Geophysics Papers 733–748, 1959.

Aeromagnetic maps that show by contour lines the total magnetic intensity at about 1,000 ft above ground level have been published for the following quadrangles in the District of Mackenzie: 733, Salt River; 734, Tethul River; 735, Copp Lake South; 736, Buffalo Lake South; 737, Buffalo Lake West; 738,

Buffalo Lake North; 739, Copp Lake North; 740, Sass River; 741, Lake of the Grave; 742, Hawkes Lake; 743, Deschaine Lake; 744, Needle Lake; 745, Lobstick Creek; 746, Higgins Lake; 747, Klewi River; and 748, Le Grand Detour.—*W. L. G.*

179–340. Pobul, E. A. Kaalijärve meteoriidikraatri no. 3 magnetomeetrilisest uurimisest [Magnetometric investigations of Kaalijärv meteor crater no. 3]: Eesti NVS Teaduste Akad. Geol. Inst. Uurimused, v. 2, p. 119–132, 1958.

Meteor crater no. 3 of Kaalijärv group in Estonia was investigated with a magnetometer for the purpose of locating meteoritic iron. No outstanding magnetic anomalies were observed in the crater, which was traversed in separate transverse profiles on a net of 1 by 1 m. The mean square error of the observations was $\pm 1\gamma$. Microanomalies observed in the crater were of the order of 10γ. A magnetic microanomaly of such magnitude can be produced by a meteorite fragment of 20 g. The heaviest fragment found in the Kaalijärv craters weighs 24 g.—*A. J. S.*

179–341. Dąbrowski, Adam. Der Bau des tieferen Untergrundes Westpolens nach geophysikalischen Untersuchungsergebnissen [The structure of the deep underground of western Poland according to data of geophysical investigations]: Zeitschr. angew. Geologie, v. 5, no. 9, p. 392–395, 1959.

The deep structure of western Poland is interpreted on the basis of magnetic and gravimetric surveys as a broad depression bounded on the northeast, south, and southwest by rigid blocks but open on the west and northwest. Evidence that orogenic processes have been active in the basin is particularly clear on its margins. The depression is filled with sediments reaching a thickness of some ten thousands of meters in the center.—*D. B. V.*

179–342. Agocs, William B. Profondità e struttura dell' orizzonte igneo fra Catania e Tunisi dedotte da un profilo aero magnetico [Depth and structure of the igneous horizon between Catania and Tunis deduced from an aeromagnetic profile]: [Italy] Servizio Geol. Boll., v. 80, no. 1, p. 51–57, 1959.

An aeromagnetic profile was made at 460 m altitude from Catania, Sicily, to Tunis, Tunisia, across Gela, Pantelleria, and Kelibia, for a length of 460 km. This is a continuation of the areomagnetic profile from Tunis to Lisbon flown in 1956 (see Geophys. Abs. 165–282). Strong anomalies were found over known volcanic (mafic) outcrops west of Catania and on Pantelleria Island. Between these two areas the anomalies are moderate and probably reflect a granitic basement. The depth to this igneous basement varies from 305 to 610 m in the areas of volcanic rock. On Sicily it reaches a maximum of 4,575 m between Palagonia and Caltagirone; at Gela it is 3,050 m. Maximum basement depth in the whole profile (7,625 m) occurs near the Tunisian coast, at Kelibia. A series of faults are indicated, upthrown on the west except for the fault near the Tunisian coast, which is upthrown on the east.—*D. B. V.*

179-343. Airinei, Ştefan. Asupra anomaliei magnetice regionale din centrul bazinului Transilvaniei [Regional magnetic anomalies in the center of the Transylvanian basin (in Rumanian with Russian and French summaries)]: Acad. Romîne Bull. Ştiinţ, sec. geol. şi geog., v. 2, no. 2, p. 209–235, 1957.

Results are presented of work carried on in 1952, 1954, and 1955 for determination of the boundaries of regional magnetic anomalies. Several magnetic maps are presented; these reveal a large positive anomaly that is due to the presence of a rigid basement block. The orientation of this block corresponds to that of the Carpathian tectonics and is considered to be one of the primary factors contributing to the formation of the Carpathian arc in Rumania.—*Author's summary, J. W. C.*

179-344. Corvin-Papiu, V., Savu, H., Romanescu, D., and Pîrvu, Livia. Corelaţia dintre alcătuirea geologică şi anomaliile magnetice din zona axială a masivului Drocea (Munţii Apuseni) [Correlation between the geologic structure and the magnetic anomalies of the axial zone of the Drocea massif (Apuseni Mountain—in Rumanian, with Russian and French summaries)]: [Rumania] Com. Geol. Dări de Seamă ale Şed., v. 42, p. 49–86, 1954–55 (1959).

The relationship between the magnetic anomalies and the geologic structure of the axial zone of the Drocea massif has been determined. The region is underlain largely by igneous rocks. The mafic varieties commonly contain 5–10 percent magnetite, and one gabbro contains 24 percent magnetite. The intermediate and silicic rocks are represented by several varieties from diorite to pegmatite.

Detailed magnetic studies were made using 2 Askania and 1 Russian M_2 variometers. The hypabyssal diabases are characterized by a range in the ΔZ values from $-2{,}000\gamma$ to $+5{,}000\gamma$. The ΔZ anomalies over nonmineralized gabbro and diorite are elongate, and the values do not exceed 500γ. Contacts of barren gabbro with diabase are marked by zones of very low or even negative values. Strong gravity gradients up to 700γ per 20 m characterize some contacts. The magnetite gabbros are similar magnetically to diabases. Their values are generally greater than $1{,}000\gamma$ and may reach $3{,}000\gamma$. The granitic rocks produce an effect similar to that of the nonmineralized gabbros; the ΔZ values do not exceed 500γ. Steep gravity gradients mark the contacts of the granitic rocks with diabases.

The paper is accompanied by several magnetic maps and profiles. It is concluded from this study that magnetic measurements are a precise and useful method for mapping mafic igneous rocks.—*Authors' summary, J. W. C.*

179-345. Airinei, Şt[efan]. Ridicări magnetice regionale în Transilvania (Arahida-Dej-Beclean-Teaca) [Regional magnetic measurements in Transylvania (Arahida-Dej-Beclean-Teaca) (in Rumanian with Russian and French summaries)]: [Rumania] Com. Geol. Dări de Seamă ale Şed., v. 42, p. 149–157, 1954–1955 (1955).

Regional magnetic measurements were carried out in the Transylvanian basin in 1952; an area of 1,800 km^2 was surveyed and 537 stations were occupied. The magnetic field over this territory is almost entirely anomalous. A map of the vertical anomalies shows a strong positive anomaly flanked by less defined negative anomalies. Neither the positive nor negative magnetic anomalies bear a relationship to the structures of the sedimentary cover.

Analysis of the positive magnetic anomaly in conjunction with the maximum gravity anomaly indicates that these anomalies together reflect the existence of a large fold in the basement, on the flanks of which basic rocks may have been intruded. It is concluded that the geomagnetic field in the center of the Transylvanian trough is disturbed by a large positive anomaly that corresponds to strongly magnetic rocks of the subbasement.—*J. W. C.*

Airinei, Şt[efan]. Gravimetric and magnetic research in the region of Singeorgiul de Padure-Miercurea Nirajului. See Geophys. Abs. 179–225.

179–346. Ozertsova, V. A., Polyakova, L. V., and Spizharskiy, T. N. Rel'yef kristallicheskogo fundamenta Yugo-Vostochnoy chasti Sibirskoy platformy po dannym aeromagnitnoy s"yemki [Relief of the crystalline basement of the southeastern part of the Siberian platform according to aeromagnetic survey data]: Sovetskaya Geologia, no. 5, p. 66–72, 1959.

The depth of the magnetic formations was computed at about 2,000 points in the southeastern part of the Siberian platform from the anomalies of the magnetic field obtained by an aeromagnetic survey by the Yakutsk geophysical expedition. The integral method of Simonenko and the method of tangents were used in the determinations. The method of higher derivatives was also used for the bodies of great horizontal extent. Two main structures were found, the Aldan anticline and the Vilyaysk syncline. The deepest point in the center of the syncline is more than 7 km below sea level. On the background of these large structures a number of small uplifts and troughs are outlined. The results of these computations of the basement relief are in good agreement with known geologic data and form an important addition to our knowledge of this vast area. (See also Geophys. Abs. 172–190.)—*S. T. V.*

Ostenso, Ned A., and Bentley, Charles R. Gravity and magnetic studies on the Marie Byrd Land traverses, 1957–58. See Geophys. Abs. 179–235.

