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

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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 geological problems, and geophysical exploration. The table of contents, which is alphabetically arranged, shows the material covered.

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

LIST OF JOURNALS

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

The following references cited in Geophysical Abstracts 178 are not included in this master list:

Acad. Romîne Analele Romîno-Sovetice, ser. geol.-geog.—Academia Republicii Populare Romîne Anelele Romîno-Soveticé [Academy of the Rumanian People's Republic, Rumanian-Soviet Annals]. Bucureşti (Bucharest) Rumania.

Akad. Nauk Kirgiz. SSR Yubileynaya nauch. sess., Otdel tekh. nauk—Akademiya Nauk Kirgizskoy SSR, Yubileynaya nauchnaya sessiya, Otdel tekhnicheskikh nauk, [Academy of Sciences of the Kirgiz SSR, Anniversary Scientific Session, Division of Technical Sciences]. Frunze, Kirgiz S.S.R.

Akad. Nauk SSSR, Inst. Geologii Rudn. Mestorozhdeniy, Petrografii, Mineralogii i Geokhimii Trudy—Trudy Instituta Geologii Rudnykh Mestorozdeniy, Petrographii Mineralogii i Geokhimii. [Papers of the Institute of Geology of Ore Deposits, Petrography, Mineralogy, and Geochemistry]. Moskva (Moscow), U.S.S.R.

Akad. Nauk SSSR, Sibirskoye Otdeleniye Izv.—Akademiya Nauk SSSR, Sibirskoye Otdeleniye, Izvestiya [Academy of Sciences of the U.S.S.R., Siberian Branch, Bulletin]. Novosibirsk, U.S.S.R.

Akad. Nauk SSSR, Soveshch. ekspt. i tekh. mineralogii i petrografii, 5th, Leningrad, 1956, Trudy—Akademiya Nauk SSSR, Trudy pyatogo soveshchaniya po eksperimental'noy i tekhnicheskoy mineralogii i petrografii, 26–31 marta 1956 g. [Academy of Sciences of the U.S.S.R., Proceedings of the fifth conference on experimental and technical mineralogy and petrography, March 26–31, 1956, Leningrad]. Moscow, U.S.S.R.

Annales des Mines de Belgique—Annales des Mines de Belgique [Annals of Mines of Belgium]. Bruxelles (Brussels), Belgium.

Archives Sci. (Genève)—Archives des Sciences. Société de physique et d'histoire naturelle de Genève. [Archives of Sciences. Geneva Society of physics and natural history]. Genève, Switzerland.

Chile Inst. Inv. Geol. Bol.—Chile, Instituto de Investigaciones Geológicas, Boletin [Bulletin of the Institute of Geological Investigations, Chile]. Santiago, Chile.

Cranbrook Inst. Sci. News Letter—Cranbrook Institute of Science News Letter. Bloomfield Hills, Michigan.

Federation of Malaya Geol. Survey Econ. Bull.—Ministry of Natural Resources. Records of the Geological Survey Economics Bulletin. [Headquarters of Malaya Geological Survey, Kuala Lumpr]. Ipoh, Malaya.

Földrajzi Közlemények—Földrajzi Közlemények. A Magyar Földrajzi Társaság Tudományos Folyóirata [Geographical Publications. Scientific Journal of the Hungarian Geographical Society]. Budapest, Hungary.

Glückauf—Glückauf. Bergmännische Zeitschrift [Good Fortune. Mining Journal]. Essen, Germany.

Intermountain Assoc. Petroleum Geologists Guidebook to Geology of Paradox Basin, 9th Annual Field Conference, 1958. Available through Utah Geological and Mineralogical Society, University of Utah, Salt Lake City, Utah.

Japanese Assoc. Mineralogists, Petrologists, Econ. Geologists Jour.—The Journal of the Japanese Association of Mineralogists, Petrologists, and Economic Geologists. Association of the Institute of Mineralogy, Petrology, and Economic Geology, Tohoku University. Sendai, Japan.

Kansas Geol. Survey Bull.—State Geological Survey of Kansas, Bulletin. University of Kansas. Lawrence, Kansas.

Leningrad Univ. Vestnik, ser. fiziki i khimii—Vestnik Leningradskogo Universiteta, seriya fiziki i khimii. [Notes of Leningrad University, series of physics and chemistry]. Leningrad, U.S.S.R.

Leningrad Univ. Vestnik, ser, mat., mekh. i astron.—Vestnik Leningradskogo Universiteta, seriya matematiki, mekhaniki i astronomii [Notes of Leningrad University, series of mathematics, mechanics, and astronomy]. Leningrad, U.S.S.R.

Liverpool and Manchester Geol. Jour.—Liverpool and Manchester Geological Journal. Liverpool Geological Society and Manchester Geological Association. Liverpool, England.

Moskov. Geologorazved. Inst. Ordzhonikidze Trudy—Trudy Moskovskogo Geologorazvedochnogo Instituta imeni S. Ordzhonikidze [Papers of the Moscow Geological Survey Institute in the name of S. Orzhonikidze]. Moskva (Moscow), U.S.S.R.

Moskov. Neftyanoy Inst. Gubkin Trudy—Moskovskiy Neftyanoy Institut imeni Akad. I. M. Gubkina, Trudy [Moscow Petroleum Institute in the name of Academician I. M. Gubkin, Papers]. Moskva (Moscow), U.S.S.R.

Naturw. Ver. Schleswig-Holstein Schr.—Schriften des Naturwissenschaftlichen Vereins für Schleswig-Holstein [Papers of the Natural-Scientific Association of Schleswig-Holstein]. Kiel, Germany.

Oilweek—Oilweek. Myers' Oil News Ltd. Calgary, Alberta.
Physics of Fluids—The physics of fluids. American Institute of Physics, Inc. New York, New York.
[Poland] Inst. Geol. Muzeum Ziemi Prace—Prace Muzeum Ziemi, Instytut Geologiczny [Works of the Museum of the Earth, Geological Institute]. Warsaw, Poland.
Polar Rec.—The Polar Record. The Scott Polar Research Institute. Cambridge, England.
Shale Shaker—Shale Shaker. Oklahoma City Geological Society. Oklahoma City, Oklahoma.
Sovkhoznoye proizvodstvo—Sovkhoznoye proizvodstvo. Organ Ministerstva Sovkhozov SSSR, Ministerstvo Sel'skogo Khozyaystva SSSR [State farm industry. Organ of the Ministry of state farms of the U.S.S.R., Ministry of Agriculture of the U.S.S.R. Moskva (Moscow), U.S.S.R.
Sredneaziatskiy Univ. Trudy aspirantov—Trudy aspirantov Sredneaziatskogo Universiteta [Papers of graduate students of Central Asiatic University]. Tashkent, Uzbek S.S.R.
Technique de l'Eau—La Technique de l'Eau et de l'Assainissement. Revue européenne d'expression française. [The technique of water and sanitation. European review published in French]. Bruxelles (Brussels), Belgium.
[U.S.] Natl. Acad. Sci.—Natl. Research Council Pub.—Publication of the National Academy of Sciences—National Research Council. Washington, D.C.
U.S. Natl. Bur. Standards Tech. News Bull.—U.S. National Bureau of Standards Technical News Bulletin. Washington, D.C.
Verkfraeðingafélags Íslands Tímarit—Tímarit Verkfraeðingafélags Íslands [Journal of the Engineering Society of Iceland]. Reykjavík, Iceland.

