Geophysical Abstracts 175 October-December 1958

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

GEOLOGICAL SURVEY BULLETIN 1086-D

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1959

UNITED STATES DEPARTMENT OF THE INTERIOR

FRED A. SEATON, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 35 cents (single copy). Subscription price: $1.25 a year; 35 cents additional for foreign mailing. The printing of this publication has been approved by the Director of the Bureau of the Budget (December 5, 1957).

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INTRODUCTION

EXTENT OF COVERAGE

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

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

LIST OF JOURNALS

Full titles and abbrevations of journals cited for the first time in this issue (with the sponsoring organization and its address where these do not form part of the title) are given below. This list supplements the List of Journals published in Geophysical Abstracts 160 (January–March 1955, Bulletin 1033–A) and the supplements published in Geophysical Abstracts 161–174.

Acad. R. P. R. Bul. stiint., sec. geol. şi geog.—Academia Republicii Populare Române, Buletin ştiinţific, Secţia de geologie şi geografie. Bucharest.

Acad. R. P. R. Studii Si cercetari de astronomic şi seismologie—Academia Republicii Populare Române Studii şi cercetari de astronomie şi seismologie. Bucureşti (Bucharest).

Akad. Nauk Beloruss. SSR Inzh.-Fiz. Zhur.—Inzhenerno-Fizicheskiy Zhurnal, Akademii Nauk SSR, Belorusskoy SSR, Minsk.

Am. Water Works Assoc. Jour.—Journal American Water Works Association. New York.

Anuarul Comitetului geol.—Anuarul Comitetului geologic. Analele Româno-Sovietice, Seria geologie-geografie, Academia Republicii Populare Române, Institutul de Studii Româno-Sovietice. Bucharest.

Arbeitsgemeinschaft für Forschung des Landes Nordrhein-Westfalen.—Arbeitsgemeinschaft für Forschung des Landes Nordrhein-Westfalen. Westdeutscher Verlag. [Association for investigation of the North Rhine-Westphalia District. West German Press.] Köln and Opladen, Germany.

Bŭlgarskata Akad. Nauk Priroda—Bŭlgarskata Akademiya na Naukite Priroda. Sofiya, Bulgaria.

Geol. Soc. China Proc.—Proceedings of the Geological Society of China. Tiawan, China.

Illinois Acad. Sci. Trans.—Transactions of the Illinois State Academy of Science. Springfield, Illinois.

Jour. Mechanics and Physics of Solids—Journal of the Mechanics and Physics of Solids. Pergamon Press. London, England.

Karl Marx Univ. Leipzig Geol. u. Paläontol. Inst. Mitt.—Karl Marx University Geologisches und Paläontologisches Institut, Mitteilungen. (Geologie u. Geophysik) 60th Anniversary Publication. Leipzig.

Minno Delo—Ministerstvoto na Tezkhata Promishlenosto. Sofia.

Naturalia.—Naturalia. Revista de Divulgaçãs de Biologia e História Natural. Sociedade Portuguesa de Ciéncias Naturais. Lisboa, Portugal.

Nauchno-issled. Inst. Zemnogo Magnetizma Trudy—Trudy nauchno-issledovatel-'skogo instituta zemnogo magnetizma ionosfery i raspredelenyi voln. Glavupravleniye Gidrometeorologicheskoy Sluzhby. Leningrad.

Nigerian Geog. Jour.—The Nigerian Geographical Journal. Nigerian Geographical Association. Ibadan, Nigeria.

Norges Geol. Undersökelse, Årb.—Norges Geologiske Undersökelse Årbok [Norway Geological Survey Yearbook]. Oslo, Norway.

Rhodesian Min. Jour.—Rhodesian Mining Journal. The Mining and Industrial Magazine of Southern Africa Ltd., Johannesburg.

Sci. de la Terre.—Annales de l'École Nationale Supérieure de Géologie Appliquée et de Prospection Minière de l'Université de Nancy du Centre de Recherche, Pétrographiques et Géochimiques. Editées par la Fondation Scientifique de la Géologie et de ses Applications. Nancy, France.

FORM OF CITATION

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

ABSTRACTORS

Abstracts in this issue have been prepared by J. R. Balsley, P. E. Byerly, W. J. Dempsey, Wanda L. Grimes, R. G. Henderson, Anna Jespersen, H. R. Joesting, R. M. Moxham, Virginia S. Neuschel, L. Peselnick, A. J. Shneiderov, and H. C. Spicer, as well as by the prin-

cipal authors. The notation "Author's abstract" followed by the initials of an abstractor indicates a translation of the author's abstract. The cooperation of Miss Marie Siegrist of the Geological Society of America is also gratefully acknowledged.

AGE DETERMINATIONS

175–1. Bowen, R. N. C. The exploration of time: London, George Newnes Limited, 143 p., 1958.

An elementary discussion of physical and chemical, astrophysical and astronomical, biological, geological, geographical, archeological and anthropological methods of dating the past.—*D. B. V.*

175–2. Aldrich, L. T., and Wetherill, G. W. Geochronology by radioactive decay: Ann. Rev. Nuclear Sci., v. 8, p. 257–298, 1958.

This is a review of developments in radioactive dating methods in the past few years, based on a survey of the literature through March 1958. Most striking advances have been in the fields of potassium-argon and rubidium-strontium dating. The most reliable method of dating common rocks is from the potassium-argon and rubidium-strontium ages of mica. Data exist which indicate that discordant uranium-lead ages of several minerals from the same geologic unit may in some cases provide both the age of the rock formation and the time the rocks were altered. Similar information may be included in the discordance of potassium-argon and rubidium-strontium ages, but sufficient data are not yet available to know how to derive this information. A bibliography of 147 items is appended.—*D. B. V.*

175–3. Crane, H. R., and Griffin, J[ames] B. University of Michigan radiocarbon dates III: Science, v. 128, no. 3332, p. 1117–1123, 1958.

As this list of 94 radiocarbon dates from the University of Michigan is the last to be published in *Science*, the technique of measurement is described more completely. The CO_2–CS Geiger counter is used. This has the advantage over the pure CO_2-filled counter of a very high tolerance for nonradioactive impurities, making chemical preparation simpler and practically eliminating error due to impurities. A disadvantage stems from the fact that the count is triggered by the slow-moving ions rather than by free electrons, necessitating a delay of several milliseconds after each count to allow the negative ions to reach the anode. In the counter of the size used, this blanking time is but a small penalty, but it would be appreciable with larger dimensions or higher pressures.

As in earlier lists (see Geophys. Abs. 167–9 and 173–2), ages are tabulated regionally, for the upper Mississippi Valley and Great Lakes, Mexico and Central America, lower Mississippi Valley, eastern United States, the Plains, western United States, Far East and Pacific, and southeastern United States. They are mainly of archeological interest.—*D. B. V.*

175–4. de Vries, H., and Waterbolk, H. T. Groningen radiocarbon dates III: Science, v. 128, no. 3338, p. 1550–1556, 1958.

The results of a series of carbon-14 age determinations made at the University of Groningen between March 1956 and August 1957 are presented in four tables. The first consists of geological samples from northwestern Europe, the second

and third of archeological samples from Europe and from outside Europe, respectively, and the fourth includes two special problems. Measurements on the radioactivity of shells and snails from different environments during the last four years have been published separately (see Geophys. Abs. 174–308), as have a group of Würm interstadial samples (see Geophys. Abs. 175–5).

Since completion of the present list, a careful study of a series of samples of known age (see Geophys. Abs. 175–333) has shown that the activity of carbon-14 in the atmosphere was fluctuating even before the Industrial Revolution; this affects dating results in a complicated way. As a first correction, 240 years should be added to all Groningen carbon-14 dates so far published, including the present list. Another correction which may amount to 100 years must also be applied, in either direction according to the age of the sample (see also Geophys. Abs. 160–158 and 172–7).—*D. B. V.*

de Vries, H. Variation in concentration of radiocarbon with time and location on earth. See Geophys. Abs. 175–333.

Crowe, C. Carbon–14 activity during the past 5,000 years. See Geophys. Abs. 175–334.

Münnich, K. O., Östlund, H. G., and de Vries, H. Carbon–14 activity during the past 5,000 years. See Geophys. Abs. 175–336.

Barker, H. Carbon–14 activity during the past 5,000 years. See Geophys. Abs. 175–335.

175–5. de Vries, H. Radiocarbon dates for upper Eem and Würm-interstadial samples: Eiszeitalter und Gegenwart, v. 9, p. 10–17, 1958.

Radiocarbon dates have been obtained for Eem-interglacial and Würm-interstadial sections from Loopstedt (Germany) and Amersfoort (Netherlands), for a few isolated peat samples from North-Western Europe and for charcoal samples from Austrian loess regions. Even the upper part of the Eemian proved to be too old to give a significant activity (age more than 53,000 years).

According to the present results the interstadial Würm II/III (fossil soil of Paudorf) occurred at about 26,000 years ago. Because of various contaminations of the samples (infiltrated humus, rootlets, etc.) the results for the interstadial Würm I/II are somewhat controversial, but it is not impossible that it should be identified with the fairly cool period between 33,000 and 42,000 before present. A somewhat warmer interstadial ended about 48,000 years ago. The results fit well with Emiliani's paleotemperature curve.—*Author's summary*

175–6. Fairbridge, Rhodes W. Dating the latest movements of the Quaternary sea level: New York Acad. Sci. Trans., ser. 2, v. 20, no. 6, p. 471–482, 1958.

Carbon-14 dating offers a solution to the problem of correlation of coastal terraces over the period of the last 45,000 yrs. Data so far available indicates that coastal terraces are controlled by eustatic oscillations and clues to the pattern of recent eustatic changes are emerging from a worldwide survey now in progress. A correlation chart and graph of sea level oscillations of the last 12,000 yrs is presented, based on radiocarbon dates and including pollen zones.—*V. S. N.*

175–7. Broecker, Wallace S., and Orr, Phil C. Radiocarbon chronology of Lake Lahontan and Lake Bonneville: Geol. Soc. Am. Bull., v. 69, no. 8, p. 1009–1032, 1958.

Carbon–14 measurements on freshwater carbonates have been used to determine the absolute chronology of the two largest fossil lakes in the Great Basin. Most of the 53 measurements tabulated are considered to be accurate within 10 percent. The major fluctuations of Lahontan and Bonneville over the past 25,000 yrs have been determined, and show two pronounced maximums in each case, a broad one between 24,000 and 14,000 yrs ago and a sharp one close to 11,500 years ago, and a possible third maximum 10,000 yrs ago. The fluctuations of lake level are positive indices of climate; hence the lake-level curves constitute a climate chronology for the Great Basin.—*D. B. V.*

175–8. Stoenner, R. W., and Zähringer, J. Potassium-argon age of iron meteorites: Geochim. et Cosmochim, Acta, v. 15, no. 1/2, p. 40–50, 1958.

The K^{41} and A^{40} have been determined in seven specimens of five falls of iron meteorites. The measured A^{40} content was found to be principally radiogenic in origin, and associated with the potassium. Under the usual assumptions accepted for this method, ages have been calculated and found to be close to 10×10^9 years, which is about twice the reported age of stone meteorites, and also higher than the supposed age of the universe.—*Authors' abstract*

175–9. Goldich, S. S., Nier, A. O., and Washburn, A. L. A^{40}/K^{40} age of gneiss from McMurdo Sound, Antarctica: Am. Geophys. Union Trans., v. 39, no. 5, p. 956–958, 1958.

Biotite from paragneiss of Gneiss Point, McMurdo Sound, Antarctica, is dated at 520 million years by the A^{40}/K^{40} method. Metamorphism of Precambrian sediments at the close of Precambrian or in Cambrian time is indicated, but additional work is needed.—*Authors' abstract*

175–10. Curtis, G[arniss] H., Evernden, J[ack] F., and Lipson, J[oseph]. Age determination of some granitic rocks in California by the potassium-argon method: California Div. Mines Spec. Rept., no. 54, 16 p., 1958.

Potassium-argon age determinations made on five intrusion in the Sierra Nevada foothills and Klamath Mountains, ten in the high Sierra Nevada, and six in the Coast Ranges fall into two age groups, or within two orogenic epochs. The earlier group was emplaced during the Nevadan orogeny 133 to 143 million yrs ago; the later group was emplaced during the Santa Lucian orogeny 78 to 95 million yrs ago.

Comparison with potassium-argon dates on glauconite in sandstones indicates that the Santa Lucian orogeny occurred during the Cenomanian, Turonian, and Senonian stages of the Upper Cretaceous, which is in harmony with the limited geologic data. The dates of the Nevadan intrusions suggest that the Holmes time scales are incorrect for the beginning and end of the Jurassic period, probably because Holmes used too small a total thickness in his computations. A correction based on published data increases the length of the Jurassic from 25 million yrs to 40 million yrs and decreases proportionately the lengths of the Permian, Triassic, and Cretaceous periods.

The Coast Ranges are in fault contact with Jurassic and Lower Cretaceous rocks but nowhere intrude them. They are locally overlain nonconformably by

late Upper Cretaceous sediments. At the time of emplacement the Coast Ranges intrusions were probably in the central part of a single fold belt which included the plutons of the high Sierras and the Southern California batholith; since Upper Cretaceous time they have been displaced at least 300 miles along the San Andreas fault.—*D. B. V.*

175–11. Gentner, W., and Kley, W. Argonbestimmungen an Kaliummineralien—V. Alterbestimmungen nach der Kalium–Argon–Methode an Mineralien und Gesteinen des Schwarzwaldes [Argon determinations on potassium minerals—5. Age determinations by the potassium-argon method on minerals and rocks of the Black Forest]: Geochim. et Cosmochim. Acta, v. 14, no. 1/2, p. 98–104, 1958.

The ages of 19 samples from 14 different rocks underlying the Black Forest (Schwarzwald) in Germany have been investigated systematically by the potassium-argon method. Inasmuch as the area is well mapped and the petrogenetic sequence well established on geologic grounds, the comparison of the argon ages with the geologic ages affords a good test of the efficiency of the potassium-argon method.

The results show an exact correspondence between the relative and absolute ages. It is concluded that argon age determinations can be used to examine special problems of petrogenetic evolution.—*D. B. V.*

175–12. Mehnert, K. R. Argonbestimmungen an Kaliummineralien—VI. Die geologische Entwicklung des Schwarzwald–Grundgebirges anhand absoluter Alterbestimmungen nach der K–A–Methode [Argon determinations on potassium minerals—6. The geologic evolution of the Black Forest basement complex from absolute age determinations by the potassium-argon method]: Geochim. et Cosmochim. Acta, v. 14, no. 1/2, p. 105–113, 1958.

The age of 14 samples of Variscan and pre–Variscan rocks of the Black Forest (Schwarzwald), Germany, has been measured by the potassium-argon method (see Geophys. Abs. 175–11). The accuracy, determined from comparison of the spread of argon ages of some upper and lower Carboniferous granites, pegmatites, and porphyries whose geologic age is well established, is found to be ±10 million yrs, or ±4 percent.

The argon age of the metamorphic and granitized rocks is a minimum age, because of argon loss during granitization. The oldest rock measured was 362×10^6 yrs old; this shows that the regional granitization of the Black Forest basement complex, which preceded the oldest Variscan intrusions, took place about in Upper Devonian or at latest in the Wende in Upper Devonian–Kulm. The original sedimentary material of the gneisses and migmatite is probably Precambrian.—*D. B. V.*

175–13. Tilton, G[eorge] R., Wetherill, G[eorge] W., Davis, G. L., and Hopson, C. A. Ages of minerals from the Baltimore gneiss near Baltimore, Maryland: Geol. Soc. America Bull., v. 69, no. 11, p. 1469–1474, 1958.

The age of zircon, biotite, and microcline from three domes of the Baltimore gneiss in Maryland has been investigated by appropriate methods. Biotite is dated as 300 to 350×10^6 yrs old by the potassium-argon method, zircon and microcline as 1,000 to $1{,}100\times10^6$ yrs on the basis of lead-isotope and rubidium-strontium determinations respectively. It is concluded that the microcline and

zircon probably record an early crystallization and the biotite a second crystallization during the Paleozoic. Either a sedimentary or igneous origin is allowed for the gneiss. These data substantiate the assignment of the Baltimore gneiss to the Precambrian basement complex and are consistent with Eskola's hypothesis for the origin of these mantled gneiss domes.—*D. B. V.*

175–14. Aldrich, L. T., Wetherill, G. W., Davis, G. L., and Tilton, G. R. Radioactive ages of micas from granitic rocks by Rb–Sr and K–A methods: Am. Geophys. Union Trans., v. 39, no. 6, p. 1124–1134, 1958.

Age determinations on cogenetic minerals from 16 pegmatites and granites from different places by the potassium-argon, rubidium-strontium, and in some cases uranium-lead and thorium-lead methods, are compared. The results indicate that potassium-argon and rubidium-strontium ages of mica usually agree when modern laboratory-determined values of the decay constants of potassium-40 and rubidium-87 are used; that both agree with concordant uranium-lead ages of cogenetic uraninite, zircon, and monazite; that when the uranium-lead ages are discordant, the mica ages agree best with the 207/206 age; and that the pattern of potassium-argon and rubidium-strontium ages of micas can be explained most simply by postulating loss of variable but small amounts of argon.—*D. B. V.*

175–15. Herzog, Leonard F., Pinson, William H., Jr., and Cormier, Randall F. Sediment age determination by Rb/Sr analysis of glauconite: Am. Assoc. Petroleum Geologists Bull., v. 42, no. 4, p. 717–733, 1958.

A study has been made of the feasibility of applying the Rb/Sr method of age determination directly to sedimentary rocks through the use of the sedimentary accessory mineral glauconite. Seven glauconites of Cambrian to Tertiary age, separated from shales, sandstones, and limestones, were found to have Rb contents of 180 to 310 parts per million; 14 samples were found to have nonradiogenic Sr concentrations of 5 to 310 parts per million and radiogenic Sr–87 contents of 0.05 to 0.7 parts per million. The large variation in Sr content is believed to be due to differences in the proportion of contamination $CaCO_3$ (containing traces of Sr) remaining in the samples, which were purified by physical means only, and not to variations in the glauconites. The glauconites analyzed may be truly authigenic, as all the ages computed are reasonable; however, the great present imperfection of knowledge of absolute sedimentary time makes critical evaluation of such data most difficult. Further development of this method is well justified, for the demonstrated analytical feasibility of the determination of both Rb/Sr and K/A ages for glauconites and other authigenic K, Rb minerals may make possible the establishment of a dependable absolute time scale for at least the post-Precambrian sedimentary column.—*Authors' abstract*

175–16. Matzko, J. J., Jaffe, H[oward] W., and Waring, C[laude] L. Lead–alpha age determinations of granitic rocks from Alaska: Am. Jour. Sci., v. 256, no. 8, p. 529–539, 1958.

Seventeen lead–alpha age determinations were made on zircons from eight granitic rocks of southeastern and central Alaska. The results of the age determinations indicate two periods of igneous intrusion, one about 100 million years ago during the middle Cretaceous period in southeastern and east-central Alaska,

and another about 55 million years ago either very late in the Cretaceous or early in the Tertiary period in central Alaska. The individual ages determined on zircon from two rocks from southeastern Alaska and two from east-central Alaska gave results of 93, 103, 103, and 105 million years; those determined on four rocks from central Alaska gave results of 49, 53, 58, and 60 million years.—*Authors' abstract*

175–17. Mürtz, H. J. Age determinations of galena from Lausitz, Billiton, and Nigeria: Geologie en Mijnbouw, v. 20, no. 3, p. 107–108, 1958.

Correct values are given for the lead isotope ratios and model ages of galenas from Lausitz, Billiton (Indonesia), and Nigeria, incorrectly reported in a previous paper (see Geophys. Abs. 171–49). The model ages of the second and third are $105\pm50\times10^6$ and $660\pm110\times10^6$ yrs respectively, both in good agreement with ages determined by radioactive methods and geological estimates. The age of the Lausitz galena is $600\pm60\times10^6$ yrs, quite different from the Pb^{206}/U age and the real geologic age; the galena might thus be a B-type ore (see Geophys. Abs. 175–258).—*D. B. V.*

Ehrenberg, H. F., and Mürtz, H. J. Isotopic composition of some galenas. See Geophys. Abs. 175–259.

175–18. Deutsch, Sarah, and Chauris, Louis. Application de la méthode d'estimation d'âge par les halos pléochroïques à quelques granites de Normandie [Application of the pleochroic halo method of estimating age to some granites from Normandy]: Soc. géol. France Comptes Rendus, no. 11–12, p. 277–280, 1958.

The Vire granite of Normandy has been dated as older than the Cambrian transgression on the basis of field relationships; the granite of the Chausey Islands resembles the Vire granite petrographically but is nowhere in contact with the Cambrian. Age determinations by the pleochroic halo method show that both granites are Precambrian, the Chausey possibly being somewhat older. They therefore represent a magmatic cycle distinctly different from that of the Flamanville granite (Hercynian).—*D. B. V.*

175–19. Pettersson, Hans. Shooting stars: Göteborg, Sweden, Tor E. J:son Broström festskrift, Sjöfartsmuseet, p. 117–132, 1955.

The number of small meteorites and micrometeorites falling on the earth as cosmic dust is estimated as nearly eight billion per day, ranging from 0.025 mg to a few milligrams in weight. Cosmic spherules formed from larger iron meteorites become embedded in the sediment of the ocean floor in a concentration inversely proportional to the rate of sedimentation. In the process of melting and solidifying the "cosmic spherules" become thermomagnetized by the earth's magnetic field, and can be extracted from the deposit magnetically. If the rate of meteorite deposition has been constant, the concentration of the spherules in different deposits may serve as an inverse measure of the rate of sedimentation. Pettersson has determined the concentration of spherules in a number of specimens from ocean cores obtained by the Swedish Deep-Sea and other expeditions from depths of 2,417 to 5,980 m. The presence of the spherules throughout the upper few meters of the ocean floor sediments (for instance in red clay cores taken from the central Pacific Ocean) proves that meteor falls have been going on for millions of years and are not limited to the late

Quaternary as stated by Schwinner. The cosmic spherules, if recognized as a worldwide phenomenon, may serve as a basis for a geochronologic method extending back in time possibly 10 to 20 million yrs; this would be preferable to the method based on ionium-supported radium, which Pettersson considers to be lacking in definitiveness, or the method based on beryllium-10 which has a half life of 2.7×10^6 yrs.—*A. J. S., D. B. V.*

175–20. Starik, I. Ye., Kuznetsov, Yu. V., Grashchenko, S. M., and Frenklikh, M. S. K voprosu ob ioniyevom metode opredeleniya vozrasta morskikh osadkov [The ionium method of determination of the age of marine sediments]: Geokhimiya, no. 1, p. 3–13, 1958.

The vertical distribution of uranium, radium, ionium, and thorium, as well as of iron, manganese, and calcium in seven cores of marine sediments from the Indian and Pacific Oceans has been studied in order to investigate the distortion of the exponential curve of radium distribution which is an expression of the geologic age of the sediments. It is concluded from the results that radium and thorium are in equilibrium in the sediments at all points measured; that ionium and thorium occur in various forms in marine sediments; that the thorium and uranium contents are constant throughout the length of the core; that littoral, intermediate, and typical deep sea sediments can be distinguished according to the character of the distribution of their ionium and radium; and that there is a correlation between vertical distribution of ionium and radium and that of calcium in a number of cores.—*D. B. V.*

Cook, R. M. Intensity of remanent magnetization of archaeological remains. See Geophys. Abs. 175–296.

EARTHQUAKES AND EARTHQUAKE WAVES

175–21. Naturwissenschaftliche Rundschau. Erdbebenreiches Jahr 1957 [Earthquake-rich year 1957]: Naturw. Rundschau, v. 11, no. 5, p. 190, 1958.

The astronomical-meteorological institute of the university at Basel reports that they recorded 502 earthquakes in 1957, by far the most in any year since seismic operations began there in 1933. The average since 1933 has been about 220 per year, higher (more than 350) in the last few years. The number of near earthquakes was about average; it was the distant earthquakes that accounted for the increase.—*D. B. V.*

175–22. Bourcart, Jacques, and Glangeaud, Louis. Perturbations sousmarines et courants de turbidité du séisme d'Orléansville [Submarine disturbances and turbidity currents from the Orléansville earthquake]: Acad. Sci. Paris Comptes Rendus, v. 242, no. 11, p. 1504–1506, 1956.

More than 350 submarine aftershocks were recorded during November following the Orléansville, Algeria, earthquake of September 9, 1954 (see Geophys. Abs. 163–103). These provoked submarine slumping along the continental flexure, involving not only recent and Quaternary sediments but also Tertiary and Mesozoic deposits. Turbidity currents descending along submarine canyons eroded unconsolidated sediments and mingled deposits of different ages.—*D. B. V.*

175–23. Jaeger, J. C., and Browne, W. R. Earth tremors in Australia and their geological importance: Australian Jour. Sci., v. 20, no. 8, p. 225–228, 1958.

Australia is a minor seismic area; recorded epicenters show that a certain amount of weak activity takes place at the western edge of the shield, in the Spencer's Gulf-Lake Eyre rift, in the Dalton region and its coastward extension, in Bass Strait, and in the east coast ranges. The study of small shocks is now being undertaken in connection with the Snowy Mountains hydroelectric project. The planned network of stations, to be equipped with sensitive seismographs of small period, high magnification, and fairly high speed recording and to be placed in sites of very low noise level, should be capable of determining the pattern of minor seismic activity all over southeastern Australia. Some geologic problems on which such information may throw light are enumerated.—*D. B. V.*

175–24. Kirov, K., and Paliyeva, K. Zemetreseniyata v Bŭlgariya prez 1955–1957 godina [Earthquakes in Bulgaria during the years 1955–1957]: Bŭlgarskata Akad. Nauk Priroda, no. 2, p. 37–41, 1958.

In the three-year period 1955–1957, seismic activity in Bulgaria was very quiet. There were 19 macroseismic disturbances in 1955, two in 1956, and six in 1957 as against a previous average of 97 per year. The strongest earthquake was 7° (Mercalli-Cancani-Sieberg scale) with its epicenter at Shabla and Balchishko. Detailed chronological and seismological descriptions are given for the 27 earthquakes which occurred during the reported period. It is concluded that inasmuch as Bulgaria has not had a catastrophic earthquake since 1928, a sudden increase in seismic activity would not be unexpected.—*A. J. S.*

175–25. Savarenskiy, Ye. F. O rabotakh po seysmologii v Kitayskoy Narodnoy Respublike [Seismological studies in the People's Republic of China]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 765–769, 1958.

This is a brief report on the trip made by Savarenskiy, as chairman of the council on seismology of the Russian Academy of Sciences, to China in 1957–1958. From a map given it can be seen that over half the territory of China is seismically active. The central and western portions of China are subject to violent earthquakes, for example, the earthquake of Hansu on December 16, 1920, one of the most violent earthquakes of the entire globe. China is only little less dangerous seismically than Japan, the most dangerous region being in eastern Tibet. Here near the boundary between India and China an earthquake of magnitude 8.6 occurred on August 15, 1950.

The foci of most of the earthquakes are located within the earth's crust. At present China has 25 seismic stations. All the equipment of these stations is built in China, although most of the instruments are of foreign design. Two tripartite seismic stations, one in Shanghai, another in Canton, are built for the study of microseisms.

Along with the industrial development of the country, much attention is being given to engineering seismology and to the development of earthquake-resistant industrial construction.

The article ends with the description of several seismic stations in different parts of China.—*S. T. V.*

175–26. Ramirez, Jesus Emilio. Los terremotos de enero y febrero de 1958 en la costa del Pacífico de Ecuador y Colombia [The earthquakes of January and February of 1958 on the Pacific coast of Ecuador and Colombia]: Soc. Geog. Colombia Bol., v. 16, no. 58, p. 67–74, 1958.

The series of earthquakes that occurred off the coast of Ecuador and Colombia on January 19–20 and February 1–2, 1958, caused 15 deaths and 45 injuries in the port of Esmeraldas, Ecuador, and serious damage in other coastal settlements, principally in Tumaco, Colombia. The first shock, the strongest, occurred at about 9:09 a.m. (local time); another of almost equal intensity followed at 9:45 a.m., with smaller movements at 2:09 p.m. on the same day and at 8:22 p.m. the following day. The epicenter was about 700 km off the coast, opposite Esmeraldas. The second series of shocks occurred on February 1 at 11:15 a.m., 12:00 noon, 1:30 p.m., and on February 2 at 3:20 and 4:00 in the morning. According to the U.S. Coast and Geodetic Survey, the epicenters were as follows: January 19 at $09^h09^m00^s$, and at $09^h45^m02^s$, lat 1.5° N, long 79.5° W; February 1 at $13^h04^m05^s$, lat 2.0° N, long 79.0° W; February 1 at $15^h47^m19^s$, lat 1.5° N, long 79.0° W; February 2 at $03^h50^m50^s$, lat 2.0° N, long 79.0° W. Macroseismic effects are described, with three photographs.—*D. B. V.*

175–27. Science Council of Japan. Seismology and physics of the interior of the earth. National report in Japan, 1954–1956: Sci. Council Japan, Natl. Comm. Geodesy Geophysics, Sec. Seismology Rept., 17 p., 1957.

A summary of seismological observations and studies in Japan during 1954 through 1956 presented to the 11th General Assembly of the International Association of Seismology and Physics of the Earth's Interior in Toronto, Canada, in September 1957. It includes lists of seismological stations and major earthquakes, and a bibliography of seismological papers published in Japanese periodicals from 1954–1956.—*V. S. N.*

175–28. Akamatsu, Kei. On microtremors (in Japanese with English summary): Zisin, ser. 2, v. 9, no. 1, p. 21–39, 1956.

Microtremors with frequencies between 1 and 20 cycles per sec were observed at Hongo in Tokyo and at Mount Tukuba, Japan, in tripartite and parallel observations made with seismometers of different frequencies. At Hongo, tremors were found with frequencies of 2 to 5, 7 to 9, and 10 cycles per sec, with a day-to-night ratio of amplitude variation of 17/1. At Mount Tukuba tremors were found with a frequency of 20 cycles per sec and with a day-to-night ratio of amplitude variation of 2/1. Data from tripartite observations were used to find the time difference in wave arrivals between two points and, by cross correlation, to determine the direction of wave propagation and phase velocity. Space correlation between two points decreased more rapidly for shorter period waves than for longer ones (see also Geophys. Abs. 174–26).—*V. S. N.*

175–29. Silgado F., E[nrique]. Acceleraciones instrumentales de los sismos fuertes en Lima, 1946–1954 [Instrumental accelerations of strong earthquakes in Lima, 1946–1954]: Soc. geol. Peru Bol., v. 32, p. 221–224, 1957.

Accelerations, periods, and displacements of the 10 strong earthquakes originating in the vicinity of Lima from 1946 to 1954 are tabulated. Except for the shock of January 31, 1951, which was slightly destructive, all were of moderate intensity.—*D. B. V.*

175–30. Silgado F., E[nrique]. El movimiento sísmico del 12 de diciembre de 1953 [The earthquake of December 12, 1953]: Soc. geol. Peru Bol., v. 32, p. 225–228, 1957.

The earthquake of December 12, 1953, in northwestern Peru and southern Ecuador killed 6, injured 20, and caused extensive damage in the Peruvian villages of Tumbes and Corrales. The shock was felt over an area of approximately 700,000 km^2 and the area of destruction was about 5,000 km^2. Intensity was between 7 and 8 on the Modified Mercalli scale. From *P*–wave arrivals at various stations, the epicenter was located at lat 3°38′ *S*, long 80°31′ *W*. The paper deals mainly with the macroseismic effects.

S–P intervals for 12 shocks from 1947 to 1954 suggest that the seismic activity of this region occurs along a deep geotectonic line, probably an orogenic fault as postulated by Benioff (see Geophys. Abs. 140–11735 and 157–173).—*D. B. V.*

175–31. Schulz, R[udolfo]. Resultados sobre la actividad sísmica en El Salvador segun los registros en las estâciones sismológicas de este pais [Results on the seismic activity in El Salvador according to the records at the seismological stations of that country (with English summary)]: El Salvador servicio geol. nac. Bol. sismol., v. 4, p. 2–6, 1958.

On the basis of near-earthquake records of the seismic stations at San Salvador and Santiago de Maria, three zones of seismic activity can be established in and near El Salvador: a zone of shallow epicenters on the continent, a zone of deep epicenters (h=60 to 100 km) about 20 km off the coast in the Pacific Ocean, and a third zone of shallow shocks (±20 km) within the Central American Trench. From records of the El Carmen earthquake of June 26, 1957, the epicenter of which was in line with both stations, the travel times of *P* and *S* were calculated to be 6.7 kmps and 3.8 kmps respectively; this suggests that the granitic layer is lacking.—*D. B. V.*

175–32. Rezanov, I. A. Ashkhabadskoye zemletryaseniye 1948 g. i geologicheskiye usloviyya yego vozniknoveniya [The Ashkhabad earthquake of the year 1948 and the geologic conditions of its origin]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 713–728, 1958.

The epicenter of the Ashkhabad earthquake of 1948 was the line between the points at lat 38°03′ N, long 58°31′ E, and lat 37°75′ N., long 58°65′ E, forming the major axis of the oval formed by the grade 9 isoseismal line. The earthquake was related to recent tectonic uplift of the southwestern portion of the Kopet-Dag depression. Judging from the depth of the aftershocks, the fracture involves the Paleozoic basement down to about 10 to 12 km. The earthquake records and the data of a precise leveling made after the earthquake show that the southwestern side of the fracture moved upward and the northeastern side downward. The location of the aftershocks at either end of the epicentral axis confirms the linearity of the focus and proves that the initial assumption of the existence of two distinct epicenters of this earthquake was erroneous.—*S. T. V.*

175–33. Davis, T. Neil. Preliminary report on the Alaskan earthquake of April 7, 1958: Am. Geophys. Union Trans., v. 39, no. 5, p. 941–942, 1958.

The Alaskan earthquake of 05h 30m April 7, 1958 (150° WMT) is the largest (Richter scale 7.0–7.5) of a series of shocks centered in an area near Huslia, Alaska. Severe breakage of lake and river ice and many ground cracks and mud flows occurred in the region of the field epicenter. A preliminary isoseismal map is presented.—*Author's abstract*

175–34. Richter, C[harles] F., Allen, C[larence] R., and Nordquist, J. M. The Desert Hot Springs earthquakes and their tectonic environment: Seismol. Soc. America Bull., v. 48, no. 4, p. 315–337, 1958.

The Desert Hot Springs earthquake of December 4, 1948, was one of the larger recorded earthquakes of southern California, and its aftershocks have continued into 1957. The epicenter was at lat 33° 56.4′ N, long 116° 23.1′ W; origin time was 15: 43: 16.7 (PST), magnitude 6½. Anomalous *S–P* intervals at very nearby temporary stations cannot be attributed to varying depth of focus.

Accurately located epicenters of 72 aftershocks are concentrated in a zone 18 km long, parallel to the Mission Creek fault trace but 5 km north of it. Aftershock activity is markedly concentrated towards the ends of this line. Location of the main shock suggests that fracturing started near the southeast end and progressed northwestward. The field observations together with first motions at stations within 6° of the epicenter, require a combination of thrust-slip and right lateral-slip on a fault dipping north less than 66°; this is consistent with the tectonic pattern of the region.—*D. B. V.*

175–36. Dvořák, Arnošt, and Zátopek, Alois. K zemětřesnému ohrožení staveb v Československu [On the seismic danger to buildings in Czechotween the seismicity and the isostatic gradient in Algeria]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 18, p. 1476–1478, 1958.

The epicenters of Algerian earthquakes are located in areas where the isostatic gradient is high, generally in the zones separating areas of positive and negative isostatic anomalies. The earthquakes mark stages of tension faulting along the zones of friction between rising and sinking blocks. It is true that the epicenters are never far from the major anticlinal axes, but these are secondary rather than determining features.—*D. B. V.*

175–36. Dvořák, Arnošt, and Zátopek, Alois. K zemětřesnému ohrožení staveb v Československu [On the seismic danger to buildings in Czechoslovakia]: Československá Akad. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 71, p. 619–631, 1957.

A map of seismic activity in Czechoslovakia for the last 200 years is given, showing the epicenters of strong and weaker earthquakes, and the characteristic vibrations at different intensities. The effect of earthquakes and tremors on the buildings of the areas was studied. It is concluded that there is no danger of damage to buildings until 6° (Mercalli-Cancani-Sieberg scale) intensity is reached. For the shocks of higher intensities the buildings must be constructed to withstand the horizontal component of ground displacement during the earthquake.—*A. J. S.*

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175–37. Suzuki, Ziro. A statistical study of the occurrence of small earthquakes III: Tohōku Univ. Sci. Repts., ser. 5, v. 10, no. 1, p. 15–27, 1958.

In order to examine the question of whether or not the magnitude distribution of small earthquakes is different from that of larger ones, the variations in the value of the exponent m in the Ishimoto-Iida relation (see Geophys. Abs. 158–143, 163–106) are examined in detail. The effect of mode of classification of data, the accuracy of m in the case of cumulative frequency distribution, and the variation caused by taking amplitude in one component, are considered. A fluctuation of 0.3 in the numerical value of m may commonly be expected even when the total number is as large as 1,000. The best method of estimation seems to be to adopt the original frequency rather than the cumulative frequency; to take the mean of classes as not widely different from the visual criterion; and when the number of earthquakes in a class is less than 10, to use the mean of several neighboring classes and the corresponding amplitude. The distribution obtained by taking the mean value gives better agreement with the Ishimoto-Iida relation than the original distribution.—*D. B. V.*

175–38. Popescu, Ioan [G]. Despre epicentrele cutremurelor din Republica Populară Romînă [Epicenters of earthquakes in the Rumanian People's Republic]: Acad. RPR Bul. ştiinţ., Sec. mat. şi fiz., v. 9, no. 2, p. 521–536, 1957.

The most seismically active area of the Rumanian People's Republic is that adjacent to the Carpathian mountains near Fokshani. Out of 665 earthquakes recorded in Rumania, 307 occurred in the Vrancha mountain area. The least active seismically are the Rumanian Plains, Hett lowland, Dobrudja, and the northern part of the Moldova district. A few local tremors were recorded by the seismic observatory at Bucharest.—*A. J. S.*

175–39. Tokarev, V. A. Geologicheskaya interpretatsiya materialov po seysmichnosti Kol'sko-Skandinavskego regiona [Geologic interpretation of data on the seismicity of the Kola-Scandinavia region]: Akad. Nauk SSSR Doklady, v. 119, no. 4, p. 772–775, 1958.

The distribution of foci of earthquakes that occurred in the period 1891–1950 in the region comprising Norway, Sweden, Finland, and the Kola Peninsula shows two major zones of activity, the Sogne-Bergen zone along the west coast of Norway, and the Klar-El'vskaya zone running from Oslo Fiord northeastward along the Swedish coast of the Gulf of Bothnia; seismicity is highest where these zones are intersected by other lines of activity roughly transverse to them. Deep vertical displacements of the crust are taking place on a large scale along these zones, which dip 60° to 90° under the continent. The Sogne-Bergen zone follows the trend of Caledonian (lower Paleozoic) folding, and the Klar-El'vskaya zone follows very old Precambrian trends. Further study will be undertaken of the relationship of the seismicity of Scandinavia to that of the Kola Peninsula, Karelia, Greenland, the Norwegian Sea and the North Atlantic, in the hope of throwing light on the evolution of geologic structures of the crust in general.—*D. B. V.*

175–40. Buss, E. I. O seysmichnosti Zakavkaz'ya [The seismicity of the Transcaucasus]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 95–99, 1956.

In this review of seismic studies in the Transcaucasus, Buss discusses the seismicity of individual areas, based on the data on 2,600 earthquakes available for the period from 139 to 1956. Further study of structural geology of the regions is needed to determine the relationship between their seismicity and tectonics.—*A. J. S.*

175–41. Tamrazyan, G. P. Zakonomernosti v raspredelenii zemletryasenii Turkmenii i nekotorye voprosy prognoza zemletryaseniy [Regularities in distribution of earthquakes in the Turkmen SSR and certain problems of earthquake prediction]: Akad. Nauk Turkmen. SSR Izv., no. 5, p. 76–84, 1956.

About 98 percent of the total earthquake energy in the Turkmen S. S. R. for 1917–1951 was released during the moon's orbital passage between the perigee and syzygy. Tamrazyan finds a relationship between earthquakes and certain cosmic factors; for example the number of earthquakes increases markedly when the distance between the lunar perigee and the nearest syzygy decreases (see also Geophys. Abs. 123–8240, 173–38, 174–34).—*A. J. S.*

175–42. Woollard, G[eorge] P. Areas of tectonic activity in the United States as indicated by earthquake epicenters: Am. Geophys. Union Trans., v. 39, no. 6, p. 1135–1150, 1958.

A study based on earthquake occurrences in the United States shows several zones of continuing seismic activity. Over the past 30 years there is a suggestion of systematic variations in seismic activity following what appears to be a three-year cycle which is superimposed on a longer period. Areas of activity can not be related to either geologic age or type of structure. In California transcurrent movement on known faults is associated with seismic activity. In the other western states activity is associated with the boundaries of areas of epeirogenic uplift and subsidence and appears to involve predominantly vertical crustal displacement. In the Midcontinent area activity for the most part is associated with positive crystalline rock tectonic elements and their borders. In the Appalachian area activity is associated with the zones of overthrusts and shear. A conspicuous zone of earthquakes paralleling the Appalachians from Missouri to the St. Lawrence River valley while not related to known geologic controls does follow a zone of better-than-normal seismic transmissibility. The depth of focus varies from area to area and appears to be related directly to crustal thickness and possibly also changes in crustal rigidity with depth. No direct relation is noted between areas of isostatic unbalance and seismic activity or variations in degree of seismic activity with changes in crustal thickness. For the most part, it appears local stress conditions are dominant in causing earthquakes.—*Author's abstract*

175–43. Suzuki, Masazi. Aseismic properties of a wooden house, part 2, observation of earthquakes (in Japanese with English summary): Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 2, p. 235–250, 1958.

A discussion is presented of the period response in displacement and acceleration of the ground, displacement of house ceiling, strain on a pillar, and the

vibration characteristics of a pendulum in the house. Measurements were made in a wooden house in the Kanto district, Japan.—*P. E. B.*

175–44. Kolosenko, M. N. Uchet elliptichnosti zemli pri opredelenii epitsentral'nykh rasstoyaniy [The consideration of the effect of the ellipticity of the earth on the determination of epicentral distances]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 116–120, 1958.

The ellipticity of the earth affects the travel time of seismic waves, for this time interval is determined not only by the epicentral distance from the station, but also by the relative position of the epicenter and the station on the terrestrial ellipsoid. For the sake of uniformity the observations made at different points are usually referred to a conventional sphere of the same volume as the terrestrial ellipsoid. This permits the use of the Jeffreys-Bullen tables. It is necessary in this case to use the geocentric coordinates φ^1 and λ^1, related to the geographic coordinates φ and λ by the equations: $\lambda^1=\lambda$, $\tan \varphi^1=(1-\alpha^2) \tan \varphi$, where α is the flattening of the ellipsoid. If the geographic coordinates are used, an error is introduced which in the case of the epicenters situated in North America can be as high as 0.4° for the Soviet seismic stations.

The procedure is given for evaluating the correction for different positions of the epicenter and for different points of observation. A table is included giving for each of the 75 Russian stations its geographic and geocentric latitude and longitude, as well as the geocentric direction cosines and the value of the radius of curvature for different latitudes. Finally the length of one degree on the earth's surface is given in lateral and meridional directions at different points.—*S. T. V.*

175–45. Puchkov, S. V. Ob osnovakh kompleksnogo metoda seysmicheskogo rayonirovaniya [Concerning the bases of the complex method of seismic zoning]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 107–115, 1958.

Certain points to be taken into consideration in the new edition of the seismic atlas of the U.S.S.R. are discussed. Earthquakes result either from the displacement of tectonic structures along slippage planes or from the rupture of the structure under stresses exceeding the limit of resistance of the rock material. These faults may appear on the terrestrial crust under a thick layer of friable argillaceous sandstones. It is important to distinguish those which are "active," that is, capable of producing new displacements in successive earthquakes. Buried ruptures can be located by instrumental surveying. The force manifested during the rupture is determined by the area and mechanical resistance of the rock at the depth of the focus of the earthquake. The limiting intensity of earthquakes on basic rocks cannot exceed 7 to 8 for focal depths of 10 to 30 km. The initial waves consume only 2 to 3×10^{-3} of the total energy of the shock, but the intensity of waves emanating from the focus can increase, due to resonance phenomena in the upper formations. Thus earthquakes on friable formations can be two grades higher than on basic rocks (see Geophys. Abs. 168–28). Puchkov also points to the fact that the greatest amplitude of the waves and consequently of the intensity of the earthquake may not be found at the focus but at some distance from it.—*S. T. V.*

175–46. Bisztricsány, Ede. A földrengések méretmeghatározásának új módszeréről [A new method of earthquake magnitude determination (with English summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, v. 7, no. 2, p. 69–96, 1958.

The method of magnitude determination described in the present paper utilizes the duration of the surface wave. Its main interest lies in the fact that this parameter is independent of distance within the interval 4 to 160 degrees. Beside the records taken by the Wiechert pendulum at Budapest (V~190, ξ~5, T_0~10), those by the Wiechert pendulum at Prague and the Galitzin instrument at Warsaw, were also utilized. The results seem to indicate that the method is of universal applicability, independently of the kind of the pendulum used. However, there is a slight dependence on the duration of the surface waves in the case of small period instruments. The method is also applicable to deep focus shocks, if a simple correction for the focal depth is taken.—*Author's abstract*

175–47. De Noyer, John. Determination of the energy in body and surface waves (Part 1): Seismol. Soc. America Bull., v. 48, no. 4, p. 355–368, 1958.

This part of the paper presents the basic mathematical theory for estimating energy in body and surface waves. The limits of epicentral distances within which satisfactory results can be obtained for *P*- and *SV*-waves are between 50° and 103°, if a velocity of 7 kmps is used for *P*-waves near the surface. Methods of obtaining the energy of both Love and Rayleigh waves are developed for the case of a superficial layer overlying a semi-infinite medium of differing elastic properties.—*D. B. V.*

175–48. Miller, Maynard M. The role of diastrophism in the regimen of glaciers in the St. Elias District, Alaska: Jour. Glaciology, v. 3, no. 24, p. 293–297, 1958.

Anomalous glacier advances in Yakutat Bay, Alaska, in the early part of the century were explained by Tarr and Martin (1914) as a result of earthquake avalanches produced by the severe earth tremors in the fall of 1899. A record of excessive precipitation along this coast in the late 1870's and 1880's was dismissed as being in error but the extensive coverage of recent surveys aided by aerial photography has revealed similar advances at the turn of the century on glaciers throughout southeastern Alaska including areas where the effect of the earthquakes was negligible. Miller concludes that the earthquakes were a supplemental and generally minor factor in a widespread set of advances initiated by meteorological causes. It is possible that the increased load caused by excessive accumulation over the broad névés of the St. Elias Mountains upset the orogenic balance at a time when the tectonic stress in the bedrock had already approached its limit of rupture and thus triggered the earthquake. Yakutat Bay lies in a zone of stress clearly sensitive to tectonic adjustment and a relationship to load changes accompanying major glacial fluctuations should be expected.—*V. S. N.*

175–49. Yurkevich, O. I. Endogennyy factor pri naklonakh zemnoy poverkhnosti [The endogene factor in crustal tilts]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy ser. geofiz., no. 2, p. 69–78, 1958.

Tilting of the earth's surface is caused by epeirogenic processes, by changes in temperature and barometric pressure, by the earth and ocean tides, and by

endogene forces. The paper discusses the surface tilts due to the last and explores the possibility of predicting earthquakes preceded by ground tilts. It is concluded that no valid prediction is possible until tiltmeters are improved. The geophysical problem of displacement of the earth's crust under forces acting on its lower boundary is worked out mathematically. Assuming a force to be distributed systematically over the lower boundary of the crust, formulas are obtained giving a relationship between the values of the normal displacement $v\left(\frac{dv}{dx}\right)$, coordinate x, and the force P under the earth's crust.—*A. J. S.*

175–50. Egyed, László. On the mechanism of deep-focus earthquakes: Československá Akad. Věd Studia Geophys. et Geod., v. 2, no. 3, p. 291–292, 1958.