Thiel, Edward, and Behrendt, John C. Gravity and magnetic measurements on the Ellsworth oversnow traverse, 1957–1958. See Geophys. Abs. 179–233.

MICROSEISMS

179–347. Das Gupta, Sushil Chandra. On microseisms produced on the surface of the earth due to passage of storm over the deep sea: Jour. Physics of Earth [Tokyo], v. 4, no. 2, p. 31–40, 1956.

The generation of microseisms due to progressive sea waves produced by storms is considered mathematically. It is shown that the approximate period of microseismic vibrations is half the period of the sea waves generating them and the character of microseisms is approximately that of the Rayleigh type. It is demonstrated that the velocity of propagation is much smaller than that of Rayleigh waves and depends mainly on the geologic structure of the ocean floor. Wavelength is found to conform to observations, and the ratio of the horizontal to the vertical amplitude is obtained. The fact that microseisms are observed in case of typhoons but not in case of monsoons is explained; when the end points of the disturbed area are at very great distances, as in the case of the very large front of a monsoon, displacement becomes too small to be detected at a large distance and appreciable microseisms are unlikely.—*V. S. N.*

179–348. Kishinouye, Fuyuhiko, and Kotaka, Mieko. Microseisms and typhoons: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 171–176, 1959.

The relationships of microseisms to central pressure, traveling velocity, and wind velocity of typhoons were studied in records of four storms at different Japanese stations. Microseisms at Osaka seem to vary with traveling velocity, whereas those at Akita, Onahama, and Tokyo do not. Data at Osaka also show some correlation with wind velocity. In the case of Tokyo and Akita the amplitude of microseisms might depend on the position of the cyclone center. It is concluded that microseisms are not simple elastic waves, but depend on conditions of the cyclones.—*D. B. V.*

179–349. Carder, Dean S., and Eppley, Robert A. The microseismic program of the U.S. Navy—A terminal report: U.S. Coast and Geodetic Survey, 196 p., 1959.

This report presents all essential microseismic data derived from 12 years of operation of the Microseismic Research Project, U.S. Navy Hurricane Weather Center, and evaluates all results and procedures developed relative to sensing, locating, appraising, and tracking tropical storms by microseismic methods. Observations were made at stations bordering the Gulf, the Caribbean, the North Atlantic, and the North Pacific. The tripartite system was used until 1951 when it was abandoned because microseisms from two or more sources often crossed the net simultaneously producing spurious apparent-wave speeds and directions. From results of the studies it is evident that microseisms may be generated directly in a storm area; or they may be generated close to the shore or somewhere between the storm area and shore; and finally, winds not necessarily associated with a hurricane or tropical storms may create conditions that produce microseisms.—*V. S. N.*

179–350. Stolypina, N. V., and Monakhov, F. I. Sinopticheskiye usloviya vozbuzhdeniya microseysm v Chernom more [The synoptic conditions exciting microseisms in the Black Sea]: Meterologiya i gidrologiya, no. 2, p. 27–30, 1958.

The periods of microseisms at the Yalta seismic station range from 2 to 8 sec, and their amplitudes from 0.2μ to 10μ. The sources of these microseisms are cyclones and cold fronts passing over the Black Sea, the North Atlantic, and adjoining seas. The periods of those generated over the Black Sea usually do not exceed 4 sec, whereas those generated over the Atlantic are of 5 sec or longer periods. Microseismic disturbances can be produced not only by cold, but also by warm fronts. When the fronts reach the Black Sea from the west, the amplitudes at Yalta gradually increase and reach a maximum 6 hr after the front passes the central part of the sea. A lag thus exists between the excitement of the microseisms and the passing of the front over the Black Sea.—*S. T. V.*

179–351. Santo, Tetsuo A[kima]. Investigations into microseisms using the observational data of many stations in Japan (Part 1). On the origin of microseisms: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 307–325, 1959.

Microseisms were examined by a synoptic (macroscopic) method using observational data from many stations over a wide area. Continuous observations were made at about 15 stations in Japan as part of the International

Geophysical Year program; the data used in this paper were those for the period September 1957 to May 1958. It was found that when a cyclone or typhoon traveled northeastward over the ocean, the microseismic storm at a given station on the mainland of Japan occurred considerably later than the passage of the cyclone center. Microseismic storms also occurred when a strong cold front passed across Japan from west to east; in this case they occurred almost simultaneously at every station.

The direct cause undoubtedly is swells. Maximum amplitudes at a station never occurred before the arrival of the highest swells near that station. The microseism periods were nearly half the periods of swells, a fact which satisfies the Longuet-Higgins theory. If this theory is the true explanation of microseisms, the region where interference between two trains of swells occurs is near the coast rather than around the center of the cyclone or typhoon; in other words, these disturbances on the ocean are undoubtedly the source of energy of microseisms, but not the cause of microseisms.—*D. B. V.*

179–352. Kishinouye, Fuyuhiko, and Shida, Isamu. Tripartite observations of microseisms in Yamagata City: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 177–181, 1959.

Tripartite observations of microseisms have been made at Yamagata, Japan, in order to compare microseisms at Yamagata with those observed at Sakata (see Geophys. Abs. 172–198), which is on softer ground. Amplitudes were so small at Yamagata that usable records were obtained only on 3 days of the 2-month observation period. Records obtained on those days are compared with those of several other Japanese stations.

No correspondence could be found between direction of propagation of microseisms and azimuth of cyclone from the stations. Periods of microseisms at Yamagata averaged 2.9 sec, which is smaller than the 4.0 sec average at Sakata. Wavelength was calculated to be 4.5 km at Yamagata compared to 2.2 km at Mitaka and 2.0 km at Sakata; this difference may be due to differences in elasticity of the ground at the different stations.—*D. B. V.*

179–353. Kishinouye, Fuyuhiko, and Shida, Isamu. Tripartite observations of microseisms at Sakata (second paper): Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 183–188, 1959.

This is a report on tripartite-microseism observations made at Sakata, Japan, in December 1956 on an alluvial plain about 2 km southeast of the first series, which were made on a sand dune (see Geophys. Abs. 172–198). Average velocity of propagation was about 1,000 m per sec and period about 2.8 sec; in the previous observations velocity was 750 m per sec and period 4.0 sec; wavelengths are thus nearly equal. From these values, no effect of geology on microseisms was apparent. Propagation direction again varied over a fairly wide angle; most waves came from the north or northeast, pointing to the northeastern sea off the mainland rather than to the Japan Sea.—*D. B. V.*

179–354. Kishinouye, Fuyuhiko, and Shida, Isamu. Tripartite observations of microseisms in Shonai Plain Yamagata Prefecture: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 1, p. 189–192, 1959.

Tripartite observations of microseisms were made on the alluvium-covered Shonai plain in Japan, in order to investigate the relation between microseisms and subsoil conditions and between microseisms and damage in the Shonai

earthquake of 1897. Direction of microseisms was almost opposite to the position of the center of the cyclone of December 1957. Velocity of propagation was expectedly small, 820 m per sec. Mean period was 2.4 sec, mean wavelength 2 km as at Sakata (see Geophys. Abs. 179–353). These results may be characteristic of weak ground for earthquakes.—*D. B. V.*

179–355. Kishinouye, Fuyuhiko, and Watanabe, Yoshio. An electromagnetic horizontal seismograph for recording microseisms: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 2, p. 327–335, 1959.

A new electromagetic seismograph for recording the horizontal component of microseisms consists of a horizontal pendulum or transducer, a galvanometer and an optical recording camera. The pendulum and recorder, designed by Kishinouye and Watanabe, are described in detail in this paper with photographs, schematic diagrams, and equations and graphs.—*D. B. V.*

179–356. Sytinskiy, A. D. Seysmicheskiye nablyudeniya v observatorii Mirnyy [Seismic observations at Mirnyy Observatory]: Sovet. Antarkt. Exped., Informatsionnyy Byull., no. 1, p. 79–80, 1958.

The seismic station at Mirnyy in Antarctica has operated regularly since June 1956. It is equipped with Kirnos seismographs for galvanometric recording of all three components. The seismographs are placed at a 17-m absolute altitude in a 2-m shaft in charnockite. None of the 196 earthquakes recorded by the station from June 23, 1956 to February 1, 1957, originated in Antarctica; most of those whose epicenters were determined were in the belt of Tonga, Fiji, Samoa, and other Pacific islands. Three types of microseisms were recorded: those with periods of 6–10 sec and 18μ maximum amplitude, observed the year round; those with periods of 2–5 sec and 7μ amplitude, observed during the summer and fall seasons; and those due to high winds, which occurred a few days in the year.—*A. J. S.*

SEISMIC EXPLORATION

179–357. Petrashen', G. I. [Editor]. Materialy kolichestvennogo izucheniya dinamiki seysmicheskikh voln [Data on quantitative studies of the dynamics of seismic waves]: Vses. nauchno-issled. inst. geofiz. metodov razvedki, v. 2, 153 p., 1957.