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 is given in Geophysical Abstracts 148 (January–March 1952, Bulletin 991–A) and in the "List of Journals" announced above. Titles of papers in Japanese and Chinese are given in translation only.

ABSTRACTORS

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

AGE DETERMINATIONS

178–1. Kroebel, Werner. Alterbestimmung mit radioaktiven Elementen [Age determination with radioactive elements]: Naturw. Ver. Schleswig-Holstein Schr., v. 29, no. 2, p. 59–64, 1959.

A review of the principles of the uranium-lead, thorium-lead, and carbon-14 methods of age determination. The time scales based on each are presented in tables.—*D. B. V.*

178–2. Burkser, E. S. Kak opredelyayetsya vozrast gornykh porod i Zemli [How the age of rocks and of the earth is determined]: Kiev, Izdatel'stvo Akad. Nauk Ukrain. SSR, 32 p., 1954.

A popular book on geochronology describing the lead (uranium, actinouranium, and thorium), helium, argon, strontium, and carbon-14 methods. The last three pages give mathematical formulas for age determination of rocks and minerals.—*A. J. S.*

178–3. Semenenko, N. P. Geokhronologiya dokembriya v absolyutnom letoischislenii [Geochronology of the Precambrian in absolute age calculation]: Akad. Nauk SSSR Izv. ser. geol., no. 5, p. 3–15, 1959.

On the basis of available absolute age determinations from various continents, Precambrian time (from 500 to 3,500 million years ago) is divided into 4 megacycles, with post-Precambrian time constituting a fifth. The first megacycle (about 2,650–3,500 million years ago) includes two epochs of folding and mineralization; the second (about 1,900–2,650 million years ago) and third (about 1,200–1,850 million years ago) each include three epochs of folding and mineralization; the fourth (about 500–1,150 million years ago) includes two epochs; and the fifth (the last 500 million years of development of the sial crust) includes three epochs—Caledonian, Hercynian, and Alpine.—*D. B. V.*

178–4. Komlev, L. V. Nekotorye voprosy absolyutnoy geokhronologii dokembriya Ukrainy [Some questions of the absolute geochronology of the Precambrian of Ukraine]: Ministerstvo Vyssh. Obrazovaniya SSSR, Nauch. Doklady Vyssh. Shkoly, Geol.-geog. nauki, no. 1, p. 22–24, 1958.

The Precambrian is divided into Early Precambrian, $3{,}500–2{,}500\times10^6$ yr; Middle Precambrian (Archean), $2{,}500–1{,}500\times10^6$ yr; and Late Precambrian (Proterozoic), $1{,}500–500\times10^6$ yr. The geologic units of the Ukrainian Shield are referred to a relatively narrow interval of the Middle Precambrian, for the bulk of the granites and migmatites have been dated as 1,700–2,000 million years old. These dates were determined on monazite by the lead isotope method and on micas and feldspars by the argon method. The absence of Late Precambrian rocks here and in Karelia, a gap of about 1,000 million years, is possibly due to deep erosion that has destroyed the younger units.

Our ideas on the development of geologic cycles are based on the study of late stages in the formation of the crust, under conditions of relatively stable continental blocks and mobile belts. The possibility of distinguishing individual geologic cycles and corresponding tectonic-magmatic belts for the Middle Precambrian of the Ukrainian Shield seems doubtful.—*J. W. C.*

178–5. de Vries, A. E., and Haring, A. An improvement on age determination by the carbon-14 method: United Nations Conf. on Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 249–250, 1958.

The carbon-14 concentration can be enriched by a factor of 12 in a thermal diffusion column; this means a gain of about 20,000 years in the age determination.—*J. W. C.*

Whitaker, W. W., Valastro, S. Jr., and Williams, Milton. The climatic factor in the radiocarbon content of woods. See Geophys. Abs. 178–320.

178–6. Münnich, K. O., and Vogel, J. C. C^{14}-Alterbestimmung von Süsswasser-Kalkablagerungen [Carbon-14 age determination of fresh-water lime deposits]: Naturwissenschaften, v. 46, no. 5, p. 168–169, 1959.

The carbon-14 content of hard ground water and of calcium carbonate precipitated from it has been found to be about 85 percent of that of recent wood (Geophys. Abs. 176–8). This suggests the possibility of dating fresh water lime deposits on the basis of their carbon-14 content; this has been done for 20 samples (stalagmites, sinter, tufa, calcite, loess, limy weathered soils). The ages should be sufficiently accurate if the carbon-14 content of the precipitate has not departed significantly from 85 percent of the modern wood standard, and if subsequent exchange has not taken place with younger ground water. As carbon-13 analyses can be used as a control, the method should prove valuable in Quarternary and prehistoric investigations.—*D. B. V.*

178–7. Flint, Richard Foster, and Deevey, Edward S. Radiocarbon Supplement: Am. Jour. Sci., v. 1, 218 p., 1959.