Earthquakes are produced by tensional stresses originating from expansion of the earth. The focal plane is a surface of rupture along which rupture proceeds upwards or downwards, causing shallow and deep-focus earthquakes respectively. The characteristics profile of deep-sea troughs usually associated with deep-focus earthquakes seems to be a result of deformation and thinning of the crust caused by the tension. The fact that the focal plane of deep earthquakes always dips below continental areas is new proof of the differences between continental and oceanic structure.—*D. B. V.*

175–51. Hodgson, John H., and Stevens, Anne. Direction of faulting in some of the larger earthquakes of 1955–56: Dominion Observatory Ottawa Pubs., v. 19, no. 8, 34 p., 1958.

Fault-plane solutions are presented in tabular form for fifteen of the larger earthquakes of 1955–56. Twenty-nine principal earthquakes and seven aftershocks were covered, but all aftershocks and four principal shocks were too small to provide sufficient data and two other earthquakes failed to provide unique solutions (possibly indicating a more complex mechanism than failure under a couple).—*V. S. N.*

175–52. Scheidegger, Adrian E. Seismological evidence for the tectonics of the Northwest Pacific Ocean: Seismol. Soc. America Bull., v. 48, no. 4, p. 369–375, 1958.

From a series of fault-plane solutions of earthquakes in any one area, it is possible to determine the tectonic displacement of that area by a least squares solution. This method has been applied to the areas marginal to the Northwest Pacific Ocean. It turns out that the directions of the tectonic displacement in the Kurile Islands, Honshu, the Marianas Islands, and the Philippines are more or less parallel: the direction is approximately N 14° W. This is a rather startling result: it appears that the whole Northwest Pacific Ocean is moving *en bloc* with regard to its margin. A determination of the motion for Sakhalin gives an entirely different direction (N 36° E), which is an indication that the tectonic motion of Sakhalin is unrelated to that of the Pacific Ocean.—*Author's abstract*

Lensen, G. J. Rationalized fault interpretation. See Geophys. Abs. 175–175.

175–53. Gutenberg, B[eno]. Caustics produced by waves through the earth's core: Royal Astron. Soc. Geophys. Jour., v. 1, no. 3, p. 238–248, 1958.

Caustics produced by *SKP*, *PKS*, *PKP* and other phases through the earth's core are investigated. No impulses from diffracted waves with periods of two seconds or more have been found beyond five degrees from caustics. Short waves preceding the main *PKIKP*-phase at distances between 125° and 140° probably have their deepest point in or near a transition zone between the liquid outer and the probably solid inner core and it is unlikely that they are related to the caustic of *PKP* near 145° although their travel-time curves end near this caustic. The observed range of long-period waves diffracted beyond the caustics of several phases is smaller than the maximum range calculated by Jeffreys.—*Author's summary*

175–54. Gutenberg, B[eno]. Wave velocities in the earth's core: Seismol. Soc. America Bull., v. 48, no. 4, p. 301–314, 1958.

More than 700 seismograms of 39 shocks recorded mainly in southern California at epicentral distances between 105 and 140 degrees are used to investigate records of phases which have penetrated the earth's core. Properties of *PKIKP*, *SKP*, *SKIKP*, *PKS*, and *PKIKS* are discussed. Portions of travel-time curves of these phases are revised. Travel times of waves starting and ending at the surface of the core, and wave velocities in the core, are recalculated. Between about 1,500 and 1,200 km from the earth's center in the transition zone from the liquid outer to the probably solid inner core, waves having lengths of the order of 10 km travel faster than longer waves. This is probably caused by a rather rapid increase in viscosity toward the earth's center in this transition zone.—*Author's abstract*

175–55. Jeffreys, Harold. On the interpretation of *Pd:* Royal Astron. Soc. Geophys. Jour., v. 1, no. 3, p. 191–197, 1958.

Lehmann's observations of a large phase about 21°, lying a few seconds after the first arrival *Pr*, are discussed on two extreme hypotheses. On the first the distance varies as a quadratic function of sin e, so that $d\Delta/de$ vanishes at 21°, where there is a cusp in the time curve. The values of dt/Δ for *Pr* and *Pd* are found to be such that there is no possible position for the nearer cusp. On the second, a cubic form for t is assumed up to 21° for *Pd*. *Pr* must enter between 17° and 18°. The *Pd* ray emerging at 21° must reach about 0.03 R below the Mohorovičić discontinuity. The times of *Pr* imply that at the transition there must be a considerable discontinuity of velocity gradient but only a small one of velocity. The nearer cusp would be near 15°, but as it lies less than a second after the first arrival it is probably undetectable.—*Author's summary*

175–56. Aki, K[eiiti], Tsujiura, M., Hori, M., and Goto, K. Spectral study of near earthquake waves (1): Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 2, p. 71–98, 1958.

A tripartite system of seisometers with spacing of about 100 to 150 meters is used in determining magnitudes of velocities and their azimuths (but not polarities) of prominent waves of limited portions of near earthquake records by a spectral analysis of these portions. Assuming the waves within the frequency range and record interval studied to be stationary in space and time, the correla-

tion coefficient, over the record intervals examined, between the records at two stations, for a particular frequency f_o is $\rho\ (r, f_o) = cos\left(2\pi\frac{rf_o}{v}\right) = \cos\left(2\pi\frac{f_o}{f^*}\right)$ if the direction of the wave is parallel to the line joining the stations, and the distance between station is r. Evidently if the record interval is filtered for f_o and $f_o = f^*$, the maximum correlation should be found. Formulas analogous to the above are presented for a wave composed of partial waves having different velocities and amplitudes, and for a wave approaching the net at an arbitrary azimuthal angle. For the latter wave, determination of f^*_{12}, f^*_{23}, and f^*_{13} from a spectral filtering and correlation of the records permits the determination of the magnitude of the wave velocity and its azimuthal angle. In this method, the three apparent velocities between stations are determined independently of one another, and it is possible, for example, to detect two waves approaching at different angles. Choice of span length for the net can be determined from $\frac{r\,\Delta f}{v} = 1$, where Δf is the frequency range examined.

Examples of correlation of limited portions of records of near earthquakes are presented.—*P. E. B.*

175–57. Takeuchi, Hitoshi. On the torsional oscillation of the earth [in Japanese with English summary]: Zisin, ser. 2, v. 11, no. 2, p. 68–75, 1958.

A method is given to calculate torsional frequencies of an elastic sphere of variable density and elasticity; then the period of fundamental torsional oscillation of the earth is shown to be 43.4 minutes. The phase velocity of the corresponding surface wave has a miximum value 6.90 km per sec for a wave length of about 10,000 [sic] km. The decrease of phase velocity for longer wave lengths may be due to the presence of the earth's core at a depth of 2,900 km.—*D. B. V.*

175–58. Jobert, Nelly. Sur une application du principe de Rayleigh à la dispersion des ondes de Love de grande période (ondes *G*) [On an application of the Rayleigh principle to the dispersion of large period Love waves (G waves)]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 16, p. 1222–1224, 1958.

A method based on the Rayleigh principle is used to calculate the phase velocity of large-period Love waves at the surface of the earth. Phase velocities as a function of wave length A are tabulated. The group velocity deduced from the curve calculated for Bullen's model A is 4.45 kmps for 533 km $< A <$ 1,200 km (if the period is 110 sec $< T <$ 223 sec), in good agreement with experimental results concerning the *G* wave.—*D. B. V.*

175–59. Oliver, Jack, and Ewing, Maurice. The effect of surficial sedimentary layers on continental surface waves: Seismol. Soc. Am. Bull., v. 48, no. 4, p. 339–354, 1958.

Surface waves in the ½-second to 12-second period range, recorded at several stations in eastern North America from the eastern Tennessee shock of June 23, 1957, are the bases for several deductions concerning the effect of sedimentary layers on continental surface wave propagation. These are: (1) The velocities of surface waves of the fundamental Love and Rayleigh modes having periods less than about 10 seconds may be strongly affected by sedimentary layers of average thickness. The decrease in velocity accounts, at least in part, for the prolongation of surface-wave trains in this period range when sedimentary layers of appreciable thickness have been traversed. (2) Higher-mode propagation for

both types of surface waves is a possible explanation for the velocities, frequencies, and amplitudes of the phase *Sg* at moderate epicentral distances, and of its long-distance counterpart the high-frequency component of *Lg*. The lower-frequency components of *Lg* have been explained previously by other aspects of normal-mode propagation in the crust. (3) Study of dispersion of short-period surface waves can result in fairly detailed knowledge of velocity-depth relation within the sedimentary column and may also reveal information on anisotropy. (4) The results of this study must bear heavily on studies of microseism propagation. As an example, the increase of microseismic activity along the entire east coast of the United States when a storm moves onto the continental shelf may be attributed to channeling of the waves in the deep sedimentary trough beneath the shelf.—*Authors' abstract*

175–60. Lehmann, I[nge]. On *Lg* as read in North American records: Annali Geofisica, v. 10, no. 1–2, p. 1–18, 1957.

The period of *Lg* is usually from 0.5 to 6 sec., and well-determined velocities of North American *Lg* are between 3.5 and 3.6 kmps. *Lg* appears as a wave with inverse dispersion preceding or riding on Love waves of longer period. The nature of *Lg* as recorded at various stations in America for a number of earthquakes is discussed in detail. In normal shocks the phase was usually found to be clearly present. København *Lg*'s in general are less conspicuous than those recorded in North America. The periods of the North American *Lg*'s studied were mostly from about 0.5 to 3 sec, whereas København *Lg*'s are mostly in the period range 4–6 sec. This difference is not of instrumental origin. København *Lg* velocities were usually found to be smaller than North American velocities. *Lg* may possibly be *S* waves reflected at the surface of the earth and refracted at some depth in the crust.—*P. E. B.*

175–61. Utsu, T[okuji]. On the *Lg* phase of seismic wave observed in Japan (1) (in Japanese with English summary): Quart. Jour. Seismology, v. 23, no. 2, p. 7–22, 1958.

The short period seismic surface wave phase *Lg*, velocity about 3.5 kmps was recorded at Nagasaki on a seismogram of the Siberian earthquake of January 5, 1958. Since then this phase has appeared at Nagasaki on seismograms of shallow earthquakes in Siberia, Outer Mongolia, and China. A study of records from 20 other stations in Japan made it clear that this phase is recorded only in Kyushu and occasionally in Hokkaido. Since the *Lg* phase travels only on a continental path, it is clear that the crustal structure under the Yellow Sea and northern East China Sea is continental whereas the structure under the central Japan Sea is not.—*V. S. N.*

175–62. Sato, Ryōsuke. On the determination of crustal structure by the dispersion curves of surface waves (I) [in Japanese with English abstract]: Zisin, ser. 2, v. 11, no. 2, p. 76–86, 1958.

Discusses the adequacy of present procedures for determining crustal structure from observations of the dispersion of Love and Rayleigh waves.—*V. S. N.*

Demetrescu, Gheorghe. Attempt at the determination of the thicknesses of the layers of the earth's crust. See Geophys. Abs. 175–249.

175–63. Popov, T. T. Korotkoperiodnyy vertical'nyy seysmograph s magnitnoy vozrashchayushchey siloy [A short-period vertical seismograph with magnetic restoring force]: Akad. Nauk SSSR Izv. Ser. geofiz, no. 6, p. 783–786, 1958.

A description is given of a new type of short-period vertical seismograph with a magnetic restoring force. A magnetized mass m moves on a vertical guide line under the action of gravity and the force exercised by the magnet M placed slightly off the line of motion of the mass m. The vertical component of the restoring force $f_1=B \sin^2 \phi \cos \phi$, where B is a constant of the instrument and ϕ is the angle between direction of the restoring force and the vertical. This restoring force increases from the equilibrium point to a maximum, then decreases and even changes its sign. This stops the operation of the seismograph. For sufficiently small amplitudes of vibration it operates with great amplification. The degree of damping and the amplification of the seismograph can be varied over a wide range.

An experimental model of this seismograph was built and tested on the shaking table of the seismometric laboratory of the Institute of the Physics of the Earth; it proved to be a reliable and sturdy instrument, especially suitable for strong earthquakes.—*S. T. V.*

175–64. Hagiwara, Takahiro. A note on the theory of the electromagnetic seismograph: Tokyo Univ. Earthquake Research Inst. Bull., v. 36, pt. 2, p. 139–164, 1958.

The expressions for the theory of the electromagnetic seismograph are derived "in a more convenient form for practical use."

The expression for the coupling factor, expressing the magnitude of the reaction of the galvanometer on the seismometer is independent of the inertia of the pendulum and galvanometer, but depends on the damping constants and constants of the electrical circuit.

Numerical calculation of the period response for various values of the coupling factor and damping constants of transducer and galvanometer are presented.—*P. E. B.*

175–65. Tucker, M. J. An electronic feedback seismograph: Jour. Sci. Instruments, v. 35, no. 5, p. 167–171, 1958.

The seismograph described has a nearly uniform response to ground oscillations whose periods lie between 1.5 sec and 12 sec, which is the range of particular interest for research on microseisms generated by sea waves. The seismograph consists of a 1-sec pendulum which measures ground acceleration over the range of frequencies of interest, and an electronic circuit performing double integration to give a signal proportional to ground displacement. The 1-sec pendulum has negative feedback which allows simple damping arrangements and easy absolute calibration, as well as improving stability and linearity. A horizontal-component instrument has been built, but the principle should be equally applicable to measuring the vertical component.—*Author's abstract.*

175–66. Mathey, Raymond, and Rocard, Yves. Performances de séismographes à forte amplification [Performances of seismographs with strong amplification]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 20, p. 1764–1766, 1958.

Vertical and horizontal seismographs with easily determinable period and an amplification of one million have been constructed and operated in France. Some

results of their performance are outlined. In addition to the usual microseisms of 4 to 5 sec periods, an apparently irreducible residual background movement of 10 to 20×10^{-8} cm with a period of about one second was observed. Vibrations caused by human activity were such that even 30 km from Paris at the calmest times of night, amplification above 200,000 could not be used. At two stations in Orne, quarry explosions of 10 to 30 kg of dynamite 75 km away were recorded readily, and signals were picked up from an explosion of several tons 800 km away over an unfavorable microseism background. The underground atomic test in Nevada, 8,550 km away, gave a strong signal. Large earthquakes completely "saturated" the instruments, but many small near earthquakes that usually escape ordinary seismographs gave records of good quality. Special filters are necessary to screen out the effects of certain parisite currents in the electronic circuit.—*D. B. V.*

175–67. Petkov, I. N. Desvoltarea seismologiei bulgare [Development of seismology in Bulgaria]: Acad. RPR, Studii şi cercetări astron. şi seismol., v. 1, no. 1, p. 135–144, 1956.

An outline of seismological studies in Bulgaria from 1892 to 1955 is given. The only seismic station in Bulgaria, in Sofia, was equipped with two 10-kg Omori-Bosch seismographs, to which a 1,000-kg Wiechert and a 100-kg Krumbach seismograph were added in 1936 and 1942 respectively. The latest acquisition of the station was a set of two horizontal and one vertical Krumbach seismographs. The microseismic bulletin has been published continuously for 65 years, isoseismal maps have been made for more than 300 strong earthquakes, and 230 earthquake foci have been determined, the deepest of which was 50 km.

The seismic activity and characteristics of the different seismic zones of the country are reviewed. (See also Geophys. Abs. 173–22).—*A. J. S.*

175–68. Mügge, R. Das Grundwasser als geophysikalischer Indikator [The ground water as a geophysical indicator]: Zeitschr. Geophysik, v. 20, no. 2, p. 65–74, 1954.

Fluctuations of ground water level are affected by other geophysical factors besides atmospheric pressure; they may also reflect earthquakes and lunar and solar tides. (See also Geophys. Abs. 163–112 and 164–54).—*D. B. V.*

EARTH TIDES AND RELATED PHENOMENA

175–69. Jobert, Georges. Influence du relief sur les déformations de la Terre dues à des charges superficielles [Effect of the relief on the deformations of the earth due to superficial loads]: Acad. Sci. Paris Comptes Rendus, v. 239, no. 23, p. 1653–1655, 1954.

The effect of ocean tides on earth tides is calculated more accurately than by the Boussinesq method, by introducing superficial relief and by assuming a core that is infinitely rigid or hollow.—*D. B. V.*

175–70. Pícha, Jan, and Skalský, Lumír. Beitrag zum Studium des Nullpunktsganges der Horizontalpendel [Contribution to the study of the zero point drift of the horizontal pendulum]: Československá Akad. Věd Studia Geophys. et Geod., v. 2, no. 3, p. 243–260, 1958.

The zero point drift of the horizontal pendulum at the Březové Hory earth tide station shows periodic annual and semiannual components. At a depth of 1,000 m below the earth's surface, the former has an amplitude of the order of

1 or 2 sec and is undoubtedly related to seasonal temperature changes. It is remarkable that the stresses produced by temperature changes are still felt so deep. The semiannual component has a smaller amplitude; its period is apparently about 6.5 to 7 months rather than the supposed 182.5 days. A 20-year period is also deduced from the course of the linear components. The existence of others, such as a 3-month component, is not impossible.—*D. B. V.*

175–71. Jeffreys, Harold. The damping of the variation of latitude: Royal Astron. Soc. Monthly Notices, v. 116, no. 4, p. 362–364, 1956.

Bondi and Gold [see Geophys. Abs. 173–114] have pointed out a mistake in an estimate of the viscosity of the Earth's core based on the damping of the 14-monthly variation of latitude. The full force of this criticism is diminished when account is taken of a second serious mistake, and correction of this leads to the conclusion that the damping might just be due to dissipation in the core, but for other reasons it cannot be due to viscosity there. The damping could be due to elasto-viscosity in the shell at depths greater than 700 km, in which case the viscosity would be about 10^{20} cgs units, or to elastic afterworking. In the latter case a wide range of parameters in the laws is permissible.—*Author's summary*

175–72. Walker, A. M., and Young, Andrew. The analysis of observations of the variation in latitude: Royal Astron. Soc. Monthly Notices, v. 115, no. 4, p. 443–459, 1955.

A statistical model of the variation of latitude is formulated and a detailed analysis of its properties is made. Difficulties arising from the necessity to account for observational errors are discussed.

The computational procedure is obtained and applied to a 35-year series of observations in which the z-term has not been taken into account. It is found that the damping factor is $\kappa=0.322\pm0.103$ year^{-1}, giving a relaxation time of about 3.1 years; and the free period is $2\pi/\gamma=1.267\pm0.039$ years$=462.8\pm14.2$ mean solar days. The value of κ is several times that of the only previous determinations, and the free period is longer than has hitherto been determined.

These results are provisional pending the completion of full numerical analysis.—*Authors' summary*

175–73. Walker, A. M., and Young, Andrew. Further results on the analysis of the variation of latitude: Royal Astron. Soc. Monthly Notices, v. 117, no. 2, p. 119–141, 1957.

This paper gives much more detailed results and examines some points raised in the previous paper (see Geophys. Abs. 175–72). It is found that best results are those derived from the unsmoothed series of values given monthly by the International Service. Estimates are biased; qualitatively, the bias is consistent with the hypotheses that the data are inhomogeneous and that autocorrelation exists in the series of disturbances. The period of free motion may be taken to be 435.8 mean solar days. The bias is fatal for accurate estimation of the damping factor, for which however there is some evidence suggesting that the relaxation time is between about 10 and 30 yrs.—*D. B. V.*

175–74. Jeffreys, Harold, and Vicente, R. O. The theory of nutation and the variation of latitude: Royal Astron. Soc. Monthly Notices, v. 117, no. 2, p. 142–161, 1957.

The theory of bodily tide and of the various nutations is developed. Elasticity of the shell and fluidity of the core are taken into account. The model used for the shell is Takeuchi's Model 2, based on one of Bullen's. The core is replaced by a homogeneous incompressible fluid, with an additional particle at the centre chosen to make the mass and moment of inertia of the core correct. Effects of the ocean are neglected, but can be allowed for at a later stage.

The period of free nutation is found to be 392 days (which would be increased by the ocean). The bodily tide numbers for semidiurnal and long-period tides are: h=0.58, k=0.29, l=0.082. They have other values for diurnal tides, the greatest observable differences from the statical values being for the lunar tide 0. The correcting factor for the 19-yearly nutation is 0.9964.—*Authors' summary*

175–75. Jeffreys, Harold, and Vicente, R. O. The theory of nutation and the variation of latitude: the Roche model core: Royal Astron. Soc. Monthly Notices, v. 117, no. 2, p. 162–173, 1957.

The theory given in a previous paper (see Geophys. Abs. 175–74) is modified by the use of a core with the density a quadratic function of the radius, the variation of density being wholly due to pressure. Three pairs of cubic terms are introduced into the displacements. The period of the Eulerian nutation would be 395 days, and the amplitude of the 19-yearly nutation would be multiplied by a factor of 0.9975. Allowance for the effect of the ocean would increase the former period to about 430 days, and in both respects there is now tolerable agreement with observations. Correcting factors are given for the other principal nutations. Those for the fortnightly nutation do not differ much from those for the central particle model. There are substantial changes for the semiannual nutations, owing to changes in free periods that occur in their neighborhoods. The 19-yearly nutation in longitude remains anomalous.—*Authors' summary*

ELASTICITY

175–76. Steketee, J. A. Some geophysical applications of the elasticity theory of dislocations: Canadian Jour. Physics, v. 36, no. 9, p. 1168–1198, 1958.

The geophysical significance of the elasticity theory of dislocations is discussed for the case of static equilibrium and with assumptions for the classical theory of elasticity. The displacement component and various types of strain nuclei, together with dynamical nuclei of Love, are introduced for discussion of seismological models of earthquakes. The equivalence of static nuclei types B and D is proved. The displacement and stress fields of a Griffith crack is computed to show that the crack may be considered as a special type of dislocation. Properties of B and C strain nuclei are investigated; it is found that the equilibrium state of slip fault is due to static B nuclei, while it is improbable that it is due to static C nuclei. A discussion of the experiments of Press is given in terms of the results of statical dislocation theory. The strain energy of the dislocation is discussed and the fundamental theorem of Colonnetti is proved. Finally, the displacement field at the surface of a semi-infinite medium containing a buried B nucleus is discussed, together with general remarks on the theory of dislocations.—*L. P.*

175–77. Ivakin, B. N. Mikrostruktura i makrostruktura uprugikh voln v odnomernykh nepreryvnykh neodnorodnykh sredakh [The micro- and macrostructures of elastic waves in unidimensional infinite heterogeneous media]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 39(166), p. 1–92, 1958.

The microstructure of elastic waves in a heterogenous medium comprises the wave characteristics determined on bases that are infinitely small or comparable to the wave length in the medium (velocity, amplitude variation); by macrostructure of waves in a heterogeneous medium is understood the characteristics determined on bases greater (or very much greater) than the wave length. The problems analyzed illustrate the limits of applicability of the principles of geometric seismics, and also present the complete wave picture in the commonest unidimensional media: the cases of one boundary plane, of two boundary planes, and of periodically repeated strata.

The problems of the properties of waves propagating under these conditions can be solved by the methods of the well-developed theory of "four poles" and of conducting lines, often applied in electrotechnics, especially in the theory of electrical communications. An analogous theory is developed for the propagation of mechanical (elastic) waves along an infinite wave-guide (mechanical line). Two fundamental ideas characterizing the wave-guide are introduced, the differential constant of the wave-guide and its integral constant.

By an elastic wave is meant the synphasal combination of a pressure wave T and a displacement wave V, producing an intensity wave $Q=V.T$. These two waves behave oppositely if the differential velocity of propagation of either of these waves increases while the velocity of the other decreases and vice versa.

The treatment of the problems on the propagation of waves in wave-guides is presented, using the operational methods of analysis, so that solutions can be obtained for the transient period. This is the great advantage of the method.—*S. T. V.*

175–78. Gassmann, Fritz. Ueber Herde elastischer Wellen in isotropen homogenen Medien [On foci of elastic waves in isotropic homogeneous media]: Geofisica Pura e Appl., v. 40, p. 55–77, 1958; reprinted as, Eidgenoss, Tech. Hochschule Zürich, Inst. Geophysik Mitt., no. 34, 24 p., 1958.

1) Multiplets as solutions of the scalar wave equation $\partial^2 f/\partial t^2 - c^2$ div grad $f=0$ are considered. Such solutions can be obtained either directly by aid of spherical harmonics of order n, or by differentiating the single pole $f=1/p\ F(t-p/c)$ with respect to n directions. The relations between the results of those two procedures are shown.—2) In the case of small elastic displacements $\vec{s}$, the density of energy and the flow of energy through spherical surfaces are expressed by spherical coordinates.—3) Multiplets which satisfy the equation of motion $\vec{s}=a^2$ grad div $\vec{s}-b^2$ curl curl $\vec{s}=0$ and the equation curl $\vec{s}=0$ are given, and expressions for the density and flow of energy are found.—4) The same is done with multiplets satisfying the equation of motion and the equation div $\vec{s}=0$.—5) General multiplets which satisfy the equation of motion are treated. As special cases, multiplets with excitation of finite length and multiplets with periodic excitation are considered, furthermore solutions of the equation of motion and of the equations curl $\vec{s}=0$ and div $\vec{s}=0$ are given.—6) It is shown how elastic waves whose origin is a region of finite extension in the sense given

by Stokes, can be approximated by elastic multiplets.—7) Some indications are given on the problem of how to find the functions of excitation and the energy of an elastic multiplet by measuring components of $\vec{s}$ or $\vec{s}$ etc., at points in the interior of the medium. The same problem is considered in the case of the single elastic pole. $\vec{s}=grad\ 1/p\ F\ (t-p/a)$, if the measurements are made at the surface of an elastic half space.—*Author's English summary*

175–79. Helbig, Klaus. Elastische Wellen in anisotropen Medien, Teil I [Elastic waves in anisotropic media, part 1]: Gerlands Beitr. Geophysik, v. 67, no. 3, p. 177–211, 1958.

A mathematical treatment of the propagation of elastic waves in anisotropic media. In this first part it is shown that nearly all problems connected with elastic wave propagation under anisotropic conditions can be handled by means of three "characteristic surfaces", the wave surface, normal surface, and index surface. These characteristic surfaces are calculated as functions of the elastic constants, with particular attention to media having axial symmetry.—*D. B. V.*

175–80. Tesser [Teisseyre], R[oman] K. Seysmicheskiye volny v ideal'nykh volnovodakh, izluchayemyye tochechnym istochnikom [Seismic waves in ideal wave-guides, emitted by a point source]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 6, p. 67–70, 1957.

An English version of this paper has been published in Acta Geophys. Polonica, v. 5, no. 2, 1957 (see Geophys. Abs. 173–120).—*A. J. S.*

175–81. Babich, V. M., and Alekseyev, A. S. O luchevom metode vychisleniya intensivnosti volnovykh frontov [On the beam method of evaluating the intensity of wave fronts]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 17–31, 1958.

The dynamic theory of elasticity is presented. Following the beam method of Hadamard in geometric optics, generalized curvilinear coordinates are introduced; the wave front is chosen as the first axis and the beam perpendicular to the lines of wave fronts following the trajectory of a point on it is chosen as the other coordinate axis. The method is applied to the problem of calculating the intensity of nonsteady elastic waves propagating in a heterogeneous medium. The basic formulas are derived and their solution given. The treatment is analytical, similar to the method of conjugated function frequently used in the determination of stress and strain in the theory of elasticity as well as in the analysis of electrostatic fields and in aerodynamics.—*S. T. V.*

175–82. Filippov, A. F. O priblizhennom vychislenii otrazhennykh i prelomlennykh voln [An approximate evaluation of reflected and refracted waves]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 841–854, 1957.

For an approximate method of calculating the amplitudes of reflected and refracted waves for the case when both elastic media are homogeneous and isotropic, when the angle of incidence is less than the critical angle, and the reflected waves do not intersect within the region in question, the following rules may be used: at the point of incidence the amplitude of the reflected wave is approximately equal to the amplitude of the incident wave multiplied by the

same coefficient of reflection as in the case of a plane boundary and plane wave, and multiplied by the square root of the ratio of the radii of curvature of the reflected wave front at the point of reflection and at the point of observation. Refracted waves can be computed in an analogous manner. In three-dimensional problems it is necessary to take the product of the principal radii of curvature of the wave front surface instead of the radius of curvature.

If the incident wave is produced by an impulse, the above procedure will be accurate only if the duration of the impulse multiplied by the wave velocity is smaller than the smallest of the radii of curvature of all waves under consideration. These radii should be taken into account not only at the instant of observation but at the instant of reflection as well. For other waves the method is applicable only for a zone of the wave near its front.—*S. T. V.*

175–83. Kaufman, R. N. Funktsiya i tensory Grina nekotorykh krayevykh zadach teorii potentsiala i staticheskoy teorii uprugosti dlya sloya i poluprostranstva s sharovoy ploskost'yu [Green's functions and tensors of some boundary problems in potential and static elasticity theory for a layer and half-space having a spherical cavity]: Akad. Nauk Beloruss. SSR Inzh.-Fiz. Zhur., no. 7, p. 72–83, 1958.

Green's function for Dirichlet's problem of potential theory and Green's tensors are constructed by the method given by Kaufman earlier for the boundary value problems $\sigma_{zz}=f_1(P)$, $\sigma_{zy}=f_2(P)$, $U_z=\varphi(P)$ or $\sigma_{zz}=f(P)$, $U=\varphi_1(P)$, $U_y=\varphi_2(P)$, where σ_{zz}, σ_{zy}, σ_{zz} are the components of the stress tensor, U is the displacement vector sought, and P is a point on the plane. A development of the mirror method was applied, and the summation theorem for Legendre polynomials used in the construction of the function. Green's functions are found in the form of a series of solutions of corresponding equations, and the coefficients for the series are determined from an infinite system of equations derived in the paper. The method makes the boundary conditions of the potential theory and the static theory of elasticity more general, and applicable for a greater variety of problems.—*A. J. S.*

175–84. Caloi, Pietro. Dispersione delle onde sismiche nell'ambito delle altissime frequenze [Dispersion of seismic waves in the very high frequency range]: Accad. Naz. Lincei Atti, Cl. Sci. fis., mat. e nat. Rend., v. 24, no. 3, p. 239–246, 1958.

Substantially the same paper as that published in Annali di Geofisica v. 10, no. 3–4, p. 193–208, 1957 (see Geophys. Abs. 174–326), showing that in seismic waves as well as in the field of X-rays and optics, dispersion is intimately related to absorption.—*D. B. V.*

175–85. Knopoff, Leon, and MacDonald, Gordon J. F. Attenuation of small amplitude stress waves in solids: Rev. Modern Physics, v. 30, no. 4, p. 1178–1192, 1958.

Mathematical analysis of the attenuation of stress waves in solids leads to the conclusion that the dissipative characteristics of many solids cannot be accounted for by any linear mechanism of attenuation. One particular model which is explored in detail involves a nonlinear hysteresis loop resulting from a nonrecoverable deformation at small stresses; this model is by no means unique and other models involving some frictional dissipation could also account for the observations. In particular, Förtsch suggests Coulomb friction as a

mechanism for attenuation (see Geophys. Abs. 174–76); Förtsch's description however allows for no variation in the relative absorptions for compression and shear wave with choice of material.

The detailed specification of the dissipative mechanism will require observations other than the dependence of attenuation on frequency. The fact that a single crystal of a given material has a lower dissipation than an aggregate suggests that a mechanism depending on surface area is important, possibly a frictional mechanism involving movement of one surface past another.—*D. B. V.*

175–86. Mitra, M. Note on a type of surface waves traveling in a semi-infinite solid of varying elasticity and density: Seismol. Soc. America Bull., v. 48, no. 4, p. 399–402, 1958.

The propagation of a type of waves similar to Love waves in a homogeneous semi-infinite medium with a single surface layer in which the density ρ and the coefficient of rigidity μ vary exponentially with depth is considered. The period equation is solved numerically for the first mode only, and the results are compared with Jeffreys' values for Love waves. There are no marked differences, although it has been assumed here that the values of μ and ρ at the bottom of the layer are more than double those at the top, whereas Jeffreys assumed them to be constant throughout the layer.—*D. B. V.*

175–87. Lockett, F. J. Effect of thermal properties of a solid on the velocity of Rayleigh waves: Jour. Mechanics and Physics of Solids, v. 7, no. 1, p. 71–75, 1958.

This note is concerned with the propagation of Rayleigh waves in an isotropic thermoelastic solid. It is found that, within the frequency range normally attainable, the velocity of propagation of these waves can be determined from the classical equation merely by replacing the parameter $\beta^2=(\lambda+2\mu)/\mu$ occurring in that equation by $(1+\epsilon)\beta^2$, where $\epsilon=\gamma^2 v_P^2 T(1+\nu)^2/c(1-\nu)^2$ where γ is the coefficient of linear expansion, v_P is the velocity of purely elastic longitudinal waves in the solid, T is the absolute temperature of the solid in its reference state of uniformly zero stress and strain, c is the specific heat at constant strain and ν is Poisson's ratio. A typical case is examined numerically and it is found that taking into account the thermal properties of the solid produces a difference of less than one per cent in the velocity and amplitude of the Rayleigh waves.—*Author's summary*

175–88. Rizničenko, Ju. V. [Riznichenko, Yu. V.] Anwendung des Ultraschalls in seismischen Fragen [Application of ultra-acoustics in seismic questions]: Československá Akad. Věd Studia Geophys. et Geod., v. 2, no. 3, p. 231–242, 1958.

This is a review of the application of ultrasonic techniques in seismic research. Elastic impulses having frequencies of 10 kilocycles or more can produce in solid bodies all the types of elastic waves known in seismology. Ultrasonic investigations of elastic wave propagation by means of model studies or by measurements on rock samples throw light on seismological studies of the earth's structure, and investigations of the processes leading to rock fracturing under stress are connected with studies of earthquake mechanism. Research projects along these lines currently being conducted in the laboratory or in mines by the Institut Fiziki Zemli (institute of the physics of the earth) of the Soviet Academy of Sciences are described briefly.—*D. B. V.*

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175–89. Khalevin, N. I. K voprosu ob izmerenii skorostey uprugikh voln v usloviyakh yestestvennogo zaleganiya gornykh porod [On the question of measurements of the velocity of elastic waves in conditions of natural occurrence of rocks]: Akad. Nauk SSSR Ural. Filial, Gorno-geol. Inst. Trudy no. 30, geofiz. Sbornik, no. 2, p. 133–141, 1957.

A description is given of a convenient portable setup for field determination of the velocities of elastic waves propagated over the surface of rocks in outcrop. The source of elastic waves is a body weighing some 2 to 5 kg, freely falling from a height of 0.5 to 2.0 m. The receiver uses two piezo-electric crystals (Seignette's salt) which transform the shocks into electrical pulses. The amplifier has a maximum coefficient of amplification of 1×10^5. The results of measurements in the Mesozoic and Cenozoic deposits and in the basement are given. The values obtained for longitudinal wave velocities in the granitoid complex can be considered fully reliable; Rayleigh waves were determined with lesser accuracy. It was found that the character of the surface waves, and supposedly of longitudinal waves also, is much affected by the conditions of the excitation of the waves. Knowing the longitudinal wave velocity and the density of the granite-gneiss complex, it was possible to determine the Young's modulus, the shear-modulus, and the Poisson coefficient in cases where a transverse wave (velocity 2.70 kmps) appears. The values obtained agree well with possible values obtained by other means.—*S. T. V.*

175–90. Nakamura, Yosio. Measurement of elastic wave velocity in polycrystalline tin, especially in the vicinity of its melting point: Tōhoku Univ. Sci. Repts., ser. 5, v. 10, no. 1, p. 28–35, 1958.

As a preliminary approach to the measurement of rocks and rock-forming minerals, the longitudinal wave velocity was measured in polycrystalline tin from room temperature up to 232° C (20° above the melting point), under ordinary pressure, using the ultrasonic pulse technique. The velocity decreased gradually with temperature up to the melting point, and became 27 percent smaller in the liquid state, with a discontinuous decrease at the melting point. No trace of a wave could be indentified during the melting process.—*D. B. V.*

175–91. Volarovich, M. P., and Stakhovskaya, F. I. Issledovaniye modulya Yunga obraztsov gornykh porod pri vsestoronnikh davleniyakh do 5,000 kg/cm² metodom izgiba [An investigation of Young's modulus of rock samples under hydrostatic pressures up to 5,000 kg per cm² by the bending method]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 582–592, 1958.

The Young's modulus of different rocks (basalt, gabbro, labradorite, syenite, marble, and sandstone) was measured by the static method at hydrostatic pressures ranging up to 5,000 kg per cm², which corresponds to a depth of 20 km in the earth's crust. The apparatus is described. Careful attention was given to exact measurement of the stresses applied and the deformation, using a dynamometer aand "deformometer" for the purpose. It was found that Young's modulus increases rapidly at pressures up to 1,000 kg per cm², less rapidly from there to 5,000 kg per cm². If the specimens were coated with copper foil their Young's modulus was increased 30 to 70 percent; this is explained as the effect of closing of the pores. The results are presented in numerous graphs and a table.—*S. T. V.*

175–92. Busby, J., and Richardson, E. G. The absorption of sound in sediments: Geophysics, v. 22, no. 4, p. 821–828, 1957.

The ultrasonic absorption in the range 0.5 to 3.0 megacycles per sec was measured for compacted water-immersed sediments, and for artificial sediments of glass spheres and marine sands of varying concentrations and particle size. The absorption was determined by measuring the attenuation of an ultrasonic wave train as a function of the acoustic path length. It is concluded that taking the mean diameter of irregular particles in a natural sand leads to a result in agreement with that for spheres of this diameter, and that for measurements in sediments composed of glass spheres, the relationship between attenuation (α) and frequency (f) is approximately $\alpha=kf^4$; however, this law is not obeyed in all of the natural sands so far examined.—*L. P.*

175–93. Matveyev, A. K., and Martyanov, Ye. G. Zavisimost' skorosti ul'trazvuka v iskopayemykh uglyakh ot stepeni ikh metamorfizma [The dependence of ultrasonic velocity in coals on their degree of metamorphism]: Akad. Nauk SSSR Doklady, v. 122, no. 3, p. 459–461, 1958.

Measurements of ultrasonic wave velocities in lignite, bituminous, and anthracite coals show that velocities differ mainly as a function of rank. Anisotropy is shown by the fact that the velocities measured in the direction parallel to the bedding are higher than those perpendicular to it; coals of intermediate rank (coking coals) show least acoustic anisotropy.—*D. B. V.*

175–94. Balakrishna, S. Velocity of compressional waves in some Indian rocks: Am. Geophys. Union Trans., v. 39, no. 4, p. 711–712, 1958.

Longitudinal wave velocities determined in the laboratory for samples of Indian rocks (two granites, nine charnockites, three basalts, a marble, two limestones, and a sandstone) by direct measurement of propagation times are presented. In six cases the results are compared with measurements on the same rocks by the "wedge" method and method of "critical transmission." It is concluded that the two latter methods are unsuitable for coarse-grained rocks composed of highly anisotropic crystals.—*D. B. V.*

175–95. Balakrishna, S. Variation of compressional velocities in Indian rocks at low pressures: Current Sci., v. 27, no. 7, p. 251–252, 1958.

Longitudinal wave velocities have been measured in some Indian rocks (granite, Deccan trap, charnockite, limestone, sandstone, and marble) at atmospheric pressure, in a direction parallel to the compression. Results are given in a table showing rock type, locality, density, length in cm, traveltimes in microsec, velocity at low pressure, and velocity at 4,000 lb per in^2 as determined in earlier work. Velocities increase with pressure but there is considerable variation even within the low pressure region; in sandstone it is as much as 8 percent, attributed to the high porosity. See also Geophys. Abs. 175–94.—*D. B. V.*

175–96. Balakrishna, S. Ultrasonic velocities in rocks: some special features of Indian granites: Indian Acad. Sci. Proc., sec. A, v. 48, no. 2, p. 69–75, 1958.

Ultrasonic velocities in 16 Indian granites were measured by the total internal reflection method. The velocity in most Indian granites is of the order

of 6.2 kmps, relatively high compared with granites from other countries; this indicates greater compactness probably due to greater age. Transmission of sound also depends largely on the granular texture. A plot of longitudinal velocity against hydrostatic pressure on the sample shows that velocity increases rapidly with pressure at values to the order of 2,000 bars, then increases slowly at higher pressures. (See also Geophys. Abs. 172–55.)—*D. B. V.*

175–97. Vopilkin, A. A., Galushko, P. Ya., and Sollogub, V. B. Pro seysmichniy metod vimīryuvannya napruzhen' v tsilīkakh solyanikh shakht [A seismic method of measuring stresses in pillars of salt mines (in Ukrainian)]: Prykladna mekhanika, v. 3, no. 2, p. 229–232, 1957.

Experiments were made in the Solotvin salt mines in the Ukraine to establish a functional relationship between elastic wave velocity and the compressional stress in a salt pillar. In contrast to the relationship in sandstone and shale where the stress is directly proportional to the velocity, the stress in salt is inversely dependent on velocity. It was found that the velocity V_p, parallel to the compressive force, is more affected by stress than the velocity V_n, perpendicular to the compressive force. A formula has been derived to determine the stress in a salt pillar when V_n is known.—*A. J. S.*

175–98. Wright, J. K., Carpenter, E. W., Hunt, A. G., and Downhill, B. Observations of the explosion at Ripple Rock: Nature, v. 182, no. 4649, p. 1597–1598, 1958.

The explosion at Ripple Rock in Seymour Narrows on the west coast of Canada on April 5, 1958, was one of the world's largest manmade nonnuclear explosions, in which 1,400 tons of explosive were detonated in a series of tunnels honeycombing the rock. Among the teams observing the blast was one from the Atomic Weapons Research Establishment of Foulness, England, which made the close-in and air blast measurements reported here. Three types of seismic instruments were used, a ground velocity meter and Cambridge accelerometers at the surface, and variable-inductance accelerometers underground in shaft and tunnel. Air blast measurements were made with mechanical gages.

Peak accelerations in or out and up or down were fitted to an expression $A=3r^{-2.75}\times10^5$ g's (r is in feet), and agreed well with Lampson's estimates. Peak velocities were fitted to an expression $V=2r^{-1.2}\times10^3$ ft per sec and agreed well with unpublished estimates of the Atomic Weapons Research Establishment. The seismic velocity obtained for the local basalt was 15,000 ft per sec. Seismic energy was estimated as 7×10^{16} ergs, or about 2×10^{-3} of the available energy calculated on the basis of 4×10^{16} ergs per ton.

Air blast records clearly showed the effects of the 50 feet of rock and water covering the explosive in reducing the peak pressure. Origin time was estimated as 9:31:02.05±0.02 sec (PST).—*D. B. V.*

175–99. Oliver, Jack, and Ewing, Maurice. Seismic surface waves at Palisades from explosions in Nevada and the Marshall Islands: Natl. Acad. Sci. Proc., v. 44, no. 8, p. 780–785, 1958.

Surface waves were detected at Palisades, New Jersey, from nuclear explosions on or above the surface in the Marshall Islands (at a distance of 105°) and in Nevada (at a distance of 33°). Signals from both sites consist entirely of Rayleigh wave trains. The dispersive pattern may be explained by using dispersion curves developed in studies of earthquake-generated surface waves.

The small underground nuclear explosion was not detected at Palisades.—*D. B. V.*

175–100. Ritsema, A. R. On the seismic records of nuclear test explosions: Indonesia Madjalah Ilmu Alam, v. 113, p. 123–127, 1957; reprinted as, Indonesia Univ. Dept. Geology Contr. no. 30.

Origin times of the nuclear test series carried out by the United States in the Pacific in 1956 have been calculated by the Geophysical Institute at Djakarta, Indonesia, using data compiled in the international seismological bulletins published at Strasbourg. The times thus calculated are identical with those derived by Burke-Gaffney and others for the same series.

During the 1954 and 1956 test series, the *Z*-component seismograph at Lembang was the only instrument in Indonesia at which waves generated by these explosions could be expected. The first Bikini test was not recorded; records of the other Bikini tests are clear except for no. 7 (June 25, 1956), but neither of the Eniwetok tests showed any trace. In keeping with the explosion character of the initial disturbance, all direct waves recorded at Lembang started with a compression, and the dilatational motion following the first compression had the largest amplitude. No *S*-waves, surface waves, or channel waves were observed. The total absence of any reflected *P*-waves, such as *PP* or *PcP*, is remarkable. It is suggested that local crustal structure at the point of reflection for *PP* may cause interference phenomena that reduce *PP* wave energy to zero. Similarly, irregularities of the core boundary may cause extinction of *PcP*.—*D. B. V.*

Carder, Dean S., and Bailey, Leslie F. Seismic travel times from nuclear explosions. See Geophys. Abs. 175–246.

175–101. Dvořák, Arnošt. Poškození staveb v okolí komorových odstřelů [Damage to building constructions in the vicinity of chamber blasts]: Československá Akad. Věd Geofys. Ústav Práce, Geophys. Sborník, no. 67, p. 381–392, 1956 (1957).

Experimental study of the effect of underground blasts on building construction is described. The amplitude and frequency of oscillations produced in the ground and their effect on the buildings were observed for charges up to 35 tons. A relationship was established between the size of the charge and the periods of maximum amplitude. Observations on 30 houses at distances of 300 to 500 m from a blast of 5,600 kg showed that cracks formed in the walls of the houses. The cracks continued to increase during the following two years, thus indicating that a substantial tectonic disturbance was caused by the blast. Similar observations made on a river lock after 20, 17, and 10 ton blasts confirmed the results of previous experiments. Splitting the explosion by millisecond intervals of time is recommended to reduce the intensity of the shock.—*A. J. S.*

ELECTRICAL EXPLORATION

175–102. Lasfargues, Pierre. Prospection électrique par courants continus [Electrical exploration by means of direct currents]: Paris, Masson et Cie., 290 p., 1957.

This is one of a series of manuals on geophysical prospecting, covering the methods of potential mapping (equipotential line and potential profile) with both direct and alternating current, resistivity, potential-drop ratio, self-

potential, and induced polarization. For each, the theory, apparatus, and interpretation are discussed, and practical examples are given. Bibliography of 48 entries.—*D. B. V.*

175–103. Teisseyre, Roman K. New method of calculating three-layer curves for geoelectric methods: Acta Geophys. Polonica, v. 6, no. 2, p. 97–104, 1958.

The expression for the potential function for the case of a three-layered earth is given in terms of Roman's function $W(Q,a)$ (see Geophys. Abs. 31–476). It is further shown that the parameter Q is in general a complex quantity, while maintaining the condition of convergence $|Q| \leq 1$. The calculation of the function $W(Q,a)$ for complex values considerably extends the possibility of calculating electric curves without the tedious and time-consuming computations so far necessary. The method can be extended to systems of four layers or more.—*D. B. V.*

175–104. Tikhonov, A. N., and Skugarevskaya, O. A. Ob interpretatsii protsessa stanovleniya elektricheskogo polya v sloistykh sredakh [On the interpretation of the transient process of the build-up of an electrical field in stratified media]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 358–362, 1958.

In continuation of previous studies (see Geophys. Abs. 142–12271 and 148–13473, –13476) a method is presented for computing master charts for interpreting transient processes in layered media. The charts are constructed by a procedure similar to that used for curves of the stationary field, with the values of $\overline{E}_x = \rho_k/\rho_1$, as abscissa ($\rho_k$=apparent specific resistivity between electrodes, ρ_1=specific resistivity of the upper layer, in ohm-m) and $L=r/h_1$, as ordinate (r=distance between feeding and measuring dipoles, h=thickness of upper layer in km). During the transient period $\overline{E}_x$ is determined not only by the geoelectric profile and distance from the source producing the field, but also by the time. The unit of time used is $\tau = t/t_0$ (where $t_0 = 0.314\ h_1^2/\rho_1$). Cures are computed for two-layer and three-layer cases assuming that the bottom layers lie on a medium of infinite resistivity.

A second method of constructing the curves is also given, in which $\overline{E}_x$ is plotted against τ ($\tau = \tau/L^2 = t\rho_1/0.314\ r^2$).

To interpret an experimental curve it is necessary to bring it into agreement with the best-fitting theoretical curve. From the superposition of the curves and the shifting of the axes of the coordinate systems, ρ_1 and h_1 can be determined, and knowing these, ρ_i and h_i can be calculated.—*S. T. V.*

175–105. Mooney, Harold M. A qualitative approach to electrical resistivity interpretation: Geofisica Pura e Appl., v. 40, p. 164–171, 1958.

A qualitative analysis of the formula for apparent resistivity for the Wenner electrode array is made in terms of electrical processes. It is shown to depend on geologic structure through two factors: distribution of current flow in the earth, particularly its density between potential electrodes; and true resistivity between these electrodes. Qualitative interpretations are given for two-layered examples, a vertical high-resistivity dike, and a dipping high-resistivity dike. The method can be used for both depth and horizontal profiling.—*H. C. S.*

175–106. Kalenov, Ye. N. Interpretatsiya krivykh vertikal'nogo elektricheskogo zondirovaniya [The interpretation of the curves of vertical electric profiling]: Moscow, Vses. Nauchno-issled. geol.-razved. inst., Gosgeoltekhizdat, 472 p., 1957.