This is the second volume of the planned three-volume monograph under the title given above. The volume consists of tables and graphs with explanatory text, to serve as a basis for calculations of the dynamic properties of seismic waves and for construction of theoretical seismograms for isotropic layered media of arbitrary structures. The 5 chapters of volume 2 present: tables of the direction functions of the initial point sources, conversion coefficients, and reflection coefficients of elastic waves from the earth's surface; tables of formation coefficients of head waves of the principal type; tables of complex coefficients of reflection-refraction transverse waves of the *SH* type; graphs of typical forms of seismic records, method of determination of the forms of seismic records for measuring apparatus of any amplitude-phase frequency characteristic; and elementary methods of construction of theoretical siesmograms. The data presented are expected to facilitate the identification of arrivals on the seismograms of various waves and to increase the accuracy and reliability of the interpretation of seismic observations.—*A. J. S.*

179–358. Slotnick, Morris Miller. Lessons in seismic computing: Tulsa, Okla., Society of Exploration Geophysicists, 268 p., 1959.

This volume of 44 lessons in the theory behind the day-to-day techniques used in seismic computing was edited by Richard A. Geyer and published as a memorial to Dr. Slotnick, who originally prepared the lessons for the use of a group of oil company geophysicists. The lessons are arranged in four parts covering the fundamental concepts of seismic interpretation, the concepts and analysis of the theory associated with three-dimensional single and dipping layers, analysis of the multilayered problem, and analysis of the theory of curved paths and its application to the case in which velocity is assumed to be linear with depth.—*V. S. N.*

179–359. Knopoff, Leon, and Gangi, Anthony F. Seismic reciprocity: Geophysics, v. 24, no. 4, p. 681–691, 1959.

The reciprocity relationship describing the relations among the fields resulting from the interchange of point sources and receivers may be extended to the seismic case. Seismic reciprocity can be described either in terms of the scalar product of the vectors representing the excitation of the source and the field at the receiver, or in terms of a Green's tensor describing these two quantities. Theoretical reciprocity relations give no information concerning reciprocity in the cases for which the scalar product vanishes. A simple experiment in the vector case demonstrates that reciprocity is not obtained when the scalar product of the two vectors vanishes.—*Authors' abstract*

179–360. Acheson, C. H. The correction of seismic time maps for lateral variation in velocity beneath the low velocity layer: Geophysics, v. 24, no. 4, p. 706–724, 1959.

Lateral variation in velocity beneath the low-velocity layer often causes time anomalies that obscure the true structural picture. A method of correction to a deep datum has been developed to minimize the spurious anomalies without affecting those caused by structure. This method makes use of the discovery that for any particular well in western Canada, there exists a simple exponential relationship between time and depth so that the results of relatively shallow core hole velocity surveys can often be extrapolated to predict times to much greater depths. An example is given to show this method was applied successfully to a particular problem area in western Canada. It has since been used in several other places.—*Author's abstract*

179–361. Ryazanova, Ye. V. Uproshchennyy sposob vychisleniya effectivnoy skorosti po sopryazhennym tochkam godografov otrazhennykh voln [A simplified method of calculating effective velocity according to the conjugate points of the reflected wave traveltime curves]: Razvedochnaya i Promyslovaya Geofizika, no. 17, p. 36–40, 1957.

The method of calculating effective velocity v_{ef} according to the conjugate points on the traveltime curves of reflected seismic waves was given by A. I. Bogodanov (Prikladnaya Geofizika, no. 9, 1952) for any pair of conjugate points and for any form of reflecting boundary. As the formulas contain the apparent velocities v_{ap} of the waves, and since the values of v_{ap} determined graphically are subject to considerable errors, an accurate determination of v_{ef} by Bogodanov's method is difficult. Ryazanova suggests that v_{ap} be disregarded when the reflecting boundary is almost horizontal. By assuming the dip angle to be zero,

Ryazanova develops a simple formula for a calculation of v_{ef}; the error of determination of effective velocity by this method can be reduced to 2 percent or less.—*A. J. S.*

179–362. Priyma, V. I. O vvedenii popravok v godografy otrazhennykh voln [On corrections of traveltime curves of reflected waves]: Razvedochnaya i Promyslovaya Geofizika, no. 17, p. 12–19, 1957.

Recent practice in interpreting reflection profiles is to neglect the upper zones of low velocity where the surface terrain is rough. It has been found that this practice can improve considerably the profiling data, but also can introduce a substantial error in the traveltime curve. The factors that affect the accuracy of determination of the depth of the reflection horizon are discussed, and a method for correction of the data is proposed.—*A. J. S.*

179–363. Shushakov, S. D. Kratnyye otrazhennyye volny [Multiply reflected waves]: Prikladnaya Geofizika, no. 20, p. 3–25, 1958.

Multiple reflections can be an aid in seismic exploration if correctly interpreted. The results of studies on models of multiply reflected waves and of theoretical computations by the method of contour integrals are presented. Multiply reflected waves can be distinguished more easily if the kinematic characteristics are supplemented by dynamic analysis. An important feature for the analysis of multiple reflections is the effect of the number of reflections (even or odd) on the direction of the wave. Under certain conditions the frequency of vibrations of multiply reflected waves propagating through media with weak-absorption coefficients may increase with increase in number of reflections and in distance from the source; in the case of simple reflections the frequency usually decreases. At a certain distance from the source, some multiply reflected waves may have intensities greater than waves with only few reflections. Yepinat'yeva also observed this fact and suggested an explanation (see Geophys. Abs. 179–365)—*S. T. V.*

179–364. Yepinat'yeva, A. M., and Mikhaylova, N. G. Opredeleniye tipov mnogokratnykh otrazhennykh voln po ikh kinematicheskim i dinamicheskim kharakteristikam [The determination of types of multiply-reflected waves from their kinematic and dynamic characteristics]: Akad. Nauk SSSR Izv. ser. geofiz., no. 7, p. 965–980, 1959.

This study is concerned with the finding of effective means of distinguishing multiple reflections by using different kinematic and dynamic characteristics of these waves. The geologic conditions favorable to the appearance of multiple reflections were also studied. Experiments were carried out in the Black Sea depression, where numerous horizontal strata form both sharp and weak boundary planes favorable to the formation of multiple reflections. Two sets of instruments with frequencies of 37 cycles per sec and 105 cycles per sec, respectively, were used. Several types of multiple reflections were recorded; some were reflected at every possible reflecting boundary, and others were reflected only at some of the boundaries. In the region surveyed the main reflecting horizon was located at a depth of 800 m and was characterized by a high reflecting coefficient (q=0.3). The intermediate horizontal reflecting boundary was located near the zone of low seismic velocity. Using the vertical traveltime curve, several possible schemes for the propogation of multiple reflections were determined. In many cases the kinematic characteristics are

insufficient for a positive identification of the recorded waves. The analysis of amplitudes of the waves in different sections of the wave path was completely successful.—*S. T. V.*

179–365. Yepinat'yeva, A. M. O summarnykh mnogokratnykh volnakh [On summary multiple reflections] : Akad. Nauk SSSR Izv. ser. geofiz., no. 8, p. 1089–1102, 1959.

The results of experiments on multiply reflected waves and on a new type of these waves characterized by high intensity are reported. These waves are called *summary waves*, because they are produced by interference of two or more reflected waves arriving at a point on the surface simultaneously and and almost identical phase angles. The amplitude of such a wave can be greater than that of a simple reflected wave. When the medium has a constant seismic velocity and contains numerous thin layers having equal coefficients of reflection (q), summary waves can become more intensive than simple reflected waves, especially when the stratum has a high value of q. In mediums in which the acoustic coefficients increase with depth and q is constant at all boundaries, the number of reflecting strata necessary for the appearance of summary waves decreases as q increases. In such mediums, summary waves can be more intensive than the simple reflected wave only if q is ≤ 0.02 when there are many separating boundaries. Yepinat'yeva experimented only with reflection of waves incident at a right angle. In several mediums studied, the conditions of simultaneity of the arrival of waves can be fulfilled also in the case of an inclined angle of incidence, if that angle is the same at all boundaries. If the seismic velocity of the medium changes, the conditions of interference are violated, and changes of wave shape occur rather than summation of the greatest amplitudes of waves. These conclusions were reached from the analysis of ideal cases. In real mediums the conditions are more complicated, but in many respects the phenomena remain the same.—*S. T. V.*

179–366. Tarasov, Yu. A. O znachenii krivizny godografa otrazhennoy volny pri gruppirovanii seysmopriyemnikov [On the significance of the curvature of the traveltime curve of a reflected wave in the grouping of geophones] : Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy Neft' i gaz, no. 3, p. 17–24, 1959.