The American Journal of Science Radiocarbon Supplement is planned as a one-volume publication to serve as a medium for primary publication of all radiocarbon measurements or at least of radiocarbon date lists. To insure completeness, republication of lists published elsewhere in the future will be considered. All papers in this first volume include descriptions of samples and information on methods used. The following papers are included:

a. Olson, Edwin A., and Broecker, W[allace] S. Lamont natural radiocarbon measurements V: p. 1–28. Radiocarbon age measurements made at the Lamont Geological Observatory between February 1957 and July 1958 are reported in seven tables: North American glacial geology, pluvial lake levels, relative sea level changes, oceanography, miscellaneous, archeologic, and check samples.

b. Heusser, Calvin J. Radiocarbon dates of peats from North Pacific North America: p. 29–34. Ages are presented for 17 Late Pleistocene peat samples from sections that range from Karluk on Kodiak Island, Alaska, to Port Orford, Oregon, and interpretation of environments and changes in sea level are discussed.

c. Östlund, H. Göte. Stockholm natural radiocarbon measurements II: p. 35–44. A list of radiocarbon age determinations made in 1958 of geologic and archeologic samples from Sweden and of a few from Egypt and Italy is presented.

d. Ralph, Elizabeth K. University of Pennsylvania radiocarbon dates III: p. 45–58. Radiocarbon dates determined in 1958 are given for archeologic samples from the Near East and South America.

e. Shutler, Dick, Jr., and Damon, Paul E. University of Arizona radiocarbon dates II: p. 59–62. Radiocarbon age measurements determined from May 1957 to May 1958 are reported for 20 archeologic samples from Arizona and Illinois.

f. Godwin, H., and Willis, E. H. Cambridge University natural radiocarbon measurements I: p. 63–75. Radiocarbon dates, obtained up to the end of De-

cember 1958, of samples from peat bogs in the British Isles are presented in five groups: pollen-zone boundary determinations, British late-glacial series, coastal peat beds, further British pollen-dated levels, and checks and problematic dates.

g. Nydal, R. Trondheim natural radiocarbon measurements I: p. 76–80. Radiocarbon dates determined during the period from July 1957 to September 1958 are presented for geologic samples from Sweden and Norway and for archeologic samples from Norway.

h. Barker H., and Mackey, D. J. British Museum natural radiocarbon measurements I: p. 81–86. This is a report on the first series of radiocarbon dating measurements made at the British Museum and includes archeologic samples from Africa, Central America, Egypt, and Great Britain, and one geologic sample from Great Britain.

i. Olsson, Ingrid. Uppsala natural radiocarbon measurements I: p. 87–102. This is a report on radiocarbon measurements at Uppsala during 1957 and 1958 and includes geologic samples from the Mediterranean area, Iceland, Spitzbergen, Norway, and Sweden; samples dating sea level changes and strandlines; archeologic samples from India, Egypt, and Sweden; an industrial sample; and samples to demonstrate atomic bomb effect.

j. Ferrara, G., Reinharz, M., and Tongiorgi, E. Carbon-14 dating in Pisa: p. 103–110. This is a report on the first series of radiocarbon measurements made at Pisa and covers archeologic samples from Italy and geologic samples from Italy, Switzerland, and France.

k. Broecker, Wallace S., and Olson, Edwin A. Lamont radiocarbon measurements VI: p. 111–132. This list of radiocarbon measurements contains only known-age samples most of which formed during the past ten years. Measurements were made to gain understanding of the distribution of radiocarbon within the dynamic carbon reservoir both today and at times in the past.

l. Oeschger, H., Schwarz, U., and Gfeller, C. Bern radiocarbon dates I: p. 133–143. This list covers measurements at the University of Bern to the summer of 1958 and includes geologic samples to date Quaternary geology and vegetational history in Switzerland, and archeologic samples from Switzerland.

m. Deevey, Edward S., Gralenski, L. J., and Hoffren, Väinö. Yale natural radiocarbon measurements IV: p. 144–172. This list of dates brings the Yale list up to the end of 1958 and includes geologic samples from North and South America, Australia, and miscellaneous places, and archeologic samples from North, middle, and South America, and Africa.

n. Crane, H. R., and Griffin, James B. University of Michigan radiocarbon dates IV: p. 173–198. Radiocarbon dates are given for geologic samples from the United States, the West Indies, and Greenland, and for archeologic samples from the United States, Canada, Mexico, South America, and the North and South Pacific.

o. Johnson, Frederick. A bibliography of radiocarbon dating: p. 199–214. This bibliography is classified in the following groups: lists of dates, the method (techniques and geochemistry), the method (explanatory essays), interpretation (selected geologic titles), interpretation (selected archeologic titles), and bibliographies and reports on conferences.— *V. S. N.*

178–8. Rainey, Froelich, and Ralph, Elizabeth [K.]. Radiocarbon dating in the Arctic: Am. Antiquity, v. 24, no. 4, pt. 1, p. 365–374, 1959.

This is the first of a series of lists of carbon–14 ages determined on Arctic materials at the University of Pennsylvania's dating laboratory. The solid

carbon method was used in earlier measurements, the CO_2 method in later. Those obtained by the latter are more reliable and more consistent with the archeological evidence. A convincing cultural chronology cannot yet be defined for the American Arctic.—*D. B. V.*

178–9. Gross, Hugo. Die bisherigen Ergebnisse von C^{14}-Messungen und paläontologischen Untersuchungen für die Gliederung und Chronologie des Jungpleistozäns in Mitteleuropa und den Nachbargebieten [The results to date of carbon-14 measurements and paleontological investigations for the subdivision and chronology of the Late Pleistocene in central Europe and neighboring region (with English summary)]: Eiszeitalter und Gegenwart, v. 9, p. 155–187, 1958.

The Last Interglacial which ended more than 53,000 years ago is classified on the basis of pollenanalytical findings and marine and continental faunas. The chronology of the Last Glacial (Würm, Weichsel) is based on more than 120 carbon-14 dates; for subdivision the chronologic and paleoclimatic evaluation of loess sections in the more arid and warmer regions of southeastern central Europe are decisive. The Gottweig Interstadial, between 44,000 and 29,000 years ago, divides the Last Glacial into two stages: Old Würm, with 3 stadials and 2 interstadials; and Main Würm, with a weak interstadial, Würm maximum, and several short interstadials during the late-glacial period. Results of the study, shown in tabular form, verify the correctness of Woldstedt's hypothesis (1954) that interstadials (similar to the Late Würm deglaciation) interrupted the Old Würm advance.—*V. S. N.*

178–10. Naar, Karl J. C^{14} Daten und die Gliederung des Jungpleistozäns [Carbon-14 dates and the subdivision of the Late Pleistocene]: Forschungen und Fortschritte, v. 33, p. 147–151, 1959.

Correlations of Aurignacian and Mousterian cultures with glacial intervals are critically reviewed on the basis of carbon-14 age data. Naar concludes that an interglacial stage that ended 50,000 B.C. corresponds to the Gottweig-Fellabrum-Stillfried A soil. The Aurignacian culture made its first appearances during this stage in southeast middle Europe although Mousterian still dominated in west and middle Europe. In the following millennia began the early glaciation with which a Mousterian occurrence of 46,000 B.C. is correlated. The beginning of the early glacial retreat is at least 36,000 B.C. and its end earlier than 30,000 B.C. The beginning of the full glaciation is placed in the first millennia after 30,000 B.C. and the end at before 15,000 B.C.—*J. W. C.*

178–11. Stieff, L[orin] R., Stern, T[homas] W., Oshiro, Seiki, and Senftle, F[rank] E. Tables for the calculation of lead isotope ages: U.S. Geol. Survey Prof. Paper 334–A, 40 p., 1959.