This is a very complete and detailed handbook on the interpretation of the curves obtained in vertical electric profiling, using the symmetrical four electrode arrangement AMNB. It covers hundreds of cases of two, three, and four layers with horizontal and inclined boundary planes and different ratios of resistivity and layer thickness, and the case of a multilayered formation overlying substrata having infinite and finite resistivity. The last chapter deals with the interpretation of the curves obtained in drill holes. Numerous practical examples are presented.—*S. T. V.*

175–107. Veshev, A. V., Fokin, A. F., Ivanov, V. K., and Semenov, A. S. Eksperimental'nyye raboty po dipol'nomu profilirovaniyu [Experimental studies on dipole profiling]: Vses. nauchno-issled. inst. razved. geofiz., Geofiz. metody razvedki, p. 3–24, 1955.

Extensive experimental study of dipole profiling was made in a tank 2 × 2 × 1.5 m filled with water. The purpose of the experiments was to determine the applicability of dipole profiling in prospecting for conducting minerals. An aluminum sphere 10 cm in diameter, duraluminum and glass plates 20 × 20 × 0.4 cm in dimension were used for the models; the contact model was made of veneer in the form of a right angle made of two sides 80 × 80 cm each.

The forms of the profile curves and their ability to represent the models and conditions were studied for the cases of a conducting sphere, a conducting plate, two conducting plates, a nonconducting plate, two nonconducting plates, one conducting and one nonconducting plate, the contact, and a conducting plate and the contact. The results of the experiments are presented in a number of curves. It was found that dipole profiling detects conducting and nonconducting objects as in the method of combined profiling, but yields anomaly curves having greater detail and higher amplitude. Dipole profiling can be done with both direct and alternating currents.—*A. J. S.*

175–108. Buhle, Merlyn B. Uses and limitations of electrical prospecting for water supplies: Illinois Acad. Sci. Trans., v. 50, p. 167–171, 1958.

The electrical resistivity method of surveying is one of the many methods employed by the Illinois Geological Survey in locating water-bearing sand and gravel within glacial drift on the uplands and within alluvium in valley flats and lowlands. Nearly 500 separate resistivity surveys have been made in the state in the past 25 years, ranging in extent from one-acre surveys for farm water to 100 square miles for municipal water supplies. A diagram shows the instrumentation and illustrates the theory. The method is most effective where a large volume of water is needed, where geologic factors are favorable, and where the radius of permissible prospecting is within one to five miles of the point of use; it is least effective for small supplies, such as for farms, where the prospecting area is severely limited.

The method has a high level of discoveries, nine out of ten for municipal and commercial supplies.—*A. J.*

175–109. Spanski, Robert F. Geophysical techniques in the location of new sources of water: Am. Water Works Assoc. Jour., v. 50, no. 2, p. 175–178, 1958.

An elementary discussion of the principles and field techniques of the two geophysical methods, seismic and electrical resistivity, which are at present most applicable to ground water prospecting.—*V. S. N.*

175–110. Beltman, J. H., Dam, J. C. van, and Volker, A. Geofysische opsporingsmethoden in het werkterrein van de civiel-ingeniur [Geophysical exploration methods in the field of the civil engineer]: Geologie en Mijnbouw, v. 20, no. 11, p. 394–405, 1958.

Examples are given of the application of resistivity methods to engineering problems such as contamination of ground water by salt water along the coast and groundwater movement near a deep polder, both in the Netherlands, and the search for groundwater in Iraq and Japan. Method and instruments are described, and the personnel and programs of the Werkgroep Geo-elektrisch Onderzoek T.N.O. ("Geoelectric investigation work group") are outlined.—*D. B. V.*

175–111. Smirnov, A. A. Primeneniye metoda yestestvennogo elektricheskogo polya v rayone Kungurskoy ledyanoy peshchery [Application of the self-potential method in the area of the Kungursk ice cave]: Moskov. Univ. Vestnik, no. 2, p. 195–200, 1958.

A map of the distribution of the natural electrical field of filtration obtained in the course of geophysical investigations in the Kungursk cave region of the U.S.S.R. corresponds completely with the geologic structure of the area and drainage features in local river valleys. Relationships between river waters and ground water in the region in question appear to be one of the most important factors hastening karst processes; it is possible to study them very effectively by the self-potential method.—*D. B. V.*

175–112. Belluigi, A[rnaldo]. Electromagnetic fields produced by a cable (carrying an alternating current) placed on a ground with an interstratum: Annali Geofisica, v. 9, no. 3, p. 349–370, 1956.

This is an English version of the paper published in Geofisica Pura e Appl., v. 32, p. 85–101, 1955 (see Geophys. Abs. 165–116).—*D. B. V.*

175–113. Molochnov, G. V. Vertical'nyy magnitnyy dipol' na poverkhnosti gorizontal'noy sloistoy structury [A vertical magnetic dipole on the surface of a horizontal layered structure]: Vses. nauchno-issled. inst. razved. geofiz., Geofiz. metody razvedki, p. 25–33, 1955.

When a vertical magnetic dipole is operated on the surface of a horizontal two-layered medium, the magnetic and electric fields can be described by Maxwell's equations for harmonic fields. Assuming that the magnetic and electric fields generated by the dipole are equal, $\mu=1$, and introducing boundary conditions for the single vertical component of the electromagnetic vector $\vec{\Pi}$, Molochnov constructs a system of equations and derives from them three formulas which determine the magnetic and electric fields of a vertical magnetic dipole of two-layered structure. The dipole generates conduction and displacement currents in the layers creating a secondary electromagnetic field. From the magnitudes of the real and imaginary parts of either magnetic or electric

component of the field the effective permeability and effective conductivity of the layer medium can be determined.—*A. J. S.*

175–114. Molochnov, G. V. Paletki dvusloynykh krivykh i ikh analiz v metode garmonicheskogo elektromagnitnogo zondirovaniya s pomoshch'yu vertikal'nogo magnitnogo dipolya [Master charts for two layer curves and their analysis according to the method of electromagnetic profiling with the aid of a vertical magnetic dipole]: Vses. nauchno–issled. inst. razved. geofiz., Geofiz. metody razvedki, p. 34–38, 1955

The paper considers master charts of effective conductivity with reference to Molochnov's previous paper (see Geophys. Abs. 175–113). A family of logarithmic curves $\frac{\sigma_1}{\sigma_2}$ as a function of ξ are drawn as master charts (σ_1 and σ_2 are conductivities of the first and second layers, and $\xi=\frac{ro}{2h}$ is a non-dimensional distance). It was found that the depth reached by this method for $\frac{\sigma_1}{\sigma_2}<1$ is 7/3 of the depth reached when $\frac{\sigma_1}{\sigma_2}>1$.—*A. J. S.*

175–115. Molochnov, G. V., and Balobayev, V. T. Provodyashcheye telo v elektromagnitnom pole vertikal'nogo magnitnogo dipolya [A conducting body in the electromagnetic field of a vertical magnetic dipole]: Leningrad Univ. Uchenyye Zapiski, no. 249, p. 80–89, 1958.

In the electromagnetic induction method of exploration for ore deposits, a circular frame is often used as an emitting antenna. In these experiments the frame was 5.5 cm in diameter. The receiving antenna was similar in construction but only 3 cm in diameter. The electromagnetic field produced was experimentally investigated by placing disturbing conducting bodies of different shapes and materials in different positions relative to the emitting and receiving antennas. The following cases were investigated: a conducting aluminum plate, $60\times40\times0.2$ cm; a conducting cast iron sphere; and a conducting copper cylinder 16 cm in diameter and 27.5 cm in height. With each of these objects several positions were tried out and the corresponding field was determined by constructing equipotential lines. It was found that more complete and more reliable information on the resulting electromagnetic field and consequently on the position of the disturbing body is obtained if the exciting antenna is tilted. Measurements in this position make it possible to determine the angle between the vertical and the horizontal components of the magnetic field as well as the position of the angle of the inclination of the ellipse of polarization. It is concluded that the investigation of the magnetic field produced by a harmonic magnetic dipole makes it possible to map the anomaly and obtain information about the location of the conducting disturbing body and its shape.—*S. T. V.*

175–116. Gel'fand, I. S. Peremennoye pole vertikal'nogo elektricheskogo dipolya v sloistoy srede [The alternating field produced by a vertical electric dipole in a stratified medium]: Akad. Nauk SSSR Ural. Filial, Gorno-geol. Inst. Trudy no. 30, geofiz. sbornik no. 2, p. 60–71, 1957.

Formulas are derived for the electric field produced by a vertical electric dipole on the surface of a two-layer earth. The conductivity in the air and in

both layers is taken into account, but displacement currents in the ground are neglected. An approximate solution better adapted to numerical computations is also given.—*S. T. V.*

175–117. Gel'fand, I. S. Peremennoye pole gorizontal'noy ramki v sloistoy srede [The alternating field of a horizontal frame in a stratified medium]: Akad. Nauk SSSR Ural. Filial, Gorno-geol. Inst. Trudy no. 30, geofiz. sbornik no. 2, p. 72–83, 1957.

Using the same methods as in the preceding paper (see Geophys. Abs. 175–116) Gel'fand derives approximate formulas for calculating the magnetic field produced on the surface of the ground by a horizontal frame over a two-layered earth.—*S. T. V.*

175–118. Enenshteyn, B. S., and Rybakova, E. V. Nekotoryye rezul'taty elektromagnitnogo zondirovaniya geologicheskikh struktur [Some results of electromagnetic sounding of geologic structures]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 136–137, 1958.

This paper presents the results of electromagnetic sounding of a geologic structure screened by intermediate nonconducting strata, in an unidentified area of the U.S.S.R. The geologic structure, established from the data of electric logging and vertical electric profiling near the drill hole, is as follows: 500 m of clays, sandstones, and marls of Cambrian, Silurian, and Devonian age with resistivities ranging from 3 to 6 ohm-m, rest on the Precambrian basement; these are overlain by some 100 m of Permian anhydrite of practically infinite electric resistivity; above these lies a Triassic formation about 100 to 110 m thick with a specific resistivity of about 50 ohm-m, and above this 130 m of argillaceous sands with a resistivity of 70 to 80 ohm-m. The field survey was made by the method of "equatorial electromagnetic frequency soundings". The results are presented in two curves. Analysis of these curves on the basis of the considerations explained in a previous article (see Geophys. Abs. 172–73), shows sufficiently good agreement with the results obtained earlier and indicated above.—*S. T. V.*

175–119. Kamenetskaya, P. M., and Yakubovskiy, Yu. V. Opyt primeneniya metoda bluzhdayushchikh tokov dlya razvedki polimetalicheskogo mestorozhdeniya [The results of the application of stray currents to the exploration of a polymetallic deposit]: Razvedka i okhrana nedr, no. 3, p. 45–47, 1958.

During 1954–1955 a region in Russian Central Asia containing polymetallic deposits was explored by measuring the field produced by stray currents from a nearby industrial installation. The frequency of the stray currents was 50 cycles per sec. The potential of the field was investigated simultaneously on two sets of apparatus, each consisting of two mutually perpendicular measuring dipoles, oriented in meridional and lateral directions. One installation remained immovable, the other was moved from point to point along the profiles of the surveys. The variation of the potentials was measured and recorded by oscillographs. The time for one measurement was about ten minutes. From the data obtained, a map of the total intensity vectors of the field was constructed. The interpretation of this map was based on the assumption that the greatest amplitudes occur over the better conducting portion of the deposit. Control drilling of several holes confirmed the results of the geophysical survey. One of the

oscillograms obtained and the final map of the measured vectors are reproduced in the article.—*S. T. V.*

175–120. Brubaker, D. G. Apparatus and procedure for electromagnetic prospecting: Am. Inst. Min. Metall. Engineers Trans., no. 208, p. 777–780, 1957.

Describes a method of electromagnetic prospecting where the object is to locate and outline conducting bodies from a ground survey. The method was developed by W. H. Westphal and Brubaker and is based on the methods of M. Mason (1929) and the Boliden Mining Company. A small vertical source coil, powered by a vacuum tube oscillator, and a direction-finding receiving coil are used. Source and receiver are kept a fixed distance apart and move as a unit along survey lines. At each receiver station only the inclination of the magnetic field created by the source is measured. Two procedures are used: the in-line method for reconnaissance surveys, in which source and receiver travel in tandem along the same line with standard separation and measurements are made at 100 or 200 foot intervals; and the broadside method, preferred for detailed surveys after conductors are found, in which lines are run perpendicular to the expected strike direction and 400 feet apart with source and receiver moving along adjacent lines and maintaining a line along the strike.—*V. S. N.*

175–121. Kokourov, V. D. Polevoy nizkochastotnyy komparator [Low frequency comparator for field work]: Akad. Nauk SSSR Ural. Filial, Gorno-geol. Inst. Trudy, no. 30, geofiz. sbornik no. 2, p. 42–52, 1957.

Field measurements in electrical exploration of sulfide deposits are ultimately reduced to measurements of small voltages, from some tens to some hundreds of microvolts. The measurements are made with a vacumm-tube voltmeter after the small voltages are first amplified. This arrangement gives accurate values only if the amplification factor remains constant during the time interval necessary for the measurements. As this requirement is not always fulfilled, it is necessary to check repeatedly the amplification factor of the measuring instrument as well as to take its variation into account in the calculations. An instrument is described which compares the observed value with a set of standard voltages. The error of this procedure does not exceed 3 percent. A drawback is the absence of a filter, which would eliminate industrial disturbances; these have a frequency of 50 cycles per sec and could easily be filtered out. A detailed description of the instrument is given, with wiring diagram and photographs.—*S. T. V.*

175–122. Rodionov, P. F., and Kokourov, V. D. O primenimosti elektromagnitnogo polya vysokoy chastoty dlya razvedki sul'fidnykh mestorozhdeniy Urala [On the use of the high frequency electromagnetic field in the exploration of sulfide deposits of the Urals]: Akad. Nauk SSSR Ural. Filial, Gorno-geol. Inst. Trudy no. 30, geofiz. sbornik no. 2, p. 3–23, 1957.

After a brief explanation of the theory of the propagation of electromagnetic waves over the earth's surface and their use in exploration for metallic ore bodies, the application of the "shadow method" is discussed. This method is based on the sharp differences in the electric properties of sulfide ores and the surrounding formations. If electromagnetic waves propagating along the crust meet a well-conducting body, the radio signal producing these waves disappears

behind it because the wave energy is almost completely transformed into heat. The greatest drawback of radio waves as a tool in exploration for pyrite is their insufficient depth of penetration into the ground. Under conditions prevailing on the Ural Mountains this depth is never greater than 10 to 12 m in summer or in winter, whereas the pyrite ores are seldom found less than 10 to 15 m deep.

In several field tests in mining galleries radio signals could seldom be recorded at distances exceeding 40 to 50 m. In addition, artificial conductors such as electric transmission and telephone lines, railway tracks, pipe lines, and cables create great difficulties. The use of radio waves from broadcasting stations was also tried but found to be impractical for exploration for sulfide deposits owing to the relatively high electric conductivity of the upper layer of the ground. As a result of these studies, it is concluded that no noticeable development of this method is expected.—*S. T. V.*

175–123. Rodionov, P. F. Opyt primeneniya metoda nezazemlennoy petli pri poiskakh kolchedannykh mestorozhdeniy na Urale [Experiences with the utilization of the ungrounded loop method in prospecting for pyrite deposits on the Urals]: Akad. Nauk SSSR Ural. Filial, Gorno-geol. Inst. Trudy no. 30, geofiz. sbornik no. 2, p. 24–31, 1957.

A brief description is given of the method, instrumentation and the results obtained in electromagnetic exploration in different parts of the Ural Mountains, using the ungrounded loop method. The rectangular loop was 1,000 to 2,000 m long and 500 to 600 m wide. The frequency of the alternating current applied ranged from 50 to 4,000 cycles per sec; higher frequencies were used on formations of higher electric resistivity. The results obtained have proved the suitability of this method of prospecting for pyrite deposits, especially in the case of stony or frozen ground. Under many geologic conditions this method is more productive and more convenient than other methods. In the Ural mountains the winter months are recommended for surveying in swampy areas for they are inaccessible during the summer. Maximum thickness of the upper layer in which the presence of pyrite deposits can be positively determined by the ungrounded loop method is about 10 to 11 m. Curves of the horizontal (H_p) and vertical (H_s) components of the magnetic field are given for measurements made on greenstone and quartzitic rocks, metamorphosed shales, massive sulfides, and disseminated sulfides.—*S. T. V.*

175–124. Bulgakov, Yu. I. Apparatura dlya i mereniya peremennykh poley nizkoy chastoty v elektrorazvedke [Apparatus for and measurement of low frequency alternating fields in electrical surveying]: Leningrad Univ. Uchenyye Zapiski, no. 249, p. 71–79, 1958.

The use of low frequency alternating currents has a number of advantages over the direct current procedure. This article is a description of a set of instruments designed for a frequency of 20 cycles per sec, selected to avoid industrial frequencies of 0 to 3 cycles per sec and 50 cycles per sec. The apparatus consists of a vacuum tube millivoltmeter, an amplifier, a calibrating instrument, a number of filters, and a rectifier. The range of measurements is adjustable within wide limits, from 0 to 1 mv on one end and 0 to 1,000 mv on the other. The input resistance is about 4 megohm; the coefficient of amplification at 20 to 24 cycles per sec is 20,000 or for 50 cycles per sec amplification is 0.2. An additional phasometer is built in as well as a special motor generator set of 70 watts. All instruments were designed and manufactured in Russia. Several characteristic curves of various instruments as well as the wiring diagram of

the installation are given. The setup described was tested in the field in mines in the Altai Mountains and was found to be fully satisfactory.—*S. T. V.*

175–125. Bashmakov, A. A., and Kokourov, V. D. Generatory peremennogo toka [Alternating current generators]: Akad. Nauk SSSR Ural. Filial, Gorno-geol. Inst. Trudy, no. 30, geofiz. sbornik no. 2, 36–41, 1957.

Two methods are described for generating low frequency alternating current, to be used in the exploration of sulfide deposits. One method involves the use of motor-generator sets or of single-armature converters, the other of an electronic set-up often used in radio practice. The power produced in either case is about 100 watts. The primary source of energy is a 12 to 24 volt storage battery of 60 amp-hr capacity. The first arrangement is recommended for surveys using a single frequency; when several frequencies are necessary, the vacuum tube generator is used. The range of voltage in this case can be 75 to 2,000 cycles per sec. Wiring diagrams of both schemes are given.—*S. T. V.*

Lafargue, Maurice, and Millecamps, Rolland. On the electromagnetic properties of glacier ice. See Geophys. Abs. 175–184.

ELECTRICAL LOGGING

175–126. Tixier, M. P., and others. Fundamentals of logging: Kansas Univ. Petroleum Eng. Conf., Topeka, Kansas, April 2 and 3, 1956, 169 p., 1956.

Tixier, M. P. Fundamentals of electrical logging, p. 1–14.

Martin, Maurice. S. P. and conventional resistivity logs, p. 15–41.

Tixier, M. P. Microlog and microlaterolog, p. 43–65.

Martin, Maurice. Resistivity measuring devices using focusing systems, p. 67–95.

Martin, Maurice. Interpretation in shaly sands, p. 97–113.

Tittman, Jay. Radiation logging, 115–136.

Tittman, Jay. Radiation logging: Application, p. 137–154.

Tixier, M. P. Summary and conclusions, p. 155–169.

By means of text, equations, logs, graphs, and charts, these eight articles discuss the principles and application of radioactivity and electrical logging in petroleum exploration.—*A. J.*

175–127. Kunz, K[aiser] S., and Moran, J[ames] H. Some effects of formation anisotropy on resistivity measurements in boreholes: Geophysics, v. 23, no. 4, p. 770–794, 1958.

It is shown that a wide class of potential problems involving anisotropic media can be transformed into equivalent problems involving only isotropic media. By means of such transformations it is possible, in a large number of cases, to determine the apparent resistivities which would be observed in anisotropic formations, using electrode-type resistivity logging devices. Discussion is given of an infinite, anisotropic medium with and without borehole, of two semi-infinite anisotropic beds (without borehole), and of a thin isotropic bed bounded by anisotropic adjacent formations (without borehole). An interpretation chart for the normal device is presented for thick, non-invaded, anisotropic beds penetrated by a borehole.—*Authors' abstract*

175–128. Kunori, Shoichi, and Yokoyama, Hidekichi. Studies of the new electrode logging method. (1st Report). A. Rod electrode (Part I) (in Japanese with English summary): Tōhoku Kozan, v. 5, no. 1, p. 42–47, 1958.

A new electrode configuration which seems to produce particularly good results in thin geologic formations was investigated experimentally and the results compared with the modified guard and latero-electrode systems. The report is well illustrated.—*V. S. N.*

175–129. Zablocki, C[harles] J., and Keller, G[eorge] V. Borehole geophysical logging methods in the Lake Superior district, *in* Drilling symposium, 7th annual, exploration drilling: Minneapolis, Minnesota Univ. Center for Continuation Study, p. 15–24, 1957.

This reports on a study made by the U.S. Geological Survey to evaluate geophysical logging techniques in the Lake Superior district. Conventional electrical logging with resistivity and spontaneous potential measurements, induction logging with electrical conductivity and magnetic susceptibility measurements, pulse-transient logging, and gamma-ray logging were tested in drill holes in the iron ranges of Minnesota and Wisconsin and in copper ore zones in northern Wisconsin and upper Michigan. It was found that induction logs are useful in estimating the amount of magnetite present in taconite ores, electrical resistivity logs can differentiate enriched hematite ores from non-commercial carbonate iron formations and other rocks, induced polarization logs can locate and estimate the concentration of sulfides and native copper, and radiometric logs can detect shale and slate members in the iron formation.—*V. S. N.*

175–130. Hallof, Philip G. Drill hole electromagnetic exploration for sulphide ores, *in* Drilling symposium, 7th annual, exploration drilling: Minneapolis, Minnesota Univ. Center for Continuation Study, p. 8–14, 1957.

Electromagnetic surveying of a diamond drill hole may be used to explore massive sulphide mineralization to depths as great as 2,500 feet and within a radius of 300–400 feet of the hole. Surveys may be made in vertical or inclined holes and results will indicate the direction in which conductive structures lie relative to the drill hole and their depth. A survey of the Lake Dufault pyrite-pyrrhotite mines near Noranda, Quebec, is used to illustrate the method. The results show clearly how electro-magnetic logging can indicate the direction in which further drilling should be done to intersect the conductive zone, thus reducing the number of exploratory drill holes necessary. New equipment has been designed for use in mines; the transmitting coil is inserted in one hole and the receiving coil in an adjacent hole, so as to detect a conducting body between holes as much as 400 feet apart.—*V. S. N.*

175–131. Boyum, Burton H. Schlumberger electrologging of small diameter drill holes on the Marquette Range, Michigan, *in* Drilling symposium, 7th annual, exploration drilling: Minneapolis, Minnesota Univ. Center for Continuation Study, p. 49–54, 1957.

Discusses the results of the application of Schlumberger electrical logging methods to a study of the surface overburden and bedrock of the Marquette Iron Range in Michigan. Logs of holes in bedrock correlated well with the known geology and pronounced differences in resistivity were noted between

the iron formation and intrusive dikes and sills. Logs were made in two rotary mud-drilled holes in the overburden. Typical logs are shown.—*V. S. N.*

175–132. Grechukhin, V. V. Rezul'taty provedeniya promyslovogeofizicheskikh rabot v pechorskom ugol'nom basseyne [The results of geophysical surveys in the coal mines of the Pechora mining basin]: Razvedka i okhrana nedr, no. 5, p. 43–51, 1957.

A report is presented on the development of continuous geophysical observations in the mines of the Pechora coal basin during 16 years beginning in 1940. As a rule the coal seams are evaluated by means of the apparent resistivity curve. In addition the spontaneous potential and induced potential curves are also determined regularly. Different measuring setups were tried. The best results were obtained with a gradient probe 3.55 m in length. Other probes, for instance the potential probe or an arrangement with two gradient probes, were used in the investigation of complicated geologic profiles. A correct lithological separation of coal-bearing strata always could be obtained. The data on the sequence of coal veins with rock partings obtained by geophysical measurements are always more complete than those previously obtained by core lifting and were fully reliable. Increase of the ash content of the coal in a given layer is clearly indicated by a decrease in resistivity. This is seen on the curve of apparent resistivity as well as on the curve of induced potential. Thus not only the presence of the coal stratum, but also its rank and grade were determined geophysically, completely eliminating core lifting in all Pechora coal fields.—*S. T. V.*

175–133. Grechukhin, V. V. Opredeleniye zol'nosti ugolnykh plastov po gruntonosnym probam i diagrammam kazhushchikhsya soprotivleniy [The determination of the ash content of coal seams from core samples and apparent resistivity diagrams]: Razvedka i okhrana nedr, no. 10, p. 35–40, 1957.

The ash content of a coal layer in a borehole is ordinarily determined by a very costly coring operation and subsequent laboratory analysis of the cores obtained. This article describes a method of determination of the ash content of coal from the diagram of apparent resistivity that is regularly used by geophysicists in the Pechora coal basin. From numerous tests on drill holes and measurements of the apparent resistivity it was possible to distinguish in the drill hole coal seams as thin as 5 cm. The best results were obtained with a gradient probe 3.55 m length. With such a probe, curves of apparent resistivity, spontaneous polarization, induced potentials and others were constructed; their interpretation often gave more reliable and more precise data on the lithological profile of the hole and the ash content of the coal than was possible by core lifting. (See also Geophys. Abs. 175–132)—*S. T. V.*

EXPLORATION SUMMARIES AND STATISTICS

175–134. Solaini, L[uigi]. Un coup d'oeil sur la contribution scientifique fournie par l'E.A.E.G. de 1951 ā 1958 [A glance at the scientific contribution of the European Association of Exploration Geophysicists from 1951 to 1958]: Geophys. Prosp., v. 6, no. 3, p. 157–166, 1958.

This is the text of the presidential address delivered at the fourteenth meeting of the European Association of Exploration Geophysicists at The Hague in May 1958, a general review of progress in gravity, magnetic, seismic, electrical and electromagnetic methods of prospecting.—*D. B. V.*

175–135. Studt, F. E. Geophysical reconnaissance at Kawerau, New Zealand: New Zealand Jour. Geol. and Geophys., v. 1, no. 2, p. 219–246, 1958.

Geophysical methods were used to investigate the possibility of exploiting the Onepu hydrothermal resources in the Kawerau papermills. Changes in the hydrology and chemistry of the hot springs in the last fifty years are attributed to down cutting by the Tarawera River into a Recent alluvial fan; surface runoff has given place to seepage and alkaline waters have given place to acid. Electrical surveying extended the known hot-water zone across the Tarawera River, where test holes gave satisfactory steam and water discharges, and exploitation followed. The natural heat flow was estimated at about 25,000 kcal per sec (above 12° C), but the potential output of eight drillholes at 100 lb per in^2 pressure is 2.7 times this figure. High enthalpy discharges and enthalpies which rise with the wellhead pressure may result from tapping the margin of the hot-water zone.

Seismic refraction tests showed the existence of extensive rhyolites, which, being less permeable than the pumice sediments, act as cap rocks in the hydrothermal system. These rhyolites have little influence on the magnetic field intensity, having low remanent polarization. A gravity survey reveals some details of the geological structure and suggests a genetic relationship between the hot water and rhyolitic intrusions, and between faulting and the volcanic cone of Mt. Edgecumbe.—*Author's abstract*

175–136. Skorupa, Jan. Uvagi o pracach geofizycznych na niżu w przemyśle naftowym [On geophysical work in oil industry of the Polish lowland]: Przegląd Geol., no. 10, p. 449, 1957.

The paper outlines a program of geophysical study and exploration for petroleum in the Polish lowland, planned in accordance with an instruction of the Polish oil department to the geophysical office of the petroleum industry at the end of 1955. A number of seismic groups, a few gravimetric parties, and magnetic and electric prospecting are recommended for determination of regional geological structures, with subsequent logging of suitably located boreholes. Scientific organization and administrative methods for oil research are suggested.—*A. J. S.*

175–137. Hales, A. L. Geophysics in South Africa: Royal Astron. Soc. Geophys. Jour., v. 1, no. 3, p. 249–256, 1958.

This is a review of progress in South Africa in 1958 in those branches of fundamental geophysics which are concerned with the solid earth. In gravity, a Bouguer map was published (see Geophys. Abs. 174–209); the most spectacular anomaly shown on this map centered on Trompsberg. The isostatic reductions have been made for *8* possible distributions of compensation; crustal thickness estimated from the isostatic anomalies (35 to 40 km) is in good agreement with seismological results. South African gravity stations are firmly tied to the international network through pendulum and gravimeter observations made in the past ten years.

Investigations of crustal structure by means of traveltimes of earth tremors in the Witwatersrand, using new transistorized field equipment (see Geophys. Abs. 170–285), support the presence of an intermediate layer. Seismograph observations for the International Geophysical Year at the Bernard Price Institute, at the Hermanus Observatory, and at an additional station at Windhoek show that there are many more small earthquakes in South Africa than expected.

The normal program of geomagnetic observations at Hermanus has been extended for the I.G.Y. to include cosmic ray observations and earth current measurements as well as additional variograph recording. Paleomagnetic measurements have been made on Pilansberg dikes (see Geophys. Abs. 168–244) and are now being made on the Bushveld Complex. Two active groups are doing age determinations, the National Physical Research Laboratory (by the various methods applicable to uranium and thorium minerals) and the Bernard Price Institute (by the rubidium-strontium method). Temperature measurements have recently been made in deep boreholes in the Southern Cape.—*D. B. V.*

175–138. Klubov, V. A., and Meshcheryakov, Yu. A. Ispol'zovaniye geologo-geomorfologicheskikh metodov pri kompleksnykh poiskakh neftyanykh mestorozhdeniy na platforme [Application of geological-geomorphological methods in complex prospecting for oil deposits on a platform]: Geologiya Nefti, no. 8, p. 18–27, 1957.

A method of comparing geomorphological structure (contours of equal denudation areas, orinetation of geomorphological profiles), tectonic structure (first, second, third order and local elevations), and the gravity and magnetic anomalies in platform regions is discussed. Applying this method of analysis of data to the Volga-Ural region, Klubov and Meshcheryakov determine the areas favorable for oil accumulation, verify their findings by seismic surveying, and where promising, proceed with drilling.—*A. J. S.*

GENERAL

175–139. Ahrens, L. H., Rankama, Kalervo, and Runcorn, S. K. [editors]. Physics and chemistry of the earth, v. 1: London, Pergamon Press, 317 p., 1956.

This volume consists of eight papers, each solidly supported by appropriate bibliographies:

Spencer Jones, Harold. The origin of the solar system (p. 1–16)—Reviews the theories on the origin of the solar system, discusses their pros and cons, and concludes that although some progress has been made in recent years in formulating a satisfactory theory, the problem is still not solved.

Verhoogen, J. Temperature within the earth (p. 17–43)—Gives a detailed analysis of various attempts to determine the distribution and the maximum of the earth's interior temperature and concludes that at the boundary of the outer core the temperature cannot be hotter than 5,000° K (in Verhoogen's opinion, about 3,000° K).

Ahrens, L[ouis] H. Radioactive methods for determining geological age (p. 44–67)—Discusses the lead, potassium-argon, rubidium-strontium methods and other natural and artificial isotopes potentially applicable in age determinations.

Bullen, K. E. Seismology and the broad structure of the earth's interior (p. 68–93)—The earth is divided into seven zones and an inner core according to *P*- and *S*-wave velocities, and into six zones according to density, pressure, incompressibility, and rigidity for earth model A, seven for model B. The related question of composition of the earth is also treated.

Hide, Raymond. The hydrodynamics of the earth's core (p. 94–137)—The hydrodynamics of the core, and the most modern aspect of the problem, magnetodynamics in an incompressible fluid, are reviewed and treated mathematically.

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Roy, Rustum, and Tuttle, O. F[rank]. Investigations under hydrothermal conditions (p. 138–180)—Discusses investigations under hydrothermal conditions that provide data on the physical chemistry of the earth. These data can be applied to problems of geothermometry and metamorphism in the crust.

Correns, Carl W. The geochemistry of the halogens (p. 181–233)—Discusses the geochemistry of the halogens, exploring the correlation between halogen content and chemical composition of rocks.

Tomkeieff, S. I. Geochemistry in the U.S.S.R. (1948–1953) (p. 235–284)—A review of geochemistry in the U.S.S.R. in the period 1948–1953, in six chapters covering the geotectonic, structural, climatic, geomorphologic zones and the "penosphere" (the zone of human activity) substantiated by a bibliography of about 700 titles.—*A. J. S.*

175–140. Ahrens, L. H., Press, Frank, Rankama, Kalervo, and Runcorn, S. K. [editors]. Physics and chemistry of the earth, v. 2: London, Pergamon Press, 259 p., 1957.

This volume contains seven papers:

von Arx, William S. An experimental approach to problems in physical oceanography (p. 1–29)—This is a study of marine circulation with the aid of laboratory models. Pressure gradient forces are considered as opposed by friction, or by friction and inertial effects due to the earth's rotation (Coriolis force), or by the Coriolis force alone, or combinations of these forces. The observed forces are synthetized in such a way as to produce simplified analogues of nature to be used in synoptic problems.

Ahrens, L. H. A survey of the quality of some of the principal abundance date of geochemistry (p. 30–45)—Ahrens discusses the quality of geochemical abundance data as determined by classical methods of chemical analysis, by instrumental and physical methods, and by colorimetric procedures. In some isolated cases (for example, TiO_2 in chondrites) the relative deviation from estimated abundance reached 65.9 percent. In his comments on future development Ahrens emphasizes the need for high quality data on the rare elements.

Urey, Harold C. Boundary conditions for theories of the origin of the solar system (p. 46–76)—Evidence additional to that presented in Spencer Jones' paper (see Geophys. Abs. 175–139) is discussed, to be used in constructing theories of the origin of the solar system. Urey considers that the earth consists of 30 to 40 percent metallic iron and 60 to 70 percent silicates and that its temperature continues to increase.

Richards, Francis A. Some current aspects of chemical oceanography (p. 77–128)—The composition of sea water, distribution of its constituents, and the biochemical and hydrochemical cycles which cause such a distribution are discussed.

Hill, M. N. Recent geophysical exploration of the ocean floor (p. 129–163)—Crustal structure of the oceans determined by gravity measurements at sea (1945–1955), by seismic methods (refraction and reflection), and by a study of the velocity of dispersion of surface waves are discussed. Heat-flow measurement, volcanic islands and coral atolls, and structure of the deep sea trenches are also considered.

Shaw, Denis M. The chemistry of gallium, indium, thallium—a review (p. 164–211)—The history, chemistry, and cosmic abundance of gallium, indium, and thallium are briefly discussed, and the geochemistry of each reviewed.

Melchoir, P[aul] J. Latitude variation (p. 212–243)—Latitude variation resulting from oscillation of the earth's axis due to motion of masses on the earth's surface and in its interior is discussed, bringing out the relative importance of these various effects.—*A. J. S.*

175–141. Pekeris, C. L. Geophysics, pure and applied: Royal Astron. Soc. Geophys. Jour., v. 1, no. 3, p. 257–262, 1958.

This is the text of an address delivered on May 6, 1958, on the occasion of the award of the Weizmann Prize in the Exact Sciences by the municipality of Tel Aviv, Israel. The talk constituted a review of some geophysical problems which have been investigated by the mathematicians of the Weizmann Institute; these include density in the center of the earth, crustal thickness, and petroleum exploration.—*D. B. V.*

175–142. Tsesevich, V. P. Mezhdunarodnyy Geofizecheskiy God [The International Geophysical Year]: Moscow, Gosudarstvennoye izdatel'stvo tekhniko–teoreticheskoy literatury, 136 p., 1957.

This book is a review of the problems that are being investigated during the current International Geophysical Year. It is hoped that the accuracy of determination of the following parameters of the earth will be improved: equatorial radius, 6,378,388 m; polar radius 6,356,912 m; polar flattening, 1/297; polar gravity, 978.0543 cm per sec^2; equatorial gravity, 978.0490 cm per sec^2; temperature at center, 2,000 to 3,000° k (assumed); mass, 5.97×10^{27} g; mean density, 5.52 g per cm^3; mean crustal density, 2.7 g per cm^3; mean crustal thickness, 70 km; Gutenberg-Wiechert discontinuity, 2,900 km; radius of inner core, 1,300 km (see Geophys. Abs. 118–7517).

Geomagnetism and earth currents are also being studied; data will be compiled on magnetic declination, secular, annual, and lunar-diurnal variation, 5–100 sec pulsations, and magnetic storms. Magnetic observations are being conducted by the U.S.S.R. at 29 stations; nine of these were added for the I.G.Y. program, including three in Antarctica and two on drifting ice packs in the Arctic. The nonmagnetic schooner *Zarya* will make cruises in the Atlantic and across the Pacific to the Japan Sea. Perturbations and short-period variations of the earth's electrical field are also being studied. In exploration of magnetic anomalies some source of disturbances were found at the bottom of the mantle.—*A. J. S., D. B. V.*

175–143. Lauterbach, Robert. Geophysikalisch-geologisches Kartieren [Geophysical–geological mapping]: Karl Marx Univ., Leipzig, Geol. u. Paläontol. Inst. Mitt., Geologie u. Geophysik (60th anniversary pub.), p. 106–112, 1957.

Geophysical methods are useful not only in mapping deep geology but also in revealing features that are often missed in ordinary surface mapping. Two methods in particular are discussed, shallow resistivity measurements by the Wenner arrangement ("resistivity mapping" or "horizontal profiling"), and micromagnetic investigations (see Geophys. Abs. 160–45). The former are suitable for determining the nature of the substance encountered, the latter for determining its structure (for example, direction of sedimentation and provenance).

Examples are given from various parts of Germany; near Kitzen, the results of resistivity surveys over fluvioglacial sands were confirmed by hand borings; an infaulted limestone block was distinguished from surrounding clays and sandstones by resistivity surveys near Ermsleber in the northeastern Harz; micromagnetic surveys of the main structural directions of the sediments on the Darss peninsula in Pomerania gave evidence of a transgression; and magnetic measurements near Sohland in the Lausitz granite massif showed lamprophyre dikes not noticed in ordinary mapping.—*D. B. V.*

175–144. Köhsling, Juliusz. Badania geofizychne w geologii inżynierskiej [Geophysical exploration in engineering geology]: Przegląd geol., no. 5, p. 204–208, 1958.

The purpose of the paper is to demonstrate the wide applicability of geophysical research to the problems of engineering geology, such as determination of the geological structure of a particular region or of the physical properties of the ground within a particular area investigated for engineering constructions. Köhsling describes seismic and radioactivity methods of prospecting, mostly from the point of view of hydrological exploration, without going into the theoretical foundations or the interpretation of field measurements.—*A. J. S.*

175–145. Koefoed, O. De plaats van de geofysica in de ertsexploratie [The place of geophysics in ore exploration]: Geologie en Mijnbouw, v. 20, no. 11, p. 387–393, 1958.

This is a discussion of the economic, psychological, and technical aspects of the applictaion of geophysical methods to mining, with brief descriptions of the use of magnetic, electrical resistivity and self-potential, gravity, and seismic methods. The need for close cooperation and good mutual understanding between geologist and geophysicist is stressed.—*D. B. V.*

175–146. Lauterbach, Robert. Paläogeophysik [Paleogeophysics]: Karl Marx Univ. Leipzig, Geol. u. Paläontol. Inst. Mitt., Geologie u. Geophysik (60th anniversary pub.), p. 57–66, 1957.

"Paleogeophysics" includes all methods which can lead to an understanding of former physical conditions and processes in the earth during its evolution; it is a part of paleogeography. Paleoclimatology involves the study of glaciations and their cause, and the composition of the atmosphere; micromagnetic measurements throw light on details of glacial deposition (see Geophys. Abs. 160–46). In paleooceanography, stable oxygen isotope ratios in fossils indicate past water temperatures.

For the solid earth, past seismicity can be interpreted from present structure; gravity and magnetic anomalies can affect deposition of sediments (see Geophys. Abs. 150–13925); paleotemperature measurements can be made by means of isotopes, as well as by "geologic thermometer" minerals. Paleomagnetism is particularly promising, for it is hoped that measurements of remanent magnetization can be used for stratigraphic correlation. At present the course of declination and inclination can be traced through series of basalt flows, varved clays, and ocean sediments for certain areas.—*D. B. V.*

175–147. Timofeyev, A. N. Raschety interpretatsionnoy seti geofizicheskikh s"emok [Numerical analysis of the interpretation network of geophysical surveys]: Akad. Nauk SSSR Ural. Filial, Gorno-geol. Inst. Trudy no. 30, geofiz. sbornik no. 2, p. 178–188, 1957.

Because interpretations of geophysical anomalies based on an insufficient number of stations can lead to unnecessary errors and expense, and because good agreement of data obtained from a few drill holes may lead to dangerous generalizations, objective evaluation of the accuracy of survey results is of great theoretical and practical importance. The relative accuracy of interpretations of geophysical anomalies based on surveys of different station densities is analyzed mathematically, and methods are given for interpreting observational networks as a function of depth and dimensions of the disturbing

body. The results are applicable to advance determination of station density necessary for a desired accuracy.—*S. T. V.*

175–148. Borisevich, Ye. S. Magnitoelektricheskiye ostsillografy dlya eksperimental'nykh geofizicheskikh issledovaniy [Magneto-electric oscillographs for experimental geophysical investigations (with English summary)] Československá Akad. Věd Studia Geophys. et Geod., v. 2, no. 3, p. 261–268, 1958.

This is a survey of light-ray oscillographs and their basic parts (galvanometers, optical systems, mechanical parts), constructed by the geophysical institute of the Academy of Sciences of the U.S.S.R. for field and laboratory use. The oscillographs consist of blocks of 6, 9, 12 or 14 with a common permanent magnet having a working field intensity up to 14,000 oersteds. Two types of miniature galvanometers were developed for them, the type GB–III, with a frequency range of 1 to 65 cycles per sec and the type GB–IV, with a frequency range of 20 to 10,000 cycles per sec. The constants of 19 of these serially produced galvanometers are tabulated, giving frequency, current constant, current sensitivity, and internal and external resistance. Another table summarizes the technical characteristics of 24 oscillographs (some of which are produced serially for other branches of science and engineering). These are of three types, high-speed-recording for short period measurements, long-speed-recording, and universal type with a wide range of recording speeds. For each there is given the number of galvanometers, their frequency, width of recording paper, range of recording speeds, types of driving mechanism, and total weight.—*D. B. V.*

175–149. Pisarev, V. V. Fotograficheskaya privyazka marshrutov i anomaliy pri krupnomasshtabnykh aerogeofizicheskikh s"emkakh [Photographic tying of traverses and anomalies in large-scale aerogeophysical surveys]: Razvedka i okhrana nedr, no. 8, p. 32–37, 1957.

The efficiency of airborne geophysical surveying can be vastly improved if a reliable and precise method could be introduced to tie in the separate traverses of the airplane and points of the observed anomalies. Such precise ground control can be obtained either by the radio-geodetic method from radio stations, if located sufficiently near, or by photographic procedure taking photographs from the airplane simultaneously with fixed landmarks such as public buildings, churches, bridges and the like. A description is given of a specially constructed camera with large aperture. As the speed of the surveying airplane may be as great as 50 to 70 m per sec (250 km per hr), the exposure time must be very short. Another feature of this camera is the synchronization of the moment of the exposure with the moment of the recording of other instruments. With good equipment the error in locating the position of the anomaly can be reduced to ±8 to 16 m, and the time of one reading can be reduced to 2 to 3 minutes.

A chart is given of the traverses covered by the airplane, and results are reproduced, both as obtained by the old visual observation, and by the photographic method. The latter is much more precise.—*S. T. V.*

175–150. Blanchard, J. E. The possibilities and limitations of geophysical exploration from diamond drill holes, *in* Drilling symposium, 7th annual, exploration drilling: Minneapolis, Minnesota Univ. Center for Continuation Study, p. 3–7, 1957.

Geophysical exploration in a diamond drill hole gives as much information as a series of cores, and at a much reduced cost, therefore should be an essential part of mining exploration. Electromagnetic, electrical resistivity, and radioactive methods are the most applicable at present to well logging, although it is possible that other methods, such as gravity measurements may be adapted to this work.—*V. S. N.*

175–151. Moore, E. James. Application of borehole geophysics to mining exploration, *in* Drilling symposium, 7th annual, exploration drilling: Minneapolis, Minnesota Univ. Center for Continuation Study, p. 25–43, 1957.

Describes briefly the physical theory, the property measured, and the application to surveys of mining drill holes of the geophysical methods of well logging now in use in petroleum drill hole exploration. Electrical logging, radiation logging, and auxiliary logging services (temperature log, magnetic collar locator, acoustic velocity log, caliper log, dipmeter survey, and directional survey) are discussed and the adaptation to mining drill hole exploration fully summarized in tables.—*V. S. N.*

175–152. Franks, Curtis, and White, Bill. More from your dip-log surveys: Oil and Gas Jour., v. 55, no. 14, p. 102–105, 1957; Shale Shaker, v. 8, no. 8, p. 12–16, 1958.

Describes a new method of interpreting continuous dip logs that results in a comprehensive record of the entire well, indicating the magnitude and direction of dip of all formations and locating faults and unconformities as closely as possible. To avoid confusing true formation dips with dips of minor features such as crossbedding, three dip-log curves are calculated over 10 feet or more of hole and only in the better grade of intervals. Intervals are classified in four grades in order of decreasing merit: a dip station interval that includes a thin, clean sand, 10 feet or less thick, in the midst of a long shale section; a station located at the base or top of a thick sand body, with 50 feet or more of homogeneous shale adjacent and a sharp contact between the two; a station similar to the second but with a gradual transition from sand to shale over a thickness of several feet; and, when no other stations are available, a station located on limestone streaks or thin shale breaks within thick sand bodies (in such cases, as many stations as possible are calculated). After dip data are selected, graded, and computed results are plotted on a graph of depth versus dip and a tentative interpretation is made. With the preliminary graph and a general knowledge of structure, it is possible to find at least one interval on the graph where a trend of dips and strikes can be established and further interpretations made.—*V. S. N.*

175–153. Ferre, Maurice, and Kinnaird, Richard. Dipmeter curve comparator, an optical aid to the interpretation of dipmeter data: Rev. Sci. Instruments, v. 28, no. 9, p. 690–693, 1957.

Determination of dip from borehole logging records requires comparison of three depth curves generated by sensing devices in the probe, the relative verti-

cal displacement of the curves being a measure of the inclination of the strata. An optical instrument has been designed, consisting of two pairs of mirrors and beam splitters. The portions of the curves being examined appear as differently colored superimposed images. The mechanism of the optical system is calibrated such that the longitudinal position of the images is a measure of their vertical displacement.—*R. M. M.*

GEODESY

175–154. Izotov, A. A. Současný stav a úkoly studia tvaru Země [The present state and problems of study of the figure of the earth]: [Czechoslovakia] Geod. a kartograf. Obzor, no. 8, p. 141–146, 1957.

In the first part of this paper, published on the occasion of his 50th anniversary of scientific activity, Izotov discusses the determination of the figure, dimensions, and gravity field of the earth in different countries. Only about 15 percent of the earth's surface has been mapped gravimetrically. On the basis of determinations of the magnitude of degree of arc made in the United States, western Europe, and the U.S.S.R., the major semi-axis of the Krasovsky ellipsoid was found to be 6,378,245±15 m, and the respective reciprocal of the ellipticity 298.3±0.4. These values have been used since 1946 in all geodetic work in the U.S.S.R. and its sphere of influence. The latest determinations of the major semi-axis and the polar flattening are 6,378,181 m and 1/294.1 (Liebermann, see Geophys. Abs. 170–147), and 6,378,240±100 m and 1/297 (Chovitz and Fischer, see Geophys. Abs. 167–11).

In the second part Izotov discusses the gravimetric determination of the size, shape, and gravity field of the earth, and quotes various values determined for the acceleration constant (reduced to the equator) and for polar flattening; the latest of these are 978,057.3 mgal and 1/296.6, respectively (Zhongolovich, 1956). Values of the equatorial flattening range from 1/63,000 (+12° E) according to Yurkina and Yeremeyev, to 1/21,500 (−6° W) according to Niskanen.—*A. J. S.*

175–155. Strasser, Georg. Ellipsoidische Parameter der Erdfigur (1800–1950) [Ellipsoidal parameters of the figure of the earth (1800–1950)]: Deutsche Geod. Komm. Veröffentl., ser. A, no. 19, 113 p., 1957.