An effort is made to compensate for the assumption of linearity of the seismic wave front in the two-dimensional problem in the theory of the directional effect of an interference system used in seismic exploration using grouped geophones. An approximate solution of the problem is obtained by replacing the actual spherical wave with two plane waves. It was found that a sphericity of the wave front can be disregarded if the group base does not exceed some tens of meters, and in some cases registration can be improved by suppression of diffracted and scattered waves, which usually have abnormally great curvature of their traveltime curves.—*A. J. S.*

179–367. Kobayashi, Naota. A method of determining of the underground structure by means of SH waves [in Japanese with English abstract] : Zisin, ser. 2, v. 12, no. 1, p. 19–24, 1959.

A new method of interpretation of underground structure from the *SH*-wave was attempted by field application of the theory that if one superficial layer exists on a semi-infinite elastic medium, the *SH*-wave critically reflected at the

interface shows a very large amplitude at the surface. Results in the field were almost identical with those obtained by *P*-wave prospecting.—*V. S. N.*

179–368. Richards, T. C. Broadside refraction shooting: Geophysics, v. 24, no. 4, p. 725–748, 1959.

The three-dimension refraction trajectories and travel times in seismic broadside refraction shooting across simple steeply dipping or faulted hypothetical structures are determined when the shotpoint is displaced from the axis. No curved surfaces are assumed and the diffractions to be expected from the structural discontinuities are evaluated. An approximate method for correcting arc time measurements taken over the opposite side to that of the shotpoint is investigated while the conversion of times to dip is discussed. Discussion is also given to the differences in the diffraction time curves caused by changing the shotpoint from the up to the down side of a fault and the relationship these curves have with the refraction time curves in both arc and broadside shooting.

The results of these studies indicate the care that should be taken in distinguishing between refracted and diffracted events, and in relating a measured broadside time to a particular point on the refractor. The latter may lead to significant error when simple midpoint depth computations, often resorted to in fieldwork, are employed.—*Author's abstract*

179–369. Oblogina, T. I. O difragirovannykh seysmicheskikh volnakh [On diffracted seismic waves]: Prikladnaya Geofizika, no. 20, p. 26–45, 1958.

This is a discussion of the kinematic and dynamic characteristics of seismic waves in the case of diffraction on the border of a vertical contact. The wave front and the traveltime curve of diffracted waves are analyzed for the case where the wave travels from a higher velocity medium to one of lower velocity. Experiments were made in regions containing sandy and argillaceous deposits using a measuring station with a natural frequency of 37 cycles per sec. On the basis of numerous seismograms and extensive mathematical analysis, traveltime curves were constructed for the case of a vertical contact and of a pinching wedge. The latter problem is solved by the functional-invariant method suggested by Smirnov and Soboleb. It is found that the minimums of the direct and reversed traveltime curves of diffracted waves fall at the same point on the profile. The amplitudes of the diffracted waves increase when approaching the point of contact with the refracted wave. At that point the phase angle of the diffracted wave becomes reversed.—*S. T. V.*

179–370. Broding, R. A. How to cross-check accuracy of velocity and seismic data: World Oil, v. 149, no. 6, p. 137–139, 1959.

This is the same report as published in Shale Shaker, v. 9, no. 9, p. 3–21, 1959 (see Geophys. Abs. 178–362 d).—*J. W. C.*

179–371. Howell, B[enjamin] F., Jr., Andrews, A. B., and Huber, R. E. Photomechanical method of frequency analysis of seismic pulses: Geophysics, v. 24, no. 4, p. 692–705, 1959.

The harmonic analysis of a seismic pulse performed by a photomechanical wave analyzer is analytically related to the Fourier integral analysis of this aperiodic pulse. The calculated integral spectra of three simple analytical pulses are compared to the spectra obtained from this wave analyzer. The

integral analyses of two seismic pulses are compared to the harmonics obtained through numerical analysis.

The frequency range of the integral analysis which can be performed by this analyzer is from 5 to 300 cycles per sec. Integral analyses of recorded seismic pulses up to 6 inches long (0.10 sec) and with peak amplitudes up to 0.69 of an inch can be performed by this analyzer. From an evaluation of the equipment and operational errors involved in the measurements, the integral approximations obtained from the analyzer are estimated to be accurate on the average to within one *db* in the frequency range of 5–100 cycles per sec. For frequencies greater than 100 cycles per sec this accuracy will decrease. This is as great an accuracy as is usually obtained by numerical analysis.—*Authors' abstract*

179–372. Kaplan, B. L., and Mayorov, V. V. Izucheniye nekotorykh parametrov vozdushnogo vzryva primenitel'no k seysmorazvedke [A study of certain parameters of an air explosion as applied to seismic prospecting] : Razvedochnaya i Promyslovaya Geofizika, no. 28, p. 22–30, 1959.

The paper discusses the problem of the most effective shape of explosive charges for air shooting. Considering the physics of explosion phenomena and applying a mathematical analysis it was found that a 1 kg charge in the shape of a low cylinder of height H and radius R, having $H/R=0.1$, exploded in the air 1.5 m above the ground, should have the optimum effect.—*A. J. S.*

179–373. Heinitz, Karlheinz. Das Problem der Bündelung von Geophonen [The problem of grouping of geophones] : Freiberger Forschungshefte, C66 Geophysik, 49 p., 1959.

This is a review of methods of suppressing interference by means of geophone grouping. The reasons for the appearance of interfering waves is examined. These are classified as regular (that is, their apparent velocities and frequencies can be determined) or irregular. In the case of the former, the theory of the directional effect of the grouping is applied in finding the best geophone arrangement; individual intensive interfering waves can be suppressed by use of linear or areal geophone arrays. A development of this method uses geophones of different sensitivity in the array. If the interference is irregular, the determination of the effect of grouping is accomplished by means of the probability theory; according to this the effect of a geophone group is proportional to the square root of the number of geophones in the group.

The application of geophone grouping in underground seismic surveys is examined more closely, group shooting is discussed briefly, and examples are cited from the literature to illustrate the effect of geophone grouping.

By grouping of geophones, and to an even greater degree by simultaneous use of grouped shots, a substantial improvement can be achieved in the signal-to-noise ratio of seismic signals.—*D. B. V.*

179–374. Kaneko, Tetsuichi. Some aspects of multiple geophone setting and pattern shooting in seismic reflection prospecting [in Japanese with English abstract] : Japan Geol. Survey Rept., no. 182, 60 p., 1959.

Various aspects and results obtained from a theoretical and experimental study of multiple geophone spreads and pattern shooting in seismic-reflection prospecting are discussed. The combined characteristic functions of multiple geophone spreads and pattern shooting are defined and presented as a product

of each characteristic function. The approximate-attenuation ratio of amplitude of the distorted signal is obtained by the characteristic function of multiple geophone and pattern-shooting methods. The characteristic function $K(\omega)$ is calculated for a linear array of nine evenly spaced geophones and the cross pattern of five shot holes—for a quick estimate of the cutoff region of the first crest, a nomogram is made to give the relation between number of geophones, spacing of geophones, apparent velocity, and cutoff frequency. Five types of variable weighted multiple geophone spreads or pattern shooting are compared and the exponential pattern is found to be best. The characteristic functions for the weighted 3-channel mixing combined with linear full spaced geophones are calculated. The distortion of the signal in an area of steep dip is discussed and it is noted that the distortion of the signal in the spread of the down-dip side is controlled mainly by the characteristic function of the receiving system in the steep-dip area, whereas the distortion of the signal in the spread of the opposite side is controlled by the characteristic function at the shot point. An experiment by Ryugasaki on the reduction of wave noise is described.—*V. S. N.*

179–375. Napalkov, Yu. V. Postroyeniye kharakteristik napravlennosti dlya slozhnogo gruppirovaniya v seismorazvedke [Construction of directional characteristics for complex grouping in seismic exploration]: Prikladnaya Geofizika, no. 22, p. 25–53, 1959.