Tables are presented for calculating geologic age by using the atomic ratios of Pb^{206}/U^{238}, Pb^{207}/U^{235}, Pb^{207}/Pb^{206}, and Pb^{208}/Th^{232}.

Tables of values of N_d/N_p and t are given for the age equation $\frac{N_d}{N_p}=exp\ \lambda t-1$ where λ is the decay constant, t is age, in million years, N_d is the number of atoms of daughter products, and N_p is the number of atoms of parent. Values for N_{207}/N_{206} and t are also given in tabular form for the age equation $\frac{N_{207}}{N_{206}}=\frac{exp\ \lambda\ 235^{t-1}}{k(exp)\lambda\ 238^{t-1}}$ where N_{207} and N_{206} are the number of atoms of radiogenic

Pb^{207} and Pb^{206}, respectively, and where k, the present-day atomic ratio of U^{238} to U^{235}, is taken as 137.7. The half lives (T) of U^{238}, U^{235}, and Th^{232}, used in the calculations are: $T_{238}=4.51\times10^9$ yr, $T_{235}=7.13\times10^8$ yr, $T_{232}=1.42\times10^{10}$ yr.

The tables cover selected values of t from 1 to 6,000 million years (6×10^9 yr) at intervals of t ranging from 1 to 15 million years. Only the calculated errors in t resulting from experimental uncertainties in the determinations of the decay constants and relative abundance of U^{238} and U^{235} have been included. An example is given for a hypothetical geologic age calculation by use of these tables.—*Authors' abstract*

Boyle, R. W. Some geochemical considerations on lead-isotope dating of lead deposits. See Geophys. Abs. 178–274.

Russell, R. D. Some geochemical considerations on lead-isotope dating of lead deposits. See Geophys. Abs. 178–275.

178–12. Brown, John S., and Kulp, J. L[aurence]. Lead isotopes from Balmat area, New York: Econ. Geology, v. 54, no. 1, p. 137–139, 1959.

The lead isotope method of age determination is evaluated on the basis of a comparison of data from the Balmat area, New York. Three samples of lead minerals from the Balmat-Edwards deposits yield an age of $1,050\pm100\times10^6$ yr, based on the Houtermanns-Holmes model; this is in agreement with determinations made by other radioactive methods. Lead from the Rossie area about 15 miles away yields a high Pb^{206}/Pb^{204} ratio, which indicates a post-Cambrian age.—*J. W. C.*

Klemic, Harry, Eric, John H., McNitt, James R., and McKeown, Frank A. Uranium in Phillips Mine-Camp Smith area, Putnam and Westchester Counties, New York. See Geophys. Abs. 178–164.

178–13. de Villiers, J. W. L., Burger, A. J., and Nicolaysen, L. O. The interpretation of age measurements on the Witwatersrand uraninite: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 237–238, 1958.

Radioactive age determinations for the Witwatersrand System are reviewed, and new lead isotope data are given. A comprehensive study was made of the isotopic composition of 27 galenas from veins in the vicinity of gold- and uranium-bearing conglomerates. The ratio of radiogenic lead-207 to radiogenic lead-206 is a basis for a minimum age of $2,470\times10^6$ yr for the parent uranium-bearing minerals that supplied the radiogenic components. The galena is believed to have developed through reworking or recrystallization of uraninite in the banket reefs themselves. This chemical rejuvenation and expelling of radiogenic lead from the uraninites apparently took place 2,100 million years ago.—*J. W. C.*

178–14. Amirkhanov, Kh. I., and Brandt, S. B. Opredeleniye absolyutnogo vozrasta porod po radioaktivnomu prevrashcheniyu kaliya 40 v argon 40 [Determination of absolute age of rocks by transmutation of potassium-40 into argon-40]: Makhachkala, Akad. Nauk SSSR Dagestan. filial, 149 p., 1956.

The book deals with mass-spectrographic method of determination of the potassium-40 and argon-40 contents of substances and with determination of the absolute age of rock for which the K/A ratio is measured. The introductory chapter of the book gives a brief historical review of the potassium-argon method.

The second chapter deals with relationship between geochronology and radioactivity, and presents a general theory of radioactive methods according to Starik, Gerling, and Rankama (see Geophys. Abs. 163–119). The mechanism of K→A transmutation is presented in chapter 3, where the determination of the constants of this disintegration is analyzed critically, and the formulas used in the argon method are shown. In chapter 4 the works of Gerling, Gentner, and the Dagestan branch of the Academy of Sciences of the U.S.S.R. on the retention of argon in rocks are discussed. Chapter 5 describes high-vacuum separation of argon from the rock, refining the extracted argon gas, and mass-spectroscopic methods of measuring its amount. The essentials of the isotope dilution technique are also discussed in chapter 5.—*A. J. S.*

178–15. Shur, A. S. K argonovoy metodike opredeleniya absolyutnogo vozrasta gornykh porod i mineralov [On the argon method of determination of absolute age of rocks and minerals]: Akad. Nauk SSSR Izv. ser. geol., no. 6, p. 109–111, 1959.

This paper describes a new setup for volumetric determination of radiogenic argon for potassium-argon dating purposes. Its chief merit is its productive capacity; 6 samples are run simultaneously so that 6–12 determinations can be made in 1 week, or 1–2 a day. This is achieved by applying external heat for melting the sample. Another advantage is the small use of quartz. A schematic diagram is given, and the operational procedure is outlined.—*D. B. V.*

178–16. Afanassiev [Afanas'yev], G. D. Development of magmatism in the Caucasus in the light of absolute age determinations: Bull. volcanol., v. 20, p. 173–191, 1959.

The main igneous cycles of the North Caucasus folded region have been dated as follows: Calendonian, 290–350 million years ago; Hercynian, 180–240 million years ago; Mesocenozoic, 80–120 million years ago; Tertiary, 25–50 million years ago; and Quaternary, not yet absolutely dated. The laws governing the development of magmatism in the region are discussed.

Afanas'yev then comments on the reliability of the potassium-argon method of age determination. The ages of some associated rocks and minerals in different geological conditions are tabulated. The results show that where the rocks were not affected by later magmatism, the ages determined on muscovite and microline perthite in the same rock are in agreement with each other and with geologic evidence. Dynamometamorphism and heating, however, cause loss of argon from mica and even more from feldspar, leading to erroneous results. These age distortions are usually reflected in specific geological-structural conditions accompanied by peculiar petrographic phenomena; in such cases the potassium-argon method, without giving the real age of the rock, may help give an idea of the processes which took place; this is also very important.—*D. B. V.*

178–17. Folinsbee, R. E., and Baadsgaard, H. An absolute age for the Exshaw shale: Alberta Soc. Petroleum Geologists Field Conf., 8th, p. 69–73, 1958.