The 107 determinations of the figure of the earth from 1800 to 1950 are reviewed historically and the results compiled, giving the dimensions in their original national unit, observational data used, original publicaton, tables available, and countries where these dimensions have been applied as reference surface.—*D. B. V.*

175–156. Wolf, Helmut. Versuch einer Geoidbestimmung in mittleren Europa aus astronomisch-geodätischen Lotabweichungen [Attempt at a determination of the geoid in central Europe from astronomic-geodetic deflections of the vertical]: Deutsch. Geod. Komm. Veröffentl., ser. A, no. 18 (Inst. für angew. Geodäsie, Mitt. no. 15), 31 p., with 32 p. appendix, 1956.

In conjunction with the international project of determining the geoid by means of astronomic-geodetic deflections of the vertical, an attempt has been made by the Institut für angewandte Geodäsie (Institute for applied Geodesy) at Frankfurt, Germany, to determine the geoid for Central Europe. The results are presented in 32 maps.—*D. B. V.*

175–157. Wolf, Helmut. Astronomisch-geodätische Lotabweichungen im mittleren Europa [Astronomic-geodetic deflections of the vertical in central Europe]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 39, 29 p. plus appendix, 1957.

Astronomic and trigonometric data available in central Europe are compiled, reduced to two uniform triangulation systems (the German, referred to Bessel's ellipsoid, and the Central European, referred to the international ellipsoid), and presented as tables of deflections of the vertical.—*D. B. V.*

175–158. Arnold, Kurt. Zur Theorie der gravimetrischen Verbesserung astronomischer Nivellements [On the theory of the gravimetric correction of astronomic levelling]: Gerlands Beitr. Geophysik, v. 67, no. 3, p. 171–176, 1958.

A new rigorous expression is given for the gravimetric correction of astronomic levelling, based on an exact theory of gravimetric geoid undulations and deflections of the vertical.—*D. B. V.*

175–159. Bodemüller, Hellmut. Beitrag zur Schwerekorrektion geometrischer Nivellements [Contribution to the gravity correction of geometric levelling]: Deutsch. Geod. Komm. Veröffentl., ser. A, no. 26, 167 p., 1957.

Available information on the gravity correction of geodetic levelling surveys are compiled uniformly. Dynamic altitudes should be determined for scientific purposes and in rare practical cases; otherwise orthometric altitudes should be calculated, in which the gravity correction is determined according to Niethammer or Helmert, or by means of an adjusted gravity, or even neglected. Scientific "working altitudes" should not be used. Theoretical closure errors should be calculated from measured gravity values or values taken from gravity maps, except where it is known in which cases the spheroidal error of closure is sufficiently accurate.—*D. B. V.*

175–160. Bragard, L[ucien]. Sur la condensation ellipsoidale du relief topographique [On the ellipsoidal condensation of topographic relief]: Soc. Royale Sci. Liège, v. 27, no. 7–8, p. 185–188, 1958.

Topographic relief is broken down into point-masses such that the corresponding densities of ellipsoidal condensation, which are calculated, are of the same order of magnitude as that of the precision with which the gravity anomalies are determined. From these are derived the expressions of the corresponding terms entering into the formula giving the departure of the geoid from the reference ellipsoid.—*Author's summary, D. B. V.*

175–161. Ramsayer, K. Schwerereduktionen des Badisch-Württembergischen Haupthöhennetzes [Gravity reductions of the Baden-Württemberg main altitude network]: Deutsch. Geod. Komm. Veröffentl., ser. A, no. 22, 35 p., 1957.

Gravity measurements made in 1952–1954 along the lines of the Baden-Württemberg main altitude network afforded a chance to test the application of different gravity reductions to a large leveling network. In this paper the different altitude systems are compared quantitatively. The feasibility of using normal gravity values instead of true gravity is given particular consideration. Mean errors of closure are calculated as follows for one kilometer of double

leveling: for leveled altitude differences without gravity reduction, ±0.99 mm; for dynamic altitude differences (pure leveling error), ±0.64 mm; for normal-dynamic altitude differences, ±0.74 mm; for the effect of theoretical errors of closure in error-free leveling without gravity reduction, ±0.86 mm, and for the effect of errors of closure caused by gravity anomalies in error-free leveling with normal gravity reduction, ±0.34 mm. It can thus be seen that consideration of normal gravity greatly increases the accuracy, whereas the additional accuracy gained by use of true gravity instead of normal gravity is of great importance only in levelings of highest precision (mean kilometer error ±0.4 mm).—*D. B. V.*

GEOTECTONICS

175–162. Sonder, Richard A. Mechanik der Erde. Elemente und Studien zur tektonischen Erdgeschichte [Mechanics of the earth. Elements and studies on the tectonic history of the earth]: Stuggart, E. Schweizerbart, 291 p., 1956.

The first part of the book describes the tectonic processes (orogenesis; epeirogenesis; regmagenesis, or large-scale fracturing; taphrogenesis, or formation of rift valley grabens and long horsts; phorogenesis, or changes in geographic distance between points, with or without polar wandering; and pyrogenesis, due to magnetic forces), the geologic cycles, and the structure of the earth. The second part is devoted to theoretical geomechanics, with sections on the mechanical properties of the crust, tangential stress, undation of the crust, the potentials of each of the tectonic processes, orogenesis in relation to tangential stress, and contraction of the earth.—*D. B. V.*

175–163. Hupé, Pierre. Aperçus sur le réseau rhégmatique de la croûte terrestre [Notes on the regmatic network of the earth's crust]: Chronique des Mines d'Outre-Mer, v. 26, no. 265–266, supp. no. 40, 16 p., 1958.

This is a review of Sonder's hypothesis of regmagenesis, or the origin of fractures of the earth's crust (see Geophys. Abs. 175–162). The fundamental postulate is tangential stress due to contraction of the earth.—*D.B.V.*

175–164. Vening Meinesz, F. A. Convectiestromen in de aarde, het ontstaan van continenten en ketengebergten, en het optreden van vertikale bewegingen van het aardoppervlak [Convection-currents in the earth, the origin of continents and mountain ranges and the role of vertical movements of the earth's surface (in Dutch with English summary)], *in* Vening Meinesz, F. A., and others. The earth, its crust and its atmosphere, studies presented to Jacoba B. L. Hol: Leiden, E. J. Brill, p. 221–226, 1957.

Convection current systems, caused by the earth's cooling, are present in the mantle during orogenesis. These currents bring low temperature matter down and high temperature matter up, and a long period must elapse before cooling of the upper mantle and heating of the lower creates convection currents again and starts a new orogenic period. The episodic character of orogeny, of regressions during the first part of the orogeny, and of transgressions afterward are thus explained. Down-buckling of the crust, where drag is exerted by the currents causes great compression and produces geosynclines. These geosynclines become mountain ranges when the currents stop and compression ceases

Distribution of the continents shows that such currents have always been present; in the early history of the earth they brought nickel-iron towards the center to form the core and light sialic matter to the surface to form a proto-continent. A second stage convection-cycle tore apart the proto-continent and transported the parts to form the present continents. After this the oceanic parts consolidated, and later convection currents formed only geosynclines and mountain ranges in zones of crustal weakness.—*V. S. N.*

175–165. Vening Meinesz, F. A. Het van plooiingsgebergten en middelgebergten, van continenten en oceanen [The origin of fold mountains and "mittelgebirge," of continents and oceans]: Geologie en Mijnbouw, v. 20, no. 11, p. 376–386, 1958.

The first section of this paper reviews the constitution of the earth, isostasy and departures from equilibrium; the second part describes gravity anomalies in island arc regions (particularly Indonesia), downbuckling of the crust into geosynclines, and convection in the mantle. The third section concerns the later history of a geosyncline. As mantle currents become slower, and pressure in the crust therefore is decreased, isostatic equilibrium sets in in the geosyncline, and the plastically thickened crust gives rise to a high mountain range. A mountain range can disappear in one of two ways: either by erosion, or because the down-dragged root becomes plastic and spreads laterally under the rigid crust. This latter in turn leads to the rise of "mittelgebirge" in the foreland at some distance from the folded mountains.

The arcuate form of geosynclines is explained, in the fourth section, by the relative motion of the surrounded crustal block with respect to the outlying crust.

The occurrence and periodicity of mantle currents and effect of the transition layer is discussed in the fifth section. In the sixth the origin of continents and oceans is discussed: at the beginning of earth history a proto-continent was formed by the joining together of sialic elements floating on the fluid earth; this continent, which must have covered a third of the earth's surface, subsequently has broken into the present continental segments through convection current action.—*D. B. V.*

175–166. Bemmelen, R. W. van. Stromingsstelsels in de silicaatmantel [Current systems in the silicate mantle]: Geologie en Mijnbouw, v. 20, no. 1, p. 1–17, 1958.

Convection current systems in the mantle cannot be explained on a purely physical basis; geochemical processes, ultimately caused by the inhomogeneity of the mantle and ion diffusion, can upset the hydrostatic equilibrium and set such currents in motion. Bemmelen discusses the mechanics and origin of convection currents in this light, then applies it to the Caribbean region.

Convection current circuits are classified according to their sphere of influence as mega-circuits, which involve the outermost 900 km of the mantle, and extend hundreds of km vertically and thousands of km horizontally; meso-circuits, in the tectonosphere or outermost 100–200 km of the mantle, extending tens of km vertically and hundreds of km horizontally; and local circuits, in the upper part of the crust and epidermis, a few km in vertical and tens of km in horizontal extent. The mega-circuits produce epeirogenic movements, or "geo-undations." Upward pressure, due to accumulated pressure of basaltic magma, forms geo-tumors such as Tibet; downward pressure, due to basification of crustal segments, causes the breakup of continents and subsidence of areas such

as Atlantis or Caribbea. The meso-circuits produce orogenic movements or "meso-undations." Upward pressure, from asthenolithic mountain roots, forms geanticlinal ridges, tumors, horst mountain ranges, and causes isostatic adjustment upon release of pressure by erosion or secondary tectonic denudation; downward pressure produces rift valleys and intermontane basins such as the Mediterranean basin, also isostatic adjustment upon release of pressure of neptons (sediment accumulations) or secondary tectonic accumulation of material. Local circuits produce "detail-undations" such as anticlines, domes, and troughs. Upward pressure, due to rise of magmatic or sedimentary material of lower density, causes volcanic and sedimentary diapirs, domes and horsts; downward pressure, owing to loading of the crust and its sedimentary skin with material of higher density, produces volcanic-tectonic collapses, calderas, and differential compaction.—*D. B. V.*

175–167. Nikolayev, N. I. Izucheniye noveyshego geologicheskogo etapa razvitiya zemnoy kory i znacheniye etikh dannykh dlya ponimaniya teoreticheskikh problem geotektoniki [On the study of the most recent geological stage in development of the earth's crust, and the significance of these data for an understanding of the theoretical problems of geotectonics]: Moskov. Obshch. Ispytaley Prirody Byull. Otdel geol., v. 31, no. 5, p. 123–124, 1956.

In this summary of a lecture read March 30, 1956, before the society for the investigation of nature in Moscow, Nikolayev points out that the complex mechanism of the origin of the earth's crust and its development cannot be correctly interpreted in terms of an isolated hypothesis pertaining to one or another branch of earth science, but must be studied and investigated in the light of the facts provided by geology, geodesy, geophysics, geochemistry, and astronomy. He supports the idea that hereditary structural features exist in the Precambrian platforms, not only in the structures of later periods. The network of faults and seams which separate the mosaic of tectonic blocks extends over the entire planet; its continued development is expressed in orogenesis on land and ocean floors. A possible cause of deep ruptures and "geosutures" may be changes of the earth's angular momentum due to variations in solar activity, tidal friction, or atmospheric circulation.

A sudden reconstruction of the relief took place between Neogene and Anthropogene time, when crustal blocks were moved, uplifted, and anticlines in depressions formed in Asia and in the Pacific Ocean. This period could also have contributed to the development of the tectonic network mentioned above. On the basis of others' estimates of secular variation in position of the poles and its irregularity in the past (12.5 cm per yr for the Paleozoic, 9 cm per yr for the Tertiary) Nikolayev considers the total possible displacement of the poles to be 10° to 20°.—*A. J. S.*

175–168. Bemmelen, R. W. van. Magmatic diapirism and tectonic deformation: Indonesia Madjalah Ilmu Alam, v. 113, p. 1–5, 1957; reprinted as, Indonesia Univ. Dept. Geology Contr. no. 26.

All geologic processes result from a general tendency toward equilibrium, and are accompanied by readjustment in the distribution of matter with associated forms of energy (nuclear, chemical, thermal, gravitational). These readjustments are effected by migration of atoms or ions, or by mass displacements caused by the former; thus we can speak of geochemically generated mass-

circuits, which are "buoyant" or "foundering" according to whether the bodies disturbing the hydrostatic equilibrium are too light or too heavy.

If magmatic material of lower viscosity is involved in these mass circuits it tends to rise by means of diapirism, causing plutonic intrusions and volcanic extrusions. Thus volcanic and tectonic processes at or near the surface both stem from such geochemical causes at depth.—*D. B. V.*

175–169. Lotze, Franz. Probleme der Gebirgsbildung [Problems of mountain-building (with discussion)]: Arbeitsgemeinschaft für Forschung des Landes Nordrhein-Westfalen, no. 37, 40 p., 1957.

A broad review (based essentially on Stille's concepts) of the types of mountain building deformation, their temporal and spatial distribution, and the general trend of geotectonic events. This paper was presented at a meeting in Düsseldorf in 1953; 10 pages are devoted to the discussion that followed it.—*D. B. V.*

175–170. Yaranov, D. Bŭrkhu nyakoi novi geotectonski khipotezi [On certain new geotectonic hypotheses]: Minno Delo, no. 3, p. 76–83, 1957.

The paper is essentially a review of Belousov's, Goguel's, Gignoux', and Lugeon's hypotheses of tectonophysics and the sources of energy. Yaranov concludes that the fundamental problem of the energy source in structural genesis of the earth's crust is still far from solved.—*A. J. S.*

175–171. Beloussov [Belousov], V. V. Some factors governing the development of the earth's crust: Endeavour, v. 27, no. 68, p. 173–180, 1958.

A review of the tectonic processes which are taking place or have taken place in the continental parts of the earth's crust, based mainly on the results of Soviet investigations, including Belousov's own. Movements are classified as oscillatory, fold-forming, and fault-forming; of these the first are of fundamental importance, possibly the basic cause of the other two. (See also Geophys. Abs. 167–114.)—*D. B. V.*

175–172. Bucher, W[alter] H., and others. Summary of discussion with Dr. W. H. Bucher of his theories of orogenesis with particular reference to the Canadian Rockies and foothills: Alberta Soc. Petroleum Geologists Jour., v. 6, no. 2, p. 50–56, 1958.

A compilation by L. V. Illing of remarks by Dr. W. H. Bucher and a group of Calgary geologists and geophysicists at an informal meeting held under the auspices of the Alberta Society of Petroleum Geologists to discuss Bucher's paper "The problem of orogenesis in the light of new field and experimental evidence" (see Geophys. Abs. 170–153, 171–155).—*V. S. N.*

175–173. Klompé, T. H. F. Pacific and Variscan orogeny in Indonesia. A structural synthesis: Indonesia Madjalah Ilmu Alam, v. 113, p. 43–87, 1957; reprinted as Indonesia Univ. Dept. Geology Contr. no. 28.

It is pointed out that there are great differences in the structural development of eastern and western Indonesia, with Makassar Strait forming the dividing line. In the western part the Pacific orogeny has been mainly responsible for the present structure; the eastern part, in which traces of Variscan dislocations can be seen, forms what Stille calls an intermediate or "quasi-cratonic" area. Gravity anomalies in western Indonesia are consistently posi-

tive; in the eastern part they are strongly variable, negative as well as positive. The tectonic development of western Indonesia is related to that of southeast Asia, with zonal growth outward from the Precambrian nucleus of Indochina. The development of eastern Indochina is related to that of Australia and the Banda geosyncline. An extensive bibliography is given.—*D. B. V.*

175–174. Ma, Ting Ying H. Continental drift and the present velocity of shift of the continental margin of eastern Asia: Geol. Soc. China Proc., no. 1, p. 7–26, 1957 (1958).

This paper was read before the 9th Pacific Science Congress in Bangkok, Thailand, in 1957 and is the same as the paper published in "Research on past climate and continental drift", v. 13, 1957 (see Geophys. Abs. 174–170).—*V. S. N.*

175–175. Lensen, G. J. Rationalized fault interpretation: New Zealand Jour. Geology and Geophysics, v. 1, no. 2, p. 307–317, 1958.

The ratio of the horizontal and vertical components of the displacement along a fault can be used to determine the character of the faults and the direction of the principal horizontal stress. A new classification based on this ratio and the direction of horizontal displacement is proposed. Four types of faults are recognized—normal, transcurrent clockwise, reverse, and transcurrent anticlockwise—each occupying two opposite sectors of 45°. Within each sector the strikes of faults that are soley normal, reverse, or transcurrent coincide with the bisectors of the sectors. Away from the bisector the character of the fault acquires increasingly a component typical of the faults that occur in the adjacent sector.

Fault plane solutions of earthquakes give the horizontal and vertical components of displacement; from these the directions of principal horizontal stress can be determined, and from these directions the stress patterns of earthquake regions can be plotted. The directions of principal horizontal stress were determined from data published by Hodgson (see Geophys. Abs. 164–60) for Pacific earthquakes. A pattern emerges from the directions based on foci to a depth of 0.01 radius of the earth, which includes the thickness of the crust; directions obtained from earthquakes below the solid crust do not fit this pattern. With sufficient data from all depths it should ultimately be possible to draw stress patterns at selected horizons, thereby facilitating the study of subcrustal stresses.—*D. B. V.*

175–176. Köster, Rolf. Faltung und Überschiebung im tektonischen Experiment [Folding and overthrusting in tectonic experiment]: Neues Jahrb. Geologie u. Paläontologie Monatsh., no. 8/9, p. 337–355, 1958.

Model experiments on the deformation of homogeneous models of warm sand-paraffin mixtures with intercalated layers of gypsum and paper pulp show the influence of the constitution, nature of the lower boundary of the deformed zone, velocity of compression, and duration of compression. Correspondence with the most important fundamental features of mountain tectonics is astonishing, and inasmuch as it is impossible to duplicate natural conditions very closely, such models cannot be expected to parallel the finer details of natural structures.—*D. B. V.*

175–177. Macfarland, D. R. On the causes of submergence and re-emergence at Plettenberg Bay: South African Jour. Sci., v. 54, no. 9, p. 231–240, 1958.

The rise and fall of the Plettenberg coast of South Africa is explained in terms of recent renewal of movement along the Middle Cretaceous fault system. The first movements were downward, resulting in drowning of the watercourses. This movement was halted and reversed, resulting in re-emergence of the land, formation of estuarine terraces, and uplifting of river deposits at the mouth of the Keurbooms gorge.—*D. B. V.*

175–178. Khorosheva, V. V. Vliyaniye atmosfernogo davleniya na naklony zemnnoy poverkhnosti [The effect of atmospheric pressure on the inclination of the earth's surface]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 131–135, 1958.

Measurement of the inclination of the earth's surface is the only method of determining its secular movements. In this paper the area and depth of penetration of baric deformations of the earth's surface are calculated on the basis of the theory of elasticity. It is assumed that atmospheric pressure forms a load on the earth's surface of about 760 mm Hg; this value is increased by the pressure produced by anticyclones and decreased by cyclones. The effect of this pressure is calculated, using Darwin's formula $w=\frac{g\delta h}{4\pi\mu}(1+2\pi\frac{Z}{\lambda}1\frac{-2\pi Z}{\lambda}\cos 2\pi\frac{X}{\lambda}$, where w=vertical displacement; h=height of the atmospheric layer producing the pressure; g=gravitational constant; γ=length of the sinusoidal curve representing the variable load on the earth; μ=modulus of rigidity; Z=depth of the point below the terrestrial surface; and X=distance from the point of observation. It is concluded that the depth of the deformed area of the ground approximately corresponds to the diameter of the atmospheric disturbance. Baric deformation computed for the region around the Poltava (Ukraine) meteorological station, even assuming extreme barometric disturbance, is negligible for the present precision of measurements; accuracy must be increased a hundredfold for the effect of barometric pressure to be detectable.—*S. T. V.*

175–179. Burgess, J. M., and Collette, B. J. On the problem of the postglacial uplift of Fennoscandia: Koninkl. Nederland Akad. Wetensch. Proc., ser. B., v. 61, no. 4, p. 221–232 (part 1) and 233–241 (part 2), 1958.

Burgess and Collette independently have come to conclusions contradicting details of Niskanen's calculations of the postglacial uplift of Fennoscandia; the former started from a reformulation of the equations, the latter from model experiments with very viscous material (heavy oil cooled to 1° C). The principal results of their calculations and experiments are as follows: if the earth's mantle can be considered as a Newtonian fluid, then a positive bulge should appear around a depression, representing a part of the crust where load has been removed (as in Fennoscandia). This bulge will move inward gradually and later disappear. It should be marked by a zone of positive gravity anomalies bordering the negative anomalies and partaking in the rising, and it should be detectable in the history of surface movements such as in diagrams of fossil shore lines.

The gravity anomaly due to the bulge will be only about +7 mgal and, therefore, may be obscured by the effects of geological structure. The region of

negative anomalies will be of smaller extent than the originally ice-covered area, whereas if Niskanen's deductions were correct and if the viscously behaving mantle is of small thickness, the depression would simply flatten out and the negative anomaly would cover a wider area than the unloaded region. The gravity map of Finland shows the area of negative anomalies to be smaller than the depressed area, thus supporting the former model. Fossil shore lines also confirm the fact that the region of rising became narrower.

The picture resulting from Burgess' and Collette's model is thus confirmed in its general features by the data, although certain discrepancies exist. The facts that uplift has not been continuous and that the positive bulge has not developed evenly, cannot be explained by a viscous model; the yield strength of the material may have to be introduced. Changes in rate of uplift with time also require further explanation; the initial state, initial motion, constancy of the coefficient of viscosity, compressibility, isostasy, the mantle-core discontinuity, and the transition layer in the mantle all may have some effect. Thus it is not possible to use these results in a quantitative discussion of the probable subsidence of the Netherlands as a result of postglacial upheaval of Fennoscandia; the total amount however has probably been small so far and no large vertical movements are to be expected for the future.—*D. B. V.*

175–180. Tugolesov, D. A. [editor]. Zhivaya tektonika [Living tectonics]: Moscow, Izdatel'stvo Inostrannoy Literatury, 339 p., 1957.

This is a Russian translation of the symposium entitled "Lebendige Tektonik" that appeared in Geologische Rundschau, v. 43, no. 1, 1955 (see Geophys. Abs. 163, tectonophysics section). A paper by Gallwitz that appeared only as an abstract in the symposium but was published in full elsewhere (see Geophys. Abs. 175–181) is also included.—*A. J. S.*

175–181. Gallwitz, H[ans]. Vermessung von Krustenbewegungen an der Rändern des Elbtalgrabens durch Feinnivellement [Measurement of crustal movements at the margins of the Elbe valley graben by means of precise levelling]: Geologie, v. 3, no. 6–7, p. 943–949, 1954.

The differences between very precise levelling surveys made in 1938 and 1953 along two profiles across the edges of the Elbe valley graben near Dresden, Germany, show that the graben segment has sunk about 2±0.5 mm in that period..—*D. B. V.*

Woollard, G[eorge] P. Areas of tectonic activity in the United States as indicated by earthquake epicenters. See Geophys. Abs. 175–42.

Hospers, J. The gravity field in northern South America and the West Indies. See Geophys. Abs. 175–218.

GLACIERS

175–182. Rigsby, George P. Effect of hydrostatic pressure on velocity of shear deformation of single ice crystals: Jour. Glaciology, v. 3, no. 24, p. 273–278, 1958.

It is recognized that there are greater shear forces at depth in a glacier than near the surface; in order to determine experimentally the effect of hydrostatic pressure on the rate of deformation of a single crystal under constant shear conditions, a pressure chamber was built capable of withstanding 350 atmospheres, equivalent to hydrostatic pressures under four kilometers of ice.

Single crystals were placed in mounts in such a way that deformation occurred by gliding on the basal glide plane. It was found that the shear strain rate increased as the pressure was increased at constant temperature, but that the rate is practically independent of hydrostatic pressure when the difference between the ice temperature and the melting temperature is kept constant.—*V. S. N.*

175–183. Gold, L. W. Some observations on the dependence of strain on stress for ice: Canadian Jour. Physics, v. 36, no. 10, p. 1265–1275, 1958.

Observations were made on the longitudinal and transverse strain of rectangular ice samples stressed at the rate of 2 kg per cm^2 per sec to a maximum stress of 10 kg per cm^2. The duration of the stress was kept less than 10 seconds. Under these conditions the ice behaved elastically. The observations indicated that two deformation processes contributed to the measured strain. It is concluded that the two sources of strain are deformation of the grains and slip at the grain boundaries.—*Author's abstract*

175–184. Lafargue, Maurice, and Millecamps, Rolland. Sur les propriétés électromagnétiques de la glace de glacier [On the electromagnetic properties of glacier ice]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 12, p. 884–886, 1958.

Measurements of the propagation of high-frequency electromagnetic waves (50, 100, 150, 200, and 400 kc per sec) over distances of 2, 3 (including a crevasse), 6, and 25 m through the ice of the Mer de Glace glacier in the Alps, show that the attenuation as a function of distance practically follows the classic law of transmission without losses. Impedances remained practically constant whatever the distance, even where a small crevasse interrupted the segment.

It is tentatively concluded that in the frequency range studied, glacier ice behaves as a dielectric with weak losses. The dielectric constant is estimated to be 80; therefore the wave length λ is $\sqrt{80}$ times smaller in the glacier than in air or at 100 kc per sec. λ=330 m rather than 3 km.—*D. B. V.*

175–185. International Geophysical Year Bulletin No. 11. Blue Glacier studies: Am. Geophys. Union Trans., v. 39, no. 3, p. 575–579, 1958.

An outline of the programs of research on the Blue Glacier in Olympic National Park, Washington. The University of Washington is investigating meteorological conditions, snow-ice budget, ice movement, and snow temperature. The California Institute of Technology is making seismic reflection and refraction surveys and studying ice movement and ice fabrics and structure. Preliminary results show a maximum ice thickness of 920 feet and a velocity of 3,650 m per sec in the ice.—*D. B. V.*

175–186. Mellor, M[alcolm]. Australian glaciological contributions in Antarctica—preliminary report: Jour. Glaciology, v. 3, no. 24, p. 279–285, 1958.

A brief outline of the glaciological work of the Australian National Antarctic Research Expedition in 1957–58 along the coast between long 45° and 75° E and inland to approximately lat 73° S. Results of a gravimetric and seismic traverse along long 62°07′ E will be published separately.—*V. S. N.*

175–187. International Geophysical Year Bulletin No. 13. Preliminary report on the thickness of ice in Antarctica: Am. Geophys. Union Trans., v. 39, no. 4, p. 772–778, 1958.

Sufficient seismic measurements have been made so far on the Antarctic ice cap by the various international teams to show that the average ice thickness is 8,000 feet or more and that the underlying bedrock surface is quite irregular and probably consists of igneous rocks. Profiles so far obtained suggest crustal warping inland, to establish isostatic equilibrium for the ice load; no appreciable crustal flexure is indicated within the border of the ice plateau.—*D. B. V.*

175–188. International Geophysical Year Bulletin No. 14. Ross Ice Shelf deformation project: 1957–58: Am. Geophys. Union Trans., v. 39, no. 4, p. 794–799, 1958.

The Ice Shelf Deformation Project of the International Geophysical Year is concerned mainly with the measurement and mapping of the deformed ice features of the Ross Ice Shelf between Roosevelt Island and the Bay of Whales. If the mechanism of this deformation (which appears to involve plastic flow) can be determined, the results may be applicable to larger structures of the earth's crust such as the folded Appalachians.

Three types of deformational features are recognized. Anticlines, produced by horizontal compression, are roughly parallel, about 15 to 50 feet high, more than 300 feet across, and 2,000 to 5,000 feet long; most are symmetrical. Evenly spaced crevasses cutting across the axes of these anticlines at right angles are produced by tension and range in width from a few inches to more than 100 feet, being widest where they cross anticlinal crests. Strain gages show that the rate of opening of these crevasses is constant, although rates differ from one to another. Shear features consist of crevasse systems, in echelon patterns, not associated with anticlines; other shear features are produced late in the developmental history of the anticlines when the strain rate increases to the point where plastic deformation is impossible.—*D. B. V.*

175–189. Mellor, Malcolm. Photogrammetric flow measurements on Antarctic glaciers: Am. Geophys. Union Trans., v. 39, no. 6, p. 1158, 1958.

Measurements of rate of ice flow were made by the Australian expedition on large glaciers in the Antarctic by means of aerial photogrammetry over a period of several months in 1957. The most important prerequisites were fixed control points and ground marks on the moving ice. The diplacements measured corresponded to velocities of 8.3 to 113 inches per day; the transverse velocity distributions conform to those expected from established theory. Full results will be published elsewhere. The method is suitable for use on the inland ice streams wherever rock control points and reasonably snow-free ice surfaces are present, and where midstream surface velocities are at least 15 inches per day.—*D. B. V.*

175–190. Schlich, Roland. Interprétation d'un profil sismique de réfraction, à la station Charcot, en Terre Adélie [Interpretation of a seismic refraction profile at the Charcot station in Adélie Land]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 20, p. 1761–1764, 1958.

Study of a refraction profile about 1,750 m long, made at the Charcot station in Adélie Land, Antarctica, shows that maximum longitudinal wave velocity in

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the névé is 3,800 m per sec mean velocity in the first 140 m of névé, 3,138±6 m per sec. From the curves thus obtained for density distribution with depth, the average accumulation of névé at Charcot is calculated to be 10 cm per year.— *D. B. V.*

GRAVITY

175–191. Heiskanen, W. A., and Vening Meinesz, F. A. The earth and its gravity field: New York, McGraw-Hill Book Company, 470 p., 1958.

This book deals with the problems of the earth's gravity field, giving the most important lines of advance and results. First, significant data relating to the earth provided by seismology, geomagnetism, and other geophysical means are summarized. The second chapter discusses the three major discontinuities which divide the earth into the crust, mantle, outer core, and inner core. The third chapter deals with the foundation, by means of potential theory, of the treatment of the earth's gravity field and its relations to the geoid and other potential surfaces, introducing spherical harmonics for the purpose.

The fourth chapter is devoted to the theory of the mathematical and physical pendulum, pendulum gravity observations on the continents and at sea, and main types of ordinary and undersea gravimeters and their accuracy. The fifth chapter is on isostasy, the sixth on reduction of gravity measurements, the seventh on types of gravity anomalies from the point of view of isostatic equilibrium. Chapters eight and nine, on physical geodesy and the world geodetic system, contain the essential portions of the main problems of modern geodesy, those which can be solved solely by the gravimetric method and those in which the gravimetric method leads to better solutions than are possible by other existing methods.

Chapter ten discusses deviations from isostatic equilibrium, giving formulas for elastic, plastic, and shear deformations of the crust, and treating the formation of geosynclines, post-glacial readjustments, negative anomalies in Indonesia and other island arcs, and the development of grabens. Chapter eleven deals with the hypothesis of convection currents in the mantle, showing how they were probably preceded by a current system in the whole earth. This caused a core and proto-continent at the beginning of the earth's history, and was probably followed by a current system that drew the proto-continent apart into the present continents. To these current systems are attributed not only the relative movement of crustal blocks and the development of geosynclines between them with accompanying orogeny, but also the subsidence of zones of deep basins such as the Banda Sea and Celebes Sea in the Indonesian archipelago, the Gulf of Mexico and Caribbean Sea in the West Indies, and the West Pacific basins; further, these episodic current systems probably can explain polar wandering. The final chapter investigates these polar migrations and the shear pattern in the crust to which stresses caused by crustal migrations over a flattened earth must have led.— *D. B. V.*

175–192. Cook, A[lan] H[ugh]. Recent developments in the absolute measurement of gravity: Bull. géod., no. 44, p. 34–59, 1957.

The reason for measuring the absolute value of gravity with an accuracy better than one part in one million is that the earth's gravitational attraction on a body of known mass provides a very convenient standard of force. Different methods of measuring the value of gravity (the reversible pendulum, the long pendulum, the rotating fluid method, and methods involving the free motion of a body) are reviewed in some detail and their advantages and disadvantages

pointed out. Six recent absolute measurements made in the United States, Great Britain, France, and the U.S.S.R. are tabulated, giving method used, measured value, value in Potsdam system, and difference from Potsdam system. These show that the absolute value of gravity has not yet been determined anywhere to the desired accuracy, but some of the apparent discrepancy may be due to errors in the measured differences between sites. It is not yet possible to decide on a new standard to replace the Potsdam value.—*D. B. V.*

175–193. International Geophysical Year Bulletin No. 17. Pendulum and gravimeter measurements of the earth's gravity: Am. Geophys. Union Trans., v. 39, no. 6, p. 1205–1211, 1958.

The International Geophysical Year pendulum program to date has resulted in a new series of Gulf pendulum measurements extending the North American standardization range northward to Point Barrow, Alaska, and southward through Panama to Punta Arenas, Chile. In the Pacific, another north-south line has been established from Hokkaido, Japan, southward through Australia and New Zealand to McMurdo Sound, Antarctica.

The general objectives of the gravimeter program are to evaluate the accuracy of the various national gravimeter bases, to integrate these bases into a unified network, to extend and strengthen the international network of bases, and to build up auxiliary gravimeter coverage on a regional basis in areas not likely to be investigated in the foreseeable future. More than 3,000 gravimeter bases have been established in 85 countries, most of them at airports; large gaps still exist however. The IGY gravimeter program also includes establishment of base gravity values in Antarctica; traverse measurements in Antarctica; ice floe observations in the Arctic, with periodic ties to mainland bases; checking of key stations in the primary world network using the new LaCoste geodetic gravimeter; and expansion of the overall world net of gravimeter bases. Preliminary gravity values are listed for the 11 Antarctic bases; these range from 982.3290 gals (at the Pole) to 983.0719 gals (at Beardmore). Small free-air anomaly values for the Byrd Station traverse (0 ± 50 mgals, average) suggest isostatic equilibrium, the minor fluctuations suggest considerable variation in ice thickness, or in the underlying rock type, or both.

The workable shipboard adaptation of the Graf motion-compensated gravimeter, developed by the Lamont Geological Laboratory, is now essentially operational; it is only a matter of time until gravity information at sea will be as complete as on the continents.—*D. B. V.*

175–194. Rieckmann, E., and German, S. Das Potsdamer Schweresystem, seine vollständige Definition und seine richtige Übertragung [The Potsdam gravity system, its complete definition and its accurate conversion]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 50, 35 p., 1957.

In referring gravity values to Potsdam it is found that some intermediate references must be completed or corrected; therefore the Potsdam system is incomplete at least regarding the altitude of the reference point. The Potsdam system is defined as follows: g=981,274.00 mgal exactly, at the point approximately located at λ=13°04.06′ E, ϕ=52°22.86′ N., H=86.24 m above sea level. Before the Potsdam system is changed in the light of new absolute gravity determinations, the system must be completely defined; conversion to other absolute stations must be brought to the degree of accuracy now possible, and absolute determinations must be compared critically and the optimum values determined for the correction to the Potsdam system.—*D. B. V.*

175–195. Wielądek, Romuald. Wyrównanie pomiarów wahadłowych [Adjustment of pendulum measurements]: Acta Geophys. Polonica, v. 6, no. 2, p. 110–126, 1958.

Using a generalized method of least squares and the Borrass theory of error in the period of pendulum oscillations, Wielądek adjusts that theory to modern gravimetric measurements with a four-pendulum apparatus according to Shokin, and also with a two-pendulum gravimeter. Applying his mathematical derivations to the gravimetric measurements at Potsdam, Wielądek finds $0.0074(10^{-7}$ sec per degree$)^2$ for the square of mean error in the factor of linear thermal correction for the mean pendulum. This correction results in g=981,238.2 mgal and g=981,239.6 mgal for the Potsdam values measured in 1934 and 1937, respectively, as against the previous value of g=981,275.2 mgal.—*A. J. S.*

175–196. Kaula, W[illiam] M. Gravity formulas utilizing correlation with elevation: Am. Geophys. Union Trans., v. 39, no. 6, p. 1027–1033, 1958.

Solutions for the first two terms of the standard gravity formula $\gamma_e(1+\beta \sin^2\phi)$ were made, all based on the assumption that the gravity anomalies in areas without observations will average the same as observed values of the same elevation. The solution by the method considered theoretically best yields

$\gamma=(978040.4\pm1.3)\,[1+(0.0053014\pm0.0000030)\sin^2\phi-0.0000059\sin^2 2\phi]$, and $f=1/298.15\pm0.26$.

The coefficients of the fourth and sixth degree zonal harmonics were also computed and used to estimate how much a flattening found from satellite motion would differ. For example, it is estimated that an orbit approximating that of 1958 β would give $f=1/298.00$.—*Author's abstract*

175–197. Coulomb, Jean. Sur la profondeur d'un corps produisant une anomalie gravimétrique [On the depth of a body producing a gravimetric anomaly]: Acad. Sci. Paris Comptes Rendus, v. 247, no. 8, p. 719–720, and no. 17, p. 1370, 1958.

The formulas of Bott and Smith (see Geophys. Abs. 173–194) give the maximum depth to an entirely positive or entirely negative gravitating body when the distribution $g(x)$ of the vertical component along a horizontal of the ground is known. Calculations made by means of analogous formulas, for the case where $g''(x) > 0$ lead to the following expressions:

$$h^2 \leq \frac{9}{8}\frac{g}{g''\left(\frac{x}{x}\right)} \text{ and } h^2 \leq \frac{3}{5}\frac{g}{g''\left(\frac{x}{x}\right)}.$$

These are corrected in the later note to

$$h^2 \leq \frac{12}{5}\frac{g}{g''\left(\frac{x}{x}\right)} \text{ and } h^2 \leq \frac{9}{8}\frac{g}{g''\left(\frac{x}{x}\right)}.$$

The complete calculations are not presented.—*D. B. V.*

175–198. Nepomnyashchikh, A. A. Interpretatsiya gravitatsionnykh anomaliy metodom sravneniy logarifmicheskikh krivykh [Interpretation of gravity anomalies by the method of comparison of logarithmic curves]: Akad. Nauk Kazakh SSR Izv., Ser. geol., no. 121(16), p. 68–75, 1953.

This paper is a development of one previously published (see Geophys. Abs. 149–13696). The number of logarithmic charts has been extended from 66 to 82. With this method the maximum error in determining the dip is ±50 percent; depth of burial, depth to the bottom of the layer, and width, ±12.5 percent; and layer density ±5 percent. Master charts for interpretation of gravity anomalies resulting from two or more disturbing bodies are being prepared.—*A. J. S.*

175–199. Balavadze, B. K. O vliyanii topograficheskikh mass na vertikal'nyy gradient a sily tyazhesti [Effect of topographic masses on the vertical component of the gravity gradient]: Akad. Nauk Gruzinskoy SSR Soobshcheniya, v. 19, no. 1, p. 30–32, 1957.

The gravity effect of topographic masses may obscure or conceal an anomaly. Balavadze derives two formulas for the vertical gravity gradient ($\partial g/\partial z$) due to topographic masses. For a cylindrical body of height H, radius r, and mean density ρ the first formula can be written: $(\partial g/\partial z)_H = 2\pi G\rho[(H/\rho) - (H^3/2r^3) + (3H^5/8r^5)]$ . . . . , G being the gravitational constant. This solution gives the vertical gravity gradient of the layer at the epicenter of the cylinder. The gradient $(\partial g/\partial z)_H$ becomes zero when $r=\infty$. The second formula determines $(\partial \bar{g}/\partial z)$ due to a rugged terrain. The terrain around the point at which the gradient is sought is divided into m concentric layers of mean height h, and n equal sectors:

$$(\partial g/\partial z)_r \approx (2\pi G\rho/n)\sum_{k=1}^{n}\sum_{i=1}^{m}[h_{ik}(r_{i+1}^{-1} - r^{-1})]$$

for $r > 10k$.—*A. J. S.*

175–200. Yun'kov, A. A., and Bulakh, Ye. G. Vozmozhnosti ispol'zovaniya metoda setok dlya interpretatsii anomaliy gorizontal'nogo gradienta sily tyazhesti [On the possibility of using the network method for the interpretation of anomalies of the horizontal gradient of gravity]: Akad. Nauk Ukrainsk. SSR Inst. geol. nauk Trudy, ser. geofiz., no. 2, p. 94–97, 1958.

The problem of a two-dimensional homogeneous space containing one or more regions occupied by masses of excess density that produce a potential $V=V(x,o)$ at the surface, is solved by finding the density distribution of the lower space by means of the integral equation

$$V_{x,o} = k\int \sigma(x,z) ln \frac{1}{R} ds.$$

Unique solutions can be obtained by a different approach, in which it is assumed that the lower semi-space consists of n elemental prisms, each characterized by a constant density different from the others. If V_i is the gravity field produced by the i-th prism the total gravity field V can be represented as the sum of all V_i,

$$V = \sum_{i=1}^{n} V_i \text{ . . . . . .}$$

Similarly, the horizontal gradient

$$V_{xz} = \sum_{i=1}^{n} V_{xz_i}$$

and the potential at the k-th point

$$Vk_{zz}=\sum_{i=1}^{n} k\sigma_i a_i,$$

where σ is density at point i. This last equation is equivalent to the system of equations:

$$V_{zz}^{0}=a_1^0 k\sigma_1+a_2^0 k\sigma_2+ \ldots . a_n^0 k\sigma_n$$
$$V_{zz}^{1}=a_1^1 k\sigma_1+a_2^1 k\sigma_2+ \ldots . a_n^1 k\sigma_n$$
$$V_{zz}^{n-1}=a_1^{n-1} k\sigma_1+a_2^{n-1} k\sigma_2+ \ldots . a_n^{n-1} k\sigma_n.—S.\ T.\ V.$$

175–201. Grushinskiy, N. P. Ob oshibkakh interpolyatsii i predstevitel'stva detal'nykh gravimetricheskikh s"emok, tochnosti kart i tselesoobraznom razmeshchenii punktov [On the errors of interpolation and representation in detailed gravimetric surveys, the accuracy of maps and efficient distribution of stations]: Astron. Zhur., v. 34, no. 2, p. 267–275, 1957.

The errors of interpolation and representation in detailed gravimetric surveys are analyzed, on the basis of extensive data. On the supposition that the accuracy of gravimetric maps is determined by the error of interpolation, the most efficient density distribution of stations is calculated. It is recommended that the instructions for gravimetric prospecting take into account the error of interpolation. For detailed surveys on a plain with anomalies of average intensity, the interpolation error can be calculated from the approximate empirical formula $\overline{E}=0.3x^{0.7}$, where $\overline{E}$=interpolation error in mgal, x=mean distance between stations in km.—*D. B. V.*

175–202. Romberg, Frederick E. Key variables of gravity: Geophysics, v. 23, no. 4, p. 684–700, 1958.

A check list of variables important to the correlation of gravity data and geology is offered to help bridge the gap between those who interpret the data and those who apply the results. These key variables to look for on gravity maps are size (magnitude in mgals), sharpness, perceptibility, resolution, and shape; each is discussed.

The proper way to use gravity in exploration is to assume a target based on geologic knowledge of the area, estimate the key variables of this target, and compute its probable gravity anomaly. If it appears that the target will be perceptible after background "noise" or crowding of other structures has been taken into account, gravity will probably be useful as an exploration tool.

In interpreting the results the most effective method is to single out the variables in the observed gravity map that are the most important and use them to deduce what structures may be their cause. This is best done by assuming model structures and computing their anomalies. Residual and derivative methods are useful for shallow targets where stations are dense and data are accurate, but for deeper targets and with sparse or inaccurate data they contribute little. Critical quantitative studies of the Bouguer anomalies, correlated with all known geologic and geophysical evidence, are the best way to get full information from gravity.—*D. B. V.*

175–203. Graf, Anton. Gravimeter: Messprinzipien, Aufbau, Masstechnik [Gravimeters: principles of measurement, construction, measuring techniques]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 30, 74 p., 1957.

Various systems of gravimeter measurement are outlined, the characteristics and measuring devices common to all gravimeters are more closely investigated, and finally some of the best known (Askania Gs9, Worden, and North American) are individually described; numerous diagrams and photographs are included.—*D. B. V.*

175–204. Brein, Rudolf. Untersuchungen einiger Fehlereinflüsse bei der Messung von Schwereunterschieden und bei der Registrierung kleinster Schwereänderungen mit dem Gravimeter [Investigations of some effects of errors in the measurement of gravity differences and in the registration of very small gravity variations with the gravimeter]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 37, 30 p., 1957.

After a brief explanation of the accuracy required for different measuring programs, results of studies on the North American gravimeter are presented. The rate of drift in the field can be eliminated by means of exact determination of temperature inside the instrument. The effect of atmospheric pressure must also be considered. With a stationary set-up, variations in interior temperature of the gravimeter, which acts on a spring system, can be determined with an accuracy of 5×10^{-6} degrees C; thus the drift rate can be determined with an accuracy of about one mgal or better. This accuracy is significant, as it has been shown that chance variations of gravity are smaller than 1 mgal.—*D. B. V.*

175–205. Schulze, Reinhard. Gravimetermessungen über grosse Entfernung [Gravimeter measurements over great distance]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 35, 16 p., 1957.

Highly accurate gravimeter measurements over great distances are possible with the new gravimeter type Gs12. By means of five different, very accurately known auxiliary measurements, a total of 1,800 mgal can be compensated in steps of about 100 mgal. Using values determined from preliminary calibrations, measurements were made in two days between Berlin, München, Hamburg, and Frankfurt. Results are tabulated.—*D. B. V.*

Grandjean, Alice, and Lagrula, Jean. On a relation between the seismicity and the isostatic gradient in Algeria. See Geophys. Abs. 175–35.

175–206. Baltosser, R. W., and Wilcox, S. W. Optical analog computer simplifies gravity analysis: World Oil, v. 145, no. 5, p. 188–190, 1958.

A new method of interpreting gravity data is provided by the optical analog computer, designed to analyze an easily modified geologic picture or model which is made by drawing to scale cross sections or sketches outlining the expected geologic configuration. Each significant geologic member is given an optical density or opacity proportional to the assumed specific gravity of the formation and the shading is accomplished by using the instrument as a densitometer where small areas of the cross section are compared against a standard. The shaded model is prepared to scale on transparent film and the film placed in the instrument over an illuminated opening in contact with the optical graticule. Light passes through the optical graticule and the superimposed geologic section and is gathered onto the surface of a photoelectric cell, the output from which is read in milligals on an attached dial. The cross section is moved across the graticule to simulate the running of a gravity meter traverse and instrument readings are recorded station by station.

The optical analog computer was designed specifically for gravity use but is adaptable to all potential field problems by construction of appropriate graticules.—*V. S. N.*

175–207. Saxov, Svend [E.]. Keldseå diabase dike and gravity: [Denmark] Geod. Inst. Meddel., no. 35, 24 p., 1958.

Fifteen gravity profiles, made to trace the course of the Keldseå diabase dike across Bornholm Island, Denmark, are shown and the principal facts given for each station. The density values were determined for the diabase, and the density contrast between diabase and granite was found to be 0.30 g per cm^3. Using this density contrast, the gravimetric effect of the dike was found to be of the order of 0.50 mgal, which agrees with figures obtained by direct measurements on exposed portions of the dike.—*V. S. N.*

175–208. Watermann, H[einz]. Richtlinien für den Aufbau des Deutschen Schwerenetzes [Rules for the construction of the German gravity network]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 28, 19 p. 1956.

Instructions for the compilation, archiving, and publication of gravity measurements for the German gravity network are presented, with examples.—*D. B. V.*

175–209. Kneissl, M[ax], Watermann, H[einz], and Bruns, R. Das Deutsche Schweregrundnetz. I. Pendel- und Gravimetermessungen 1952–1955 [The German gravity base network. 1. Pendulum and gravimeter measurements 1952–1955]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 23, pt. 1, 59 p., 1956.