This paper is a study of the characteristics of a geophone group that affect the directional selectivity of a spread. A graphical-mathematical method is developed by which a given directional selectivity of reception of seismic signals is achieved by varying the positions and characteristics of the apparatus in a group. Five examples of analysis of directional selectivity for spreads of different degrees of complexity are given.—*A. J. S.*

179–376. Priyma, V. I. Kombinirovannyy smesitel' [A combined mixing arrangement]: Razvedochnaya i Promyslovaya Geofizika, no. 18, p. 16–26, 1957.

Priyma proposes to improve the performance of the 60-channel seismic station PSS–60M by expanding the capacity of the mixing scheme. This can be done by rearranging the scheme in such a way as to make 1 galvanometer record the oscillation of 3 or 4 adjacent channels. The new arrangement is called the combined mixing arrangement; with it the number of seismometers in a group can be reduced, and a greater number of channels can be grouped without complicating the field technique or affecting its efficiency. Diagrams of the new arrangement and seismograms of its performance are given.—*A. J. S.*

179–377. Slutskovskiy, A. I. O novoy skheme smesitelya, predlozhennoy V. I. Priyma [About the new scheme of mixing proposed by V. I. Priyma]: Razvedochnaya i Promyshlovaya Geofizika, v. 18, p. 26–34, 1957.

Slutskovskiy analyses the new mixing scheme proposed by Priyma (see Geophys. Abs. 179–376) and discusses its shortcomings and merits.—*A. J. S.*

179–378. Polshkov, M. K., and Bereza, G. V. Primeneniye shirokopolosnoy apparatury v seysmorazvedke [Application of broadband apparatus in seismic exploration]: Razvedochnaya i Promyslovaya Geofizika, v. 16, p. 63–67, 1956.

A broadband seismograph, constructed from an electrodynamic low frequency seismograph SPSh coupled with a specially designed electronic broadband amplifier (diagram given), is described, and its performance is compared with the

performance of conventional SS–24–48, and SS–26–51D seismic stations. It was found that an introduction of broadband filtering into the seismic apparatus increases resolution and considerably reduces frequency distortion in registration.—*A. J. S.*

179–379. Robinson, W. B. [Editor]. Seismograph dip migration: A symposium: Shale Shaker Digest II (1955–1958), p. 297–324, 1958.

This series of articles, presented at a symposium on seismograph dip migration conducted by the Geophysical Society of Oklahoma City on February 19, 1957, deals with techniques and tools used in calculating the drilling depth required for a well to reach a specific point on a seismic reflecting horizon:

Robinson, W. B. The need for seismic dip migration, p. 297–300.

Oden, A. J. Constant velocity case, p. 301–302.

McGuckin, Glenn, M. The McGuckin section plotter, p. 303.

Stones, J. E. The application of a linear increase of velocity with depth to seismic dip migration, p. 304.

Roberts, Frank A. Chart migrations, p. 305–307.

Westphal, J. A. An electronic seismic dip plotter, p. 308–310.

Usdin, E. Machine calculation of migration data, p. 310.

Hawes, W. S. The SDP dip plotter, p. 311–312.

Mansfield, Robert H. Slide rule seismic computations, p. 313–317.

Anderson, G. E. Three-dimensional control, p. 317–320.

Fenton, Harry J. Projected sections for areas of steep dip, p. 321.

Mayo, H. Bruce. A comparison of the various methods of dip migration, p. 322–324.—*V. S. N.*

179–380. Hall, T[homas] O. Use of portable playback system effects a saving: Geophysics, v. 24, no. 4, p. 824–827, 1959.

The field-magnetic playback system which removes electrically the static and dynamic corrections in seismic surveying offers financial advantages as well as improved accuracy and speed of field office work.—*D. B. V.*

179–381. Grannemann, W. W. Field testing seismic instruments: Geophysics, v. 24, no. 4, p. 817–822, 1959.

The field tests compiled here are designed to detect the presence of the subtle as well as the obvious equipment troubles. Auxiliary test equipment used includes a low-distortion sine-wave oscillator, oscilloscope, geophone shake-table, and a timing standard as well as the usual voltmeter, ammeters, and ohmmeters which are often built in the equipment. Field test procedures on geophones, cables, seismic amplifier, seismic oscilloscope cameras, magnetic seismic recorders are included. The time lapse between each test is considered, but some flexibility in this respect is recognized, depending on the specific equipment used and the operating conditions.—*Author's abstract*

179–382. Posgay, Károly. Szeizmikus kízérlati terület kijelölése [Setting out of a seismic testing area (with English summary)]: Geofiz. Közlemények, v. 8, no. 1–2, p. 85–88, 1959.

Factors entering into the selection of an area for testing seismic instruments and for experimental field measurements to aid the solution of prospecting problems are discussed. The plan of such an area near Budapest is illustrated, and four seismograms made there are reproduced.—*D. B. V.*

179–383 Voyutskiy, V. S., Slutskovskiy, A. I., and Vishnyakov, Ye. P. Promyshlennyye ispytaniya seysmicheskikh stantsiy so skorostnymi fil-'trami [Field tests of seismic stations with velocity filters]: Razvedochnaya i Promyslovaya Geofizika, no. 17, p. 21–32, 1957.

Field tests of 10 Russian seismic-exploration stations equipped with velocity filters in the Kazakh S.S.R., Bashkir and Tatar A.S.S.R., and in the Kuybyshev district are described in this paper. The test program consisted of comparative field observations with the filters used in single or grouped geophones. The geophone spacing in a group was established at half the product of the interfering-wave velocity and the apparent period (6–8 min) of the wave, as it was found in the Kazakh tests that proper selection of distances between individual geophones considerably improves the effectiveness of the velocity-filter method. Nine seismograms characteristic of different stages of the tests are included.—*A. J. S.*

179–384. Beckmann, Walter C., Roberts, Archie C., and Luskin, Bernard. Sub-bottom Depth Recorder: Geophysics, v. 24, no. 4, p. 749–760, 1959.

The Sub-bottom Depth Recorder (SDR) has been developed to study the underlying geologic structure of water covered areas. The SDR is essentially a broad-band, high-powered echo sounder which utilizes one of two sound sources.

The first, an electrical spark discharge (Sparker), has produced penetrations in excess of 600 ft in 50 ft of water. The second, a combustion chamber using a mixture of propane and oxygen (RASS), has produced penetrations in excess of 1,400 ft in 80 ft of water.

Results obtained from the SDR have been found to be in excellent agreement with test boring and seismic-refraction data.—*Authors' abstract*

179–385. Slutskovskiy, A. I. Usiliteli morskoy seysmicheskoy stantsii [Amplifiers of marine seismic stations]: Razvedochnaya i Promyslovaya Geofizika, no. 27, p. 106–119, 1959.

A special amplifier has been designed to alleviate the difficulty of reverberations in marine seismic surveys. A schematic diagram of the instrument is given. This amplifier was tested in the Caspian Sea in 1955. In areas of particularly intense reverberation interference, the background was reduced by using this amplifier with a low-frequency filter. In areas with intensive bottom waves, inclusion of a high-frequency filter succeeded in suppressing the interference. (See also Geophys. Abs. 164–274.)—*J. W. C.*

179–386. Mozzhenko, A. N. Pribor dlya seysmicheskogo karotazha [An instrument for seismic well logging]: Razvedochnaya i Promyslovaya Geofizika, no. 29, p. 52–55, 1959.

A new geophone of small dimensions that can be used in drill holes to a depth of 2,000 m, recently developed by the seismic laboratory of VNIIGeofizika, is described. The advantage of this instrument is its small diameter, reduced weight, and capacity to record low frequencies (6–10 cycles per sec). A sketch of the instrument (without dimensions) is given, as well as examples of seismograms obtained with it.—*S. T. V.*

179–387. Karandeyev [Karandyeyev], K. B., and Hīk [Gik], L. D. Zaspokoyennya īnertsīyanykh vībrovymīryuval'nykh pryladīv [The damping of inertia-type vibrometric instruments (in Ukrainian with English and Russian summaries): Akad. Nauk Ukrayin. RSR Dopovīdī, no. 10, p. 1045–1048, 1958.