The age of the Exshaw shale is a point of minor importance in the correlation of the European with the North American Upper Devonian and in the placement of the Devonian-Mississippian boundary. The potassium-argon age of sanidine from a bentonite bed in the upper Exshaw shale was 267×10^6 yr; this was compared with a new determination of 102×10^6 yr on the Crowsnest volcanic sani-

dine of similar occurrence in Cretaceous bentonite beds of Alberta and with a determination of 419×10^6 yr on feldspar from a bentonite band in the Middle Ordovician lower Dubuque formation of Minnesota. These data are compared to the Holmes' *A* and *B* time scales and it is concluded that age of the Devonian-Mississippian boundary, as given by the potassium-argon age determination on volcanic sanidine from the Exshaw shale, represents a time at least 267 million years ago, rather than close to 275 million years of Holmes' *A* time scale. It seems important to reexamine critically the geologic uncertainties of the Holmes' scale in the light of new evidence from datable materials for which there is direct and positive paleontologic evidence of age.—*V. S. N.*

178–18. Herz, Norman. Rochas ígneas com até dois e meio bilhões de anos no Quadrilátero Ferrífero de Minas Gerais [Igneous rocks as old as two and more billions of years in the Quadrilátero Ferrífero of Minas Gerais]: Engenharia, Mineração e Metalurgia, v. 28, no. 168, p. 359–363, 1958.

The results of potassium-argon age determinations on 13 biotites, 1 muscovite, and 1 feldspar from granitic rocks from 10 localities in the Quadrilátero Ferrífero in Minas Gerais, Brazil, are tabulated and interpreted geologically. Five igneous cycles are recognized. (See also Geophys. Abs. 176–13).—*D. B. V.*

178–19. Kantor, Ján. Príspevok k poznaniu veku niektorých žúl a pegmatitov žluticko-tepelskeho kryštalinika argón-káliovou metódou [Age of some granites and pegmatites of the Žlutice-Teplá crystalline complex by the argon-potassium method (in Slovak with German summary)]: Slovenská Akad. Vied Geol. Práce, v. 15, p. 27–32, 1959.

The crystalline complex between Žlutice and Planá (northwest of Plzeň, Czechoslovakia) is considered to be Precambrian by some authors and Variscan by others. The age of three samples was determined by the volumetric potassium-argon method, using the decay constants $\lambda_k=6.02\times10^{-11}$ yr^{-1} and $\lambda\ \beta=4.9\times10^{-10}$ yr^{-1}. No correction was made for air contamination. The values obtained are 226×10^6 yr for potash feldspar and 254×10^6 yr for muscovite, both from the Křiženec pegmatite; and 250×10^6 yr for biotite from the Lestkov granite.—*H. F.*

178–20. Smales, A. A., Mapper D., Morgan, J. W., Webster, R. K., and Wood, A. J. Some geochemical determinations using radioactive and stable isotopes: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 242–248, 1958.

Elemental abundances in meteorites and the rubidium-strontium method of age determination of igneous and metamorphic rocks are discussed. Rubidium-strontium age determinations were made on nine feldspars from rocks that had been previously dated by other methods. The ages found for 3 microclines agree well with values found by other methods; 5 orthoclases and 1 albite yielded ages that are different.—*J. W. C.*

178–21. Naldrett, Stanley N. Half life of rhenium and ages of minerals: New York Acad. Sci. Annals, v. 72, art. 5, p. 215–226, 1958.

This report discusses a more accurate method of determining the rate of decay of rhenium-187 to osmium-187 to make possible the use of the Re/Os ratio as a means of estimating the ages of minerals. In age determination the Re/Os ratio offers some advantages: only a simple parent-daughter decay is involved;

parent and daughter elements are each reactive and form mostly nonvolatile, insoluble, inert compounds not likely to have been lost with time; no estimate is necessary of the amount of isotopic composition of the daughter element initially present. Counting of rhenium hexafluoride in gas counters gave erratic results—the apparent half life of rhenium-187 calculated from gas-counting data is 7×10^{11} yr. Better results were obtained from examination of solid rhenium heptasulfide in a screen-wall counter from which it was concluded that the maximum range of the beta particles is 0.29 ± 0.04 mg per cm^2 and that the half life of rhenium-187 is $3.2\pm0.7\times10^{11}$ yr. From these data the ages of molybdenite samples, determined by Herr, Hinterberger, and others (see Geophys. Abs. 159–172, –173) using Re^{187}/Os^{187} ratios, are reasonable.—*V. S. N.*

178–22. Merrill, J. R., Honda, M., and Arnold, J[ames] R. Beryllium geochemistry and beryllium-10 age determination: United Nations Internat. Conf. on Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 251–254, 1958.

Radioactive beryllium-10 is examined as a possible basis of age determinations for the span of time between that covered by carbon-14 and that covered by potassium-40, rubidium-87, thorium-232, uranium-235 and uranium-238. The half life of beryllium-10 is 2.5×10^6 yr and therefore could fill this gap. Beryllium-10 is produced in the atmosphere by cosmic rays and is then washed out of the air by rain to enter the hydrosphere. That portion entering the ocean is subject to incorporation in authigenic minerals, which would then be suitable for radioactive age determination. Unfortunately, the Be^{10}/Be^9 ratio in the sea appears not to be constant, and therefore there is doubt that radioactive beryllium-9 can be used for age determinations.—*J. W. C.*

178.23. Deutsch, S[arah], Niggli, E[rnst], and Picciotto, E[dgard] [E.]. Étude préliminaire des halos pléochroïques de quelques roches métamorphiques et éruptives du St.-Gothard [Preliminary study of the pleochroic haloes of some metamorphic and igneous rocks of the St. Gotthard]: Experientia, v. 15, no. 6, p. 214–215, 1959.

According to the pleochroic halo method, the Cadlimo Hutte orthogneiss, paragneisses from Lake Taneda and Lake Scuro, and the Alpe di Lago and Lac Stabiello biotite-garnet schists, all from the southern part of the St. Gotthard massif in the Alps, are apparently less than 60 million years old. The gneisses were probably formed in the Hercynian orogeny and the schists in the Mesozoic; therefore, earlier haloes in the biotites must have been almost or completely destroyed by recrystallization during the Alpine metamorphism.—*D. B. V.*

178–24. Marshall, Royal R. Calculation of a "cosmic ray age" for the iron meteorite "Carbo": Nature, v. 184, no. 4680, p. 117–118, 1959.