The first part, by Kneissl, describes the fundamental gravity network of Germany, including its subdivision into first, second, third, and fourth order networks, calibration of the gravimeter, and the development and status of the work. The second part, by Watermann, presents detailed results of gravimeter measurements made in 1952–1954 by the Deutsche Geodätische Forschungsinstitut (German Geodetic Research Institute) and the third part, by Burns, does the same for pendulum measurements made in 1954 and 1955.—*D. B. V.*

175–210. Brein, Rudolf, and Watermann, Heinz. Das Deutsche Schweregrundnetz. II. Die Gravimetermessungen 1954–57 des Instituts für angewandte Geodäsie [The German gravity base network. 2. The gravimeter measurements in 1954–57 of the Institut für Angewandte Geodäsie]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 23, pt. 2, 25 p., 1957.

After a brief introduction describing the instrument and procedure, detailed results of gravity measurements, made in the central part of the German gravity base network by the Institut für angewandte Geodäsie (Institute for Applied Geodesy) in 1954 to 1957, using a North American gravimeter AG1–140, are tabulated.—*D. B. V.*

175–211. Durbaum, H[ansjürgen]. Das Deutsche Schweregrundnetz. III. Gravimetermessungen des Amtes für Bodenforschung in Norddeutschland 1952–1956 [The German gravity base network. 3. Gravimeter measurements by the Amt für Bodenforschung in North Germany in 1952–1956]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 23, pt. 3, 46 p., 1958.

Results of gravimeter measurements by the Amt für Bodenforschung (Office of Earth Research) in North Germany in 1952–1956 are tabulated. (See also Geophys. Abs. 169–181).—*D. B. V.*

175–212. Marzahn, Kurt. Über die Messgenauigkeit des Askania-Vierpendelapparates des Deutschen Geodätischen Forschungsinstituts [On the accuracy of measurement of the Askania four-pendulum apparatus of the Deutsches Geodätisches Forschungsinstitut]: Deutsch. Geod. Komm. Veröffentl., ser. B, no. 43, 32 p., 1958.

Investigation of the systematic and accidental errors in pendulum measurements made in the summer of 1956 by the German Geodetic Research Institute shows that the oscillation times of the four pendulums in their Askania apparatus are not independent of one another but have a portion of error in common. A temporal systematic error for all stations could not be detected within one day, nor an observational error. Differences in daily mean at one station were strikingly systematic. The oscillation times on the second day of measurement were on the average about 1.9×10^{-7} sec larger than on the first. There is a clear dependence on the time interval between the evacuation (with respect to pendulum suspension) and the first measurement, which makes it necessary to maintain a uniform time schedule for all stations (±1 hour). On the basis of comparison of oscillation times, a linear variation of pendulum oscillation time of about 1×10^{-7} sec in ten days and a jump of about 10×10^{-7} sec were obtained for the two middle pendulums. Mean errors in gravity differences calculated from compensated oscillation times are ±0.21 to ±0.31 mgal.—*D. B. V.*

175–213. Bott, M[artin] H[arold] P[hillips], Day, A. A., and Masson-Smith, D[avid]. The geological interpretation of gravity and magnetic surveys in Devon and Cornwall: Royal Soc. London Philos. Trans., ser. A, v. 251, no. 992, p. 161–191, 1958.

The main feature of the gravity field of Devon and Cornwall, England, is a belt of negative Bouguer anomalies following the line of granite outcrops. These originate from a shallow structure and are due to the relatively low density of the granite itself; they indicate that the exposed granites are cupolas on an elongated batholith at least 8 and possibly 20 km deep. The magnetic anomalies support this idea. The shape of the body suggests that the mechanism of emplacement was a combination of forcible intrusion and stoping. Over the Lundy Island granite there is only a small drop in Bouguer anomalies, suggesting a laccolithic form.

The high ground corresponding to the granite exposures of the mainland is isostatically compensated or even overcompensated due to the relatively low density of the batholith. The distribution of the compensating mass deficiency thus suggested is in closest agreement with Pratt's hypothesis, with an unusually low depth of compensation (about 10 or 15 km).

A marked southward increase of Bouguer anomalies over the Start and Lizard peninsulas is thought to be related to an overthrust, as is the northward decrease across Exmoor. It is thus possible that the Coal Measures may be found at no great depth beneath the Devonian of the Dunster-Minhead region. Three east-west ridges of higher Bouguer anomalies superimposed on the westerly regional gradient over the Culm synclinorium are of shallow origin. High magnetic anomalies in this area suggest the presence of magnetic rocks extending to a considerable depth.

The relatively low gravity anomalies over the Crediton New Red Sandstone trough suggests a V-shaped profile at North Taunton with a maximum depth of about 340 m. Negative residual anomalies also coincide with the Bovey Tracy and Petrockstow basins and provide minimum estimates of 194 and 245 m for their respective depths.—*D. B. V.*

175–214. Szalai, Tibor. Geotektonische Synthese der Karpaten [Geotectonic synthesis of the Carpathians]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, v. 7, no. 2, p. 111–145, 1958.

The structural development of the Carpathians is worked out, on the basis mainly of geologic data but also using results of gravimetric and magnetic surveys. Three main structural trends are recognized, Erzgebirgian, Hercynian, and Tethys. Pre-Variscan tectonics strongly influenced the later structural development of the region, and with it the Variscan, Mesozoic, and, in part, Tertiary sedimentation.—*D. B. V.*

175–215. Collette, B. J. Structural sketch of the North Sea: Geologie en Mijnbouw, v. 20, no. 11, p. 366–371, 1958.

The gravity field of the North Sea is interpreted in terms of geologic structure, for which the geological and geophysical data for the neighboring countries are extrapolated. As reconstructed, the Caledonides of Scotland and Norway are not continuous but are two branches bifurcating in the North Sea; this explains the fact that the overthrusting in Scotland and Scandinavia are in opposite directions. The gravity field of the southern part of the North Sea (south of lat 57° N) can be explained by the presence of post-Hercynian sedimentary basins which are in isotatic equilibrium; this implies that the sialic crust must have undergone a thinning, but when and how this thinning took place cannot be decided from the available data.—*D. B. V.*

175–216. Fajklewicz, Zbigniew. Underground gravity measurements in the mines of Upper Silesia: Acad. Polonaise Sci., Comité de Géodésie, (Communication présentée à l'onzième assemblée générale de l'Union Géodésique et Géophysique Internationale, Toronto, 3–14 Septembre 1957), 16 p., 1957.

The results of gravity measurements in collieries in Upper Silesia (Poland) made for the purpose of determining correct densities for the whole territory are reported. Special formulas were used in reduction of the data which facilitated the calculation of the effect of shafts, mine workings, and topography. Densities were calculated according to the Hammer method, with an accuracy of 0.1 to 0.3 percent. Discrepancies between densities determined by laboratory and gravimetric methods suggest that the reference level for Bouguer reductions should be chosen as close as possible to the topographic surface of the region.—*D. B. V.*

175–217. Airinei, Stefan, and Stoenescu, Scarlat. Contributii geofizice la cunoasterea substratului bazinului Haţegului [Geophysical data on Haţega basin]: Acad. RPR, Bul. stiint., sec. geol. şi geog., v. 2, no. 2, p. 275–287, 1957.

Results of geophysical exploration in the Haţega basin (southwestern part of Transylvania) are given. A negative Bouguer anomaly of more than 40 mgal and two positive anomalies of 100 and 350 mgal are revealed. The possible causes of the anomalies are discussed, and conclusions are drawn regarding the structure of the basin.—*Authors' abstract, A. J. S.*

175–218. Hospers, J. The gravity field in northern South America and the West Indies: Geologie en Mijnbouw, v. 20, no. 11, p. 358–365, 1958.

A study of the gravity data for northern South America and the West Indies suggests that the major negative gravity axis of the West Indies can be continued on land through Venezuela and into Colombia. The negative gravity axis north of Curaçao and Bonaire is not connected with this first axis; it continues at sea and is thought to be connected with the negative gravity strip of the Lower Magdalena Depression whence it continues inland into Colombia.

On land, the negative and positive gravity axes indicate the position of belts of crustal deformation probably caused by compression. Independently, as well as in analogy with this, it is suggested that the gravity axes of the West Indies originated also through lateral compression in the crust, not through tension.

The structural interpretation of the gravity field of northern South America and the West Indies leads, it would seem inevitably, to the conclusion that lateral compression is a factor of primary importance in the creation of orogenic relief in that area.—*Author's conclusions*

175–219. Tatevosyan, L. K. Nekotoryye osobennosti glubinnogo stroyeniya zemnoy kory v Azerbaydzhane po dannym gravimetrii [Certain features of the deep structure of the earth's crust in Azerbaijan according to gravimetric data]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 643–647, 1958.

This summarizes and interprets the results of gravity surveys made in the Azerbaijan S.S.R. during the last 25 to 30 years. Three major discontinuities in density are observed in the regional profile: between the Cenozoic (2.3 g per cm^3) and Mesozoic formations (2.6 g per cm^3); between the granitic complex (2.6 g per cm^3) and basaltic layer (2.9 g per cm^3); and between the basaltic layer and the Mohorovičić surface (3.3 g per cm^3).

The maximum gravity anomaly, in the Talysh region, is caused by a decrease in thickness of the sedimentary rocks, the presence of the denser granitic complex and the approach of the basaltic layer to within 4.5 to 5 km of the surface. The minimum, on the Apsheron Peninsula, is caused by the deepening of the basement under a thick accumulation of sediments. The $\triangle g$ curve observed in the Talysh-Apsheron profile mainly reflects the contour of the basaltic layer; the effect of the Mohorovičić surface is secondary in importance.—*S. T. V.*

175–220. Bykova, M. S., and Kazanli, D. N. Svyaz' struktury gravimetricheskogo polya Tsentral'nogo Kazakhstana s rannegertsinskimi litologo-fatsial'nymi [Relationship of the structure of the gravimetric field of Central Kazakhstan to the early Hercynian lithological-facies regions]: Akad. Nauk Kazakh SSR Izv. ser. geol., no. 2 (27), p. 67–93, 1957.

The gravity field of central Kazakhstan is characterized by an overall gentle southward rise in relative values (actually a decrease in absolute values of negative anomalies); by isolated local anomalies of up to 60 mgal above or below the general level, covering a total of more than 2,000 km^2; and by linear flexures of the gravity field extending for several hundred km. Comparison with the geology of the territory shows that the gravity field reflects early Hercynian structures.—*D. B. V.*

175–221. Abel'skiy, M. Ye. Rezul'taty primeneniya gravimetrovy s"emki pri geologicheskom kartirovanii v usloviyakh Vostochnogo Zabaykal'ya [The results of the application of gravimetric surveys in geologic mapping under the conditions of Eastern Transbaikal]: Razvedka i okhrana nedr, no. 3, p. 40–44, 1957.

During 1954 a gravimeter survey was made in one of the districts of the eastern Transbaikal region for the purpose of improving the precision of the geologic maps of the region. Gravimetric observations were made along two profiles perpendicular to the trend of the basic structures, totaling 500 km in length. Magnetic measurements were also made at each station. The density of almost all the formations composing the geologic profiles were known at least approximately from investigation of 286 rock specimens collected during the survey and from other geological investigations in this area, including exploratory drilling. It was, therefore, possible to compare the value of the force of gravity at a given point with assumptions of density at different depths to check the correctness of these assumptions and thus to determine the most probable composition of the geologic profile.—*S. T. V.*

175–222. Kasatkin, D. P. Opyt vydeleniya lokal'nykh gravitatsionnykh anomaliy v severnoy Turkmenii [Attempt at the separation of local gravity anomalies in northern Turkmen SSR]: Razvedka i okhrana nedr, no. 6, p. 25–37, 1957.

Kasatkin discusses the separation of local gravity anomalies in the northern part of the Turkmen S.S.R. by means of higher derivatives, using the formulas of Elkins (see Geophys. Abs. 144–12620), Rosenbach (Geophys. Abs. 155–14811), and Nettleton (Geophys. Abs. 156–10).—*S. T. V.*

175–223. Nevolin, N. V. Tektonika Ustyurta [The tectonics of Ustyurt]: Geologiya Nefti, no. 7, p. 12–18, 1958.

Recent regional geophysical exploration carried out in Ustyurt, Kazakh S.S.R., indicates two systems of gravity anomalies, linear and mosaic. The former are especially well developed in the Permo-Triassic folded areas, whereas both linear and mosaic anomalies are prevalent in areas of Paleozoic basement. The results of these investigations confirm the conclusions of Yanshin and earlier investigators regarding the structure of Ustyurt.—*A. J. S.*

175–224. Skvortsov, I. V. Skhema tektoniki i perspektivy neftegazonosnosti severo-vostochnoy Turkmenii i prilegayushchikh rayonov Uzbekistana i Kazakhstana [The tectonic scheme and the oil and gas possibilities in northeastern Turkmen SSR and adjacent areas of the Uzbek SSR and Kazakh SSR]: Geologiya Nefti, no. 7, p. 5–12, 1958.

A new concept of the geologic structure of northeastern Turkmen S.S.R. and adjacent areas, based on recent gravimetric and geologic data, is discussed. The area is divided into two gravimetric zones, a zone of positive anomalies (+14 to +32 mgal), and one of negative anomalies (0 to −32 mgal), and analyzed with respect to Jurassic and Cretaceous deposits containing oil. The entire area of negative anomalies was judged to be oil-bearing, and this analysis was confirmed by actual discoveries of oil and gas in the South Ustyurt, Khorzem-Izmail, and Karakul' Paleozoic depressions, and in the Karakum anticline.—*A. J. S.*

175–225. Thompson, George A., and Sandberg, Clarence H. Structural significance of gravity surveys in the Virginia City-Mount Rose area, Nevada, and California: Geol. Soc. America Bull., v. 69, no. 10, p. 1269–1282, 1958.

Gravity surveys were made in the Mount Rose and Virginia City quadrangles to investigate the concealed Cenozoic structure of the alluviated basins and to explore for significant gravity differences between basins and ranges. The Bouguer anomalies in the basins are found to be closely related to changes in thickness of the Cenozoic sedimentary rocks and alluvium of the basins. In the Washoe Valley the Cenozoic sediments are at least 1,800 ft thick; in Steamboat Valley they are about 600 ft thick, thinning abruptly to the west and gradually to the east; east of Reno the sediments are 2,800 ft thick, thinning abruptly about a half mile west of the Virginia Range; in the basin west of Reno they are locally 1,800 ft or more thick. These variations reflect important structural deformation in the basins. The late Cenozoic structures that separate the basins from the ranges are a complex of contemporaneous faults and folds; folding is predominant in some areas and normal faulting in others.

The Bouguer anomaly in the ranges is not significantly different from that in the sediment-free parts of basins, suggesting that the mountains are not isostatically compensated but are excess loads on an unyielding surface; the measurements, however, cannot resolve small differences resulting from masses that are deep compared to the width of the ranges.

On a large scale, the Bouguer anomaly from San Francisco eastward shows an inverse relationship to elevation but is at a minimum along the east side of the Carson Range rather than at the main summit of the Sierra. The gravity profile may reflect a thickening of the crust eastward beneath the higher part of the continent combined with a smaller effect from the granitic rocks of the Sierra.—*D. B. V.*

175–226. Jopling, Don W., Cashion, Kendall, and King, Henry L. Regional gravity of Cooke and Grayson Counties, Texas, *in* Bradfield, H. H., and others, Geology and Geophysics of Cooke and Grayson Counties, Texas: Dallas, Dallas Geol. Soc. and Dallas Geophys. Soc., p. 189–192, 1957.

Presents a regional gravity isogal map and a regional derivative map of Cooke and Grayson Counties, Texas, and Love and Marshall Counties, Oklahoma, which illustrate the success of gravimetric mapping as a primary exploration tool for oil. The gravity maxima and minima clearly outline the relative structural highs and lows and indicate the areas that are most promising and those that should be investigated by more detailed methods.—*V. S. N.*

175–227. Stewart, Samuel W. Gravity survey of Ogden Valley in the Wasatch Mountains, north central Utah: Am. Geophys. Union Trans., v. 39, no. 6, p. 1151–1157, 1958.

Ogden Valley is a northwest-trending valley in the Wasatch Mountains of north central Utah. From geologic investigations it is inferred that Ogden Valley is structurally controlled by normal faults along both the northeast and southwest margins. Gravity measurements in the valley indicate a fault with about 2,000 ft of vertical displacement along the west margin of the valley. A fault with at least 1,000 ft of vertical displacement is postulated along the east margin of the valley, and a smaller, buried fault is postulated within the valley. The maximum thickness of Cenozoic sediments and sedimentary rocks in the valley is estimated to be about 5,000 ft.—*Author's abstract*

HEAT AND HEAT FLOW

175–228. Egyed, László. A hőfluxus eredetéről [The origin of heat flow (with English summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, v. 7, no. 2, p. 97–100, 1958.

It is suggested that at least part of the heat involved in terrestrial heat flow is due to plastic release of elastic stresses caused by expansion of the earth. This also explains the fact that heat flow is independent of crustal structure.—*D. B. V.*

175–229. Schuiling, R. D. Thermal gradient of the earth: Koninkl. Nederland. Akad. Wetensch. Proc., v. 60, no. 3, p. 212–219, 1957.

Knowledge of radioactivities and conductivities in the earth's crust provides us with the solution of the conduction equation, from which the temperature at the crust-mantle boundary is calculated to be 1,000° K. If there is a boundary between the inner and outer core, the prevailing temperature at the boundary is the melting point of iron, 3,900° K. Extrapolation of this value to the mantle, using the adiabatic value, results in a temperature of 3,000° K at the base of the mantle. In the mantle itself several solutions of the temperature distribution are possible. The effect of radiation is important but changes nothing in the basic concepts. In computing heating of the mantle by heat flow from the core, convection is the most likely explanation to carry off the heat. The equality of continental and oceanic heat flows can be explained by a transition layer between 200 and 900 km in depth, acting as a buffer on temperature changes.—*D. B. V.*

175–230. Nanikawa, Tomikazu. Fluid motions in a sphere: Jour. Geomagnetism and Geoelectricity, v. 9, no. 4, p. 182–192 (part 1), 193–202 (part 2), and 203–209 (part 3), 1957.

In the first part, thermal instability of an incompressible rotating fluid sphere with negligible viscosity heated within is examined mathematically. It is found that stationary convection is not possible; instability set in as overstability.

In the second paper the effect of a uniform magnetic field on the thermal instability of a conducting fluid sphere heated within is calculated. In this case, axially symmetrical steady state solutions exist and only U_n^m, $V^m_{(n+1, \ldots)}$ motions can arise. A relation between perturbations in magnetic field and vorticity is suggested by calculations. Under normal terrestrial conditions, instability arises as ordinary cellular convections; under astrophysical conditions it

can arise, depending on the intensity of the uniform magnetic field, as cellular convections or as overstability, oscillations of increasing amplitude.

In the third paper the effect of simultaneous action of the Coriolis force and a uniform magnetic field on convection in a non-viscous rotating fluid sphere heated within is examined. It is found that there are only axially symmetrical solutions of the marginal stability, and that inhibition of convection by a magnetic field is pronounced when the intensity of the magnetic field is larger than a critical value.—*D. B. V.*

175–231. de Vries, D. A., and Peck, A. J. On the cylindrical probe method of measuring thermal conductivity with special reference to soils. I. Extension of theory and discussion of probe characteristics: Australian Jour. Physics, v. 11, no. 2, p. 255–271, 1958.

It is shown theoretically that the thermal conductivity of soils and materials of similar thermal properties can be accurately measured by the cylindrical probe method. Experimental results in close agreement with the theory are presented. The outer diameter of the probe should preferably be of the order of 0.1 cm or less, its length of the order of 10 cm. Its volumetric heat capacity should not be large and its thermal conductivity not small, in comparison with those of the material. The effect of contact resistance on the value of thermal conductivity is negligible when the soil is well packed around the probe. Thermal diffusivity can be found when the contact resistance coefficient is negligible or is accurately known, but no high degree of accuracy is expected.—*D. B. V.*

175–232. Beck, A[lan] [E.]. A steady-state method for the rapid measurement of the thermal conductivity of rocks: Jour. Sci. Instruments, v. 34, no. 5, p. 186–189, 1957.

The principle of constant temperature difference is used in a divided bar type of apparatus with which a measurement of the thermal resistance of a specimen can be completed within twenty minutes. A thick guard ring is used. The diameter of the specimens is made the same as the external diameter of the guard ring, and irregularities in disks, which would cause appreciable errors in a more conventional apparatus, can be tolerated and an accuracy of ± 1 percent for a single measurement still be obtained.—*Author's abstract*

175–233. Beck, Alan E., and Beck, Julia M. On the measurement of the thermal conductivities of rocks by observations on divided bar apparatus: Am. Geophys. Union Trans., v. 39, no. 6, p. 1111–1123, 1958.

For given apparatus and known tolerances of rock machining, the thermal conductivity of single disks of rock can be determined rapidly by means of a divided bar apparatus (see Geophys. Abs. 175–232). Rock structure and moisture content introduce complications, as to changes of pressure and temperature when a rock is brought to the surface; therefore there is still doubt as to whether a specimen is truly representative of the rock in place. In many coarse-grained rocks the normal laboratory specimens are so small that they give a conductivity value significantly higher than that of a large mass, due to the minerals showing a dominantly parallel instead of a series arrangement. It is recommended that a thin section of a rock should be examined before disks are cut to determine average grain size, so that disks thick enough to be representative of a large mass of the rock can be prepared. Methods of saturating porous rocks must be improved. When allowance has been made for these

effects the laboratory measurements must be correlated with measurements in place. The results of measurements on 35 specimens are presented in tables showing values observed on sets of disks and single disks, and values computed from the modes by the method of Birch and Clark (see Geophys. Abs. 103–5820).—*D. B. V.*

175–234. Swartz, J[oel] H. Geothermal measurements on Eniwetok and Bikini Atolls: U.S. Geol. Survey Prof. Paper, no. 260–U, 30 p., 1958.

Geothermal measurements made in 1952 in two deep drill holes on Eniwetok Atoll and in one deep hole on Bikini Atoll, in the Marshall Island group, showed that in contrast to temperature profiles in continental areas, below the zone of annual change in atolls, temperatures decrease steadily with increasing depth to a depth of several thousand feet; there the curve reverses and temperatures increase with further increase in depth as in continental drill holes. A close parallelism between thermal profiles of the Marshall Islands ocean water and of the drill holes indicates that the character of the thermal profiles in the drill holes is a result of cooling by adjacent ocean waters. This is further substantiated by measurements of fluctuations of water levels in the drill holes. All three holes showed tidal fluctuations one-half the amplitude of the ocean tide and with a lag of one hour. The temperature gradient below the point of minimum temperature is 20° C per km, about half that observed in drill holes along the California coast; it is possible that a normal gradient would be found if the measurements could be extended deep enough.—*V. S. N.*

175–235. Voloshin, I. F., and Rutskiy, I. N. Opredeleniye koeffitsienta rasseyaniya termistora [Determination of the dispersion coefficient of thermistors]: Akad. Nauk Beloruss. SSR Inzh.-Fiz. Zhur., no. 8, p. 102–104, 1958.

The temperature T of a thermistor is usually found from the equation $T=B/(\ln R/R\infty)$ derived from the formula $R=R\infty e^{B/T}$ where R is thermistor's resistance, $R\infty$ is assumed resistance, and B is a constant of the material. This method of temperature determination of thermistors requires experimental calibration for all the volt–ampere values of the thermistor range of operation, and is cumbersome in computation. Voloshin and Rutskiy propose a simpler formula which is equally accurate, and allows a rapid and convenient determination of the thermistor's temperature at various ambient temperatures. Their formula is derived from Newton's law $P_T=k\ (T-T_o)$ where P_T is rate of dissipation of a thermistor in milliwatts, T and T_o are temperatures of the thermistor and the surrounding medium, and $k=\alpha F$, the coefficient of dispersion (α being heat exchange coefficient of the thermistor in milliwatts per degree per cm^2), and F its surface area in cm^2. Designating $1/k$ by C, which can be easily computed for a volt–ampere value, Voloshin and Rutskiy arrive at their formula $T=T_o+CP_T$, assuming C to be constant since it varies but little for $P_T>400$ milliwatts.—*A. J. S.*

INTERNAL CONSTITUTION

175–236. Gorshkov, G. P. Stroyeniye zemnogo shara [Structure of the terrestrial globe]: Moscow, Nauchno-Prosvetitel'naya Biblioteka, v. 18, 48 p., 1958.

An elementary description of the origin, age, size and shape, structure, and chemical composition of the earth and of the movements, structure and development of its crust, and the sources of energy of tectonic movements.—*D. B. V.*

175–237. Kapustinskiy, A. F. Geosfery i khimicheskiye svoystva atomov [The geospheres and the chemical properties of atoms]: Geokhimiya, no. 1, p. 51–61, 1956.

Kapustinskiy examines Goldschmidt's hypothesis of zonal chemical constitution of the earth, and Lodochnikov's view of the earth as a homogeneous nonzonal globe. Opposing both hypotheses, Kapustinskiy explains seismic discontinuities by changes which take place in atomic shells under pressures above 45,000 atm, which is reached at a depth of ~ 100 km. At these pressures valency electrons are forced to occupy the unfilled positions in the lower quantum-level shells, and form isomeric atoms having different physico-chemical properties. On this principle Kapustinskiy divides the earth into three geospheres: the perisphere extending from the surface of the earth to the asthenosphere (60 to 120 km); the intersphere, from the asthenosphere to the core of the earth; and the centrisphere, which includes the core. Only the perisphere is considered to be subject to normal chemical reactions as known from high pressure laboratory experiments. Physico-chemical estimates, prediction of earth materials transformation, and its characteristics are limited to this zone of "crystal-chemistry." The intersphere is the zone of "periodicity function"

$$\beta=\frac{1}{V_o}\left(\frac{\partial v}{\partial p}\right)_T,$$

where β is compressibility coefficient, V_o is initial volume, and

$$\left(\frac{\partial v}{\partial p}\right)^T$$

is change in volume with pressure under constant temperature. The value of this function becomes zero at 1,400,000 atm which prevails at the depth of 2,900 km. On this basis Kapustinskiy concludes that no chemical reaction is possible in the centrisphere; there all chemical properties of the elements are "annihilated," all electronic orbits are completely destroyed, and matter forms a metallic plasma identical in its properties to those of pure crystals under absolute zero temperature. The source of the earth's internal heat Kapustinskiy sees in radioactivity, and he accepts Latimer's view of the isothermic state of the core with 2,000° K temperature (Science, v. 112, no. 2900, p. 101, 1950). See also Geophys. Abs. 171–201.—*A. J. S.*

175–238. Machado, Frederico. Compressibility and temperature of the earth's interior: Am. Geophys. Union Trans., v. 39, no. 5, p. 943–946, 1958.

With a few assumptions regarding the constitution of the Earth's mantle and core, and using the values of pressure, density, and compressibility given by Bullen, the melting points at various depths were derived by Uffen's method [See Geophys. Abs. 151–14070]. Assuming for the liquid core an adiabatic gradient, it seems that in the adopted Earth model the temperature of the lower mantle (below 800 km depth) is close to the melting point of the respective material and its strength is therefore much reduced. On the contrary the temperature of the upper mantle (depths 200 to 600 km) is considerably below the melting point and the material certainly has enough strength to permit the strain accumulation necessary to produce plutonic earthquakes.—*Author's abstract*

175–239. Bobrov, V. N. K voprosu o raspredelenii electricheskoy provodimosti vnutri Zemli [On the problem of electrical conductivity distribution in the earth's interior]: Nauchno-issled. Inst. Zemnogo Magnetizma Trudy, no. 12(22), p. 3–19, 1957.

Studies of the earth's variable magnetic field by various workers have shown that the electrical conductivity of the earth's crust is approximately 10^{-15} emu and that conductivity increases with depth, reaching values of the order of 10^{-11} emu below 600 km. Bobrov presents a mathematical treatment of the distribution of the earth's conductivity, particularly of the dependence of conductivity on latitude and longitude. He derives mathematical formulas for the electromagnetic induction in a spherically symmetrical earth, in a thin spherical shell of uniform conductivity, and in a conducting shell separated from a conducting core by a non-conducting shell; if the amplitude ratio and the phase difference of the internal and external fields are known, the conductivity, the thickness of the non-conducting layer, and the depth can be determined from these formulas. By means of spherical harmonic analysis of data from 46 magnetic observatories in various latitudes and longitudes, Bobrov determines the amplitude ratios and phase differences required for a solution of the problem. Maximum conductivity is found in the western hemisphere, minimum in the western half of the eastern hemisphere. The ratio of maximum to minimum conductivity reaches 34. The non-conducting shell is thickest in the western hemisphere and thinnest in the eastern half of the eastern hemisphere, reaching a ratio of maximum/minimum=4.—*A. J. S.*

175–240. Lovering, J. F. The nature of the Mohorovičić discontinuity: Am. Geophys. Union Trans., v. 39, no. 5, p. 947–955, 1958.

New evidence for the composition of the silicate mantle of the primary meteorite body suggests that a considerable portion of the Earth's upper mantle may well be composed of silicate material of basaltic composition. Consequently the Mohorovičić discontinuity may not separate basaltic crustal material from ultrabasic upper-mantle material but rather mark a zone in which basaltic material is transforming into a high-pressure modification possibly represented by the rock-type eclogite. Estimates of the temperatures and pressures at the average levels of the Mohorovičić discontinuity under oceans and continents give two points on the 'equilibrium line' for the transformation basalt→eclogite which is roughly given by the relationship $p=21.8\theta-488$ (p in bars, θ in °C). The geophysical consequences of this hypothesis are far reaching. It removes difficulties arising from the observed equivalence of oceanic and continental heat flows, provides satisfactory 'parent magma' from which the granitic and basaltic zones in the crust have differentiated, and suggests a mechanism for elevating or depressing regions of the Earth's surface simply by increasing or decreasing the temperature at the level of the Mohorovičić discontinuity beneath that region.—*Author's abstract*

175–241. Hughes, Darrell S., and McQueen, Robert G. Density of basic rocks at very high pressures: Am. Geophys. Union Trans., v. 39, no. 5, p. 959–965, 1958.

The densities of two gabbros and one dunite have been measured at several pressures in the range from 150 to 750 kilobars (1 kilobar=986.9 atmospheres). These pressures were attained in shock fronts generated by high explosives. The densities were computed from the observed shock waves. The dunite,

initial density of 3.25 g per cc, was compressed to a density of about 4.9 g per cc at 720 kilobars. The gabbros, initial density 3.0 g per cc, were compressed to 5.0 g per cc at 750 kilobars. Both gabbros show evidence of a polymorphic transition at some pressure around 150 kilobars to a more dense, but less compressible phase. The agreement obtained from these data with a crust of dunite 400 kilometers thick underlain by a gabbroic rock with Bullen's Model A is very close.—*Author's abstract*

175–242. Ringwood, A. E. The constitution of the mantle—II. Further data on the olivine-spinel transition: Geochim. et Cosmochim. Acta, v. 15, no. 1/2, p. 18–29, 1958

Subsolidus phase equilibria were studied in the system Mg_2SiO_4–Mg_2GeO_4 at 660°C and 30,000 bars in a squeezer apparatus. From the compositions of coexisting phases, the free energy of transition of forsterite from the olivine to the spinel structure is calculated. This enables the total pressure needed to cause this transition in forsterite to be determined. It is found to be about 90,000 bars at 660°C. This result, combined with analogous data obtained in Part I [see Geophys. Abs. 173–241] makes it possible to construct a *P–T* curve defining the olivine-spinel transition in forsterite.

A similar study was made in the system Fe_2GeO_4–Fe_2SiO_4 at 700°C and 25,000 bars and it was predicted that a spinel polymorph of fayalite should become stable around 50,000 bars at 700° C. The predicted polymorph was subsequently synthesized and its transition pressure determined as 38,000 bars at 600°C. The spinel has a lattice constant of 8.235 Å and is 12 percent denser than fayalite.

A thermodynamic study of the stability of $MgSiO_3$ pyroxene in the mantle is made. It is concluded that it will break down into Mg_2SiO_4 spinel and coesite at a maximum pressure not much greater than that required to produce the olivine-spinel transition in forsterite.

The pressures and temperatures required to cause the olivine-spinel transition indicate that the transition will occur in the upper 1,000 km of the mantle. Because of solid solution effects, the transition will occur over an appreciable depth range.—*Author's abstract*

175–243. Vening Meinesz, F. A. Instability in the earth's mantle because of the phase-transition layer—second paper: Koninkl. Nederland Akad. Wetensch. Proc., ser. B. v. 61, no. 1, p. 1, 1958.

In this continuation of the discussion of instability in the mantle due to the transition layer (see also Geophys. Abs. 166–242 and 172–143), the problem of how the vertical shift of the transition layer (caused by convection currents) disappears is considered. The manner of disappearance is probably different for large and for small current systems. Large currents cross the transition layer, heat the surface layer and cool the lower layer.

The upward shift of the transition layer in the subsiding current column and its downward shift in the rising column cause the current to continue after the half-turn, but then the higher temperature matter penetrates the subsiding column and changes the amount of the heavier phase in the lighter one, and equilibrium temperature is restored in each level; the reverse occurs in the rising column.

In smaller currents whose lower horizontal branch lies in the transition layer, the vertical shifts apparently do not disappear as quickly, probably

because transportation of a large amount of heavy phase from the subsiding to the rising column considerably delays heating of the surface layer. It has been shown that subsidence of the basin above the subsiding column and rising of the arc above the rising column are more stable and last longer than the current. The smaller current itself however has a shorter duration than the large current. Temperature conduction between subsiding and rising columns may also play a part in the slow disappearance of the vertical shifts.—*D. B. V.*

175–244. Tikhomirov, V. V. K voprosu o razviti zemnoy kory i prirode granita [On the question of the development of the earth's crust and the nature of granite] : Akad. Nauk SSSR Izv. Ser. geol., no. 8, p. 3–15, 1958.

The absence of acid rocks among meteorites suggests that granites have been formed at specific times during the evolution of the earth. Granitization resulting from metasomatic processes can take place only in zones of uplift, whereas metasomatism in subsiding areas leads to the basification of sial, ultimately producing ultrabasic rocks.—*D. B. V.*

175–245. Broggi, J. A. Acciones mutuas de las esferas externas de la Tierra [Mutual actions of the outer spheres of the earth] : Soc. Geol. Peru Bol., v. 32, p. 65–77, 1957.

The physical, chemical, and biological effects of the lithosphere, hydrosphere, and atmosphere upon each other are outlined. In addition to the effects due directly to the essential constitution of each, there are also the effects of radiation from inner geospheres (subcrust or mantle) and of astrophysical radiations received by the atmosphere.—*D. B. V.*

175–246. Carder, Dean S., and Bailey, Leslie F. Seismic wave travel times from nuclear explosions: Seismol. Soc. America Bull., v. 48, no. 4, p. 377–398, 1958.

Seismograph records from nuclear explosions in Nevada and in the Pacific have been analyzed. The Nevada explosions were well recorded to distances of 6.5° (450 miles) and weakly recorded as far as 17.5° and even as far as 34°. The Pacific explosions were recorded in all parts of the world, with regional data necessarily meager.

The Nevada data indicate a crustal thickness of 35 km in that area, with velocities of 6.1 kmps in the crust and 8.0 to 8.2 kmps beneath it; no uniform crustal layering is indicated. The crust beneath the proving grounds and central California, possibly extending beneath the Owens Valley, is thickened probably to 70 to 75 km. A discontinuity is suggested at 160 to 185 km.

Pacific travel times out to 14° are 4 to 8 sec earlier than similar continental data, partly because of a thinner crust (17 km or less) under the atolls and partly because velocities in the top of the mantle are closer to 8.15 kmps than to 8.0 kmps. More distant points, at 17.5° and 18.5°, indicate slower travel times, about 8.1 kmps. A fairly sharp discontinuity is indicated at 19°. Travel times from Pacific sources to North America follow the Jeffreys-Bullen and Gutenberg curves for surface foci except they are about 2 sec earlier on the continent, and Arctic and Pacific basin data are about 2 sec earlier still. The core reflection *PcP* shows a strong variation in amplitude with slight changes in distance, at two points where sufficient data were available.—*D. B. V.*

175–247. Canadial Oil and Gas Industries. Preliminary seismic results—Ripple Rock: Canadian Oil and Gas Industries, v. 11, no. 8, p. 55, 1958.

A summary of remarks by Dr. P. L. Willmore to a meeting of the Canadian Society of Exploration Geophysicists and the Alberta Society of Petroleum Geologists, previewing the results of seismic observations made when Ripple Rock was blown up on April 5 by 2,750,000 pounds of explosive, detonated in one shot. The observations were a part of Canada's contribution to the International Geophysical Year. From preliminary studies it appears that the crust thickens from 30 or 35 km to as much as 50 km under the Rocky Mountains.—*V. S. N.*

175–248. Alberta Society of Petroleum Geologists. Seismograph recording of the Ripple Rock explosion: Alberta Soc. Petroleum Geologists Jour., v. 6, no. 5, p. 129, 1958.

Essentially the same as the report in Canadian Oil and Gas Industries, v. 11, no. 8, 1958 (see Geophys. Abs. 175–247).—*V. S. N.*

175–249. Demetrescu, Gheorghe. Essai sur la détermination des épaisseurs des couches de la croûte terrestre [Attempt at the determination of the thicknesses of the layers of the earth's crust]: Československá Akad. Věd Studia Geophys. et Geod., v. 2, no. 3, p. 293–295, 1958.

Certain weak impulses at regular intervals between the *P* and *S* arrivals noted in Rumanian records of deep earthquakes in the Vrancha region in the Carpathians are interpreted on the assumption of a two-layer crust. In crossing a discontinuity each wave separates into two waves, one longitudinal, the other transverse, such that each segment of the trajectory is traversed either by a longitudinal wave, here designated *p*, or a transverse wave, *s*. Under these conditions the following possibilities could be registered: $ppp \equiv P$, *pps*, *psp*, *pss*, *spp*, *sps*, *ssp*, $sss \equiv S$. These waves are then used to determine crustal layering under three different hypotheses which give, respectively, thicknesses of 41, 23, and 23 km for the granitic layer, 21, 33, and 34 km for the basaltic layer, and 78, 84, and 83 km for the depth of focus below the Mohorovičić discontinuity, from records of the earthquake of July 10, 1943.—*D. B. V.*

175–250. Research Group for Explosion Seismology. Crustal structure in northern Kwantō district by explosion seismic observations (in Japanese with English summary): Zisin, ser. 2, v. 11, no. 2, p. 102–113, 1958.

Seismic observations were made in Japan, from temporary observation stations between Lake Nozori in Gumma Prefecture and Hokota in Ibaraki Prefecture, of tremors generated by a series of explosions set off at Nozori and Hokota for the purpose of determining crustal structure in the northern Kwantō district. The Mohorovičić discontinuity was found to be at a depth of 25 to 30 km; since the depth of earthquake foci near Mount Tukuba in Ibaraki Prefecture, is generally greater than 30 km, earthquakes near Tukuba evidently occur in the upper part of the mantle.—*V. S. N.*

Andreyeva, I. B., and Udintsev, G. B. Structure of the Japan Sea floor according to data of investigations of the "Vityaze" expedition. See Geophys. Abs. 175–374.

Sysoyev, N. N., Udintsev, G. B., and Andreyeva, I. B. Results of seismo-acoustic investigations of the Japan Sea floor. See Geophys. Abs. 175–373.

175–251. Kosminskaya, I. P. O primenenii GSZ v razlichnykh rayonakh SSSR [The application of deep seismic sounding in different regions of the USSR]: Akad. Nauk SSSR Sovet po seysmologii Byull. no. 3, p. 38–40, 1957.

The use of deep seismic sounding (see Geophys. Abs. 160–74, 164–199) in different parts of the U.S.S.R. has shown that the instrumentation, methods of field observation, and interpretation worked out in the Tyan Shan' Mountains can be successfully applied in regions of very different seismologic structure.

Certain details of the method were slightly modified according to specific local conditions. Tests were made using reflected as well as refracted waves, and converted longitudinal-transverse waves. The most extensive tests were made in the western Turkmen S.S.R., where groups of P^*- and P-waves were recorded which corresponded to the surface of the basalt layer and the Mohorovičić discontinuity. The seismograms and the dynamic and kinematic characteristics of the waves were the same as those obtained in the Tyan Shan' Mountains. The amplitude ratio P^*/P near the point of the appearance of P waves is either less than unity (in the Turkmen S.S.R.) or equal to 1 (in the Tyan Shan'); at about 200 to 300 km from the shot point the P^* wave becomes predominant and $P^*/P>1$, whereas at a distance ~400 km P^* and P amplitudes either become equal or the P amplitude becomes slightly greater than that of P^*. Comparing the thickness of the basaltic and granitic layers in different parts of the world, it was found that regions of similar geologic history (such as the Tyan Shan' and Appalachian Mountains) have similar ratios of thickness of the basaltic and granitic layers.—*S. T. V.*

Tatevosyan, L. K. Certain features of the deep structure of the earth's crust in Azerbaijan according to gravimetric data. See Geophys. Abs. 175–219.

175–252. Veytsman, P. S. O resul'tatakh rabot po glubinnomu seysmicheskomu zondirovaniyu zemnoy kory v odnom iz gornykh rayonov Sredney Asii [On the results of work by deep seismic sounding of the earth's crust in one of the mountain regions of Central Asia (with German summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 2, no. 3, p. 213–230, 1958.

Deep seismic sounding was developed during measurements in the northern Tyan' Shan region in 1949–1950 and 1953. The advantage of this method of studying crustal structure is that seismic waves generated by relatively small charges can be registered at great distance. Two profiles (southwest-northeast, 500 km long, and southeast-northwest, 450 km long) show the positions of the boundary between the granitic layer (velocity v=5.5 kmps, density ρ=2.65 g per cm^3) and the basaltic layer (v=6.4 kmps, ρ=2.85 g per cm^3), and of the Mohorovičić discontinuity between the basaltic layer and the subcrust (v=8.1 kmps, ρ=3.5 g per cm^3). Earthquake foci plotted on the same profiles show the seismicity of the region in relation to the crustal structure, and comparison with gravimetric data in the same profiles shows which regional anomalies are produced in the basaltic layer and which originate in higher crustal layers.—*D. B. V.*

175–253. Hodge, P. W., and Wildt, R. A search for airborne particles of meteoritic origin: Geochim. et Cosmochim. Acta, v. 14, no. 1/2, p. 126–133, 1958.

A year-long programme involving daily collections of atmospheric dust at several widely separted, isolated sites has been undertaken with the object of identifying particles that may be of extra-terrestrial origin. The particles in question are opaque, shiny spherules with diameters less than 15μ. They appear to be of a nature entirely different from that of the larger spheres abounding in densely populated areas. Their meteoritic origin is suggested by recent evidence regarding ablation of meteorites and by the fact that the rate of fall and the frequency distribution with size of these particles have been found to be the same at the various stations. The average rate of fall for each station was 1·1 spherules greater than 3μ in diameter per cm^2 per day. Assuming that the density of the counted particles is that of magnetite, this rate corresponds to an annual accretion for the entire earth of about 5×10^8 kg of these particles.—*Authors' abstract*

ISOTOPE GEOLOGY

175–254. Vinogradov, A. P. The isotopic composition of rocks of the earth and of meteorites: Geochim. et Cosmochim. Acta, v. 15, no. 1/2, p. 80–90, 1958.

Differences between the isotopic ratios of the inert gases, lead, sulfur, oxygen, and carbon in different rocks and in meteorites suggest that the processes which led to the formation of the igneous rocks of the earth's crust and of meteorites must be different. The isotopic composition of lead and other stable isotopes of the rocks of the mantle and crust does not contradict the hypothesis of melting of crustal rocks and of formation of the atmosphere by degassing of the mantle in geologic time; but for all classes of meteorites the presence of inert gases having an isotopic composition different from that on earth indicates an absence of melting, liquation of hydrothermal processes, and other analogous processes of fractional differentiation of material that resemble those of the earth. Vinogradov considers that meteorites form by mutual accumulation of cooled drops of silicate material and iron; then at relatively high temperatures (about 2,000°K) isotopes of sulfur and carbon and other elements will distribute themselves uniformly in the silicates and iron. Only the appearance of new phases, for instance the formation of carbides for carbon at such temperatures, could cause some division of isotopes. (See also Geophys. Abs. 174–242.)—*D. B. V.*

175–255. Wasserburg, G. J., and Bierd, R. The A^{38} content of two potassium minerals: Geochim. et Cosmochim. Acta, v. 15, no. 1/2, p. 157–159, 1958.

The argon isotopes in a muscovite from Dickens County, Michigan, and a lepidolite from Bikita quarry, Southern Rhodesia, were determined in a mass spectrometer. The A^{40}/A^{38} ratios were found to be 5.7×10^5 and 2.8×10^5 respectively, an order of magnitude greater than the corresponding ratios of 0.55×10^5 and 0.43×10^5 calculated according to Gerling's hypothesis (see Geophys. Abs. 165–16). These results indicate that the decay constant given by Gerling and his colleagues for K^{38} is too large by an order of magnitude; their hypothesis that K^{38} occurs in nature with an abundance of $K^{38}/K=1\times10^{-10}$ and has a long-lived isomeric state ($K^{38}\rightarrow A^{38}+\beta^+$; $t_{1/2}=7.70\times10^8$ yrs), is therefore open to question.—*D. B. V.*

175–256. Bentley, P. G., and Hamer, A. N. Boron–10 abundance in nature: Nature, v. 182, no. 4643, p. 1156, 1958.

A new, more accurate value (19.3±0.1 percent) has been obtained for the natural abundance of boron–10. The method used is described very briefly. Carefully prepared primary and secondary standards were compared mass spectrometrically with a sample prepared from naturally occurring boron; details will be published elsewhere.—*D. B. V.*

175–257. Wänke, H., and Kintenberger, H. Helium and Neon als Reaktionsprodukte der Höhenstrahlung in Eisenmeteoriten [Helium and neon as cosmic ray reaction products in iron meteorites]: Zeitschr. Naturforschung, v. 13a, no. 10, p. 895–897, 1958.

This is a preliminary report on mass spectrometer measurements of helium and neon in iron meteorites. The results are tabulated for five meteorites, giving amounts of helium and neon per gram of sample; He/Ne ratio; measured values of Ne^{22}/Ne^{20} and Ne^{21}/Ne^{20}, correction for atmospheric neon, and the corrected values; and percentages of Ne^{20}, Ne^{21}, and Ne^{22}.—*D. B. V.*

175–258. Eberhardt, P[eter], Geiss, J[ohannes], and Houtermans, F. G. Isotopenverhältnisse von "gewöhnlichem" Blei und ihre Deutung [Isotope ratios of "common" lead and their significance]: Zeitschr. Physik, v. 141, no. 1–2, p. 91–102, 1955.

The isotopic composition of 60 samples of "common" lead from different parts of the world was measured, and the model ages and present U^{238}/Pb^{204} and Th/U ratios in the country rock of each locality were calculated. Results are tabulated. Two different types of abnormal isotopic composition are found, the "B-type" (Bleiberg type) in which the model age is larger than the geologic age, and the "J-type" ("Joplin type") in which the model age is smaller. The B-type is explained by remobilization of earlier-deposited lead, the J-type by contamination by radiogenic lead. The recent fumarolic lead from Vesuvius (see Geophys. Abs. 164–23) is of the J-type.—*D. B. V.*

175–259. Ehrenberg, H. R., and Mürtz, H. J. Isotopen-Zusammensetzung einiger Bleiglanze [Isotopic composition of some galenas]: Zeitschr. Naturforschung, v. 13a, no. 10, p. 854–855, 1958.

The lead isotope ratios of nine galenas from various parts of the world (mostly from Germany), were measured in the mass spectrometer at Bonn and the model ages calculated in the usual manner. Three galenas that had previously been measured at Bern were also measured for comparison purposes; results agreed within the limits of error. The decay constants used for U^{238}, U^{235}, and Th^{232} were $1.54\times10^{-10}a^{-1}$, $9.80\times10^{-10}a^{-1}$, and $0.499\times10^{-10}a^{-1}$ yrs, respectively; 4.486×10^{9} was taken as the age when all lead had uniform isotopic composition; and $U^{238}/U^{235}=139$ as the present ratio of the uranium isotopes.