As is known from the theory of vibrometers of inertia type, it becomes necessary, in cases where the measured frequency approaches reasonance conditions of the instrument, to increase the damping of the seismic system almost to its critical value. On the other hand to attain greatest precision in measurement of the phase angle the damping must be as small as possible. The problem of selection of the best coefficient of damping for given limits of errors both in amplitude and in phase is discussed. The optimum value of the damping coefficient and the least value of the relative frequency can be found by solving the system of two equations representing the displacement and the phase angle. Karandyeyev suggests a graphic method of solving this problem. This gives the optimum value of the damping coefficient that produces both these results. The article discusses the choice of optimum coefficient of damping for the case when amplitude and phase errors must not exceed a given value and for the case when phase distortions may be neglected; and choice of maximum natural frequency of vibration of the seismic system, at which pickup errors at the lower limit of frequencies do not exceed permissible limits.—*S. T. V.*

179–388. Bornmann, Günther. Grundlagen und Auswerteverfahren der dynamischen Baugrundseismik [Principles and evaluation procedures of dynamic foundation seismics]: Freiberger Forschungshefte C65 Geophysik, 99 p., 1959.

This is a summary of dynamic methods of investigating the ground by using stationary elastic waves and artificial vibrations to determine the suitability of sites for foundation purposes. Most of the work is devoted to methods of interpretation and their theoretical bases; measuring techniques are treated only so far as necessary for understanding the different procedures.

Inasmuch as the propagation and nature of the elastic waves used are not yet completely understood and the theory of artificial vibrations not yet completely worked out and tested, the development of seismic methods has by no means reached its limit. The weight and resulting cumbersomeness of the apparatus used is a practical disadvantage; the trend is toward smaller vibrators based on electrodynamic or piezoelectric principles and operating at higher frequencies of 50 cycles per sec to a few kilocycles per sec ("seismoacoustics").—*D. B. V.*

179–389. Caterpillar Tractor Company News Service Staff. How exploration can collaborate with pipe line construction: Oil in Canada, v. 11, no. 40, p. 52–54, 1959.

The Caterpillar Tractor Company has perfected a method of using seismic analysis to determine rippability of soil and rocks for purposes of laying pipelines. Some 200 tests have been made in 18 States using a refraction seismograph to establish a table of rippability based on wave velocities for 12 or more common materials. This fast, inexpensive subsurface analysis means more productive equipment and job organization at lower costs.—*V. S. N.*

179–390. Sawatzky, H. B., Agarwal, R. G., and Wilson, W. Structure test holes confirm post-Paleozoic relief as indicated by the seismograph in the Avonlea area, Saskatchewan: Alberta Soc. Petroleum Geologists Jour., v. 7, no. 4, p. 82–90, 92, 1959; *also* Oil in Canada, v. 11, no. 40, p. 56–62, 1959

The correlation between seismic and structure test-hole data is exhibited in the Avonlea area of Saskatchewan. The results appear to indicate that previously inferred faults are nonexistent. In addition, the primary causes of post-Paleozoic structure are discussed and attributed to salt removal with subsequent collapse of the overlying beds.—*Author's abstract*

179–391. Blundun, G[eorge] J. Reflection seismograph and Mississippian in Alberta: Oilweek, v. 10, no. 34, p. 25–32, 1959.

This is the same as the paper published in Geophysics, v. 24, no. 3, p. 426–442, 1959 (see Geophys. Abs. 178–389).—*V. S. N.*

179–392. Pallister, A. E. NWT survey proves value of new seismic methods: Oilweek, v. 10, no. 38, p. 19–23, 1959.

A preliminary seismic survey was made along the Mackenzie River using both the conventional marine seismic methods and the new Sparker method which provides a continuous geologic profile to a depth of 800 ft or more below the river bottom. The success of this survey promises a means by which the Northwest Territories, an area 40 percent covered by water, can be rapidly explored for oil structures on a preliminary basis at relatively low cost. The equipment, logistics problems, and methods of survey are discussed.—*V. S. N.*

179–393. Stride, A. H. On the origin of the Dogger Bank, in the North Sea: Geol. Mag., v. 96, no. 1, p. 33–44, 1959.

A reversed seismic-refraction survey and some cores taken on the Dogger Bank are described. Results showed an absence of compacted sediments within the bank and the presence of only glacial or postglacial sediments at the surface. Both facts strongly indicate that the bank is a large moraine and not an extension of a ridge of Mesozoic rock from England as has been suggested—*V. S. N.*

179–394. Schmidt, G[erhard]. Results of underground-seismic reflection investigations in the siderite district of the Siegerland: Geophys. Prosp., v. 7, no. 3, p. 287–290, 1959.

The iron ores of the Siegerland district are found in lodes occurring in schists of Lower Devonian age. These lodes, normally dipping almost perpendicularly, could be traced only by seismic-reflection measurements underground, up to distances of approximately 500 m. The geophones were attached to the walls of the galleries. The frequencies of the recorded longitudinal and transverse waves ranged from 200 to 500 cycles per sec. By this method a new siderite lode was discovered.—*Author's abstract*

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179–395. Reichenbach, R., and Schmidt, G[erhard]. Results of surface reflection seismic measurements in the siderite district of the Siegerland: Geophys. Prosp., v. 7, no. 3, p. 291–299, 1959.

The iron ores of the Siegerland district are found in lodes occurring in schists of Lower Devonian age. In the course of the geophysical exploration for these ores, an attempt was also made to clarify the structure and the tectonics of the substratum of the sedimentary rock formations by seismic reflection measurements from the surface. Reflections were recorded in great numbers from layers of Silurian and Devonian age. The form of the folding of the strata derived therefrom corresponds well with that deduced from geological investigations. Beyond that, correlatable reflections were recorded from horizons down to a depth of nearly 25,000 m. It turned out that the iron-ore lodes known from the mine workings occur almost vertically above those places where greater dislocations appear in the deepest substratum, and which geologically could be interpreted as fracture zones. The results so far obtained seem to be indicative of the fact that the tectonics of the deepest substratum and the occurrence of ore deposits are related to each other.—*Authors' abstract*

179–396. Martin, Walter. Refraktionsseismische Arbeiten in der Egelner Südmülde [Seismic refraction operations in the Egelner Süd basin]: Zeitschr. angew. Geologie, v. 5, no. 10, p. 425–428, 1959.

The procedure and results of a seismic-refraction survey in the Egelner Süd lignite basin in Germany are reported. Continuous profiling revealed the first discontinuity, the base of the Tertiary, with an accuracy of ±10 percent, as confirmed by subsequent drilling. The traveltime plan gave a qualitative picture of the basin. Tertiary and pre-Tertiary formations could be distinguished easily on the basis of velocities, but the differentiation between Buntsandstein and Muschelkalk was problematic.

Because of the small profile spacing and shot-point interval, continuous profiling surveys are more expensive than the usual reconnaissance surveys, but they yield substantially more accurate and more detailed results.—*D. B. V.*

179–397. Tuchel, Georg. Einiges über Ultraschallmessungen (acoustic log) in Deutschland [On acoustic logging in Germany]: Erdöl und Kohle, v. 12, no. 7, p. 537–541, 1959.

The apparatus and technique used in acoustic logging by the Seismos G.m.b.H. in Germany is described. The probe consists essentially of a sender and receiver separated by a distance of 1.78 m, with a geophone at the lower end. Automatic integration of the measured time differences is introduced, which gives a direct depth-time curve needed for accurate interpretation and evaluation of seismic-reflection measurements. The measured velocities are adjusted to the true velocities by means of measurements by the geophone at the end of the probe. This calibration concerns total traveltime; certain differences are still possible in the case of small depth intervals.

Examples are given of acoustic logs and correlations in eastern Bavaria. Acoustic logging is particularly valuable in salt-dome areas and should never be omitted in determinations of salt-dome boundaries by seismic surveys in boreholes on the flanks.—*D. B. V.*

179–398. Cassinis, Roberto. Studi geofisici nello Stretto di Messina [Geophysical studies in the Straits of Messina]: [Italy] Servizio Geol. Boll., v. 80, no. 1, p. 1–7, 1959.

This report outlines the criteria adopted and the procedures used in geophysical surveys in the Straits of Messina; results are presented only in a very generalized way. The principal objects were measurement of the thickness of the sediments overlying the basement between Sicily and the mainland of Italy, and determination of basement configuration and of lithology of the materials. Vertical resistivity soundings were made along the coast of the straits and Tyrrhenian Sea and on outcrops of various formations, and seismic refraction and reflection profiles were made in the straits.—*D. B. V.*

179–399. Schuster, Klaus. Geophysikalische Erkundung im Sudan [Geophysical investigation in the Sudan]: Freiberger Forschungshefte C70 Geophysik, 55 p., 1959.

Seismic-refraction surveys for ground water were made in the Kordofan highland of the Sudan in 1956–57. The geologic setting and the preparation for and execution of the surveys are described. The hydrogeologic results are discussed. Structure-contour maps of 6 refracting horizons, 4 refraction profiles, a graph of apparent velocities, a comparison of refraction with borehole data, and a plan of the Mazroub area are given in a pocket.