The cosmic ray age of the Carbo iron meteorite is calculated from the relative potassium isotope abundances as $0.6_9\times10^9$ yr using a decay constant of $\lambda=0.529\times10^{-9}$ yr^{-1}. This is essentially the same as its estimated cosmic ray helium age of 0.85×10^9 yr, and similar to the potassium-argon ages of several stony meteorites.

Evidence is rapidly accumulating for the breakup of solid bodies and for the presumably related heating of at least some of the meteorites between 0.5 and 1.0 billion years ago. Comparison of potassium analyses from other iron meteorites may help to determine whether these processes occurred throughout this interval or during a much shorter period.—*D. B. V.*

EARTH CURRENTS

178–25. Volland, Hans. Elektromagnetische Induktion in Ebenern mit örtlich variabler Leitfähigkeit. Teil I [Electromagnetic induction in planes with locally variable conductivity, part 1]: Gerlands Beitr. Geophysik, v. 68, no. 2, p. 110–122, 1959.

Maxwell's equations are solved for the following conditions: an arbitrary unidimensional electric current flows in a plane ionosphere and progresses at right angles to its current direction; a unidimensional conducting anomaly lying in a plane in the earth's interior has the form $\sigma_i(x)=\sigma_o\cdot\frac{q^2}{x^2+q^2}$, where σ_o is a constant and q is a parameter. The magnetic field of the electric current induced in the conducting sheet is determined, and a numerical example is calculated.—*Author's summary, D. B. V.*

178–26. Volland, Hans. Elektromagnetische Induktion in Ebenen mit örtlich variabler Leitfähigkeit, Teil II [Electromagnetic induction in planes with locally variable conductivity, part 2]: Gerlands Beitr. Geophysik, v. 68, no. 3, p. 161–170, 1959.

It is shown how the conducting earth's interior is influencing the induction of electric currents in anomalies of conductivity in regions down to a depth of 100 km. The earth's core is approximated by a conducting plane sheet. Numerical calculations of a special case are made. Finally the influence of self-induction of the electric currents in the ionosphere is estimated.—*Author's English summary*

178–27. Kiyono, Takeshi, and Ezoe, T. On the electric field due to tides. I: Kyoto Univ. Fac. Eng. Mem., v. 19, pt. 3, p. 255–273, 1957.
Kiyono, Takeshi. On the electric field due to tides. II: ibid., v. 21, pt. 1, p. 15–31, 1959.
Kiyono, Takeshi. On the electric field due to tides. III: ibid., v. 21, pt. 2, p. 170–191, 1959.

This study was an outgrowth of an investigation of electric currents induced in submarine cable sheaths by tides moving across the earth's magnetic field and producing extreme electrolytic corrosion of the cable.

In part 1, the electric field induced by tidal currents is discussed in detail for the case where the earth's magnetic field is vertical. In part 2, the effect of the earth's horizontal magnetic field on the electric field and on current distribution in the sea water and in the sea bed is discussed.

In part 3, the theoretical results of studies by Longuet-Higgins (see Geophys. Abs. 139–11553), Malkus, and others, leading to the practical application of this tidal electric field to oceanographic problems such as measurements of the velocity of ocean currents, are discussed. Longuet-Higgins' theory of the electric field induced by streams of elliptical cross section is developed in detail and part of the theory is generalized for the case where the stream velocity is not constant.—*V. S. N.*

178–28. Vinogradov, P. A. Ob anomalii elektrotellurichеskogo polya v rayone Ushkan'ikh ostrovov (oz. Baykal) [On anomalies of the electrotelluric field in the region of the Ushkan Islands (Lake Baikal)]: Akad. Nauk SSSR Doklady, v. 126, no. 3, p. 561–564, 1959.

In view of the location and geology of the Ushkan Islands in Lake Baikal, earth current measurements were made in that area on three occasions: July 25–August 17, 1951; August 5–September 11, 1952; and June 20–27, 1956.

Results of the 1951 and 1952 measurements are presented graphically; the exact correspondence of the curves obtained with the two different electrodes shows that the earth current variations were simultaneous at the bottom of Baikal and on Bol'shoy Ushkan island. The identical nature of the curves demonstrates the reliability of the measurements and the suitability of lead electrodes for study of earth currents in fresh-water basins.

The earth current variations in the area in question showed anomalously large amplitudes, not only in the irregular variations but also in the short-period P_c and P_t variations. On moderately disturbed days the amplitude of the irregular variations averaged 250 to 300 mv per km, and on strongly disturbed days reached an average of 500 mv per km; maximum amplitude was 1,679 mv per km. Maximum amplitude of P_t was 418 mv per km and of P_c more than 250 mv per km.

In spite of the negligible conductivity of the waters of Baikal, the telluric current density is calculated to be close to that of marine telluric currents. This is a very typical case of the effect of the relief of the crystalline basement on telluric current density. In places the Ushkan ridge, on which the islands lie, rises 1,000 m and more above the neighboring depths; the islands are made of Precambrian metamorphic rocks.—*D. B. V.*

178–29. Yokouchi, Yukio. Earth-current observation at Kanoya: Kakioka Magnetic Observatory Mem., v. 9, no. 1, p. 7–20, 1959.

Solar and lunar diurnal variations in earth currents at the Kanoya observatory in Japan have been computed for the period 1950–53; the results are presented in tables and graphs, and compared to those of several other Japanese stations. The amplitude of lunar diurnal variations is much greater at Kanoya than at the other stations, possibly due to ocean tides. The principal direction deducted from short-period variations is different from that deduced from both solar and lunar diurnal variations, and very different from the character of principal directions at the other stations.—*D. B. V.*

Yoshimatsu, Takasaburo. Changes of earth-current potentials at Kanoya and activities of the volcano Sakurajima. See Geophys. Abs. 178–432.

EARTHQUAKES AND EARTHQUAKE WAVES

178–30. Heck, N. H., and Eppley, R. A. Earthquake history of the United States, Part 1: Continental United States and Alaska (exclusive of California and western Nevada): U.S. Coast and Geod. Survey Serial, no. 41–1 revised (1956) ed., 80 p., 1958.

This publication is a revision by Eppley of the first edition of part 1 of the Earthquake history of the United States by Heck. It lists and describes the more important earthquakes (intensity 5 or over on the Modified Mercalli scale) of the United States, exclusive of California and western Nevada, from the earliest times to the close of 1956. With this information it is possible to appraise the United States as an earthquake region in comparison with the

rest of the earth; it is a region of a little more than average seismicity although the important earthquakes tend to come at long intervals. (See also Geophys. Abs. 97–4980.)—*V. S. N.*

178–31. MacCarthy, Gerald R. Some first motions as recorded at Chapel Hill, N.C.: Earthquake Notes, v. 30, no. 1, p. 1–4, 1959.