The model ages of galenas from Glückstal and Bergsegen, genetically very similar, are about 100 million yrs lower than their geologic age, showing that these are "J-type" ores (see Geophys. Abs. 175–258). Two samples are from the Maubacher Bleiberg deposit; one, from a galena-rich impregnation in the middle Buntsandstein (about 160 million yrs old) gives an age of $150\pm15\times10^{6}$ yrs; the other, from the walls of a Tertiary fracture (about 70 million yrs old) in the Buntsandstein, gives an age of $90\pm40\times10^{6}$ yrs. The last three samples, from Indonesia, Nigeria, and Lausitz (East Germany), are discussed elsewhere (see Geophys. Abs. 175–17).—*D. B. V.*

175–260. Russell, R. D., and Farquhar, R. M. Isotopic constitutions and origins of lead ores: Am. Inst. Mining Metall. Engineers Trans., no. 208, p. 556–559, 1957; and Mining Eng., v. 9, no. 5, p. 556–559, 1957.

A knowledge of isotopic ratios of common lead may assist in four different ways in understanding the genesis of ore deposits: in distinguishing leads arising from separate mineralizations, well illustrated by analyses of galena from the Cordillera region of western Canada where samples from deposits in Precambrian sediments have very different lead isotope ratios from those of ores in Paleozoic sediments; in estimating the age of deposits of *ordinary* lead (lead derived from a homogeneous mantle and incorporated directly into minerals); in determining the genetic relationships among anomalous leads such as those found in the Joplin-Tri-State area, at Sudbury, Ontario, and in the Broken Hill area, New South Wales, Australia; and the fourth is the general observation that the abundance ratios found in lead ores have been explained only by assuming that *ordinary* lead ores have come unchanged from a uniform source containing uranium, thorium, and lead (probably the mantle). If this last is true then most lead ores have come directly from the mantle during periods of orogeny.—*V. S. N.*

175–261. Cahen, L[ucien], Eberhardt, P[eter], Geiss, J[ohannes], Houtermans, F. G., Jedwab, J., and Signer, P[eter]. On a correlation between the common lead model age and the trace-element content of galenas: Geochim. et Cosmochim. Acta, v. 14, no. 1/2, p. 134–149, 1958.

Certain geological and geochemical aspects of leads whose "model" ages (based on isotopic composition) are older than their geologic ages have been investigated. For 20 leads from the Alps and 24 from North Africa the model age was compared to the age of the host formation or to that of the emplacement of the galena; the silver content of each of these galenas was also measured and compared to the model ages.

Almost all the galenas whose model ages are comparable to that of the host formation are found in veins, often with more or less obvious magmatic connections, and are silver-rich; the telethermal occurrences on the other hand are poor in silver and have model ages older than the host formation. This seems to bear out the concept that the latter type are "rejuvenated" from an older source of ore.

When the age of the host formation is known, isotope analysis of lead minerals and the model age derived from it contribute objective criteria for distinguishing between ores emplaced for the first time and those which are derived or rejuvenated. When the age of host formation is unknown, the silver content may furnish the same information.—*D. B. V.*

175–262. Sakai, Hitoshi, and Sato, Kazuo. Isotopic composition of the common lead of Japan: Geochim. et Cosmochim. Acta, v. 15, no. 1/2, p. 1–5, 1958.

Lead tetramethyl was synthesized from lead iodide isolated from 14 galenas, 2 anglesites and 6 pyromorphites of Japan. The mass spectrometric analysis was carried out for the peaks of lead and lead hydride ions. The isotopic compositions of leads from these minerals lie within a narrow range. The average values for galenas are 18.51 ± 0.05 for $^{206}Pb/^{204}Pb$, 15.60 ± 0.05 for $^{207}Pb/^{204}Pb$ and 38.76 ± 0.15 for $^{208}Pb/^{204}Pb$. For lead of secondary minerals they

are 18.52±0.05, 15.62±0.05 and 38.78±0.15 respectively. No detectable difference was observed between the isotopic compositions of primary and secondary lead ores.

The ratios, $^{238}U/^{204}Pb$ and $^{232}Th/^{238}U$, in the source magma are estimated from the lead abundances. They are 9.10~10.0 and 3.81~4.00, respectively.—*Authors' abstract*

175–263. Junk, Gregor, and Svec, Harry J. The absolute abundance of the nitrogen isotopes in the atmosphere and compressed gas from various sources: Geochim. et Cosmochim. Acta, v. 14, no. 3, p. 234–243, 1958.

The absolute isotopic abundance of nitrogen in atmospheric and compressed gas from various sources has been determined. Nitrogen gas standards, prepared by mixing separated nitrogen isotopes in the form of ammonium sulfate solutions, were used to calibrate two 60°-sector mass spectrometers. The absolute ratio of N^{14}/N^{15} in atmospheric nitrogen was found to be 272.0±0.3; small variations of this value were found for commercial compressed gas. Absolute accuracy was one part in 1,000. A reliable method was developed for correcting the observed N_2^{29+}/N_2^{28+} ratio for the background contribution.—*D. B. V.*

175–264. Thode, H. G., Monster, Jan, and Dunford, H. B. Sulphur isotope abundances in petroleum and associated material: Am. Assoc. Petroleum Geologists Bull., v. 42, no. 11, p. 2619–2641, 1958.

Study of the sulfur isotope ratios for petroleum from many different oil fields in the United States and Canada shows that the S^{34}/S^{32} ratio varies by about 4.5 percent as compared with a spread of 9 percent for terrestrial sulfur. The single large pools appear to be uniform in isotopic content; oils from the same reservoir rock from widely separated places in Alberta have similar sulfur isotope ratios, but their actual sulfur content may vary by a factor of 10. This indicates that there is little or no fractionation of sulfur isotopes in the maturation of the oil in which sulfur is lost. The fact that the H_2S and its associated petroleum have similar sulfur isotope content is further evidence for this view.

The sulfur isotope ratio therefore seems to give information on the isotopic content of the source sulfur at the time of petroleum formation, and this in turn would reveal something about the environment in which the petroleum formed. Very high S^{34} content of petroleum in recent sediments in the Uinta basin in Utah confirms their nonmarine origin. Decrease in S^{34} content with age and depth of petroleum deposit in the basin suggests gradual S^{34} enrichment of the sulfate in the enclosed lake probably due to bacterial action.—*D. B. V.*

175–265. Harrison, A. G., and Thode, H. G. Sulphur isotope abundances in hydrocarbons and source rocks of Uinta basin, Utah: Am. Assoc. Petroleum Geologists Bull., v. 42, no. 11, p. 2642–2649, 1958.

The sulfur isotope abundances in free asphalts, asphalts from supposed source rocks, and inorganic sulfur compounds of the source rocks of the Uinta basin of Utah are found to become more enriched in S^{34} with decreasing age and decreasing depth of the deposits, the youngest being enriched 31 °/₀₀ (°/₀₀= per mil deviations as compared with 20 °/₀₀ for sea water sulfate.

The results are consistent with and help to confirm an island sea or lake origin for the deposits of that area, and provide positive evidence for the

bacterial reduction mechanism of sulfur isotope fractionation. The hydrocarbon-source rock relations proposed by Hunt, Stewart, and Dickey (1954) are confirmed except in the case of ozocerite.—*D. B. V.*

175–266. Jensen, M[ead] L[eRoy]. Sulfur isotopes and the origin of sandstone-type uranium deposits: Econ. Geology, v. 53, no. 5, p. 598–616, 1958.

Isotopic study of 57 samples of sulfide minerals associated with sandstone-type uranium deposits of the Colorado Plateau and Wyoming showed S^{32}/S^{34} ratios between 21.93 and 23.32 with the majority highly enriched in the lighter isotope compared to the ratio of primordial sulfur, which is assumed to be the same as meteoritic troilities varying from 22.18 to 22.24. The ratios appear to be independent of mineral species, stratigraphic formation, occurrence within or without uranium ore zones or presence or absence of lignitic, woody, or other carbonaceous matter. The relatively broad spread of these high ratio values suggests that sulfate waters (possibly both connate and meteoric) in Mesozoic sediments of the Colorado Plateau were reduced by anaerobic bacteria to hydrogen sulfide when the waters encountered carbonaceous-rich zones which provided environment and energy source for the bacteria. The hydrogen sulfide may have remained where formed or migrated to areas barren of carbonaceous matter. Later, 60 to 75 million years ago, ore solutions encountered the effective reducing agent of hydrogen sulfide, bringing about the concentration of uranium through precipitation of soluble uranyl ions as relatively insoluble UO_2 and precipitating iron and copper sulfate as relatively insoluble sulfides.—*V. S. N.*

175–267. Vokes, F. M. A note on the sulphur isotope composition of chalcopyrite and pyrrhotite from the Moscogaissa mines, Birtavarra, Troms: Norges Geol. Undersökelse, Årb. 1957, no. 203, p. 130–132, 1958.

The stable sulfur isotope ratios S^{32}/S^{34} in two specimens of ore from the Birtavarra district in Norway, measured at Yale University, were found to be 22.21 for the chalcopyrite and 22.25 for the pyrrhotite. The close correspondence bears out the conclusion that these minerals were contemporaneous, or nearly so, in paragenesis.—*D. B. V.*

175–268. Sakai, H[itoshi], and Nagasawa, H. Fractionation of sulphur isotopes in volcanic gases: Geochim. et Cosmochim. Acta, v. 15, no. 1/2, p. 32–39, 1958.

The $^{34}S/^{32}S$-ratios in several samples of SO_2 and H_2S from the fumaroles of Volcano Showashinzan, Japan, were measured. The outlet temperature of the fumaroles from which the samples were collected ranged from 100 to 661°C. It was observed that the lower the outlet temperature of the fumarole, the higher the content of the heavy isotope in the SO_2. The isotopic ratio of H_2S was found, on the other hand, to be almost constant throughout the range of temperature given above. This isotopic fractionation between SO_2 and H_2S was ascribed to the reaction: $H_2S+2H_2O \rightleftarrows SO_2+3H_2$. The temperatures estimated from the observed fractionation factors and the theoretical ones were in fairly good agreement with the observed outlet temperatures.

The isotopic ratio of both compounds can be reasonably explained by a simplified system containing only H_2S, H_2O, SO_2 and H_2. But some difficulty arises when the chemical compositions of the actual fumaroles are taken into consideration.—*Authors' abstract*

MAGNETIC FIELD OF THE EARTH

175–269. International Geophysical Year Bulletin No. 17. Status of geomagnetism program: Am. Geophys. Union Trans., v. 39, no. 6, p. 1201–1205, 1958.

The International Geophysical Year geomagnetism program is concerned mainly with the transient fluctuations characterizing the externally generated magnetic field of the earth. Networks of stations have been established with the broad objective of recording synoptically the variations in the earth's magnetic field. The frequency band primarily under study ranges from about 50 cycles per sec to one cycle per yr. Records obtained at the four Antarctic observatories furnish material for the study of magnetic storm conditions as a worldwide phenomenon, and the variometer on the drifting station in the Arctic ice pack supplies information on general magnetic activity well within the auroral zone.

At present, processing of the records of the east-west network of stations in continental United States consists only of tabulating mean hourly values. A South American network is collecting information which will throw light on the equatorial electrojet; preliminary examination of records indicates that many of the vertical-component fluctuations related to solar disturbances are greatest in the same latitudes where the largest quiet day solar tidal variation in this component was observed, and the sign of the fluctuations is opposite at these two latitudes indicating electrojet effects.

Preliminary study of records of the Koror observatory in the Palau Islands, almost exactly on the magnetic equator, definitely supports the existence of a zone of markedly enhanced geomagnetic activity, including a very large daily variation of the horizontal component, and suggests that the source of the disturbance—the equatorial electrojet—lies slightly north of the observatory, perhaps as much as 100 km, for at least part of the year. Records from the Jarvis-Palmyra-Fanning stations also tend to support other observations of electrojet effects near the equator.

Rapid-run magnetographs are now operating at all primary IGY observatories and at Barrow and Sitka in Alaska; Tucson, Arizona; and Honolulu, Hawaii. Visible-recording one-component variometers are being used at ionospheric recording stations to help correlate their observations with the general level of magnetic activity. The subaudio frequency project investigates the nature of signals in the range of 1 to 50 cycles per sec that precede magnetic disturbances in the auroral zone by about a day. At lower latitudes, such stations can furnish a running index of the worldwide level of thunderstorm activity.—*D. B. V.*

175–270. Rikitake, Tsuneji. Oscillations of a system of disk dynamos: Cambridge Philos. Soc. Proc., v. 54, pt. 1, p. 89–105, 1958.

The behavior of two disk dynamos coupled to one another is examined in relation to the earth's magnetic field. It is found that reversals of electric current and magnetic field occur, unlike the case of a single disk dynamo. This suggests that reversals of the earth's magnetic polarity might be able to take place because of the possible couplings between various stages of dynamo action in the core, in which magnetic fields and fluid motions of many types are likely to occur.

A number of investigators have worked to establish the steady state of the earth's dynamo (see Geophys. Abs. 141–11935, 156–31, 157–25); but a nonsteady dynamo is also important because it might account for the past behavior of

the earth's field. A dynamo which is stationary in the mean in the sense of Elsasser (see Geophys. Abs. 170–225) is useful to study the averaged state of a series of dynamo elements.

A possible range of heat fluctuation related to changes in the magnetic field of a dynamo system is very approximately estimated as a few hundred degrees centigrade.—*D. B. V.*

175–271. Allan, D. W. Reversals of the earth's magnetic field: Nature, v. 182, no. 4633, p. 469–470, 1958.

Numerical integrations of Rikitake's equations for two coupled disk dynamos, carried out with the aid of a digital computer, show that reversals can occur under a wide range of conditions. The significance of the results lies largely in the fact that the phenomenon of reversal can occur both in the sense of a change of polarity and in the sense of a true reversal of behavior corresponding to a change from oscillations about one state of equilibrium to those about another. In a similar way, reversals of the earth's field may be occasional phenomena in the course of continual oscillations of considerable amplitude. Thus oscillations of the main field with a period of some thousands of years, with reversals at intervals of hundreds of thousands of years, would be quite conceivable.

There is no guarantee that the homogeneous dynamo believed to exist in the earth's core will behave similarly to two coupled dynamos; models more closely analogous to the former will be examined. Nevertheless, the fact that large scale oscillations in this simple system can lead to reversals surely indicates that the reversals of the earth's main field are not beyond conjecture.—*D. B. V.*

175–272. Dauvillier, Alexandre. Sur l'origine et le maintien du géomagnétisme, sa variation séculaire et ses inversions [On the origin and maintenance of the earth's magnetic field, its secular variation and its reversals]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 9, p. 1354–1356, 1958.

Dauvillier suggests that the origin and maintenance of the geomagnetic field, its secular variation, and reversals have a common explanation: that the entire field is due to fossil thermoremanent magnetization, acquired by ferruginous lavas poured out in oceanic troughs, the "lunar seas" of the primitive earth. This magnetization took place in a reducing medium in the course of cooling of the magnetite to the Curie point under the action of solar corpuscular radiation.

Secular variation reflects displacements of the critical isothermal Curie point surface; the thermal state of this surface depends on local radioactivity, convection in the subjacent magma, and on heat conductivity, which in turn depend on erosion, sedimentation, isostatic movements, volcanism, and structural conditions. Thus southern Africa, where secular variation is rapid and strong today, has a particularly high geothermal gradient. This concept brings out a relationship between local secular variation, volcanism, and orogenesis. Worldwide secular variation is the statistical effect of all local variations. The magnetic moment of the globe is constantly renewed by the external cosmic magnetic field of the earth every time the critical isothermal level is lowered.

Inverse magnetization is explained by displacement of the crust *as a whole* with respect to the almost invariable axis of rotation (with which it coincided before the condensation of the oceans and appearance of atmospheric oxygen); during the displacement it took some position in relation to the moon's axis,

but remained fixed with respect to the geography of the earth's surface. Every time a new basalt cooled, it became magnetized in the cosmic magnetic field and thus acquired a magnetization opposite to that of the fossil magnetism of the surounding rocks.—*D. B. V.*

175–273. Knopoff, Leon, and MacDonald, Gordon J. F. The magnetic field and the central core of the earth: Royal Astron. Soc. Geophys. Jour., v. 1, no. 3, p. 216–223, 1958.

The suggestion that the inner core of the earth is liquid and is the seat of a strong magnetic field is examined. Contrary to expectations of a magneto-hydrodynamic rigidity for the inner core, it is shown that a liquid inner core with a strong magnetic field should not transmit shear waves. The absence of the phase *PKJKP* in seismic records is favourable to the hypothesis of a strong magnetic field in a liquid inner core. If the jump in *P* wave velocity at the inner core boundary is due to a magnetic field, the strength of the field must be of the order of 5×10^6 gauss whether the field geometry is toroidal or random. A strong toroidal field leads to an apparent ellipticity of the inner core. No such ellipticity is observed, so that if the field in the inner core is toroidal, it must be less than 5×10^5 gauss. A random field does not lead to an ellipticity effect and no limit can be set on the magnitude of a random field.

The energy required for a magneto-hydrodynamic rigidity in the inner core is excessive. The magnetic energy is equally divided between the inner and outer cores. The hypothesis of a strong magnetic field in the inner core cannot explain the observed short period variations of the surface field.—*Aurthors' summary*

175–274. Zmuda, Alfred J. A method for analyzing values of the scalar magnetic intensity: Jour. Geophys. Research, v. 63, no. 3, p. 477–490, 1958.

Various studies on the interaction between charged particles and the geomagnetic field indicate the existence of a source of magnetism located above the earth's surface. It is likely that for the near future, magnetic studies connected with the external source and with upper-air magnetic properties in general, will be conducted primarily with magnetometers measuring only the magnitude of the intensity, not its direction. With this type of data, the customary methods of analysis are not applicable.

An appropriate analytic method is treated which utilizes a series for the square of the scalar magnetic intensity. The terms of this series are obtained through the use of the series of spherical harmonics generally applied to each component of the intensity. Through an analysis of scalar intensity alone, the method yields the magnetic characteristics that are normally obtainable through a spherical harmonic analysis of the vector magnetic intensity. Also, the variation with altitude of the magnetic equator is treated in conjunction with the location of the equator for cosmic rays.—*Author's abstract*

175–275. Whitham, Kenneth. The relationships between the secular change and the non-dipole fields: Canadian Jour. Physics, v. 36, no. 10, p. 1372–1396, 1958.

Using airborne, ground, and repeat magnetic observations in Canada, compiled in the isomagnetic and isoporic charts for epoch 1955.0, the drift and decay contributions of the non-dipole field to the observed secular variation have been estimated. The drift rates which produce the minimum residual

secular variation were found to be unusually small. It is then confirmed, using the longitude displacement method and isomagnetic data only, that the westward drift of the non-dipole field in recent years in Canada is significantly smaller than the world-wide average. These results clearly demonstrate the large local fluctuations which occur in westward drift.

The two different methods were applied to obtain relationships between the Gaussian coefficients in the spherical harmonic analyses of the earth's main field and the secular variation. Calculations show that both methods give the accepted world-wide average value of westward drift, that one half of the world-wide secular variation is produced by westward drift, and in general decay terms are unimportant.—*Author's abstract*

175–276. Nagata, Takesi, and Rikitake, Tsuneji. Geomagnetic secular variation during the period from 1950 to 1955: Jour. Geomagnetism and Geoelectricity, v. 9, no. 1, p. 42–50, 1957.

The geomagnetic secular variation during the period from 1950 to 1955 is estimated on the basis of annual mean values of the geomagnetic field at some seventy magnetic observatories distributed all over the earth. Judging from the spherical harmonic analysis of the variation, it seems likely that the magnetic moment of the earth's dipole is still decreasing.—*Authors' abstract*

175–277. Krzemiński, Wojciech. Establishment of net of secular variation stations in Poland: Polish Acad. Sci. Comm. of Geodesy and Inst. of Geodesy and Cartography (Report from 11th General Assembly of Internat. Union of Geodesy and Geophysics, Toronto, 3–14 September 1957), 5 p., 1957.

A network of 21 secular variation stations was established in Poland late in 1955. Pertinent data concerning these stations are tabulated giving name, latitude, longitude, altitude, approximate value of ΔZ (based on a value of 350γ adopted for Świder), date of occupation, and authors cited. Reoccupation of all points was planned for 1957 and every three years after that.—*D. B. V.*

175–278. Duclaux, Françoise, and Will, Rolland. Premiers résultats sur la variation diurne lunaire de la composante horizontale du champ magnétique terrestre à Tamanrasset [First results on the lunar diurnal variation of the horizontal component of the earth's magnetic field at Tamanrasset]: Acad. Sci. Paris Comptes Rendus, v. 246, no. 16, p. 1220–1222, 1958.

The lunar diurnal variation of the horizontal component of the geomagnetic field has been determined from eight years' records at the Tamanrasset observatory in Algeria. The maximum amplitude of this variation is 4γ, and it is greater in winter than in summer. The diurnal and semi-diurnal terms are of the same order of magnitude.—*D. B. V.*

175–279. Kurali, Ferencné. A földmagneses elemek menetének összehasonlítása néhány obszervatórium 1950–55 évi adatai alapján [A comparison of the course of the geomagnetic elements at some observatories in the years 1950–1955 (with English summary)]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, v. 7, no. 2, p. 101–109, 1958.

Comparison of annual, monthly, daily, and hourly mean values of the magnetic elements at the Istanbul-Kandilli, Budakeszi, Pruhonice, Niemegk, and

Rude Skov observatories shows that the data of the temporary Budakeszi observatory near Budapest which was in use in 1948–1955, are reliable and fit well with the data of the other European observatories.—*D. B. V.*

175–280. Pawłowski, Stanisław. Variations des éléments magnétiques à Świder par rapport à Potsdam [Variations of the geomagnetic elements at Świder with respect to Potsdam]: Acad. Polonaise Sci., Comité de Géodésie (Communication présentée a l'onzième assemblée générale de l'Union Géodésique et Géophysique Internationale, Toronto, 3–14, Septembre 1957), 10 p., 1957.

Analysis of numerous measurements show that the geomagnetic elements in Poland do not vary uniformly. Comparisons between observations at Świder and Potsdam show the general character and trends of the variations. In 1921–1942 the variation in vertical and horizontal components at Świder was 150 percent of the variation observed at Potsdam, but variations in declination (at present westward at both observatories) were slower at Świder. Phase differences complicate the comparisons of secular variations at different points.—*D. B. V.*

175–281. Unteidt, J. Über die direkte Aufzeichnung erdmagnetischer Vektogramme [On the direct recording of geomagnetic vectograms]: Zeitschr. Geophysik, v. 24, no. 3, p. 125–133, 1958.

The time variations of plane-projected geomagnetic disturbances have been recorded for the past two years in Göttingen, Germany, by means of direct-recording vectographs. The principle and construction of these vectographs are described and illustrated, and vectograms are reproduced and discussed of a loop disturbance, *bp* (formerly *psc* disturbances), "Mittagsschwingen" ("midday oscillations") and magnetic storms.—*D. B. V.*

175–282. Bryunelli, B. Ye., and Nizyayev, D. A. Mangitograf s vidimoy zapis'yu [Visual-recording magnetograph]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 1064–1068, 1957.

This paper describes a magnetograph which records geomagnetic variations visually for use when variations in field intensity must be observed instantly and directly. The apparatus consists of three parts, a variometer, transmitting element, and pen recorder. The curve is traced on paper tape by dots made at one minute intervals. Photographs and diagrams are given. The instrument is manufactured by the experimental workshop of the Soviet Arctic research institute.—*S. T. V.*

175–283. Pavlov, T. S. Vliyaniye na nyakoi faktori vŭrkhu magnitniya moment na magnitometrite [Influence of certain factors on the magnetic moment of magnetometers]: Minno Delo, no. 5, p. 85–91, 1955.

The paper discusses the electromagnetic origin of the magnetic moment of an atom, the fundamental properties of a magnetic field, and ferromagnetics. On this basis Pavlov shows that the permanent magnets in the systems of Schmidt, Tiberg-Thalén, Fanselau, and other magnetometers change their magnetic moments when subjected to blows, shaking, varying temperature, other external magnetic fields (induced and natural), long usage (aging), and other factors, any one of which results in a systematic error.—*A. J. S.*

175–284. Bobrov, V. N. O vliyanii vlazhnosti na pokazaniya magnitnykh priborov [Effect of moisture on the readings of magnetic instruments]: Nauchno-issled. Inst. Zemnogo Magnetizma Trudy, no. 11(21), p. 87–100, 1955.

The effect of moisture condensed on the parts of *Z*-variometers, *H*-variometers, and the vertical magnetic balance was investigated at the Irkutsk magnetic observatory in 1951 and later at the central magnetic observatory of the geomagnetic research institute in Moscow. The systematic displacement of the base values of *Z*-variometers observed previously in the practical work of magnetic observatories, and the systematic errors in *H*-variometers and the vertical magnetic balance, were found to be caused by the condensation of atmospheric moisture on the apparatus. Airtight enclosures for the instruments are recommended in order to avoid errors which otherwise may reach tens and even hundreds of gammas.—*A. J. S.*

175–285. Małkowski, Zdzisław. Porównanie wskazán magnetometru BMZ_{86} z bazami obserwatoriów w Rude Skov i w Świdrze [Comparison of BMZ_{86} magnetometer with base lines of the observatories in Rude Skov and Świder]: Acta Geophys. Polonica, v. 6, no. 2, p. 173–185, 1958.

The results of comparative measurements made in August 1957 with a BMZ–86 magnetometer at the Rude Skov observatory in Denmark (10 series of measurements) and Świder observatory in Poland (11 series) are presented as a supplement to a previous paper (see Geophys. Abs. 173–277). It was found that the instrument gave a value 39.5 ± 0.3 γ higher than the Rude Skov standards and 31.9 ± 0.8 γ higher than the Świder standards; therefore the difference between the standards was 7.5 ± 1 γ.—*D. B. V.*

MAGNETIC PROPERTIES AND PALEOMAGNETISM

175–286. Stacey, F. D., and Parry, L. G. A modification of the method of E. R. Deutsch for the magnetic hysteresis of rocks: Jour. Geomagnetism and Geoelectricity, v. 9, no. 3, p. 157–161, 1957.

The magnetization of rock specimens can be determined from Lissajous-type figures by the method described by Deutsch in which the voltage from a resistance in series with the coil provides horizontal deflection while a search coil in the specimen gap provides vertical deflections. This arrangement may be satisfactory provided there is no phase lag between the magnetizing current and the field. Examination of phase lag of several chokes was examined and phase lags as high as 32 degrees were measured; further, lag varied with flux. A suitable winding and core construction was found with a phase lag of less than 3.5 degrees essentially flat in the range of 1,000 to 2,000 emu. This lag will introduce unacceptable errors, but corrections may be applied if it varies sinusoidally. Since this is not so, it is best to discard the magnet current as a measure of field strength and to integrate the field strength of a search coil voltage.—*W. J. D.*

175–287. Schriever, William. Para– and diamagnetic susceptibilities in nonfluctuating weak fields: Geophysics, v. 23, no. 4, p. 712–725, 1958.

A Coulomb torsion balance apparatus was developed with which absolute measurements of para– and diamagnetic susceptibilities could be made in non-

fluctuating field strengths of the order of 1 oersted. Solid specimens of the diamagnetic elements bismuth, antimony, and cadmium, were measured in fields of 2.5, 5, and 10 oersteds, and the para-magnetic powders, $FeCl_3$, $FeSO_4+7\ H_2O$, and $Co_2(SO_4)_3+7\ H_2O$, in fields of 2, 3, and 5 oersteds. The susceptibilities decreased with increasing field strengths. A specimen of bismuth granules had lower susceptibilities than did the solid specimen made from the same supply of granules.

A semi-micro balance apparatus also was constructed for absolute measurements in fields ranging between 100 and 1,000 oersteds. The susceptibilities of the diamagnetic specimens and a water specimen were measured. The solid bismuth, antimony, and cadmium specimens and a water specimen exhibited constant susceptibilities. The susceptibility of the bismuth-granule specimen increased regularly from -4.67 to -7.87×10^{-6} cgs when the field increased from 100 to 900 oersteds. The value found for water (-0.73×10^{-6}) agreed well with the International Critical Tables value (-0.72×10^{-6} cgs).—*Author's abstract*

175–288. Kalashnikov, A. G., Petrova, G. N., and Grabovskiy, M. A. Nekotorye resul'taty izucheniya magnitnykh svoystv gornykh porod i geologicheskikh tel [Some results of investigation of the magnetic properties of rocks and geological bodies]: Akad. Nauk SSSR, Komitet po geodezii i geofizike, Tezisy dokladov na XI general'noy assamblee Mezhdunarodnogo Geodezicheskogo i Geofizicheskogo Soyuza [Theses of papers presented at the 11th general assembly of the International Union of Geodesy and Geophysics], p. 5–7, 1957.

A study of the magnetization of natural ferromagnetic rocks and of artificial rocks containing up to 10 percent of magnetite showed that the direction of remanent magnetization coincides with that of the magnetizing field only in the central part of the rock; in the outer layers the direction of remanent magnetization differed more or less from the direction of the magnetizing field. It was also found that the distribution of the outer magnetic fields of uniformly magnetized natural ferromagnetic rocks differs greatly from that of non-uniformly magnetized natural rocks; this could lead to substantial error in calculations of magnetic anomalies of strongly magnetized rocks. The vector of remanent magnetization of thermomagnetized bodies of magnetite was found to be quite different from that of bodies of isothermic and homogeneous magnetization.

Such factors as permanent and variable fields, temperature, and time, that may change the value of the vector of magnetization, are discussed; rocks of greater coercive force are found to be more stable.

In metamorphic rocks the remanent magnetization along the layers was many times stronger than that across layers. In the case of two layers the one having the larger coercive force and smaller Curie temperature is magnetized in the direction opposite to that of the magnetizing field.—*A. J. S.*

175–289. Pascu, Mihail B. Contributiuni la studiul susceptibilităţí magnetice a rocelor şi minereúrilor din R.P.R. [Contributions on magnetic susceptibility of rocks and minerals of the Rumanian People's Republic]: Anuarul Comitetulni geol. v. 29, p. 77–124, 1956.

After a historical review of field and laboratory investigations of the magnetic properties of Rumanian rocks and minerals, the results of measurements of magnetic susceptibility of 44 samples of igneous rocks and magnetite are

presented. The susceptibility of magnetite was found to vary from 0.138 to 0.398, that of granodiorite from 0.00130 to 0.00432.—*A. J. S.*

175–290. Akimoto, Syun-iti, Katsura, Takashi, and Yoshida, Minoru. Magnetic properties of $TiFe_2O_4$-Fe_3O_4 system and their change with oxidation: Jour. Geomagnetism and Geoelectricity, v. 9, no. 4, p. 165–178, 1957.

A solid solution series $x TiFe_2O_4 \cdot (1-x)\ Fe_3O_4$ was synthesized over the whole range of composition $1 \geqq x \geqq 0$. Changes of Curie point, saturation moment, and lattice parameter were examined. Generalized titanomagnetite having some vacancies in the structure normally occupied in a spinel was also prepared by oxidizing the $TiFe_2O_4$-Fe_3O_4 solid solution series. The region in the FeO-Fe_2O_3-TiO_2 ternary system within which the spinel structure can exist as a single phase was established. Equal lattice parameter lines and equal Curie point lines drawn on this system for generalized titanomagnetite resemble each other closely, whereas the equal saturation moment line is very different and intersects the others. The diagrams show that the chemical composition having a definite lattice parameter or Curie point is not represented by a point but by a line on the FeO-Fe_2O_3-TiO_2 system, so that their chemical composition cannot be determined from measurement of either value; if saturation moment of the specimen is measured at the same time, however, the chemical composition can be fixed at a single point.—*D. B. V.*

175–291. Uyeda, Seiya. Thermoremanent magnetism as a medium of palaeomagnetism, with special reference to reverse thermoremanent magnetism: Japanese Jour. Geophysics, v. 2, no. 1, p. 1–123, 1958.

After a general introduction and brief review of rock magnetism, the thermoremanent magnetism (TRM) of various ferromagnetic minerals is examined systematically. The thermal variations of magnetization, remanent magnetization, coercive force, remanent coercive force, Q-ratio, field dependence and thermal and magnetic stabilities of TRM, and the relationships between TRM and coercive force and other properties were studied on specimens of titanomagnetite, pyrrhotite, hematite, and metallic nickel. The phenomenon of thermoremanent magnetization was found to be universal to all ferromagnetic substances and to be governed by their coercivity. The TRM of metallic nickel and synthetic titanomagnetites was found to be less stable than that of natural rocks. A practical method for testing stability of natural remanent magnetization is proposed, using alternating current demagnetization.

The greater part of the paper is devoted to the question of reverse thermoremanent magnetization. Various possibilities of self-reversal are reviewed critically. Experiments established the fact that the reverse TRM in the Haruna pumice, in which it was first discovered, is an intrinsic property of the ferromagnetic ilmenite alone, rather than a product of interaction between the ilmenite and titanomagnetite. The whole ilmenite-hematite solid solution series was studied systematically using synthetic specimens. It was found that reverse TRM is really a characteristic of the members ($x \fallingdotseq 0.5$) of this series and that the interaction producing reverse TRM must originate from a kind of exchange interaction over the phase boundary. A comprehensive model of reverse thermoremanent magnetization is presented, based on this new type of interphase interaction, in which the two participating constituents are parasitically ferromagnetic titanhematite and ferromagnetic ilmenite, intermingled with good atomic coherency. The most outstanding evidence for the relevance

of exchange interaction is that reverse TRM can be produced even in a magnetic field as intense as 17,000 oersteds. The imperfect reverse magnetization of ilmenite-hematite from the Adirondacks and from Allard Lake (Canada) is attributed to the ($x \doteqdot 0.1$) members of the ilmenite-hematite solid solution.—*D. B. V.*

175–292. Pavlov, T. [S.]. Ostatŭchnoto namagnitvane na skalite i rudnite tela i negovoto znacheniye za geomagnitnoto prouchvane [Remanent magnetization of rocks and ores, and its importance to geomagnetic research]: Minno Delo, no. 1, p. 85–91, 1957.

After a discussion of the processes of magnetization in ferromagnetics Pavlov attempts to explain the origin of remanent magnetization. Considering the fact that in many cases the remanent magnetization is greater than the earth's magnetic field can induce in the same rock, Pavlov shows that natural remanent magnetization is due to thermostatic magnetization at the pre-Curie point of maximum magnetization; he disagrees with the hypothesis that high natural magnetization originated at some past period of the earth's history when its magnetic field was much stronger. He refers to the investigation of several Soviet geophysicists who have found that magnetite heated above Curie point and left to cool in the earth's magnetic field acquires remanent magnetization proportional to the coercive force of the rock. Among other causes which produce remanent magnetization he considers magnetostriction, lightning bolts, and metamorphism of high temperature magmatic rock which changes its structure and magnetic properties under a change in pressure. Geotectonic stresses exerted on magnetostrictive rocks produce electric current in rock and the consequent electromagnetic field may be sufficient to magnetize the rock. The remanent magnetization of gabbro from Bulgaria is from 250×10^{-6} to $29{,}000 \times 10^{-4}$ CGSM, and that of magnetite reaches $2{,}314{,}000 \times 10^{-6}$ CGSM. Reversed polarity is explained according to Bersudskiy's hypothesis as developed by Grabovskiy and Pushkov (see Geophys. Abs. 158–59). The negative anomalies at the villages of Golyamo Krushevo, Elkhovsko ($\Delta Z = -10{,}000\gamma$), and at Rosen and Burgasko (ΔZ=up to $-30{,}000\gamma$), remain unexplained.—*A. J. S.*

175–293. Balsley, J[ames] R., and Buddington, A. F. Iron-titanium oxide minerals, rocks, and aeromagnetic anomalies of the Adirondack area, New York: Econ. Geology, v. 53, no. 7, p. 777–805, 1958.

From studies of about 200 samples of metamorphic and igneous rocks from the Adirondacks it has been possible to relate the magnetic oxide assemblage to the lithology of the rocks and to their magnetic properties so that the magnetic anomaly produced by a particular rock type can be estimated. The intermediate members of the Fe_2O_3–$FeO.TiO_2$–(TiO_2) system are found almost uniformly to have *reverse* remanent magnetism and as much as several percent of disseminated magnetic oxides of this system may give rise to intense negative aeromagnetic anomalies. Where both magnetite and magnetic oxides of the Fe_2O_3–$FeO.TiO_2$–(TiO_2) system occur together in the same rock the resultant magnetic properties are such as to indicate that the magnetite grains have *normal* or positive remanent magnetization and the grains of the magnetic oxides of the Fe_2O_3–$FeO.TiO_2$–(TiO_2) system have *reverse* or negative remanent magnetization. The value of the reverse magnetism of titanhematite, ilmenohematite, and rutiloilmenohematite is such that it can neutralize the total positive magnetism (remanent magnetism plus induced magnetism) of an equivalent or greater amount of magnetite. In the metamorphism of a pyroxene gabbro, giv-

ing a positive magnetic anomaly, to a hornblende-plagioclase amphibolite, the primary magnetite may be taken up by the hornblende, leaving ferrian ilmenite as the only oxide and the amphibolite may then give a neutral or negative anomaly.

Various investigators have suggested that the reverse magnetization of rocks is produced by a reversal of the earth's magnetic field at the time they cooled through the Curie point. This hypothesis does not seem to fit the geological, chemical, and magnetic data for the Adirondack rocks, for the reverse magnetization here appears to be related to the content of the intermediate members of the Fe_2O_3–$FeO.TiO_2$–(TiO_2) system. These mineral mixtures have the property of "self-reversal," that is, the ability to become magnetized in a direction opposite to that of the existing magnetic field. Until the existence of "self-reversal" can be disproved, one cannot state categorically that the reversed magnetization of a rock has been produced by a reversed field of the earth.—*Authors' abstract*

175–294. Almond, Mary, Clegg, J. A., and Jaeger, J. C. Remanent magnetism of some dolerites, basalts and volcanic tuffs from Tasmania Philos. Mag., v. 1, no. 8, p. 771–782, 1956.

Magnetic measurements have been made on a number of samples of drill cores of Tasmanian dolerites, basalts, and tuffs varying in age from the Triassic to the early Tertiary. The magnetic dip of all these rocks is about 85°, significantly greater than the present magnetic dip in Tasmania which has a value of 70°. This result is believed to furnish strong evidence of support of the hypothesis that relative movement has occurred between the land mass of Tasmania and the geographical pole since the early part of the Tertiary period. The upper 700 feet of the doleritic sill is commonly magnetized normally and the lower part is reversed. One five-inch section of a continuous five-foot core was found to be reversely magnetized although the remainder of the core was magnetized normally. The magnetic material in both the normal and reversed section of the core was found to be pyrrhotite and no differences in the chemical, mineralogical, and magnetic properties of the two types of rock were detected. Because all the material in the five-foot core was apparently continuously deposited over a short period of time, it is not likely that the reversal is produced by a change in the earth's magnetic field and there is no evidence that slumping or other sedimentary reorientation occurred. It appears that the reversal of magnetization must have been produced by heating or by some long-period process but there should be differences between the normal and reverse specimens. These have not been detected but the tests may not have been sufficiently sensitive. Although there is strong presumptive evidence that supports the belief that the earth's magnetic field has reversed at times during the past geologic ages this does not appear to be a likely explanation for the reversal of the five-inch section. Until more searching laboratory tests can be developed to investigate the self-reversing mechanism of magnetic materials, every case of magnetic reversal in rocks must be treated on its own merits and its implications must be considered with reserve.—*J. R. B.*

175–295. Nagata, T[akesi]; Akimoto, S[yun-iti]; Uyeda, S[eiya]; Shimizu, Y[asuo]; Ozima, M.; Kobayashi, K.; and Kuno, H[isashi]. Paleomagnetic studies on a Quaternary volcanic region in Japan: Jour. Geomagnetism and Geoelectricity, v. 9, no. 1, p. 23–41, 1957.

A more detailed version of the article published under the same title in Advances in Physics, v. 6, no. 23, 1957 (see Geophys. Abs. 171–269).—*V. S. N.*

175–296. Cook, R. M. Intensity of remanent magnetization of archaeological remains: Nature, v. 181, no. 4620, p. 1421–1422, 1958.

Roman kilns were easily controlled, so measurements of the intensity of remanent magnetization of completely oxidized pottery should be reliable. It would be interesting to compare the intensity with that of common reduced ware of the same period to see if reduction had any effect. If the fears of Atwater and Ellickson (see Geophys. Abs. 172–167) should prove groundless, then it should be possible to determine the magnetic intensity and from it the initial activity of radiocarbon in the last four or five thousand years.

Two problems must also be examined—first, whether intensity of remanent magnetism decays slightly with time, and second, whether cosmic ray influx varies. The former can be tested by measurements of the remanent magnetism of accurately dated bricks or pottery made since A.D. 1830, for reliable observations of changes in the earth's field go back to that date. The latter can be tested on sites offering both radiocarbon specimens and structures or objects possessing remanent magnetization, which can be dated precisely by historical records or archeological context.—*D. B. V.*

175–297. Irving, E. Paleogeographic reconstruction from paleomagnetism: Royal Astron. Soc. Geophys. Jour., v. 1, no. 3, p. 224–237, 1958.

A graphic method for constructing maps of the position of continents in the past from paleomagnetic data is presented in which it is assumed that one continent and its poles are fixed and the other continents are moved in order to unify equivalent poles. As illustrations, results from Europe, Australia, Africa, South America, and India are used to prepare maps of their possible relative positions in the past.

If continental drift has happened as periods of movement separated by standstills during which polar wandering occurred, then coincidences will arise for all continents; if such coincidences should happen frequently the probability of their being significant becomes very great. It is not unlikely that relative longitudes will be more closely defined in this way, and a very limited number of solutions, perhaps even a unique solution, may arise. With the exception of India, the variations of geomagnetic latitude observed in different continents can be explained by polar wandering, and continental drift has for the most part succeeded in changing only their relative longitudes. If this statement is borne out by future observations, it will be the most important feature to be incorporated into any dynamic theory of continental drift.—*D. B. V.*

175–298. Veldkamp, J. Paleomagnetische metingen [Paleomagnetic measurements]: Geologie en Mijnbouw, v. 20, no. 11, p. 372–375, 1958.

The importance of "cleaning" paleomagnetic samples before measuring cannot be overestimated. Unstable magnetization must be removed by demagnetization, subjecting the sample to a changing magnetic field of increasing strength, and inclination must be corrected for. Without these corrections, calculations of pole positions are worthless and can lead to very erroneous conclusions concerning polar wandering and continental drift.—*D. B. V.*

175–299. Gough, D. I. The magnetic record of the rocks: Rhodesian Mining Jour., v. 30, no. 373, p. 156–157, 1958.

A popular discussion of paleomagnetism. The possibilities of practical application of rock magnetism to mining problems are currently being investigated by Gough.—*D. B. V.*

Rikitake, Tsuneji. Oscillations of a system of disk dynamos. See Geophys. Abs. 175–270.

Allan, D. W. Reversals of the earth's magnetic field. See Geophys. Abs. 175–271.

MAGNETIC SURVEYS

175–300. Hutchison, Ralph D[elamere]. Magnetic analysis by logarithmic curves: Geophysics, v. 23, no. 4, p. 749–769, 1958.

The standard expression for the anomaly of a magnetized dyke consists of two elementary functions which in practice are easily separable. Under certain conditions, these functions have a simple symmetry which makes them plottable as families of logarithmic master curves; and in each family there is a systematic change of shape corresponding to a depth per breadth parameter of the dyke. On this basis the problem of analysis can be made as simple and direct as the method commonly used for depth determinations by electrical resistivity. In addition to the dyke model, two other closely related classses are developed which thus provide master curves that can be used for a large variety of two-dimensional anomalies.—*Author's abstract*

175–301. Stupak, N. K., and Tyapkin, K. F. Interpretatsiya mestnykh magnitnykh anomaliy obuslovlennykh nekotorymi tektonicheskimi narusheniyami [Interpretation of local magnetic anomalies resulting from certain tectonic disturbances]: Glavupr. Gidrometeorolog. Sluzhby Trudy, no. 11(21), p. 81–86, 1955.

The magnetic anomalies of a symmetrical anticline and of a vertical fault, both uniformly magnetized, are expressed in the form of profile curves $T(x)$, $Z(x)$, and $X(x)$ calculated for a plane uplifted along a line to form an anticline, and for a fault having a throw d. Formulas are derived for determining the depth of the basement, thickness of the anticlinal layer, and dip angle of the anticline; and the depth of the basement, depth of the stratum, throw of the fault, and plane of the fault. The values of the horizontal components needed for the solution of the problem can be calculated from the values of Z.—*A. J. S.*

175–302. Zhogolev, L. P. Paletki dlya opredeleniya zaleganiya namagnichennykh tel s pomoschchiyu vyschikh proizvodnykh magnitnogo potentsiala [Master charts for the determination of the position of magnetized bodies with the aid of higher derivatives of the magnetic potential]: Leningrad Univ. Uchenyye Zapiski no. 249, p. 237–242, 1958.

The use of higher derivatives in geophysical exploration offers certain advantages in the determination of the upper boundary of the disturbing bodies, because the value of these derivatives is little affected by the remote portions of the bodies. This effect further decreases with increase of the order of the derivatives. Thus the effect of the lower boundary of a relatively thin vertically magnetized stratum on the value of its vertical component Z is about 33 percent, whereas its effect on the second derivatives Z''_{xx} or Z''_{zz} is only four percent. In the case of two-dimensional bodies it is possible to use the first derivative of the vertical component, Z'_x.

Zhogolev has computed the logarithmic master chart of Z'_x for a layer of infinite extent and infinite depth. Numerical values of the depth of the plate

are given in a table for various ratios of the width of the plate to the depth of its upper boundary. (See also Geophys. Abs. 172–175.)—*S. T. V.*

175–303. Loo, Syan'–Dun, and Jou, Chi–Syan. Ispol'zovaniye vysshikh proizvodnykh magnitnogo potentsiala dlya vychisleniya glubiny zaleganiya namagnichennykh tel [Application of the magnetic potential higher derivatives in calculating the depth of magnetized bodies]: Leningrad. Gornogo Inst. Sbornik nauch. rabot studentov, no. 2, p. 64–73, 1957.

Loo and Jou develop Logachev's method (see Geophys. Abs. 166–285) of applying higher derivatives of magnetic potential for determining depth of bodies which produce complex magnetic anomalies and propose a simplified method for determining the depth of burial of strata of any thickness. The third derivative of the vertical component of the magnetic field intensity ($\partial^3 Z/\partial x^3$) on half of the field diagram is considered. The third derivative can be interpreted physically as the Z-component of two pairs of horizontal cylinders of opposite magnetization, located near the basement of the bed. A formula, analogous to Logachev's, is derived for the depth of burial.

A new method of determining the depth of a magnetized body with reference to higher order derivatives is discussed. Assuming that the Z-curve represents field intensity, the maximum and minimum abscissas of the curve $\partial Z/\partial x$ are found when $\partial^2 Z/\partial x^2 = 0$. The formula derived contains a function depending only on the magnetization angle; the values of the function are determined analytically, and the curves are drawn. For a layer of considerable thickness the values of the function are between 0.5 and 0.6, and for a thin layer the value varies between 0.17 and 0.28. The error in the depth determination is not more than 10 percent in either case. In the field this method allows an approximate evaluation of the depth of a magnetized body, since the computation is rather simple, and consists of the following: $\partial Z/\partial x$ and $\partial^3 Z/\partial x^3$ are constructed at several points in the inflection zone of the Z-curve, or obtained with the aid of master charts; then the depth is calculated by the formula derived. The method of construction of master charts for the first and third derivatives of magnetic potential is given. Advantages of the proposed method are illustrated by an example. The relative error in computing the higher derivatives increases with the order of the derivative. This shortcoming can be remedied, in part, by the use of master charts.—*A. J. S.*

175–304. Wendler, Ralph. Geologische und petrographische Deutung der Ergebnisse mikromagnetischer Messungen über Sedimentgesteinen [Geologic and petrographic interpretation of the results of micromagnetic measurements on sedimentary rocks]: Karl Marx Univ. Leipzig, Geol. u. Paläontol. Inst. Mitt., Geologie u. Geophysik (60th anniversary pub.), p. 113–120, 1957.

By means of geologic and petrographic investigations of different examples, an attempt is made to recognize the cause of the micromagnetic anomalies described by Lauterbach (see Geophys. Abs. 160–45 and –46). For unconsolidated rocks it is established that gravity separation influenced by currents is responsible for oriented anomalies. In jointed sandstones, chemical exchange on the joints, with enrichment or removal of iron minerals, is recognized as important in shaping the magnetic anomalies. If the primary genetic anisotropies are great, their magnetic expression can not be masked by the secondary effects stemming from jointing.—*Author's summary, D. B. V.*

175–305. Lauterbach, Robert, Immanuel, Michael, and Wendler, Ralph. Studien zur petromagnetischen Substanz– und Strukturanalyse [Studies on the petromagnetic analysis of substances and structures]: Karl Marx Univ. Leipzig, Geol. u. Paläontol. Inst. Mitt., Geologie u. Geophysik (60th anniversary pub.), p. 13–17, 1957.