Special sections deal with special problems of fieldwork in this arid region and of interpretation. Typical traveltime curves are reproduced. Relatively good agreement was found between refraction and borehole data.—*D. B. V.*

179–400. Yengurazov, I. I., and Ezdrin, M. B. K voprosu poiskov struktur v Saratovskom Zavolzh'e [On the problem of exploration of structures in the Saratov Trans-Volga region]: Geologiya Nefti, no. 12, p. 6–11, 1958.

Seismic exploration in the Saratov Trans-Volga area is hindered by the presence of unconsolidated clays at the surface which absorb seismic waves, and by carbonate rocks near the surface which are a source of wave interference. Seismic exploration in this region should be more effective when carried out in conjunction with exploratory drilling.—*J. W. C.*

179–401. Andreyev, N. S., and Andreyeva, K. S. Opyt seysmicheskikh rabot na mestorozhdeniyakh boksitov [Seismic exploration of bauxite deposits]: Vses. nauchno-issled. inst. metodiki i tekhniki razvedki Trudy, no. 1, p. 309–322, 1958.

The results of seismic exploration for bauxite in the Tikhvino, Severnaya, Onega, and Amangel'dyy regions in the U.S.S.R. are given. A new seismic apparatus EKhO–1m, of higher resolving power than the seismic station EKhO–1 used in 1950–51, allowed the determination of a greater number of refracting and reflecting boundaries in refraction-correlation surveys which were confirmed by vertical electrical soundings. Traveltime curves along refraction profiles are given and interpreted. The possibilities of seismic methods for the exploration of bauxite deposits are discussed and techniques suggested.—*A. J. S.*

179–402. Petkevich, G. I. Deyaki rezul'taty seysmokarotazhnykh doslidzhen' u Peredkarpats'komu prohuni [Some results of seismic logging in the Fore-Carpathian depression]: Akad. Nauk Ukrayin. RSR Heol. Zhur., v. 19, no. 3, p. 37–50, 1959.

Since 1948 a total of 44 wells have been shot for velocity by different geophysicists in various areas of the Fore-Carpathian depression. The depth of the wells investigated ranges from 1,500 to 3,000 m. From the available data, Petkevich has determined the seismic velocity of different strata. The variation of velocity with depth is attributed to increasing static pressure, reducing the porosity of the formations. Lateral velocity variations are explained by the lithologic variations. Because of the great variability of the geologic structure of the Carpathian area, further velocity investigations are recommended.—*S. T. V.*

Gagel'gants, A. A., Gal'perin, Ye. I., Kosminskaya, I. P., and Krakshina, P. M. Structure of the earth's crust in the central part of the Caspian Sea according to the data of deep seismic sounding. See Geophys. Abs. 179–262.

179–403. Officer, Charles B. On some offshore seismic refraction profiles in the Cook Strait, Tasman Bay, and Golden Bay areas of New Zealand: New Zealand Jour. Geology and Geophysics, v. 2, no. 2, p. 350–354, 1959.

Marine seismic profiles show that the thickness of unconsolidated sediments varies from a few hundred feet in the Cook Strait to Golden Bay areas to 2,300 ft in the vicinity of Marlborough Sounds. The Tertiary geosynclinal sediments of N. W. Nelson thicken northwards beneath Golden Bay. The maximum recorded velocities are consistent with the basement rock mapped in neighboring land areas.—*Author's summary*

179–404. International Geophysical Year Bulletin (No. 25). Antarctic traverse reports: Am. Geophys. Union Trans., v. 40, no. 3, p. 277–282, 1959.

Seismic and gravity profiles were obtained on an airborne traverse following a path at right angles to the hypothetical trough connecting the Ross and Weddell Seas. The ice was found to be grounded at all seven stations between the mountain ranges, precluding the possibility of actual water interchange between the two seas, but the results support the thesis of a down-warped, ice-filled trough extending across Antarctica.

Three oversnow traverses in Marie Byrd Land throw further light on the bedrock topography. No broad trough appears to exist south of lat 82.5° S. connecting the Ross and Weddell Seas, but the possibility of a below-sea-level connection cannot be eliminated; a connection between the Ross and Bellinghausen Seas appears more likely.—*D. B. V.*

179–405. International Geophysical Year Bulletin (No. 27). Oversnow traverses from IGY Little America Station: Am Geophys. Union Trans., v. 40, no. 3, p. 311–315, 1959.

Preliminary results of traverses on the Ross Ice Shelf and in Victoria Land in Antarctia are reported. For the former, ice thickness and water depth are shown in sketch maps, and a seismic profile across the Victoria Land plateau and extending out into the Ross Ice Shelf is presented.—*D. B. V.*

179–406. Bentley, Charles R., and Ostenso, Ned A. Seismic program on the Marie Byrd Land traverses, 1957–1958, *in* Seismology, gravity, and magnetism: Am Geog. Soc., IGY World Data Center A, Glaciol. Rept. Ser. no. 2, p. 1–8, 1959.

Two seismic traverses were made by the Byrd Traverse Party in Marie Byrd Land: One from Little America V to Byrd Station and a second in the form of a box from Byrd Station to the Sentinel Mountains, to lat 80°27′ S., long 98°05′ W., and back to Byrd Station. For the first traverse the values given in this report for ice thickness and strike and dip of underlying bedrock are probably final; for the second traverse the results given are based on field computations only.

Seismic reflection and gravity results have been combined to draw a cross section of the icecap.—*V. S. N.*

179–407. Thiel, Edward, and Behrendt, John C. Seismic studies on the Filchner Ice Shelf, Antarctica, 1957–1958, *in* Seismology, gravity, and magnetism: Am. Geog. Soc., IGY World Data Center A. Glaciol. Rept. Ser. no. 2, p. 1–14, 1959.

The seismic program conducted at Ellsworth Station (lat 77°42.6′ S., long 41°08′ W.) at the head of Weddell Sea on the Filchner Ice Shelf during the first year of occupation is discussed. Part 1 deals with the seismic program conducted in the vicinity of Ellsworth during the Antarctic fall and spring; and part 2 reviews the seismic work of the inland oversnow traverse prior to mid-January 1958. Results are shown in graphs and tables.—*V. S. N.*

179–408. Ostenso, Ned A., and Bentley, Charles R. The problems of elevation control in Antarctica, and elevations on the Marie Byrd Land traverses, 1957–1958, *in* Seismology, gravity, and magnetism: Am. Geog. Soc., IGY World Data Center A, Glaciol. Rept. Ser. no. 2, p. 1–26, 1959.

Elevation control on the two seismic traverses in Marie Byrd Land was maintained by aneroid altimeter. Auxiliary transit-level line observations proved inadequate because of large errors due to atmospheric-refraction effects. The principles of precision barometric altimetry and the problems inherent in the method are reviewed in order to evaluate the accuracy of these measurements.—*V. S. N.*

179–409. Thiel, Edward, and Behrendt, John C. Seismic studies at the Ellsworth snow pit, *in* Seismology, gravity, and magnetism: Am. Geog. Soc., IGY World Data Center A, Glaciol. Rept. Ser. no. 2, p. 1–14, 1959.

The physical properties of the snow and ice of the Filchner Ice Shelf were observed to a depth of 57 m. A snow pit was dug to a depth of 31 m and a 26 m borehole was drilled in the floor of the pit. Results are shown on graphs and include observations on density, porosity, load, age, temperature, travel time, velocity, and elastic constants.—*V. S. N.*

VOLCANOLOGY

179–410. La Rüe, E. Aubert de. *L'homme et les volcans* [Man and volcanoes]: Paris, Gallimard, 398 p., 1958.

This is one of a series on human geography. After the introduction, which traces the development from ancient beliefs to modern volcanologic theories, the book is divided into six parts: the characteristics of volcanism, different types of eruptions, the landforms created by volcanism, some catastrophic or otherwise noteworthy eruptions, the domain of recent and contemporary volcanoes, and useful aspects of volcanism. A glossary of volcanological terms, bibliography, and geographic index are appended.—*D. B. V.*

179–411. Perrin, René. Reflexions sur des observations de G. S. Gorshkov et les théories sur le volcanisme et l'orogenèse [Reflections on the observations of G. S. Gorshkov and theories of volcanism and orogenesis]: Acad. Sci. [Paris] Comptes Rendus, v. 249, no. 15, p. 1303–1306, 1959.