A tabulation has been made of the character (compressional or dilational) of the first motions of 101 earthquakes recorded by the seismograph operated by the University of North Carolina at Chapel Hill, N.C. The azimuth of, and the distance to, each epicenter are included in the tabulation. No marked geographic or temporal patterns were found, but the data as they stand should be of interest to anyone engaged in a study of fault mechanisms.—*Author's abstract*

178–32. Slemmons, David B., Steinbrugge, Karl V., Tocher, Don, Oakeshott, Gordon B., and Gianella, Vincent P. Wonder, Nevada, earthquake of 1903: Seismol. Soc. America Bull., v. 49, no. 3, p. 251–265, 1959.

Historical research on an uncatalogued earthquake in the Wonder mining district of Nevada establishes the date with a fair degree of certainty as the fall of 1903. As much as 12 miles of surface faulting may have occurred along the Gold King fault. During the Dixie Valley–Fairview earthquake of December 16, 1954, parts of the Gold King fault were refractured with vertical displacements from a fraction of an inch at the north end to 2 ft near the south end of the 1903 fault fissure; farther south, vertical movement reached a maximum of 4 ft, then decreased as it approached Chalk Mountain. Displacements in the 1903 shock appear to have been of the same order and type.

These two displacements on the Gold King fault constitute one of only four reasonably well established examples of recurrent surface breakage on the same fault segment within historic time in the United States. The reactivation of this fault after a period of only 50 years is further evidence of the high seismicity along the 118th meridian in Nevada and California.—*D. B. V.*

178–33. Brazee, R. J., and Jordan, James N. Preliminary notes on southeastern Alaska earthquake: Earthquake Notes, v. 29, no. 3, p. 36–40, 1958.

A major earthquake, Pasadena magnitude 7¾–8, occurred on July 9, 1958, in the Fairweather Range in southeastern Alaska at lat 58.6° N., long 137.1° W. The macroseismic area was estimated to be 400,000 sq mi, with a maximum intensity of 11 at Lituya Bay and Khantaak Island. More than 200 aftershocks were recorded. The earthquakes ranged along the continental extension of the arcuate Fairweather fault at the head of Lituya Bay. The largest vertical displacement reported along the fault trace was 4 ft with a horizontal component of about 5 times this amount. Extensive avalanching occurred in the area of Yakutat Bay and Lituya Bay along with fissuring, ground heaves, sand blows, broken trees, and other effects in the vicinity of Yakutat and to the south.—*V. S. N.*

178–34. Poisson, [Charles]. Tremblements de terre malgaches en 1955 [Madagascan earthquakes in 1955]: Acad. Malgache [Tananarive] Bull., v. 35, p. 5, 1957 (1958).

Poisson, [Charles]. Tremblements de terre malgaches en 1956 [Madagascan earthquakes in 1956]: ibid., v. 35, p. 7–8, 1957 (1958).

Five local earthquakes were recorded in 1955 and 16 in 1956 at the observatory at Tananarive, Madagascar. Several of these consisted of a series of shocks. The strong earthquake (intensity 7) of April 15, 1955, and its aftershocks have been described more fully elsewhere (see Geophys. Abs. 167–53).—*D. B. V.*

178–35. Panfilis, M. de. Attività sismica in Italia dal 1953 al 1957 [Seismic activity in Italy from 1953 to 1957]: Annali Geofisica, v. 12, no. 1, p. 21–148, 1959.

This is a catalog of earthquakes of intensity 5 or more (Mercalli scale) felt in Italy in 1953–57, compiled from macroseismic data. Isoseismal maps are given for all shocks for which there were sufficient data, and a general map of epicenters summarizes the seismic activity of Italy for that period. More than 400 shocks were felt, 160 of which were of grade 4 or more in intensity. The least seismic year was 1954 with 52 shocks, and the most active was 1957 with 123 shocks. Two shocks reached an intensity of 7 to 8 (Gargano, February 1955, and Monti Volsini, December 1957). Geographically, Puglia was the most active area with 14 shocks, and Sicily a close second with 13. There were two earthquake swarms in 1957, the first epicentered in the Emilian Appennines and the second in the Monti Volsini.—*D. B. V.*

178–36. Tryggvason, Eynsteinn, Thoroddsen, Sigurdur, and Thorarinsson, Sigurdur. Greinargerð Jarðskjálftanefndar um jarðskjálftahaettu á Íslandi [Report of the Earthquake Committee on earthquake risk in Iceland]: Verkfraeðingafélags Íslands Timarit, v. 43, no. 6, p. 81–97, 1958.

All available information on earthquakes in Iceland has been compiled in order to determine the extent of earthquake risk in different parts of the country as a basis for building construction regulations. It is concluded that the risk varies widely from place to place. In some areas, such as most of the Tertiary basalt regions, the risk is negligible. There are two main seismic regions, one in the southwestern part of the country, the other along the north coast between Skagafjörður and Thistilfjörður; 38 destructive earthquakes have been recorded since A.D. 1150 in the former, 9 in the latter. Maximum risk is found in three limited areas, a small strip from West Reykjanes to Ölfus, the Land and Rangarvellir districts in Rangarvallasysla, and the immediate vicinity of Husavík.

A map of seismic regionalization of Iceland is presented, and it is strongly recommended that regulations be drawn up prescribing minimum permissible strengths for building construction in each seismic zone.—*D. B. V.*

178–37. Yaranov, D. Seysmicheskoye rayonirovaniye Bolgarii [Seismic regionalization in Bulgaria]: Ministerstvo Vyssh. Obrazovaniya SSSR, Nauch. Doklady Vyssch. Shkoly, Geol.-geog. nauki, v. 3, p. 30–36, 1958.

A map of seismic regionalization of Bulgaria is presented. The isoseismal lines of the country are reduced to a common surface layer of a standard maxi-

mum loading strength of 3.0–3.9 kg per cm.^{2} Six seismic areas are shown. Around the rising part of Mysia platform in the northeastern part of Bulgaria, seismic intensity is considerable but the area is very small. The Yambol seismotectonic area is rather diffuse; its activity is probably connected with tectonic lines of Hercynian age. The seismotectonic area of Upper Thrace is characterized by very strong shocks. In the Rhodope massif intermediate earthquakes are frequent. The Strymon River valley in southwestern Bulgaria shows typical Aegean seismicity. The Sophia area is highly seismic but of limited extent. The three aseismic areas of the country are: the Gulf of Burges and the Stranja mountain area, the main Balkan ridge, and the Pri-Balkan tectonic zone.—*A. J. S.*

178–38. Puchkov, S. V., and Khovanova, R. I. Kyrenskoye zemletryaseniye 10 avgusta 1958 [The Kyren earthquake of August 10, 1958]: Akad. Nauk SSSR Izv. ser. geofiz., no. 6, p. 891–894, 1959.