Petromagnetic analysis, or the measurement of magnetic anomalies in hand specimens of rock, can serve several purposes. Most obvious of these is the determination of distribution of susceptibility and thus of the ferromagnetic components of the rock; this is particularly important where there are two or more ferromagnetic constituents, as in some ores. Magnetic properties are closely related to rock texture; therefore the latter, for example flow structure, can be recognized from orientation of magnetic anomalies. It is also hoped that the time relations of magnetization processes, fossil as well as recent, may be interpreted by this means.

In the method used, the planed surface of the sample is moved under a stationary "Förstersonde" magnetometer in a sliding carriage, movable in two mutually perpendicular directions; the profile is recorded continuously by a light-point. The contours of the anomalies are drawn from a series of profiles across the specimen. Examples are given of the application of the method to a serpentinite with magnetite-filled fractures, and to a polzenite with flow-oriented melilite microlites that could not be distinguished optically.—*D. B. V.*

175–306. Skillman, T. L., and Bender, P. L. Measurements of the earth's magnetic field with a rubidium vapor magnetometer: Jour. Geophys. Research, v. 63, no. 3, p. 513–515, 1958.

A light from a rubidium lamp is circularly polarized, filtered to select a 7943A line and passed through an absorption cell containing rubidium vapor and an inert gas, and the light intensity is monitored with a photoelectric cell. A narrow band radio frequency applied at right angles to the transmission path which parallels the magnetic field will cause absorption, detected by a reduction in light intensity. Line width of absorption corresponding to a sweep frequency of 20 to 25 cycles is observed using argon and neon buffer gases. This permits a relative accuracy of .1 gamma, but absolute accuracy of two gammas is the best that can be obtained using the presently accepted values of the fundamental constants involved. Measurements indicated a field strength six gammas lower than measured by the sensitive magnetographs at the Fredricksburg magnetic observatory.—*W. J. D.*

175–307. Waters, G. S., and Francis, P. D. A nuclear magnetometer: Jour. Sci. Instruments, v. 35, no. 3, p. 88–93, 1958.

In the magnetometer described, a sample containing suitable nuclei situated in the earth's total field has a strong d-c field H applied to it at an angle to the direction of the earth's field F. The sample becomes magnetized in the direction of H. When H is suddenly removed the resultant magnetization vector precesses about the direction of F with a frequency which is proportional to the strength of F. Details are given of the coils, switching circuits and transistorized amplifying equipment used in measuring the precession frequency. The advantages of the magnetometer are low cost, ruggedness and absence of drift. The accuracy of an absolute measurement of the earth's total field is $\pm 10\mu$ *G.*—*R. G. H.*

175–308. Thoburn, W. C. Portable magnetic field and gradient meter: Rev. Sci. Instruments, v. 29, no. 11, p. 990–992, 1958.

A portable instrument for measuring magnetic fields and field gradients is described. The measurements depend on comparing the alternating emf's induced in two search coils oscillated synchronously at about 3 cps through angles of less than 3°, one in the field to be measured and the other in the reference field of a permanent magnet in the instrument. A precision Helipot is used as a potentiometer, in which a measured fraction of the signal from the reference coil is balanced against the signal from the probe coil. The null is obtained through an electronic amplifier and galvanometer. Tests of the instrument indicate 0.1 percent precision. A field gradient can be measured with the same instrument by use of a search coil which is given translatory oscillations in the direction of the gradient.—*Author's abstract*

175–309. Ponomarev, V. N. Portativnyy magnitometr nasyshcheniya [A portable saturation magnetometer]: Akad. Nauk SSSR Ural. Filial, gorno-geol. Inst. Trudy no. 30, geofiz. sbornik no. 2, p. 87–92, 1957.

A description is given of a simple sturdy magnetometer for field use, type PM–3. The instrument consists of an acoustic generator producing current of about 1,000 cycles per sec frequency; a closed magnetic circuit in which intensity of magnetization approaches saturation, which measures magnetic flux; a precise vacuum tube voltmeter; and a compensating circuit, which extends the range of the instrument to ±30,000γ.

The PM–3 magnetometer can be used for rapid measurements of magnetic field intensity at a series of stations, or for continuous observations of variations of magnetic intensity with time; in the latter case it may be equipped with any standard automatic recording device. The instrument is suitable for direct prospecting for strongly magnetic objects, and may be used by an observer on foot or using various means of transport.

Future improvements will be the development of automatic recorders with high zero-point stability which will not be affected by vibrations of the magnetic circuit element, and the development of economical pocket-sized magnetometers with the help of semi-conducting triodes.—*S. T. V., D. B. V.*

175–310. Bock, R. Das Wüstsche Lokalvariometer (Bemerkungen zu H. Reichs Artikel in dieser Zeitschrift 23 (169–181) 1957) [The Wüst local variometer (Remarks on H. Reich's article in this journal, v. 23, p. 169–181, 1957) (with discussion by Reich and reply by Bock)]: Zeitschr. Geophysik, v. 24, no. 3, p. 148–152, 1958.

The Wüst "local variometer" (see Geophys. Abs. 174–293), which Reich has declared to be a "thoroughly useful" instrument, is claimed by Bock to be akin to and no better than the "Gerameter" of 1936. The accuracy is shown to be only ± some hundreds of gammas.—*D. B. V.*

175–311. MacLaren, A. S., and LaRochelle, A. Geologic aeromagnetic correlation in the Eastern Townships, Quebec: Canadian Mining Jour., v. 79, no. 7, p. 73–76, 1958.

Discusses the results of an aeromagnetic survey of 12,000 square miles of the Eastern Townships, Quebec, that was made to assess aeromagnetic data as a tool in standard geological mapping. Total intensity and second derivative maps were compiled and studies were made of the magnetic properties of rock samples collected in the field. It was concluded that geology cannot be deter-

mined from a magnetic map alone; field work on the ground is necessary to make accurate use of the magnetic data. For example, aeromagnetic data over the folded relatively non-magnetic sediments were of value only in a negative sense in that they showed no intrusive rocks were present; the slight amount of ferromagnetic material present was not enough to make it possible to trace formations but when combined with the folding was enough to obscure depth determination to the basement. As a result of this aeromagnetic survey the necessity of remapping the area became obvious, as several ultrabasic rock occurrences missed in the original mapping of the Woburn area were located by the aeromagnetic method.—*V. S. N.*

175–312. Canada Geological Survey. Aeromagnetic maps of the Province of Alberta: Dept. Mines and Tech. Surveys, Geophysics Papers 716–719, 1958.

Aeromagnetic maps which show by contour lines the total magnetic intensity at about 500 feet above ground level have been published for the following quadrangles west of the fourth meridian: 716, Colin Lake; 717, Cornwall Lake; 718, Charles Lake; and 719, Andrew Lake.—*W. L. G.*

175–313. Canada Geological Survey. Aeromagnetic maps of the Province of Manitoba: Dept. Mines and Tech. Surveys, Geophysics Papers 550, 646–671, and 720–725, 1958.

Aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles: 550, North of Seal River; 646, Skromeda Creek; 647, Dickens Lake; 648, Lofthouse Lake; 649, Bylot; 650, Warkworth Creek; 651, Salmon Creek; 652, Paragon Lake; 653, Archer Creek; 654, Nares Lake; 655, Stanley River; 656, Dawes Lake; 657, Cromarty; 658, Red Head Rapids; 659, Wise Lake; 660, Knight Lake; 661, Condie Lake; 662, Allan Lake; 663, Broad River; 664, Kelsey Creek; 665, Fletcher Lake; 666, Stony Lake; 667, Overby Lake; 668, Blyth Lake; 669, Ryan Lake; 670, Wilkie Lake; 671, Tadoule Lake; 720, Legary Lake; 721, Cheyne Lake; 722, Kinsman Lake; 723, Porcupine Rapids; 724, Ashley Lake; and 725, Fox Lake.—*W. L. G.*

175–314. Canada Geological Survey. Aeromagnetic maps of Northwest Territory: Dept. Mines and Tech. Surveys, Geophysics Papers 620–627 and 672–715, 1958.

Aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles in the District of Mackenzie: 620, Croft Lake; 621, Scheelar Lake; 622, Jim Lake; 623, Shoemaker Lake; 624, Mossip Bay; 625, High Island; 626, Beck Lake; 627, Beaverhill Lake; 672, Biblowitz Lake; 673, Nieznany Lake; 674, Breithaupt Lake; 675, Olson Lake; 676, Logie Lake; 677, Snelgrove Lake; 678, Noyes Lake; 679, Bodie Lake; 680, Tite Lake; 681, Greeves Lake; 682, Dunvegan Lake; 683, Abitau Lake; 684, Mansfield Lake; 685, Cronyn Lake; 686, Miller Lake; 687, Lamarre Lake; 688, Sled Creek; 689, Huff Lake; 690 Catholic Lake; 691, Lake of Woe; 692, Knobovitch Lake; 693, Burpee Lake; 694, McArthur Lake; 695, Brooks Lake; 696, Sled Lake; 697, Timberhill Lake; 698, La Roque Bay; 699, Zucker Lake; 700, Glass Lake; 701, Carleton Lake; 702, Insula Lake; 703, Sylvan Lake; 704, Donnelly Lake; 705, Penylan Lake; 706, Coventry Lake; 707, Dymond Lake; 708, Bouvier Bay; 709, Moss Lake; 710, Blake Lake; 711, Lynx Lake; 712, McFarlane Lake; 713, Garde Lake; 714, Odin Lake; and 715, Hostile Lake.—*W. L. G.*

175–315. Agocs, W[illiam] B. Results of airborne magnetometer profile from Brownsville, Texas, to Guatemala City: Geophysics, v. 23, no. 4, p. 726–737, 1958.

An airborne magnetometer profile was obtained in the course of ferrying an aircraft from Brownsville, Texas, to Guatemala City, Guatemala, via Tampico, Tuxpan, Veracruz, Tuxtle, Tapachula and Tequisate, a distance of slightly over 1,000 miles.

The profile indicates that the basement depth is on the order of —20,000 ft along the eastern coast of Mexico, except for the Tamualipas uplift. In southern Mexico and Guatemala the basement level rises to approximately —10,000 ft, and it is exposed in the extreme southern part of Mexico. Several major fault systems and intra-sedimentary volcanic horizons are indicated by the profile.

Bouguer anomaly data, supplied by Dr. G. P. Woollard, show surprisingly good agreement with the sub-surface structure as determined from the magnetics.

Gross errors in the depth determinations from the single profile may arise due to simplifying assumptions that the trends are transverse to the direction of the profile and that they are elongate. The excellent correlation between the structures determined from the magnetics and the Bouguer gravity anomalies lends confidence to conclusions drawn from these indications, and this should permit further analysis of the gravity.—*Author's abstract*

175–316. Sonntag, Klaus. Das Verhaltnis der magnetischen ΔZ–Anomalien des assyntisch–varistischen Gebirgsbogen zur Elbelinie [The relation of the magnetic ΔZ anomalies of the Assyntic–Varistic mountain arc to the Elbe line]: Karl Marx Univ., Leipzig, Geol. u. Paläontol. Inst. Mitt., Geologie u. Geophysik (60th anniversary pub.), p. 52–56, 1957.

Within the Assyntic–Varistic mountain arc, the Elbe line represents a considerable tectonic disturbance cutting transversely across the fold pattern with a Hercynian strike. From the magnetic anomalies and gravity data this tectonic line can be followed between Hundeluft-Wittenberg-Torgau.

The magnetic anomalies form a large double arc extending from southwestern to central Germany. These are attributed chiefly to the effect of large basic plutonic masses belonging to a zone of the crystalline basement of Assyntic–Varistic age. In the vicinity of the Elbe line the course of the geomagnetic high is interpreted as a flexure of about 10 to 12 km; the Herzberg high appears to be "dragged" and a connection across the Bad Schmiedeberg anomaly to the Delitzsch high is probable.—*D. B. V.*

175–317. Kutscher, Fritz, and Stein, Albert. Angewandte erdmagnetische Messungen in Hessen. 3. Magnetische Vermessung eines Basaltvorkommens mit angrenzenden Eisenerzlager auf Blatt Weilberg (Lahn–Mulde) [Applied geomagnetic measurements in Hesse. 3. Magnetic survey of a basalt occurrence with adjacent iron ore deposit on the Weilberg sheet (Lahn–Mulde)]: Geol. Jahrb., v. 73, p. 575–594, 1957 (1958).

A magnetic survey shows that the basalt that crops out on the Tanzköppel near Blessenbach in Hesse, Germany, strikes roughly north-south, increasing in width southward from 3 to 25 m, and dips 55° west. The small adjacent iron

ore body dips about 68° to the southeast, therefore is not a continuation of the basalt as previously thought. The anomalies over the basalt and iron ore are interpreted mainly on the basis of Jung's graphic procedure for the case of thin plates. (See also Geophys. Abs. 169–244.)—*D. B. V.*

175–318. Kliewe, Heinz, and Lauterbach, Robert. Oberflächenform und Mikromagnetik auf Usedom—eine methodische Studie zur Geomorphologie [Surface form and micromagnetics on Usedom—a methodical study on the geomorphology]: Karl Marx Univ., Leipzig, Geol. u. Paläontol. Inst. Mitt., Geologie u. Geophysik (60th anniversary pub.), p. 94–105, 1957.

Micromagnetic studies (see Geophys. Abs. 160–45) were made of the geomorphologic development of the young unconsolidated sediments on the island of Usedom in the Bay of Pomerania, northern East Germany. From measurements made on the different glacial and postglacial deposits the dynamics of transport and deposition of sediment by ice, melt water, wind, and sea can be demonstrated. For selected test surfaces on each type of deposit vertical anomalies were mapped and directions plotted on rosette diagrams; the results show varying degrees of lineation, according to method of deposition.—*D. B. V.*

Bott, M[artin] H[arold] P[hillips], Day, A. A., and Masson-Smith, D[avid]. The geological interpretation of gravity and magnetic surveys in Devon and Cornwall. See Geophys. Abs. 175–213.

175–319. Menshikov, P. N. Oypt primeneniya geofizicheskikh metodov razvedki pri poiskakh kimberlitovykh trubok [Attempt at the application of geophysical methods of exploration in prospecting for kimberlite pipes]: Razvedka i okhrana nedr, no. 4, p. 42–49, 1957.

Geophysical surveys were made in 1954–1955 for the prospecting of kimberlite diamond-bearing pipes of the Yakutsk region. Positive results were obtained with the magnetic method; during the summer of 1955, 13 new kimberlite pipes were discovered. These pipes are strongly magnetic, produce sharp anomalies, and often occur in non-magnetic formations. Difficult transportation conditions created by the primeval Yakutsk forest necessitated the use of airborne magnetic surveying, flown from relatively low heights of 100, 200, 400, and 600 m. The resulting curves of magnetic anomalies have very sharp peaks so that it is easy to delineate the boundaries of the pipes. The use of aeromagnetic surveying in this inaccessible country was 35 times cheaper than ground surveying.—*S. T. V.*

175–320. Andreasen, Gordon E., Dempsey, William J., Henderson, John R., and Gilbert, Francis P. Aeromagnetic map of Alaska: U.S. Geol. Survey Geophys. Inv. Map GP 156, 1958.

An aeromagnetic map which shows by contour lines the total intensity at a barometric elevation of 4,000 feet has been published for the Copper River Basin.—*W. L. G.*

175–321. Books, K[enneth] G., Schwartz, G[eorge] M., Meuschke, J[ack] L., and Dempsey, W[illiam] J. Aeromagnetic maps of Minnesota: U.S. Geol. Survey Geophys. Inv. Map GP 140–148, 1958.

Aeromagnetic maps which show by contour lines the total intensity at about 500 feet above ground level have been published for the following: 140, eastern

Roseau County; 141, western Roseau County; 142, Kittson County; 143, eastern Marshall and northwestern Beltrami Counties; 144, central Marshall and western Pennington Counties; 145, western Marshall and northwestern Polk Counties; 146, parts of Pennington, Red Lake, Beltrami, Clearwater and Polk Counties; 147, western Red Lake and central Polk Counties; and 148, western Polk County.—*W. L. G.*

175–322. Bromery, Randolph W., Gilbert, Francis P., and others. Aeromagnetic maps of New Hampshire and Vermont: U.S. Geol. Survey Geophys. Inv. Map GP 194–196, 1958.

Aeromagnetic maps which show by contour lines the total intensity at a barometric elevation of 2,300 feet have been published for the following: 194, Littleton and vicinity; 195, Woodsville and vicinity; and 196, Lake Tarleton and vicinity.—*W. L. G.*

175–323. Henderson, John R., Tyson, Natalie S., Gilchrist, Sybil, and others. Aeromagnetic maps of New Jersey: U.S. Geol. Survey Geophys. Inv. Map GP 174 and 175, 1958.

Aeromagnetic maps which show by contour lines the total intensity at about 500 feet above ground level have been published for the following: 174, Bernardsville and part of the Bound Brook quadrangles, Middlesex, Somerset and Morris Counties; and 175, Chatham and parts of the Roselle and Plainfield quadrangles, Morris, Union, Essex, and Somerset Counties.—*W. L. G.*

175–324. Henderson, John R., Tyson, Natalie S., McGowan, Ernest F., and others. Aeromagnetic maps of Washington: U.S. Geol. Survey Geophys. Inv. Map GP 176–189, 1958.

Aeromagnetic maps which show by contour lines the total intensity at about 1,000 feet above ground level have been published for the following: 176, Grayland quadrangle, Grays Harbor and Pacific Counties; 177, Aberdeen quadrangle, Grays Harbor and Pacific Counties; 178, Montesano quadrangle, Grays Harbor and Pacific Counties; 179, Malone quadrangle, Grays Harbor, Pacific, and Lewis Counties; 180, Rochester quadrangle, Thurston, Grays Harbor and Lewis Counties; 181, part of the Tenino quadrangle, Thurston and Lewis Counties; 182, part of the Yelm quadrangle, Thurston and Lewis Counties; 183, Cape Shoalwater quadrangle, Pacific County; 184, South Bend quadrangle, Pacific County; 185, Willapa quadrangle, Pacific County; 186, Pe Ell quadrangle, Pacific and Lewis Counties; 187, Adna quadrangle, Lewis County; 188, Centralia quadrangle, Lewis County; and 189, Onalaska quadrangle, Lewis County.—*W. L. G.*

175–325. Ponomarev, V. N., and Suvorov, Ye. A. Skvazhinnaya magnitnaya razvedka [Magnetic borehole surveys]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 787–790, 1958.

This is an abridged version of the paper published in the Akademiya Nauk S.S.S.R., Izvestiya Vostochnykh Filialov (bulletin of the eastern branch of the Academy of Sciences of the U.S.S.R.); (see Geophys. Abs. 172–181).—*S. T. V.*

RADIOACTIVITY

175–326. Riezler, W., and Kauw, G. Natürliche Radioaktivität von Blei 204 und die Frage einer natürlichen Aktivität von Dysprosium 156 [Natural radioactivity of lead–204 and the question of a natural activity of dysprosium–156]: Zeitschr. Naturforschung, v. 13a, no. 10, p. 904–905, 1958.

A sample of lead enriched in lead 204 was introduced in the form of a neutral lead-ammonium citrate solution into a nuclear emulsion plate and left for a half year. When examined, the plate showed a group of tracks with a range of $8.4\pm.03\mu$, attributed to lead 204. The decay constant of lead 204 is calculated to be $\lambda\sim5\times10^{-18}$ yrs, half-life $T=1.4\times10^{-17}$ yrs, and α-particle energy $E=2.6$ MeV.

Similar treatment of a sample enriched in dysprosium 156 showed α-tracks in the 6–9μ range; if these are due to the dysprosium, the α-particle energy would be 2.2 MeV, and the half-life of dysprosium 156 more than 10^{18} yrs.—*D. B. V.*

175–327. Eberhardt, P[eter], and Signer, P[eter]. Zur Frage des Zerfalls des ^{180}Ta. Teil II [On the question of the decay of Ta^{180}. Part 2]: Zeitschr. Naturforschung, v. 13a, no. 11, p. 1004, 1958.

The hafnium content of a tantalite previously investigated (see Geophys. Abs. 164–217) has been determined mass spectrometrically by a method described elsewhere (see Geophys. Abs. 173–326), and found to be $(2.42\pm0.08)\times10^{-3}$ g per g. The tantalum content is $(525\pm3)\times10^{-3}$ g per g. Hafnium from tantalite has an isotope ratio of $Hf^{180}/Hf^{178}=1.30\pm0.05$, compared to a standard of 1.310 ± 0.025; radiogenic $Hf^{180}/Hf\leqq1.2$ percent. From these data and the known age of 2,640±42 million yrs (see Geophys. Abs. 157–135), the upper limit of the decay constant of the K-capture ($Ta^{180}\rightarrow Hf^{180}$) is calculated to be $\lambda_k\leqq1.5\times10^{-10}$ yrs^{-1}.—*D. B. V.*

175–328. Bate, G[eorge] L., Potratz, H. A., and Huizenga, J. R. Thorium in iron meteorites: a preliminary investigation: Geochim. et Cosmochim. Acta, v. 14, no. 1/2, p. 118–125, 1958.

By means of neutron activation analysis, thorium concentrations in two iron meteorites have been found in the approximate range of from 6×10^{-12} to 20×10^{-12} g Th per g meteorite. These values are lower by at least two orders of magnitude than previously determined levels of thorium concentration in irons. It is possible that the wide divergence of results must be attributed to differences in method, and evidence is presented in support of the validity of the method of neutron activation analysis.

If Urey's calculated value for the distribution coefficient of thorium between iron and silicate phases is correct, the present thorium data seem to further substantiate the view that thorium in irons occurs primarily in inclusions or in thorium compounds dissolved in the iron. Comparison with uranium concentrations in irons recently determined by neutron activation analysis suggests moreover that if the thorium is accounted for by inclusions, these inclusions are not primarily silicate in nature; or if thorium is attributable to dissolved thorium compounds, the solubility of thorium compounds is less than that of uranium compounds in the original molten iron phase.—*Authors' abstract*

175–329. Ehmann, W. D., and Kohman, T[ruman] P. Cosmic-ray-induced radioactivities in meteorites—I. Chemical and radiometric procedures for aluminium, beryllium, and cobalt: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 340–363, 1958.

It is expected that the long-lived radionuclides Al^{26}, Be^{10} and Fe^{60} (with its daughter Co^{60}), among others, are present in detectable amounts in meteorites as the result of cosmic ray action in space. Chemical isolation and purification are essential for the detection and measurement of these activities. Chemical procedures developed for the separation and purification of aluminium, beryllium, iron, and cobalt from iron and stone meteorites, tektites, and terrestrial silicate minerals are described in this paper.—*D. B. V.*

175–330. Ehmann, W. D., and Kohman, T[ruman] P. Cosmic-ray-induced radioactivities in meteorites–II. Al^{26}, Be^{10}, and Co^{60}, aerolites, siderites, and tektites: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 364–369, 1958.

The long-lived radionuclides Al^{26} and Be^{10} and the 5-year Co^{60} have been detected in stone and iron meteorites. The highest levels observed, in disintegrations per minute per gram of specimen were: in stone, Al^{26}, 0.063; Be^{10}, 0.0051; Co^{60}, 0.0018; in iron, Al^{26}, 0.0055; Be^{10}, 0.00070; Co^{60}, 0.033. The Al^{26} and Be^{10} were evidently produced by cosmic-ray bombardment of the meteorites before fall. The Co^{60} seems to have been produced principally by neutron capture in ordinary cobalt in recent years while the specimens were on earth, although disintegration of the long-lived Fe^{60} may contribute some Co^{60}.

The Be^{10}:Al^{26} ratio is definitely lower in the Plainview chondrite than in the Richardton chondrite, suggesting that the former may have existed as a small body for only about a million years. The presence of both activities in the Odessa siderite indicates that it and its associated craters are probably less than about a million years old. The absence of these activities in the Canyon Diablo siderite is probably ascribable to a shielded position of the specimen inside the large meteoroid.

Al^{26} is definitely and Be^{10} fairly certainly present in australites, indicating that tektites are glass meteorites and have spent at least a million years or so in space. Both activities are also present in Libyan Desert silica-glass, indicating that it is a variety of tektite. From the Al^{26} and Be^{10} levels or limits, in comparison with the levels in chondrites, the following approximate terrestrial ages or limits, in millions of years, are calculated: australites, <0.5; Libyan Desert silica-glass, ~ 3.5; bediasites, >1.2; moldavites, >3.

Measurements of these and other nuclides can give valuable information on the pre-fall and post-fall histories of meteorites and on the past intensity of the cosmic radiation. The average cosmic-ray flux over the past several million years appears not to have been grossly different from the present value.—*Authors' abstract*

175–331. Lockhart, Luther B., Jr. Concentrations of radioactive materials in the air during 1957: Science, v. 128, no. 3332, p. 1139, 1958.

Measurements of the concentration of radon, thoron, and fission products in the air were made daily throughout 1957 at Washington, D.C.; Yokosuka, Japan; Kodiak, Alaska; and Little America, Antarctica, using identical equipment. The averages for the year at each site are tabulated. It can be seen that the bulk of the radioactivity is due to radon and its decay products, de-

rived from radium in the soil. The concentration of radon and thoron is dependent on location of land masses relative to prevailing winds over the collecting site. Even though the concentration of products was unusually high at Washington in 1957, due to the nuclear tests in Nevada, the artificially produced material amounted to only 1.2 percent of the radon concentration. Similar ratios of fission products to radon were found at the other sites. The thoron concentration is roughly equal to that of the fission products in each case.—*D. B. V.*

175–332. Suess, Hans E. The radioactivity of the atmosphere and hydrosphere: Ann. Rev. Nuclear Sci., v. 8, p. 243–256, 1958.

The radioactive species that occur on the surface are the long-lived primary radionuclides that have survived from the time when the elements formed (Th, U, K, Rb, Sm^{147}, Lu^{176}, La^{138}, and Re^{187}), and their daughter products, or secondary radionuclides; those currently formed in nature, mainly by cosmic-ray induced processes (C^{14}, H^3, Be^7, and Be^{10}); and artificial substances produced by atomic weapons tests or in nuclear reactors. The concentrations of these various radioactive elements in the atmosphere and hydrosphere and their significance are discussed, based on a survey of the literature through April 1958. A bibliography of 64 items is appended.—*D. B. V.*

175–333. de Vries, H. Variation in concentration of radiocarbon with time and location on earth: Koninkl. Nederland Akad. Wetensch. Proc., ser. B, v. 61, no. 2, p. 94–102, 1958.

Radiocarbon measurements on samples of known age (three rings and charred wheat) have demonstrated that the concentration of carbon-14 in the atmosphere varies considerably in the course of a few centuries and also with location on earth. The variations are of the order of one percent. Evidence is presented that the fluctuations are due to variations in vertical mixing in the ocean which brings old (less active) water in contact with the atmosphere. It is not yet possible to understand the origin of the variations with location on earth.

Such fluctuations obviously affect carbon-14 dating. Aside from local effects, variations in initial activity with time give rise to errors of 100 yrs or more (80 yrs for a variation of one percent). The recent standard used so far by the Groningen dating laboratory is about 3 percent below the average activity of the two trees from Germany, therefore all Groningen carbon-14 dates tend to be about 240 yrs too low.—*D. B. V.*

175–334. Crowe, C. Carbon–14 activity during the past 5,000 years: Nature, v. 182, no. 4633, p. 470–471, 1958.

Variations during the past 5,000 yrs of the carbon-14 concentration in living material have been investigated by analysis of available carbon-14 dating measurements on samples known to have died at a certain time. The results indicate that carbon-14 activity seems to have followed a cycle with a maximum change of about 10 percent in the past 5,000 yrs; there is a sharp peak about 2,000 yrs ago.

Errors in radiocarbon dates of the magnitude found may be produced by variations in intensity of the earth's magnetic field; a cyclic variation of intensity corresponding to that of the carbon-14 activity would not conflict with the dynamo theory of the origin of the earth's field (see Geophys. Abs. 175–271).

Some changes in activity may be due to variations in vertical mixing in the oceans (see Geophys. Abs. 175–333), or to the effects of large solar flares.—*D. B. V.*

175–335. Barker, H. Carbon–14 activity during the past 5,000 years: Nature, v. 182, no. 4647, p. 1433, 1958.

Crowe's conclusions (see Geophys. Abs. 175–334) are not valid namely because he has not taken into account the fact that the different dating laboratories use different corrections. The true variations are certainly of a lower order of magnitude than Crowe implies. (See also Geophys. Abs. 175–336.)—*D. B. V.*

175–336. Münnich, K. O., Östlund, H. G., and de Vries, H. Carbon–14 activity during the past 5,000 years: Nature, v. 183, no. 4647, p. 1432–1433, 1958.

Crowe's corrections for variations in the carbon-14 content of the atmosphere during the past 5,000 yrs (see Geophys. Abs. 175–334) are too large. When Crowe's data are replotted using more realistic and smaller corrections (here tabulated), the large systematic variations vanish. The genuine variations in carbon-14 activity are an order of magnitude smaller. Comparative analysis of results from different laboratories should not be undertaken until the differences in standards are measured more exactly.—*D. B. V.*

175–337. Hiyama, Yoshio, and Ichikawa, Ryushi. A measure on level of strontium-90 concentration in sea water around Japan, at the end of 1956. Oceanog. Works, *in* Japan Rec., v. 4, no. 1, new ser., p. 49–54, 1957.

A rough measure of the level of strontium-90 concentration in ocean water caused by the fallout of fission products from nuclear tests is determined from the concentration of strontium-90 in calcareous tissue, bone and shell of marine organisms, based on a stable strontium concentration in ocean water of 7 mg per liter. Chemical analysis and radio-assays of the bones from five fishes typical of various ocean depths showed that the strontium-90 concentration in ocean water is diluted with depth. For example, a fish from a depth of 15 m in the North Pacific off Hokkaido showed a concentration of 0.23 millimicrocuries of strontium-90 per 7 mg of strontium while one from a depth of 50 m in the same locality showed a concentration of 0.03 millimicrocuries of strontium-90 per 7 mg of strontium. All specimens showed a reasonable strontium-90 concentration when considered in the light of dilution with depth of the calculated cumulative surface fallout up to the end of 1956. Similar results were obtained from clam shells collected in coastal areas for three years. Much higher concentrations found in the bones and fins of fish from the South Pacific pointed to the existence of an intensive fallout area near the nuclear test site.—*V. S. N.*

175–338. Miholić, Stanko. Radioactive waters from sediments: Geochim. et Cosmochim. Acta, v. 14, no. 3, p. 223–233, 1958.

Radon measurements on 107 mineral waters in Yugoslavia show that their radioactivity depends on the geologic age of the sediments through which they flow; those issuing from Carboniferous or Cretaceous strata show a distinctly higher radioactivity, due to the higher uranium content of those sediments. Part of the radioactive substances of the waters is sometimes deposited in sin-

ters around the springs. In these deposits the uranium is not usually in radioactive equilibrium with its daughter elements; particularly in the case of calcareous sinters and ochres, there are more ionium and radium present than necessary for equilibrium. The radioactivity of water passing through such sinters is increased. The thermal water of Višegrad shows the greatest enrichment (by a factor of 7.27).—*D. B. V.*

175–339. Yastrebov, M. T. Yestestvennaya radioactivnost' zonal'nykh pochv evropeyskoy chasti SSSR [Natural radioactivity of zonal soils of the European part of the USSR]: Akad. Nauk SSSR Doklady, v. 119, no. 3, p. 586–589, 1958.

Measurements of the natural radioactivity of four different types of soils from the European part of the U.S.S.R. are summarized. The activity ranges from 2.04 to 5.94×10^{-2} microcuries. Measurements on moist and dry samples of two of the soils shows that water (and therefore cosmic factors) has a very great effect on the amount of radioactivity.—*D. B. V.*

175–340. Hayase, Ichikazu, and Tsutsumi, Tokudo. On the emanating power of powdered rocks: Kyōto Univ. Coll. Sci. Mem., ser. B, v. 24, no. 4, p. 319–323, 1958.

The measurement of the emanating power or radioactivity of such gases as radon, thoron, and actinon emitted from pulverized rocks and soils in their natural state is important in geological age determinations. This paper reports measurements of radioactive gases from rocks and soils by exposing a nuclear emulsion from one to seven days to powdered samples enclosed in an emanation chamber of about 300 milliliters. It was found that the emanating power is relatively high in rocks showing secondary alteration or weathering, but low in fresh rocks. Thoron and radon were detectable by the difference in their alpha track lengths.—*V. S. N.*

175–341. Knetsch, Georg, and Sprengler, Erwin. Strahlungsmessungen am sedimentären Gesteinen Unterfrankens [Radiation measurements on sedimentary rocks of Unterfranken]: Neues Jahrb. Geologie u. Paläontologie Monatsh., no. 8–9, p. 385–397, 1958.

Systematic measurements of intensity of radiation of different Triassic formations in Unterfranken (Lower Franconia), Germany, were made over a period of three years. The measurements were made in the field and laboratory, by means of Geiger-Müller and scintillation counters, fluorescence, and autoradiography. Several thousand measurements show that in the sediments of this region radiation is relatively constant over considerable horizontal distances. Vertical differences are great enough that the radioactivity of a given horizon may be used as a diagnostic stratigraphic characteristic.

Apparently synsedimentary anomalies in continental deposits are interpreted as solution concentrations in arid climate.—*D. B. V.*

175–342. Coulomb, R., Goldsztein, M., and Le Mercier, M. L'uranium dans quelques granits français [Uranium in some French granites]: Geochim. et Cosmochim. Acta, v. 15, no. 1/2, p. 10–17, 1958.

The statistical distribution of uranium and potassium in granites in Brittany has been studied. A total of 215 fresh samples, collected on a fairly regular grid with approximately 2.5 km spacing, were analyzed for K_2O and Na_2O by

flame spectrometry, for uranium by fluorimetry, and the α, β, and γ activities were counted. Complete chemical analyses were made on some.

The results give a clearer picture of the petrochemical relationships of the area than do the classic analyses. The abundance and distribution of uranium are given for different zones; a lognormal distribution is confirmed.

Statistically "strong" areas are not, as often claimed, found in the borders of the intrusions. The potassium and uranium contents cannot be correlated statistically. Most of the points of uranium mineralization are situated where both potassium and uranium contents are maximum.—*D. B. V.*

175–343. Deutsch, S[arah], and Picciotto, E[dgard] [E.]. Présence d'uraninite dans les minéraux accessoires du granit de Baveno [Presence of uraninite in the accessory minerals of the Baveno granite]: Experientia, v. 12, no. 9, p. 333–334, 1956.

Microscopic crystals of uraninite are found in the accessories of the Baveno granite of Italy by the nuclear photographic emulsion technique. The uraninite is believed to be a primary mineral of the granite, its concentration in the sample is less than 1 part per million, but it contributes about 10 percent of the total α-activity. *Authors' summary*

175–344. Coulomb, R. Radioactivité du batholite d'Elbema (Hoggar). Corrélations statistiques entre les rayonnements et la composition chimique des granites [Radioactivity of the Elbema batholith (Hoggar). Statistical correlations between the radiation and the chemical composition of granites]: Soc. française Minéralogie et Cristallographie Bull., v. 81, no. 7–9, p. 227–231, 1958.

Statistical analysis of the distribution of uranium and potassium, and of alpha- and gammo-activity of the Elbema batholith, one of the granitic massifs of the Hoggar (Ahaggar) Mountains in Algeria, shows that there is a close correlation between the radioactivity and uranium content, but no clear correlation between radioactivity and potash content. These results should be useful in airborne radioactivity surveys in the Hoggar.—*D. B. V.*

175–345. Hayase, Ichikazu. The radioactivity of rocks and minerals studied with nuclear emulsion III. Radioactivity of biotite of the Tanakamiyama granite, Shigu Pref., Japan: Kyōto Univ. Coll. Sci. Mem., ser. B, v. 22, no. 2, p. 177–184, 1955.

Samples of the Tanakamiyama granite collected at Shishitobi, in Shigu Prefecture, Japan, were studied by means of nuclear emulsion to determine the order of radioactivity of the biotite constituent. The biotite occurs in two forms, large flakes of early biotite, and small flakes of late-stage biotite interstitial between quartz and feldspar grains. The early biotite itself is only feebly radioactive but it contains numerous highly radioactive inclusions, whereas the late-stage biotite is rather radioactive, especially where it has suffered deuteric attack, but contains few and weakly radioactive inclusions. (See also Geophys. Abs. 160–169, 162–202, 172–206, and 174–300.)—*D. B. V.*

RADIOACTIVITY SURVEYING AND LOGGING

175–346. Grammakov, A. G., Nikonov, A. I., and Tafeyev, Yu. P., [editors]. Radiometricheskiye metody poiskov i razvedki uranovykh rud [Radiometric methods of prospecting for and investigating uranium ores]: Moscow, Ministerstvo geologii i okhrany nedr SSSR, Gosgeoltekhizdat, 610 p., 1957.

This is an official textbook published by the Russian ministry of geology and conservation of mineral resources, a compilation of the work of 16 Russian geophysicists. It consists of four parts devoted respectively to physical and geologic principles of the methods of radiometric exploration; the methods of measurement, and the instruments and apparatus; procedures, including airborne gamma surveying, the emanation method, gamma-ray logging and other methods; and combined application of these methods, as well as the basic factors determining the relative efficiency of different methods in the exploration for uranium ores. Several practical examples of exploration are given and discussed in detail.—*S. T. V.*

175–347. Yakubovich, A. L. Yaderno-geofizicheskiye metody — vazhnyy reserv dal'neyshego povysheniya effektivnosti geologicheskikh poiskov i razvedki [Nuclear geophysical methods—important reserves for future increase of the effectiveness of geologic prospecting and exploration]: Razvedka i okhrana nedr, no. 8, p. 29–37, 1958.

A brief review is presented of several new methods of geophysical exploration based on phenomena related to nuclear physics. The most promising and best known is the "activation" analysis based on the artificial formation and subsequent measurement of radioactive isotopes in the tested element. The specimen under investigation is radiated by a stream of nuclear particles, producing in it radioactive isotopes which can be measured by the usual radiometric methods. Common procedure is the simultaneous radiation of the tested specimen and another of a known composition. The activation method is recommended for the analysis of the elements having short-lived radioactive isotopes. A brief discussion is included on the possible use of neutrons with varying energy. Also mentioned are the polonium-beryllium sources of neutrons sealed in a capsule, convenient for use. Another method, tentatively applied in well logging, uses the gamma-radiation caused by the neutron capture.

The nuclear photo-effect can be used for the analysis of rare elements such as beryllium, boron and lithium. For example the beryllium content in ore can be determined by using the nuclear photo-effect $Be^9+\gamma \rightarrow Be^8+n'$ in conjunction with subsequent measurement of artificial radioactivity produced by photo neutrons. Similar reactions can be found for the analyses of boron and lithium. For the last element the reaction used is $Li^6+n' \rightarrow He^4+H^3$.

X-ray radiometric methods are suitable for analysis of heavy elements having atomic numbers higher than 30–40.

A short discussion is given on the operation of different measuring instruments, and the necessity of designing and developing more adequate apparatus for this purpose is pointed out.—*S. T. V.*

175–348. Carrat, G. H., and Berbezier, J. Utilisation de la radioactivité pour le triage et l'évaluation d'un gisement d'uranium [Use of radioactivity for the grading and evaluation of a uranium deposit]: Sci. de la Terre, v. 4, no. 3–4, p. 229–238, 1956 (1958).

A rapid method of evaluating uranium ore without sampling is described, in which the ore cars are run through a "barrack-tunnel" containing a radioactivity detecting device (Geiger-Müller tubes plus an "integrator," an electronic amplifier). Advantages are precision in evaluating discontinuous vein formations, speed, possibility of sorting according to content, and relatively low cost. Sources of error are discussed.—*D. B. V.*

175–349. Shaw, D[enis] M. Radioactive mineral occurrences of the Province of Quebec: Quebec Dept. Mines, Geol. Rept., no. 80, 52 p., 1958.

This description of the radioactive mineral deposits in Quebec is mainly of mineralogical and economic geological interest. A short chapter on radioactive prospecting methods is included. The report is published in a French edition as well as in English.—*D. B. V.*

175–350. Broding, R. A. Radioactive surveying of drill holes, *in* Drilling symposium, 7th annual, exploration drilling: Minneapolis, Minnesota Univ. Center for Continuation Study, p. 44–48, 1957.

In any extensive drilling program in radioactive material, radiometric logging has an advantage over coring in cost, sampling volume, depth control, and continuous measurement. Experience gained in logging 7,000,000 feet of borehole in uranium prospects shows that radiometric assaying can be used in place of core analysis, although chemical analysis of cores from control borings is required for calibration of the radiometric log.—*V. S. N.*

Tixier, M. P., and others. Fundamentals of logging. See Geophys. Abs. 175–126.

SEISMIC EXPLORATION

175–351. Robinson, Enders A. Predictive decomposition of seismic traces: Geophysics, v. 22, no. 4, p. 767–778, 1957.

The generalized harmonic analysis, or spectral decomposition, of a time series results in its representation in terms of its harmonic, or sinusoidal, components. This paper, on the other hand, develops in an expository manner the generalized regression analysis, or predictive decomposition, of a time series. This decomposition results in the representation of the time series at any moment in terms of its own observable past history plus an unpredictable, random-like innovation.

For the purposes of this paper, it is assumed that a seismic trace (recorded with automatic volume control) is additively composed of many overlapping seismic wavelets which arrive as time progresses. It is assumed that each wavelet has the same stable, one-sided, minimum-phase shape and that the arrival times and strengths of these wavelets may be represented by a time sequence of uncorrelated random variables. By applying the predictive decomposition theorem, it is shown how the wavelet shape may be extracted from the trace, leaving as a residual the strengths of the wavelets at their respective arrival times.—*Author's abstract*

175–352. Küpper, Franz Josef. Theoretische Untersuchung über die Mehrfachaufstellung von Geophonen [Theoretical investigation of the multiple geophone spread (with English abstract)]: Geophys. Prosp., v. 6, no. 3, p. 194–256, 1958.

The reception of seismic waves by multiple geophones (geophone group) is described by a system of coupled differential equations taking into account only effective resistances. A method is given for solving this system of equations for the so-called symmetrical connection of the geophone group, usually used in practice. The calculation takes into account the coupling of the geophones as well as the building up of transient oscillations.

An appropriate measure of superposition is defined, based on the energy transferred during the receiving of the seismic waves. By this means interference-like effects at the geophone group are investigated, and a calculation is made for the case of a group of three geophones excited by impulse-shaped waves in the form of a damped sinusoidal oscillation. The superposition effect which occurs in this case and its dependence on direction are discussed. An appendix presents formulas for investigation of further numerical examples.—*D. B. V.*

175–353. Isayev, V. S. K teorii napravlennogo deystviya grupp seysmografov v sluchaye impul'snykh kolebaniy. I [On the theory of directional effect of a seismograph group in the case of impulse-generated vibrations, part 1]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 770–782, 1958.

This is an analysis of the effect of a group of seismographs on the direction of recorded waves as well as the distortion of their dynamic characteristics due to the same cause. Earlier work has shown that in the case of steady harmonic vibrations only the amplitude of the final wave is changed, the shape of the waves and frequency of the vibrations remaining unchanged.

In this paper a mathematical analysis of the problem is presented for one impulse and for a sequence of impulses, each in the form of a section of a sinusoidal curve. It is shown that not only the amplitude but also the shape of the wave changes. It is important to note that these changes are not essential in the case when $\Delta\tau/T$ is small (T=duration of the impulse, $\Delta\tau$=phase difference of the impulse wave with respect to the fundamental wave).

For the suppression of disturbing waves produced by impulses it is necessary to select an appropriate phase difference between individual seismographs. This distance may be determined on the basis of the theory developed for geophone grouping in the case of steady harmonic vibrations, but this is not the most suitable method for all cases.—*S. T. V.*

175–354. Straubel, Rudolf. Versuche zur seismischen Orientierung von Grubenbauen [Attempts at seismic orientation of mine workings]: Zeitschr. angew. Geologie, v. 4, no. 8, p. 390–391, 1958.

Seismic methods can be used to determine the course of abandoned mines or natural underground caverns. If the velocity in the surrounding rock is known, the distances of two or more points in the mine from fixed points on the surface can be determined seismically; these points can be connected by mine surveying and the position of the workings calculated simply. The required accuracy of ± 2 m can be obtained, as the order of magnitude of errors introduced by geologic factors and mining operations can be estimated.—*D. B. V.*

175–355. Tuttle, Curtis R. Application of seismology to highway engineering problems, *in* Symposium on geology as applied to highway engineering 9th annual: Virginia Univ. and Virginia Dept. Highways, p. 49–56, 1958.

This paper appraises the application of the seismic method to highway design problems in Massachusetts, and discusses the function of the seismograph as an engineering tool, the types of problems which can reliably be solved by seismic interpretation in the basic geologic environments found in Massachusetts, and the benefits derived from group study (integration of geophysical, soil mechanics, and geologic data requiring cooperation of specialists in several fields); and compares costs, in relation to results, of seismic and boring methods.—*V. S. N.*

175–356. Leet, L. Don. Use of seismic methods to improve blasting practice, *in* Drilling and Blasting Symposium, 6th Annual: Minneapolis, Minnesota Univ. Center for Continuation Study, p. 52–56, 1956 (1958).

A fraction of the energy resulting from mine and quarry blasting travels away from the explosion in the form of vibrations in the ground. This energy is a waste by-product of the blasting operation and can be measured and interpreted through the use of seismic methods to improve the efficiency of the blasting. Leet describes and illustrates the three-component portable seismograph which he has developed for use in this work. If maximum efficiency in blasting is to be achieved, the geology of the area must be examined with reference to distribution of rock, soil, and terrain, and a systematic program of seismograph measurements set up. A typical program begins with determination of the proper delay intervals for the detonation of parts of the total explosive charge, in general on the order of .001 sec per foot of spacing; when the interval is selected a series of seismograph readings can be taken to confirm the choice.—*V. S. N.*

Spanski, Robert F. Geophysical techniques in the location of new sources of water. See Geophys. Abs. 175–109.

175–357. Berzon, Inna Solomonovna. Vysokochastotnaya seysmika [High frequency seismic surveying]: Moscow, Akad. Nauk SSSR Geofiz. Inst., 302 p., 1957.

In modern seismic prospecting for ores, coal, and minerals, and also for engineering-geological surveying a new method using high frequency seismic waves has been developed that gives more details on geologic structure within the depth range where exploitable minerals are found. Waves from 70 to 500 cycles per sec frequency are produced by explosive charges or by heavy mechanical blows and received and recorded on specially constructed seismometers, providing structural data for depths of 20 to 800 m. The book presents the results of theoretical and experimental studies conducted by Berzon, and discusses the physical basis and methods of high frequency seismic surveying.

Chapter I describes the limitations of low frequency methods and the characteristics of the high frequency instruments. Chapters II and III describe the methods of measuring seismic velocities in geologic formations over short bases. Chapter IV discusses the resolving power of seismic methods in the case of a

horizontally stratified medium. Chapters V and VI analyze the high frequency method applied to cases of shallow horizontally stratified formations. Chapter VII discusses seismic exploration of vertically stratified media using the methods of geometric seismics. Chapter VIII analyzes the dynamic characteristics of seismic waves propagating through vertically stratified media. Chapter IX describes the tests in vertically stratified formations.—*S. T. V., A. J. S.*

175–358. Bartzsch, Heinz. Bemerkungen zum gegenwärtigen Stand der Hochfrequenzseismik und zu ihrer Bedeutung [Remarks on the present state of high frequency seismic surveying and its significance]: Zeitschr. angew. Geologie, v. 4, no. 8, p. 389–390, 1958.

A review of Berzon's comprehensive work on high frequency seismic surveying (see Geophys. Abs. 175–357).—*D. B. V.*

175–359. Domenico, S. N[orman]. Generation of seismic waves by weight drops: Geophysics, v. 23, no. 4, p. 665–683, 1958.

A series of experiments designed to evaluate the weight-drop technique was conducted in West Texas. These tests demonstrated the general nature of the seismic waves generated by a weight drop and the effectiveness of compositing drops in providing useful reflection information.