Gorshkov's observations on the depth of the magma chamber of the Klyuchevskaya volcanic group and the conclusions drawn from them (see Geophys. Abs. 176–359 and 177–380) are discussed. Perrin feels that the observations are qualitatively true and fundamental, but that at present they are not quantitatively exact enough to form the basis of theories. Other conclusions can be drawn from Gorshkov's observations, however. They show that at depths of the order of magnitude required in the theories of continental drift, isostasy, and orogenesis due to convection currents, magmas behave as true liquids and do not transmit *S*-waves; from this it follows that the parts of the crust that do transmit *S*-waves at similar depths are solid.—*D. B. V.*

Rikitake, Tsuneji. Studies of the thermal state of the earth. The second paper: Heat flow associated with magma intrusion. See Geophys. Abs. 179–239.

179–412. Eaton, Jerry P. A portable water-tube tiltmeter: Seismol. Soc. America Bull., v. 49, no. 4, p. 301–316, 1959.

The accumulation of magma within a volcano deforms the ground surface around it. Although pendulum-type tiltmeters are our most sensitive and convenient tool for detecting such deformations, their records are generally difficult to interpret because purely local disturbances obscure the subtle changes produced by the volcano.

A new tiltmeter consisting of a permanent tilt base and a portable water-tube leveling system was developed to measure tilting around Kilauea caldera. Because the tilt bases for this instrument are on the ground surface outdoors, the leveling system must be operated under conditions that are far from ideal. If the work is performed at night and if a carefully standardized procedure is followed, leveling can be carried around a circuit consisting of 3 piers at the vertices of a triangle 2,000 inches on a side with a closure error of less than 10μ (corresponding to an error in the measurement of tilt of less than 0.2×10^{-6} radian).

Tilting at four new tilt bases around Kilauea caldera between October 1958, and February 1959, shows that the summit of the volcano is swelling. An analysis of the tilting around the caldera suggests that magma is accumulating in a reservoir about 4 km beneath the southwest end of the caldera.—*Author's abstract*

179–413. Eaton, J[erry] P., and Krivoy, Harold L. Hawaiian Volcano Observatory summary 11, July–September 1958: U.S. Geol. Survey Hawaiian Volcano Observatory Summ., no. 11, 13 p., 1958.

An impressive seismic display occurred on the island of Hawaii during the first week of July 1958. Seismographs in the Mauna Loa and Desert stations recorded 2,100 separate earthquakes and almost 60 hr of nearly continuous spasmodic tremor centered about 10 km northeast of Kilauea caldera at a depth of 55 km. Only 48 of these earthquakes had a magnitude greater than 2.5; the largest was 3.4 and none was reported felt. On seismographs nearer the caldera, fewer earthquakes were discernable; Uwekahuna station registered about 1,100 earthquakes during July, but only 400 and 275 earthquakes during August and September, respectively. Data for both local and distant earthquakes are listed.

Tilting of the earth's surface at Whitney station on the northeast rim of Kilauea caldera was normal for all 3 months.—*V. S. N.*

179–414. Mooser, F., and Maldonado-Koerdell, M. Mexican national report on volcanology: Bull. volcanol., v. 21, p. 163–169, 1959.

This report was presented at the 11th general assembly of the International Union of Geodesy and Geophysics (Toronto, 1957). During 1954–57, only Colima showed signs of activity, with fumaroles and solfataras, rise of the plug in the crater, subterranean noises and earth tremors, and a constant plume of stream as of May 20, 1957. Parícutin and Bârcena were completely extinct. Geothermal power possibilities of the Pathé Grande fumarole field were in the process of exploitation.

The relationship of the volcanic belt of Mexico to the Clarion Fracture Zone in the Pacific is pointed out. The earthquake of July 28, 1957, is reported briefly. Lead-alpha determinations were made on granites from southern Mexico; they are Senonian and Early Turonian in age. Detailed field studies were made on the Tertiary volcanics in relation to hydrothermal ore deposits.—*D. B. V.*

179–415. Jolivet, J. La crise volcanique de 1956 à la Soufrière de la Guadeloupe [The volcanic crisis of 1956 at the Soufrière of Guadeloupe]: Annales Géophysique, v. 14, no. 3, p. 305–322, 1958.

The 1956 activity of the Soufrière of Guadeloupe was manifested in three distinct periods: the phase of "unplugging" (Oct. 20–24), the paroxysmal phase (Oct. 24–27), and the terminal phase (Oct. 27–late 1957). Precursory phenomena included changes in composition of the fumarolic emissions and numerous very weak local tremors. (Two shocks were actually felt in Guadeloupe between January and October, in comparison with 4 [felt] in 1955, 2 in 1954, 3 in 1953, 1 in 1952, and 7 in 1951.)

A new fracture appeared in the southeastern part of the cone; this became enlarged, secondary fractures appeared, and older fractures showed renewed activity. The effect of the activity on the fumarolic activity on the island and the two types of seismograms recorded are discussed, and the 1956 activity is compared to earlier eruptions. (See also Geophys. Abs. 168–334, –335; 177–385, –386.)—*D. B. V.*

179–416. Machado, Frederico. Submarine pits of the Azores plateau: Bull. volcanol., v. 21, p. 109–116, 1959.

Submarine pits in the Azores vicinity are depressions about 30 km wide and 1 km deep. A single mechanism may be responsible for subsidence of these pits and for the magma chambers which produce the lavas of the islands.

Although lava extrusion during subsidence is possible, ascent of magma is not necessary; the pits should be considered to be tectonic features. The amount of subsidence and dimensions of the magma chambers should be of the same order of magnitude.—*D. B. V.*

179–417. Georgalas, G. C. L'éruption du volcan de Santorin en 1939–1941. Les éruptions des dômes Smith et Reck et de l'Entonnoir jumeau (Quatrième communication provisoire) [The eruption of the Santorin volcano in 1939–1941. The eruptions of the Smith and Reck domes and of the Twin Crater (Fourth preliminary communication)]: Bull. volcanol., v. 21, p. 3–64, 1959.

This report gives a day-by-day synopsis of the fourth eruptive stage (July 12–November 15, 1940) of the 1939–41 activity of Santorin volcano in the Aegean Sea. In an effusive phase, lava flowed from three new domes (congenetic Smith *A* and Smith *B*, and Reck); in an explosive phase, a double explosion crater was formed. (See also Geophys. Abs. 147–13178, 158–199.)—*D. B. V.*

179–418. Minakami, Takeshi, and Mogi, Kiyoo. Report on volcanic activities in Japan for the period from 1954 to 1957: Bull. volcanol., v. 21, p. 127–151, 1959.

In the period 1954–57, eight Japanese volcanoes were active to varying extents: Sakura-jima, 1955–57 (see Geophys. Abs. 166–374, 172–266, 175–313), noteworthy because it was the first recorded activity in its summit crater; Me-Akan-Dake, 1955–56 (its first eruption in historic times); Asama, 1953–55; Oo-shima (Mihara), calm after February 1954 except for minor eruption in January 1956 (see Geophys. Abs. 164–315, 165–250, 167–285, –286, 172–159); Tokati-Dake, 1954–55, fumarolic only; Tarumai 1954–56, minor explosions and fumaroles; Aso, strombolian activity at intervals; and Suwanose-jima, strombolian activity, strongest in January 1957.—*D. B. V.*

Yokoyama, Izumi. Gravity survey on Kuttyaro caldera lake. See Geophys. Abs. 179–232.

179–419. Fisher, N. H. Report of the sub-committee on volcanology 1954–56; Bull. volcanol., v. 21, p. 153–161, 1959.

Volcanological work by the Australian National Committee on Geodesy and Geophysics in 1954–57 included fieldwork and observations on several volcanoes in the New Guinea area (including the Solomon Islands), research on the relationship between volcanic eruptions and seismic activity and on the influence of luni-solar factors on such activity, and petrographic study of samples from many volcanic centers of Melanesia.

Reported volcanic activity since January 1, 1954, included Tuluman, in St. Andrew Strait (continued submarine explosions at intervals); Bam (repeated mild explosions); Manam (explosions and lava extrusion, December 1956-February 1957); Long Island (ejection of incandescent ash from Lake Wisdom Island crater, June 5–13, 1955); Langila (explosive activity beginning May 18, 1954, continuing at intervals until June 1955, then milder to March 1956); Lamington (quiet dome building to September 1956, "explosion" on March 27, 1956); D'Entrecasteaux Islands (earthquake swarms in July-September 1955 and early 1957, possibly of volcanic significance); Bagana (inactive?); Savo (determined to be of pelean type; warning system set up); Tinakula (quieter since 1951); Yasour (continuously active lava pool in crater; exceptionally violent activity in January 1956).—*D. B. V.*

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