At the first of two test sites discrete waves from single drops consisted of a refracted wave, an air-earth coupled wave, reflected wave segments, and fragmentary waves which were likely dispersive surface waves. A 72-seismometer array provided appreciably more reflected wave segments on records from single drops and also on records from the composite of these drops than did a single seismometer. Additional testing revealed that records prepared from weight drops along three parallel lines 100 ft apart recorded at the same seismometer station are appreciably different. Compositing of the drop lines in general did not provide reflections superior to the best on individual lines.

At the second test site record quality appeared significantly superior to that at the first site. Discrete waves on records from single drops recorded by a 36-seismometer array were of the same types as those observed previously. However, the air-earth coupled wave, prominently developed at the first site, did not appear. Compositing of drops provided two prominent reflections which were correlatable over a 5-mile traverse.—*Author's abstract*

175–360. Meissner, R. Fehler und Korrekturen bei seismischen Messungen in Gebieten mit bewegtem Oberflächenrelief [Errors and corrections in seismic measurements in regions with rough topography]: Zeitschr. Geophysik, v. 23, no. 6, p. 287–305, 1957.

Some formulas are derived for analyzing errors inherent in the orthodox plotting methods usually used in seismic reflection surveys in areas of rough topography. The chief sources of error are near-surface velocity variations in and below the weathered layer, and the effect of the topography itself. Ways to eliminate these are discussed and illustrated. Most accurate results are obtained by constructing from a horizontal reference level, if possible corrected by temporal as well as spatial compensation with respect to a known plane horizon in the upper layers.—*D. B. V.*

175–361. Graeser, E., Lode, W., and Pott, G. Die Konstruktion gekrümmter Reflexionshorizonte bei gegebener variabler Geschwindigkeitsverteilung im Raum [The construction of curved reflection horizons in the case of variable velocity distribution in space]: Zeitschr. Geophysik, v. 24, no. 3, p. 134–142, 1958.

This paper extends previous work (see Geophys. Abs. 169–300) to cover the case where velocities vary between the refracting horizons. The method described is approximate; the degree of accuracy is discussed.—*D. B. V.*

175–362. Weber, Max. Die Interpretation von seismischer Reflexionsmessungen mit abgebrochenen Potenzreihen [The interpretation of seismic reflection measurements with power series with a finite number of terms]: Eidgenoss. Tech. Hochschule Zürich, Inst. Geophysik Mitt. no. 34, 24 p., 1958.

A reprint of the paper published in Geofisica Pura e Applicata, v. 40, p. 19–35, 1958 (see Geophys. Abs. 174–329).—*D. B. V.*

175–363. Kortmann, H. J. Bemerkungen zur Methode der iterierten Geschwindigkeiten [Remarks on the method of iterated velocities]: Geofisica Pura e Appl., v. 35, p. 33–39, 1956.

One of the methods of improving the accuracy of the image method of computing reflection segments in the case of steep dips is the method of iterated velocities described by Krey (see Geophys Abs. 142–12261). The true dip of a fairly deep reflection is determined for the case where the top layers are horizontal, and a graphic method is given for rapid location of the true position. Where velocity is constant below a given depth, the angular correction can be read from a nomogram.—*D. B. V.*

175–364. Graeser, E., and Lode, W. Zur Arbeit des Herrn H. J. Kortmann "Bemerkungen zur Methode der iterierten Geschwindigkeiten" [On the work of Mr. H. J. Kortmann "Remarks on the method of iterated velocities"]: Geofisica Pura e Appl., v. 39, p. 159–161, 1958.

Krey, T[heodor]. Erwiderung zur Schrift der Herrn E. Graeser & W. Lode zur Arbeit des Herrn H. J. Kortmann: "Bemerkungen zur Methode der iterierten Geschwindigkeiten" [Reply to the letter of Messrs. E. Graeser and W. Lode on the work of Mr. H. J. Kortmann: "Remarks on the method of iterated velocities"]: ibid., v. 39, p. 162–163, 1958.

Criticism by Graeser and Lode of Kortmann's paper (see Geophys. Abs. 175–363) is answered by Krey.—*D. B. V.*

175–365. Goląb, Maria, and Śliwiński, Zygmunt. Interpretacja materiałow sejsmicznych uzyskanych metodą refleksyjną na stromych strukturach typu Sompolna–Gopła [Interpretation of seismic data obtained by the reflection method from steep structures of the Sompolno–Gopło type]: Przegląd geol., no. 6, p. 269–272, 1958.

The problem of a correct interpretation of reflecting surfaces by Chashchin's method becomes difficult when the dip of the reflecting plane is more than 30°.

To improve the interpretation, Goląb and Śliwiński propose Rice's equation (see Geophys. Abs. 137–11090, 141–12038) for seismic wave velocity which takes into consideration the curvilinear path of the seismic ray. The advantage of the method is that once the resolved time section has been constructed (see Geophys. Abs. 160–82) it can be applied repeatedly in the interpretation of the reflecting surfaces, for each mean seismic velocity considered.—*A. J. S.*

175–366. Hales, F. W. An accurate graphical method for interpreting seismic refraction lines: Geophys. Prosp., v. 6, no. 3, p. 285–294, 1958.

A method of refraction computing is described which establishes the two points of incidence at the surface of the ray-paths from any point on the refractor when observed from opposing directions. The distance between these points is used to determine the radius and the centre of a circle to which the refractor must be tangential. The matching of forward and reverse data is intrinsic in the method so that the resulting profile is automatically positioned in depth. It is shown that if the effects of dip are neglected, errors are introduced in the derived radius and also in the position of the centre but these errors are shown to cancel each other almost exactly.—*Author's abstract*

175–367. Hagedoorn, J. G. Interpretatie van seismische refractiemetingen: de plus-minus methode [Interpretation of seismic refraction measurements: the plus-minus method]: Geologie en Mijnbouw, v. 20, no. 11, p. 406–417, 1958.

After a general discussion of the propagation of a refracted wave front through the earth and interpretation by means of wave-front diagrams, Hagedoorn describes and illustrates the "plus-minus" method of interpretation. This graphic procedure, based directly on the wave-front diagrams, is a very simple, approximate method. The diagrams are constructed for a two-layer region between two shot points; depth to the boundary plane at any point on the surface can be determined from the sum of the travel times from each shot point to the given point, and velocity can be determined in the lower layer from their difference.—*D. B. V.*

175–368. Berzon, I[nna] S[olomonovna]. Eksperimental'nyye dannyye ob obmennykh prelomlennykh volnakh tipa PSP [Experimental results concerning converted refracted waves of the *PSP* type]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 689–712, 1958.

Converted refracted waves *PSP* (see Geophys. Abs. 171–337) are encountered only in areas where the basement is granite; therefore their presence or absence can be used as an indication of the lithologic nature of the basement. *PSP* waves are characterized by a wider variation of kinematic and dynamic properties (limiting velocity, amplitudes, frequency) than longitudinal refracted waves *PPP*. As a rule their predominant frequencies are lower than those of longitudinal waves. Over a horizontal refracting boundary they also have higher damping coefficients. Further study of this phenomenon is recommended with a view to creating a universal method of seismic exploration using the entire range of different waves, not only a certain type. Many seismograms obtained in the field are reproduced in the article.—*S. T. V.*

175–369. Vasil'yev, Yu. I., Kovalev, O. I., and Parkhomenko, I. S. Ob issledovanii kristallicheskogo fundamenta metodom prelomlennykh voln v usloviyakh nepolnogo ekranirovaniya. II [The investigation of the crystalline basement by the method of refracted waves under conditions of incomplete screening. Part 2]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 5, p. 569–581, 1958.

The results of the experiments in the Volga–Ural area described in the previous paper (see Geophys. Abs. 174–332) are discussed in some detail. Some kinematic and dynamic characteristics of refracted head waves in the case of small velocity difference between media, under conditions of incomplete screening are examined. The effects of screening are calculated quantitatively, and questions of the interpretation of the recorded waves are examined.

The low frequency modification of the refraction method, using frequencies below 10 cycles per sec, diminishes the effect of partial screening of waves refracted along the basement surface (t_2) and suppresses those refracted within the overlying carbonate complex (t_1) which interfere, so that the t_2 waves may appear at distances not far from the shot point. The method should resolve basement features of the order of 100 to 200 m in amplitude and dips not less than 1 or 2 degrees; at present, with velocities in the lower terrigenous complex inaccurately known, it can come within 20 to 25 percent of the true basement relief. Boreholes in the northern part of the area investigated showed satisfactory agreement between seismic and geologic data, 10 to 15 percent differences in the southwestern part.—*S. T. V.*

175–370. Mooney, Harold M., and Kaasa, Robert A. New refraction seismograph: Rev. Sci. Instruments, v. 29, no. 4, p. 290–294, 1958.

A transistorized refraction seismograph has been developed based on pulse systems techniques. This results in direct visual time indication, major reductions in operating complexity, size, and weight, and the elimination of the necessity for photographic processing and the use of explosives. A 4-kc crystal oscillator serves as the time base. The signal passes through a gate circuit to an electronic counter; the gate is opened at the time a sound wave enters the earth and is closed at the time the sound reaches a detector on the surface. The time-distance data can be interpreted in terms of depths to subsurface layers and the nature of subsurface materials.—*Authors' abstract*

175–371. Oilweek. New magnetic recorder "One package" unit: Oilweek, v. 9, no. 26, p. 22, 1958.

Describes a new magnetic recorder, the SIE MS–15A, which, except for geophones, is a complete recording and monitoring system designed for field use, housed in a single unit ideal for installation in portable cabs, the smallest pick-up trucks, or marsh vehicles. It provides economical magnetic records for the SIE MS–12 GeoData System.—*V. S. N.*

175–372. Meinhold, Rudolf. Ergebnisse reflexionsseismischer Messungen im Bereiche der geophysikalischen Anomalien der Prignitz [Results of seismic reflection measurements in the region of the Prignitz geophysical anomalies]: Karl Marx Univ. Leipzig, Geol. u. Paläontol. Inst. Mitt., Geologie u. Geophysik (60th anniversary publication), p. 43–51, 1957.

Seismic reflection investigations of the Prignitz gravity and magnetic anomalies in northwestern Germany, combined with exploratory borings, have thrown

light on the geological relations of the region. The structure of the Werle, Rambow, Geestgottberg, Aulosen, Wilsnack, and Barenthin salt domes has been clarified, and domes thought to be present near Siggelkow and Bollbruck were found not to exist. A large Triassic dome structure near Mausitz, the Karstädt-Bernheide anticline, and the Helle salt dome were discovered.

With the aid of borings it was further recognized that the Jurassic and Lower Cretaceous are rather completely developed under the whole area and the Wealden formation, favorable for oil, reaches considerable thicknesses in the marginal depressions of the salt domes. The area of the positive gravity and magnetic anomalies in the Prignitz thus does not belong to the "Pompeckj uplift" (in the sense of Bentz and Riedel); this makes the area more interesting from the point of view of petroleum possibilities.—*D. B. V.*

175–373. Sysoyev, N. N., Udintsev, G. B., and Andreyeva, I. B. Resultaty seysmo-akusticheskikh issledovaniy dna Yaponskogo morya [Results of seismo-acoustic investigations of the Japan Sea floor]: Akad. Nauk SSSR Doklady, v. 119, no. 3, p. 575–578, 1958.

Seismo-acoustic investigations of the floor of the western part of the Japan Sea were made in April 1957, along two profiles roughly perpendicular to each other, one approximately north-south, the other approximately east-west. The results show a layer of unconsolidated sediments up to 1.7 km thick with velocities of 1.5 to 2.3 kmps; this is underlain directly by the basaltic layer, with a velocity of about 6.2 kmps, thickening eastward from 6 to 7 km to 7 to 8 km; the Mohorovičić discontinuity is about 11 to 13 km below sea level, with a velocity of about 8.0 kmps along the boundary.—*D. B. V.*

175–374. Andreyeva, I. B., and Udintsev, G. B. Stroyeniye dna Yapanskogo morya po dannym issledovaniy ekspeditsii na "Vityaze" [Structure of the Japan Sea floor according to data of investigations of the "Vityaze" expedition]: Akad. Nauk SSSR Izv. Ser. geol., no. 10, p. 3–20, 1958.

A more complete version of the paper that appeared in Akad. Nauk SSSR Doklady, v. 119, no. 3, p. 575–578, 1958 (see Geophys. Abs. 175–373).—*D. B. V.*

Hayakawa, Masami, and others. Prospecting of the underground structure of "Shōwa-Shinzan" by various geophysical methods, particularly seismic survey. See Geophys. Abs. 175–413.

175–375. Roose, Donald D. Efecto del gradiente de velocidades en la interpretacíon en un prospecto sismológico de la cuenca de Tampico [Effect of velocity gradients on interpretation in seismic prospecting in the Tampico basin]: Asoc. Mexicana Geol. Petroleros Bol., v. 10, no. 5–6, p. 273–285, 1958.

A discussion of the need to correct for lateral variations in velocity in seismic reflection prospecting in the Tampico area.—*H. R. J.*

175–376. Snijders, G. H. F. Reflection shooting techniques in the Netherlands: Geophys. Prosp., v. 6, no. 3, p. 167–193, 1958.

Reflection quality in the Netherlands is extremely variable, ranging from very good to very poor. It is believed that the variation is caused mainly by

the changing surface conditions. This suggestion is discussed in the light of available geological data.

Several examples are given showing the usefulness of making broad band recordings on normal reflection spreads.

The combination of data obtained from the study of the surface conditions and from broad band seismograms is used to select the best shooting method.

Some suggestions are made regarding seismometer and shot-hole patterns, shot medium and the choice of filters.—*Author's abstract*

Kosminskaya, I. P. The application of deep seismic sounding in different regions of the USSR. See Geophys. Abs. 175–251.

175–377. Oksa, Donald R. An empirical velocity determination in southern Oklahoma: Geophysics, v. 23, no. 4, p. 823–837, 1958.

Lack of adequate velocity data can sometimes be overcome by the proper co-ordination of seismic and geologic factors. The basic assumption that seismic and geologic data are directly correlatable must be utilized to its fullest extent. Upon this basis reliable basic seismic data of time and delta *t* values are computed with variations in the other parameters to make the computed seismic data closely match the known geologic conditions by one of several standard computing methods. The empirical fitting of the seismic data to match geologic conditions establishes the velocity gradient which can be then extrapolated into immediately adjacent areas. An iso-velocity section can also be prepared, if desired. Generally, it appears that iso-velocity contours parallel formational strikes. The application of such empirically derived velocity data will result in seismic structural maps and cross-sections which are compatible with actual geologic conditions. The value of the oftentimes neglected true dip section is shown and is actually an integral part of the analysis. The application of electronic computing techniques makes such determinations much more rapid and makes the method entirely feasible.—*Author's abstract*

175–378. Kelsey, M. C. Use of the reflection seismograph for the determination of subsurface structure in Cooke and Grayson Counties, Texas, *in* Bradfield, H. H. and others, geology and geophysics of Cooke and Grayson Counties, Texas: Dallas, Dallas Geol. Soc. and Dallas Geophys. Soc., p. 195–211, 1957.

Discusses reflection seismograph techniques most applicable to study of structural and stratigraphic features in Cooke and Grayson Counties, Texas, as a guide to individuals or companies planning exploration programs in this area.—*V. S. N.*

175–379. Levin, Franklyn K., and Lynn, Ralph D. Deep-hole geophone studies: Geophysics, v. 23, no. 4, p. 639–664, 1958.

Seismic surveys have been made in eight widely separated wells with two types of wall-coupled geophones. These geophones accurately detected and reproduced elastic waves traveling in the earth. Both direct (initial) pulses from shots and reflection events were studied. The complexity introduced into the initial pulses by secondary reflections varied from well to well. Amplitude decayed as the negative 2.4 power of travel time. Pulse-broadening caused by selective absorption of high frequencies was found. Different wells showed amounts of broadening ranging from nearly complete to that indicating little absorption of high seismic frequencies.

Reflections from interfaces below the geophone were traced to their origin in the earth. At three wells, the same reflections were found on surface seismograms giving an identification of surface detected reflections and of reflector depth. Multiple reflections were distinguished from direct reflections and were found to mask the latter at four wells. In one case, multiple reflections were identified with events on surface records. Reflection coefficients found for direct reflections averaged 0.36. Accurate velocity surveys of the wells resulted from this work.—*Authors' abstract*

175–380. Carson, Vance. The sonic logger: Canadian Oil and Gas Industries, v. 11, no. 9, p. 63–64, 1958.

Describes a new sonic logging tool with a two-receiver system. In this system there is a choice of one- or three-foot spacing; the difference in time in the reception of the energy pulse is recorded; the mud cake and mud energies cancel out and the sonde remains centralized with respect to the bore hole wall. The Δt recorded is the travel time required for the energy to traverse one foot of formation. The Sonic Log consists of a sonic surve and an *SP* recorded simultaneously; another sonde is planned which will record a scintillation gamma ray simultaneously with the sonic curve. An example of an interpretation chart is shown.—*V. S. N.*

175–381. Dürschner, H[orst]. Synthetic seismograms from continuous velocity logs: Geophys. Prosp., v. 6, no. 3, p. 272–284, 1958.

A method for constructing synthetic seismograms from continuous velocity logs is presented and described in detail. The sum of many individual reflections of a seismic impulse is made for a given filter setting and amplifier response, where the phase and amplitudes of the reflections are determined from reflection coefficients and a knowledge of the time-depth relation. This sum is then the calculated seismic field record. Assumptions and simplifications used in this method are shown. A comparison of the synthetic record with the field record is also presented, this comparison permitting better correlation between recorded reflections and their causes in the earth.—*L. P.*

175–382. Schwaetzer, T. La mesure de la vitesse verticale par le carottage continu (CVL); précision des mesures et discussions de quelques résultats [The measurement of vertical velocity by continuous velocity logging (CVL); precision of measurements and discussion of some results]: Geophys. Prosp., v. 6, no. 3, p. 257–271, 1958.

The introduction of the CVL and the "core speed tester" (on ultrasonic velocity meter) have enabled the geophysicist to complement large-interval, average velocity measurement of sedimentary formations (obtained by conventional well velocity surveys, "Gardner" velocity shots, etc.) by small interval, detailed study of the velocity of particular strata, in situ or in the laboratory. The significance of laboratory velocity measurements on cores is affected by irreversible alterations of the core. At first the integrated time curve of the CVL, calibrated with a skeleton conventional velocity survey, seemed to assure the precision of the interval velocity. Later it was realized that variations of the "Delay Time" (compensation for Mud Travel Time in the single receptor (CVL), failure to identify the first energy arrival, etc, could cause errors in the interval velocity measured. These errors can be detected and reduced by increasing the number of control points of the well survey, run-

ning logs down and up the hole, overlapping, and also by the comparison of the Continuous Velocity Logs for neighbouring wells and for various strata in a given well.

Despite these errors, the CVL has been found extremely useful, not only for the determination of average velocity, the identification of reflecting strata, and of refraction markers, but also for geological correlations between wells, the determination of maximum porosity and detailed studies of the parameters affecting the velocity of sedimentary rocks.

The relation between interval velocity and porosity is discussed and a hypothesis that the low velocity of argillaceous, low-porosity limestones may in part be due to the total fluid contained is put forward.—*Author's abstract*

Leenhardt, Olivier. State of seismic submarine research; 1. Measurements by the reflection method; 2. Study of the western Atlantic by the refraction method. See Geophys. Abs. 175–384.

International Geophysical Year Bulletin No. 13. Preliminary report on the thickness of ice in Antarctica. See Geophys. Abs. 175–187.

Schlich, Roland. Interpretation of a seismic refraction profile at the Charcot station in Adélie Land. See Geophys. Abs. 175–190.

SUBMARINE GEOLOGY

175–383. Panov, D. G. Tipy glubinnykh razlomov na dne okeanov [Types of deep fractures on the floor of the oceans]: Akad. Nauk SSSR Izv. Ser. geol., no. 9, p. 84–87, 1958.

In the present state of knowledge of submarine topography, two types of deep fractures can be recognized in the oceans, those on continental slopes and those on the floor of ocean basins. On the continental slopes the fractures may be open, very clearly expressed in the topography as benches thousands of kilometers long and thousands of meters high; or closed, expressed in the continental flexure. Deep fractures in the ocean basin floors are related to different types of features of the ocean floor: abyssal plains, submarine mountain ranges, and abyssal trenches. The Mid-Atlantic Ridge is cut by a rift valley. Deep fractures can be recognized in abyssal plains by zones of shattered relief or young volcanic forms. The relationship of the deep trenches to lines of fracture is confirmed by the distribution of foci of deep earthquakes.

Submarine fractures are more extensive and younger than those on the continents. They are major planetary features. The difference in crustal structure and evolution between the continents and oceans may depend on processes in the mantle.—*D. B. V.*

175–384. Leenhardt, Olivier. État des recherches séismiques sous-marines. I. Mesures par la méthode de réflexion; II. Étude de l'Atlantique Ouest par la méthode de réfraction [State of seismic submarine research. 1. Measurements by the reflection method; 2. Study of the western Atlantic by the refraction method]: Rev. Géographie phys. et Géologie dynamique, sér. 2, v. 1, no. 3, p. 189–198, and no. 4, p. 249–259, 1957.

The first part is a summary of seismic reflection techniques used for the study of ocean-bottom sediments and their results, in particular those used by

Swedish, French, and American investigators. The second part is a review of the principles of the seismic refraction method as applied to submarine investigations and of the results obtained in the western part of the Atlantic Ocean, mainly by the Lamont group.—*D. B. V.*

175–385. Koczy, F[ritz] F., and Burri, M. Essai d'interprétation de quelques formes du terrain sous-marin. D'après les échogrammes de l'expédition suédoise de l'*Albatros*. [Attempt at interpretation of some submarine land forms. After the echo–grams of the Swedish *Albatross* expedition (in French with English summary)]: Deep–Sea Research, v. 5, no. 1, p. 7–17, 1958.

From a comparison of the results of echo–soundings by the Swedish Deep Sea Expedition with continental structural profiles, zones of horsts and grabens, comparable to the Rhine graben, can be recognized in the Indian Ocean. The Mid-Atlantic Ridge is analogous to the great faulted folds of the Lebanon ranges. The large abyssal plains have many possible origins; in the case of the plain in the Indian Ocean, a lava flow is inferred. A small shallow submarine plateau may be due to accumulation of sediments around a still visible massif. The results of slumping can be observed at the foot of some steep slopes. The relative merits of the descriptive and generic nomenclatures for submarine landforms are discussed briefly.—*D. B. V.*

175–386. Fisher, R[obert] L., Carsola, A. J., and Shumway, G. Deep–sea bathymetry north of Point Barrow: Deep–Sea Research, v. 5, no. 1, p. 1–6, 1958.

This presents a detailed bathymetric chart of the western part of the Beaufort Basin, which embraces the region deeper than 1,900 fathoms extending northward from Point Barrow, Alaska, for an unspecified distance, between long 140° and 160° W. The chart is based on soundings made in 1950, 1951, 1954, and 1957. It shows a deep (2,000 to 2,100 fathoms) basin with a relatively smooth sea floor north of Point Barrow. North-northwest of Point Barrow is a continental borderland containing a detached ridge 100 miles long, with a steep (23°) southeast flank.—*V. S. N.*

175–387. Hersey, J. B., and Rutstein, Milton S. Reconnaissance survey of Oriente Deep (Caribbean Sea) with a precision echo sounder: Geol. Soc. Am. Bull., v. 69, no. 10, p. 1297–1304, 1958.

The submarine slope of the southern coast of Cuba is steep and rugged south of Sierra Maestra, Oriente Province; the average slope in one locality between depths of 1,000 and 2,000 fathoms is 31°. Two major reversals in slope, at about 2,000 fathoms and 2,800 fathoms, are taken as evidence of fault zones. Below 2,800 fathoms the topography is mountainous in an area parallel to the coast and about 15 miles wide; local relief is several hundred fathoms, but the area deepens to its center where there is a nearly flat plain 3 to 5 miles wide and about 25 miles long, which also parallels the coast. The plain slopes gradually westward from 3,530 to 3,542 fathoms with local northward slopes (depths are based on sound velocity of 4,800 feet per second); it is the deepest known part of Oriente Deep. The plain is surrounded by hills and intervening gorges which have relatively smooth bottoms grading down to it. Details of the topographic relations indicate that the plain is underlain by unconsolidated sediment brought in by turbidity currents flowing down the gorges. Recent

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coring in a similar nearby plain supports this view. Seismic evidence, though meager, suggests that the sediment is 1,200 to 1,500 feet thick.—*Authors' abstract*

175–388. Brodie, J. W., and Hatherton, T. The morphology of Kermadec and Hikurangi trenches: Deep–Sea Research, v. 5, no. 1, p. 18–28, 1958.

The Kermadec Trench extends 700 miles from 26° S towards New Zealand. Its steep sides with major benches, narrow floor and greater depth separate the Kermadec Trench from the slightly offset, broader and shallower Hikurangi Trench off the east coast of New Zealand. Hikurangi Trench has small-scale benching along its axial depression. Benched sides are also found in Tonga Trench and in other Pacific trenches. The benches are ascribed to superficial normal faulting on the flanks of a major deep-seated crustal depression. New soundings obtained in the S.W. Pacific by explosion sounding equipment are discussed and the instrumentation described. New names, Hikurangi Trench, Colville Ridge, and Havre Trough are proposed for bathymetric features not previously clearly defined.—*Authors' abstract*

175–389. Ihl C., Pablo. Ponencia chilena sobre: "Delimitacion natural entre los océanos Pacífico y Atlántico Sur por el Arco de Escocia" [Chilean proposal on "Natural boundary between the Pacific and the South Atlantic Oceans following the Scotia Arc"]: Union Geodesica y Geofisica Internacional, 11th Asamblea General (Toronto, Septiembre de 1957). Republica da Chile, 100 p., 1957.

This report was presented to the International Association of Physical Oceanography at the 1957 meetings of the International Union of Geodesy and Geophysics. It is a compilation of evidence supporting the Chilean proposal that the Scotia Arc, between Chile and the Antarctic peninsula, be considered the natural boundary between the South Atlantic and Pacific oceans, citing numerous prominent authors. Justification is based on data of bathymetry, marine currents and water characteristics, sedimentation, geotectonics, marine biology, tides, seismology and volcanology, and cartography.—*D. B. V.*

Starik, I. Ye., Kuznetsov, Yu. V., Grashchenko, S. M., and Frenklikh, M. S. The ionium method of determination of the age of marine sediments. See Geophys. Abs. 175–20.

TEKTITES

175–390. Barnes, Virgil E. Tektites: Geotimes, v. 1, no. 12, p. 6–7 and 16–17, 1957.

The form, composition, and geographic and temporal distribution of tektites are outlined briefly. The most persuasive evidence for their extra-terrestrial origin is the button form, which shows two periods of melting. The chemical composition is closest to that of argillaceous sedimentary rock, the oxygen isotopic composition closest to that of marine sediments. It is suggested that tektites once formed part of the sedimentary blanket of another planet. The extremely low pressure in tektite bubbles fits in with this hypothesis; in the catastrophic destruction of a planet, the violently jetted gasified and liquified materials might reach a point of nearly zero pressure before solidifying. These jets may have formed comets, varying somewhat in composition between and

within themselves due to variations in the original planet; such variations are noted between and within the various tektite showers.—*D. B. V.*

175–391. Urey, Harold C. Origin of tektites: Nature, v. 179, no. 4559, p. 556–557, 1957.

Urey suggests that tektites are a by-product of collision of a comet with the earth. If such an object entered the atmosphere at high velocity, compression and heating of the material would occur. It would explode in a chemical sense, easily heat the surface of the earth to the melting point, produce a very compressed region of gas, and this would propel terrestrial material in all directions at high velocity. Such events, some small, should occur about once in 50 million years. It is interesting to note that many of the tektites are Pleistocene in age; only those from Texas are Eocene, just about 50 million years old.—*D. B. V.*

175–392. O'Keefe, John A. Origin of tektites: Nature, v. 181, no. 4603, p. 172–173, 1958.

A difficulty encountered in the lunar impact theory of tektite origin, in explaining their distribution, can be removed if it is assumed that the earth's outer atmosphere extends to 10 radii or more and has a density of the order of 10^{-21} g per cm^3. In this case many of the particles thrown from the moon could be expected to encounter the extended atmosphere near perigee; this will diminish the eccentricity and major semi-axis of the orbit of the particle around the earth, with the result that the particle will nearly always come to earth in latitudes near the equator.—*D. B. V.*

175–393. Varsavsky, Carlos M. Origin of tektites: Nature, v. 181, no. 4603, p. 173, 1958.

Preliminary note on the results of the calculations reported in Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 291–303, 1958 (see Geophys. Abs. 175–404).—*D. B. V.*

175–394. Gold, T. Origin of tektites: Nature, v. 181, no. 4603, p. 173–174, 1958.

Assuming a lunar origin for tektites, their glassy nature can be explained by a large impact-produced pressure pulse, which can distribute energy more rapidly than heat conduction through the interior of an opaque solid having sharply nonlinear compression characteristics, such as the surface dust of the moon.—*D. B. V.*

175–395. Barnes, Virgil E. Origin of tektites: Nature, v. 181, no. 4621, p. 1457, 1958.

If tektites were of lunar origin they should be distributed fairly uniformly in space and time; this is not the case. Various groups are widely separated in time with no individuals as yet found to have arrived between times, and a few groups have characteristics that distinguish them from all other groups. The nearly pure silica glass of the Libyan Desert is particularly difficult to explain on the basis of a direct lunar origin.—*D. B. V.*

175–396. Kopal, Zdeněk. Origin of tektites: Nature, v. 181, no. 4621, p. 1457–1458, 1958.

If the impact of a large meteorite scattered lunar matter into space, its velocity components could not help but exhibit considerable dispersion in all

directions. The fact that tektites cluster in certain localities constituting only a fraction of the total solid surface of the earth, suggests that their origin must be sought nearer to the terrestrial surface than the moon. Urey's hypothesis (see Geophys. Abs. 175–391) seems to be the most satisfactory so far.—*D. B. V.*

175–397. Urey, Harold C. Origin of tektites: Nature, v. 181, no. 4621, p. 1458, 1958.

The composition of tektites, similar to terrestrial sediments, is an argument against their lunar origin. Furthermore, Varsavsky's calculations (see Geophys. Abs. 175–393 and 404) do not take into account the near misses, which would be very numerous. Their orbits would be perturbed, and those that eventually reached the earth would be generally distributed.—*D. B. V.*

175–398. Eiby, G. A. Origin of tektites: Nature, v. 182, no. 4645, p. 1298, 1958.

Eiby draws attention to the "plastic sweeping" hypothesis proposed by Hardcastle (New Zealand Jour. Sci. Technology, v. 8, p. 65, 1926), which suggests that tektites have been formed from stoney meteorites by the process of ablation during their passage through the atmosphere. The glazed surface of these meteorites is considered to be enriched in silica and is swept away piecemeal during flight; solidified remmants land as tektites.—*D. B. V.*

175–399. Kohman, Truman P. Are tektites extra-solar-system meteorites? Nature, v. 182, no. 4630, p. 252–253, 1958.

Radionuclides induced by cosmic rays have been found in some tektites (see Geophys. Abs. 175–330 and 407) at levels comparable to those observed in stone meteorites and considerably above any conceivable levels of production by cosmic or terrestrial radiations at or beneath the earth's surface. This practically eliminates not only the earth but also the moon as the source of tektites. Their distribution can be explained by the hypothesis that they arrived as clusters of objects from outside the solar system. Such an origin also lessens the difficulty of explaining their failure to fit into the system comprising the recognized types of meteorites, and opens for speculation (and experimental testing) a wide variety of possible origins not possible under the assumption that they are members of the solar system.—*D. B. V.*

175–400. Krinov, E. L. Some considerations on tektites: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 259–266, 1958.

Recent research on tektites in the Soviet Union (in whose territory none have yet been found) has been devoted to studies of viscosities, major and minor element contents, and potassium-argon age determinations. Their viscosity has been found to lie between that of quartz and ordinary glass; that of obsidian is somewhat higher, that of a meteorite very near to that of tektites. Age determinations gave the following results: moldavites $<3.1\times10^6$ yrs; indochinites $<4.6\times10^6$ yrs; philippinites (rizalites) $<1.2\times10^7$ yrs—all much younger than stony meteorites ($650–4500\times10^6$ yrs), and not more than that of the rocks where they were found. Spencer's hypothesis of the origin of tektites as fusion products of terrestrial rocks resulting from impact of giant meteorites is favored.—*D. B. V.*

175–401. Barnes, V[irgil] E. Properties of tektites pertinent to their origin: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 267–278, 1958.

Theories of the origin of tektites are examined to see if they explain the following critical properties: chemical properties, lechatelierite particles, two periods of melting, flow structure, shapes and sizes, and age distribution. Terrestrial or lunar volcanic origin, lightning, impactite origin from the moon or asteroid collisions have little or no support. The lack of partly fused tektites is against Urey's impact origin. From examination of tektites alone, their formation by destruction of a planet similar to the earth appears most likely.—*D. B. V.*

175–402. Cohen, A. J. The absorption spectra of tektites and other natural glasses: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 279–286, 1958.

The absorption spectra of individual tektites known as australite, bediasite, indochinite, javanite, moldavite, and philippinite are compared in the 3,000–26,000Å region with that of Aouelloul glass, Libyan Desert glass, americanites, obsidian, perlite and an industrial welding goggle glass. The most characteristic feature of the absorption spectra of all these glasses in the range studied is the ferrous band with maximum in the 1.1—1.2μ wavelength region of the near-infra-red. The spectra of these materials were not affected by X-ray treatment with the exception of an obsidian which showed an increase in the ultra-violet cut-off and growth in the ferrous band. The refractive indices (N_D) are compared and appear to be related to total iron content of the glass.—*Author's abstract*

175–403. Rinehart, J. S. Impact effects and tektites: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 287–290, 1958.

Data on the composition, form and distribution of tektites are examined in the light of our knowledge of high speed impact phenomena to see how strong the evidence is for an impact origin. It is concluded that tektites could be of impact origin, but the arguments are inconclusive. A strong argument against such an origin is the lack of nickel-ferrous materials within the tektite.—*Author's abstract*

175–404. Varsavsky. C[arlos] M. Dynamical limits on a lunar origin for tektites: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 291–303, 1958.

Theories regarding the origin of tektites are reviewed and it is proposed that the moon is the most likely source for these objects. Detailed calculations show that Whipple's model for the ejection of tektites from the moon makes it possible to reproduce their observed distribution over the earth's surface.—*Author's abstract*

175–405. Cassidy, W. A. Achondrite investigations and their bearing on the origin of tektites: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 304–315, 1958.

A common origin for chondrites, achondrites, and tektites seems reasonable. A lunar impactite origin for tektites seems doubtful because their content of cosmic-ray-induced ^{26}Al and ^{10}Be indicates much longer times of travel as small bodies in space than is possible in passing from the moon to the earth. A planet with a chondritic centre, an achondritic subcrust, and tektitic crust is suggested as a possible place of origin. At the time of its disruption, the outer portions

of the planet must have been hot enough so that the tektitic crust was molten and the achondritic sublayer was semi-molten. Achondrite compositions are examined from this viewpoint. With increasing SiO_2 the composition of the achondrite series varies as follows: FeO, CaO and Al_2O_3 undergo fractionations of 20:1, 6:1 and 7:1, respectively, while MgO is enriched by a factor of 8. This variation could not have been produced by crystal fractionation in a basic magma, but might have been produced by partition of chemical components between the achondrite and tektite layers due to a condition of liquid immiscibility in such a basic magma. This variation could also have been produced by crystal fractionation in an extremely acidic magma but the acidic magma itself would have had to have been produced by a segregation due to liquid immiscibility. Both methods of accounting for the observed compositional variations among achondrites would result in the formation of a siliceous phase similar in composition to tektites.—*Author's abstract*

175–406. Friedman, Irving. The water, deuterium, gas and uranium content of tektites: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 316–322, 1958.

The majority of tektites are found to have less than 0.05 percent water; the deuterium content of the water is in the same range as that of terrestrial waters. The uranium content is about 1 to 3 parts per million. No gases could be detected. The data presented favor a catastrophic terrestrial origin, but an extra-terrestrial source is not ruled out.—*D. B. V.*

175–407. Tilton, G[eorge] R. Isotopic composition of lead from tektites: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 323–330, 1958.

The isotopic composition of lead in three tektites and Libyan Desert glass is compared with that in known terrestrial and extra-terrestrial sources. The lead contained in the glasses is similar to modern terrestrial lead, particularly lead from modern oceanic sediments. The uranium, thorium and lead concentrations were determined for one of the glasses, an australite. Evidence is given which indicates that within the last tens of millions of years differentiation of uranium, thorium, and lead occurred in the parent material of the australite. These results are difficult to explain in terms of any extra-terrestrial origin involving fusion of materials from the moon, meteorites or comets, but they are readily explained if tektites are of terrestrial origin involving fusion of argillaceous sediments in some unspecified way.—*Author's abstract*

175–408. Pinson, W[illiam]. H., Jr., Herzog, L[eonard]. F., Fairbairn, H[arold] W., and Cormier, R. F. Sr/Rb age study of tektites: Geochim. et Cosmochim. Acta, v. 14, no. 4, p. 331–339, 1958.

Eight tektite samples from four localities, Australia, Indo-China, the Philippines, and the Moldau Valley were analysed for Rb and Sr, and Sr isotopic composition analyses were made on seven of the samples. Seven of the eight samples are so similar in Rb/Sr ratios that a common source origin is postulated for the tektites. No radiogenic Sr^{87} was found in the tektites. All have normal 84/88, 86/88 and 87/86 ratios, namely, 0.0068, 0.1193, and 0.712. It is shown that the present Rb/Sr and Sr isotopic composition data are compatible (but unlikely) with an origin of tektites as differentiated from either protobasaltic or achondritic material. The tektites could not have differentiated from chondritic material. Other than indicating a common and homogeneous

source origin for the tektities, the present data are not evidence for or against an extra-terrestrial origin. However, the homogeneity in Rb/Sr contents and the constancy of the Sr^{87} contents make a terrestrial origin difficult to accept because of the wide geographical distribution of tektites.—*Authors' abstract*

VOLCANOLOGY

175–409 Ribiero, Orlando, and Soeiro de Brito, Raquel. Primeira notícia da erupção dos Capelinhos na Ilha do Faial [First report on the eruption of Capelinhos on Fayal Island]: Naturalia, v. 7, no. 1–4 (nos. 13–16), p. 192–224, 1957–1958.

The eruption of the volcano Capelinhos off the tip of Fayal Island in the Azores (see Geophys. Abs. 173–361) that began late in October 1957 was typically vulcanian for the most part, with two brief episodes of lava extrusion. This report describes the position of the volcano, premonitory tremors, first eruptive manifestations, effect of the presence of the sea in the crater, ejecta and clouds, explosive paroxysms, ash falls, disappearance of the first island and renewal of activity, rhythm of the eruption, migration of the crater, volume of material emitted and changes in relief, and effect of the eruption on the life of the island. Twenty-four photographs are included.—*D. B. V.*

175–410. Parsons, Willard H., and Mulford, John W. Capelinhos Volcano, Fayal Island, Azores: Cranbrook Inst. Sci. Newsletter, v. 28, no. 2, p. 10–21, 1958.

A report on observations of the volcano Capelinhos in the Azores, which burst from the sea off the tip of Fayal on September 27, 1957, and is still active. Early activity was particularly violent because the crater was flooded with ocean water, and the new lava was blown into fine ash and cinders. The volcano became quiet in the latter part of October and disappeared during the night of October 29. Early in November activity was resumed, and another cone was built and joined to the island. Lava appeared in April, May, and June, flowing from vents near the base of the cinder cone.

On May 14, 1958, some 400 volcanic earthquakes were felt in an 18-hour period, with epicenters on two fracture zones. Shorelines were uplifted as much as three feet. Apparently magma began to move along the east-west fracture toward the main caldera in the center of the island. A fumarole opened up explosively in the floor of the caldera and has continued active ever since, but lava pressure seems to have been relieved by the activity of Capelinhos. Most of the lava was erupted after this seismic crisis. A violent explosion occurred in August, following three weeks of quiescence. Ash deposits have caused catastrophic damage to houses and farms for a distance of four miles from the volcano. (See also Geophys. Abs. 173–361, 175–409.)—*D. B. V.*

175–411. Thorarinsson, Sigurdur. The Öraefajökull eruption of 1362: Acta Naturalia Islandica, v. 2, no. 2, 99 p., 1958.

Öraefajökull, the largest active volcano in Iceland, is second only to Etna in volume. Two eruptions have been recorded in historic time, in 1362 and 1727. The 1362 eruption is reconstructed from the scanty records, supplemented by "tephrachronology" and the traces of jökulhlaups (meltwater floods). It was a typical initial eruption, purely explosive, and produced enormous amounts of rhyolitic tephra; the total volume is calculated to have been at least 10 km^3 when freshly fallen, corresponding to about 2 km^3 of solid rhyolite. With re-

gard to production of tephra, this is the biggest eruption in Iceland in historic time, probably the third biggest in the Postglacial, and certainly the biggest in Europe since Monte Somma in A.D. 78. A whole settlement was completely destroyed and much productive land destroyed. The greatest toll was caused by the tephra fall, not by the floods.—*D. B. V.*

175–412. Sakuma, Shūzō. Local geomagnetic anomalies on and around volcanic domes, with reference to the anomaly on Syowa-Sinzan, Usu: Japanese Jour. Geophysics, v. 1, no. 3, p. 1–12, 1957.

Geomagnetic anomalies and their changes in a volcanic region can supply valuable information concerning the subterranean state of a volcano. The geomagnetic field near a volcano reflects the average magnetization of the mountain and the difference in intensity of magnetization within the volcano and it is not necessary to follow the conventional assumption of uniform magnetization of a volcanic body. It should also be noted that during times of volcanic activity the geomagnetic field changes, presumably because of subterranean thermal changes, and it is possible to determine the subterranean thermal state by precise measurements of the geomagnetic field.

The results of geomagnetic surveys at four volcanic domes in Hokkaido, Japan were selected for discussion in this paper. Three of the domes—Mount Tarumai, Mount O-Usu, and Mount Atusanupuri—show similar types of anomalies. A north-south profile across each shows an increase of geomagnetic dip at the top of the dome and a decrease on the sides. This common feature is ascribed to the uniform magnetization in the normal direction of the part of the dome protruding above the surrounding area. In contrast, Mount Shōwa-Shinzan does not show homogeneous magnetization of the dome as a whole. Sakuma concludes from the anomalies that the northern part of the dome and its deeper root are non-magnetic, whereas its southern part is magnetized normally. This conclusion is supported by the fact that the temperature of the lava on the northern surface is still high above the Curie point of its ferromagnetic minerals.—*V. S. N.*

175–413. Hayakawa, Masami, and others. Prospecting of the underground structure of "Shōwa-Shinzan" by various geophysical methods, particularly seismic survey: Japanese Jour. Geophysics, v. 1, no. 3, p. 13–20, 1957.

A seismic survey was made of Shōwa-Shinzan, a parasite cone on Usu volcano, Japan, to determine its structure and the geothermal condition of the dome. The dome is covered with a thick, low-velocity layer of volcanic ash except for the fresh lava (dacite) with high temperatures exposed on the west side and showing high velocities of 4 kmps. The velocity of the *P*-waves in the interior of the dome was also 4 kmps and it is presumed that the interior of the dome is formed of solid dacite at high temperature. This high velocity layer was found to extend to the south of the dome at a gentle slope indicating an underground intrusion of magma coming from the south and rising to the surface in the dome. (See also Geophys. Abs. 174–357.)—*V. S. N.*

175–414. Pugh, J[ohn] C[harles]. The volcanoes of Nigeria: Nigerian Geog. Jour., v. 2, no. 1, p. 26–36, 1958.

The volcanoes of Nigeria are grouped significantly along southwest-northeast lines of weakness, along and parallel to the eastern frontier, that probably came into existence in Lower Cretaceous time. The appearance of both old and

young forms suggest at least two phases of activity. Only Cameroon Mountain is still active (at least five eruptions in the 19th century, and others in 1909, 1922, 1954), but on the southeastern margins of the Jos Plateau activity probably continued until a very late date. The 1922 eruption of Cameroon Mountain was the most extensive, when a number of small craters opened on the upper slopes of the mountain and lava flows reached the sea near Bibundi.—*D. B. V.*

175–415. Menyaylov, A. A. Izverzheniye vulkana Shiveluch v 1944–1948 gg [Eruption of Shiveluch volcano in the years 1944–1948]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 18, p. 3–24, 1953.

Tabakov, N. D. Nablyudeniya nekotorykh momentov izverzheniya vulkana Shiveluch v 1946–1947 gg [Observations of some moments of the eruption of Shiveluch volcano in the years 1946–1947]: ibid., p. 25–30, 1953.

Basharina, L. A. Issledovaniye gazoobraznykh produktov vulkanov Klyuchevskogo i Shiveluch v 1946–1947 gg [Investigation of the gaseous products of the volcanoes Klyuchevskaya and Shiveluch in the years 1946–1947]: ibid., p. 31–40, 1953.

Tabakov, N. D. Issledovaniye okisi ugleroda v gazakh vulkana Shiveluch v 1946–1947 gg s pomoshch'yu termoindikatora [Investigations of the carbon monoxide in the gases of Shiveluch volcano in the years 1946–1947 by means of a thermoindicator]: ibid., p. 41–46, 1953.

Naboko, S. I. Vozgony vulkana Shiveluch [Sublimates of Shiveluch volcano]: ibid., p. 47–55, 1953.

Shiveluch volcano in Kamchatka, apparently dormant since 1930, became active at the end of December 1944. All the papers in this bulletin of the Kamchatka volcanological station are concerned with this eruption in one way or another.

The first paper describes main details of the activity, which was of pelean type, and for the period September 1946–August 1948 summarizes them diagrammatically. Temperature measurements on lavas, ash, and gases, also chemical analyses of some fumarolic gases, are presented. The total volume of material erupted up to the end of 1947 is estimated to be 125 million cubic meters.

The second paper is a report of observations made in 1946 and 1947 by a party operating from a base camp on the Suelich dome, formed during the eruption. Glowing cloud eruptions and the resulting agglomerates are described, with photographs.

The remaining papers give the results of chemical analyses of gases collected from Klyuchevskaya and Shiveluch in 1946 and 1947, measurements of carbon monoxide content of gas from Shiveluch by means of a thermoindicator made in the same period, and studies of sublimates collected from various parts of the volcano and from its eruptive products.—*D. B. V.*

175–416. Gorshkov, G. S. Sostoyaniye deystvuyushchikh vulkanov severnoy Kamchatki v period s 16 Sentyabrya 1954 g. po 31 Dekabrya 1955 g. [State of the active volcanoes of northern Kamchatka in the period from September 16, 1954 to December 31, 1955]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 26, p. 3–18, 1957.

In the period September 16, 1954, to December 31, 1955, activity of Sheveluch volcano was fumarolic. Klyuchevskoy was active for 220 out of 472 days, with intermittent increases in fumarolic activity and explosive eruptions of gas clouds and some ash from the summit crater, fumarolic activity in various lateral craters. An eruption of Bezymyannyy which began in October 1955 is described in a separate paper (see Geophys. Abs. 175–417). Tolbachik was active for 133 out of 304 days (fumarolic) and Kizimen for 109 out of 304 days (mildly explosive and fumarolic).—*D. B. V.*

175–417. Gorshkov, G. S. Izverzheniye sopki Bezymyannoy [Activity of Bezymyannyy peak]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 26, p. 19–72, 1957.

This is a very detailed account of the first eruption in historic times of Bezymyannyy volcano, in the center of the Klyuchevskoy group in Kamchtka. The eruption began on October 22, 1955, after three weeks of premonitory earthquakes; it was still going on at the end of June 1956. Typical explosions sent clouds of gas and ash up to heights of the order of 2 km, showered ash as far away as 100 km and more. A terrific explosion on March 30 blew off the top of the peak, not only changing its form substantially but also that of the surrounding topography and making this the most violent eruption in Kamchatka in the last 50 years (somewhat resembling the Katmai, Alaska, eruption of 1912 in force and character). Streams of agglomerate (hornblende andesite) and lahars flowed down the east slope on March 30 and later.—*D. B. V.*

175–418. Semenov, V. I. Soobshcheniye o sostoyanii vulkana Koryaka, 4 Marta 1956 g. [Note on the state of Koryak volcano on March 4, 1956]: Akad. Nauk SSSR Lab. vulkanol., Byull. vulkanol. stantsii, no. 26, p. 73–74, 1957.

On March 4, 1956, the Avach volcano in Kamchatka began to steam, and within an hour Koryak did likewise. Such activity is rare in the Petropavlovsk region.—*D. B. V.*

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