The region around Kyren, Buryat A.S.S.R. is known as an area of seismicity 8–9. After the earthquake (class 9) of April 4, 1950, a seismological expedition was sent to this region by the Institute of Earth Physics to establish provisional seismic stations at seven points along the Irkutsk River valley. The seismographs of these stations, with about 25,000 magnification, were thrown out of order by the first shock of the earthquake of August 10, 1958. Fortunately, the Kyren station, nearest to the epicenter was provided with an accelograph (system Puchkov) with a magnification of only 6; seismograms were obtained from this instrument. From S—P arrival times, the epicentral distance Δ was determined as 16 ± 5 km. The distance Δ was also determined by the method of hyperbolas; agreement between the results of the two methods was very good. The cause of the earthquake was evidently a rupture along the northwest border of the Tunka depression.—*S. T. V.*

178–39. Grin, V.P. O seysmichnosti Kok-Shaala [On the seismicity of Kok-Shaal]: Akad. Nauk Kirgiz. SSR. Otdel Seysmologii, 139 p., 1958.

Seismic maps of the Kirgiz SSR and adjacent regions show a concentration of epicenters in certain areas. One such area embraces the Kok-Shaal region (ϕ=39.5°–41.5° N., and λ=75.0°–79.0° E.). Grin analyzes the seismicity of this region on the basis of data from the seismic network of central Asia.

The mean traveltime curves constructed by Grin for the Kok-Shaal region give slightly higher seismic wave velocities than those established earlier for central Asia. It is found that the focuses of the earthquakes in the region investigated are located in the basalt layer. This explains the absence of the direct wave arrivals in the seismograms of the region. The trend of epicentral zones coincides with tectonic trends, and the Mohorovičić discontinuity under Kok-Shaal dips toward the northwest and west.—*A. J. S.*

178–40. Tamrazyan, G. P. Nekotoryye osobennosti zemletryaseniy Tadzhikistana [Certain particular features of earthquakes in Tadzhikistan]: Akad. Nauk Tadzhik. SSR Doklady, v. 1, no. 1, p. 25–31, 1958.

Considering that the immediate causes of earthquakes are an accumulation and subsequent release of the elastic deformation energy deep in the interior of the earth, Tamrazyan has analyzed the time distribution of strong earthquakes in the Tadzhik S.S.R. within the period of 1929–48. He points out that the

magnitude of the resultant tidal forces produced by the sun and the moon in the crust of the earth varies from 0.9 to 3.52 times at aphelion, and from 0.8 to 3.62 times at perihelion (assuming that the tidal force produced by the sun alone is unity). Earthquake frequency in the Tadzhik S.S.R. increased during the periods when the resultant tidal force was on an increase. Most of the earthquakes occurred during the time of full or new moon. The greater the period between the passage of the moon through its perigee and the coming new moon date, the smaller the earthquake frequency. The correlation between the solar-lunar tide values and earthquake frequency becomes less significant with increasing depth of foci.—*A. J. S.*

178–41. Solonenko, V. P., Treskov, A. A., Florensov, N. A., and Puchkov, S. V. Muyskoye zemletryaseniye 27 iyunya 1957 g. [The Muya earthquake of June 27, 1957]: Akad. Nauk SSSR, Inst. Fiziki Zemli Trudy, no. 1(168), p. 29–43, 1958.

On June 27, 1957, an earthquake occurred in the region northeast of Lake Baikal. The magnitude of the earthquake was determined to be $M=7.5$, the greatest ever recorded in this region. Up to now this region was considered to be aseismic. The coordinates of the epicenter of the earthquake were determined as $\phi=56.1°\pm0.1°$ N., $\lambda=116.7°\pm0.1°$ E., focal depth equals 20 km. The Institute of Physics of the Earth sent an expedition to the region for seismologic and geologic investigations.

The surrounding area is sparsely populated, structures are largely made of wood, and there are no local seismic stations; therefore the collected seismologic data consists only of macroseismic observations. Several landslides were found, as well as numerous fissures more than 1 km long in crystalline formations. The expedition concluded that the intensity of the earthquake was 9, and that the eastern shore of Lake Baikal was seismically as active as the western. This is important in view of plans for development of a vast hydroelectric system along the Angara River.—*S. T. V.*

178–42. Puchkov, S. V., Solonenko, V. P., Treskov, A. A., and Florensov, N. A. Novoye sil'noye zemletryaseniye v Vostochnoy Sibiri [A new strong earthquake in East Siberia]: Akad. Nauk SSSR, Sibirskoye Otdeleniye Izv., no. 3, p. 42–51, 1958.

An earthquake which occurred in eastern Siberia on June 27, 1957 had an intensity of 7½–7¾, or 10 points on the 12-point scale. The epicentral coordinates were determined to be lat $56.4°\pm0.1°$ N., and long $116.9°\pm0.1°$ E., near the town of Muya. The earthquake was probably one of the strongest that occurred in eastern Siberia in the last 250 years; it was recorded over an area of almost 20° in latitude and 25° in longitude. The Muya earthquake was characterized by strong Rayleigh waves; these waves were registered at Irkutsk for 1½ hr, and the ground displacement recorded at Moscow was over 1,000μ. Aftershocks were observed through the end of November 1957.

The occurrence of this earthquake in an area classified in 1951 as aseismic attracted much attention; it indicates contemporary reactivation of crustal fractures in the Lake Baikal system.—*A. J. S.*

178–43. Solonenko, V. P. Zemletryaseniye v Gobiyskom Altaye 4 dekabrya 1957 [The earthquake in the Gobi Atlay, December 4, 1957]: Akad. Nauk SSSR Izv. ser, geofiz., no. 7, p. 32–39, 1959.

The earthquake that occurred at 3^h39^m (GMT) on December 4, 1957, in the Gobi Altay was one of the strongest in the last 50 years, with an intensity of 11–12 points on the international scale.

This paper describes the different types of fault cracks that resulted from the earthquake. These include regenerated older fractures; contemporary deep-seated cracks formed at the time of the earthquake; small active cracks (tens, rarely hundreds, of meters long) branching from the main faults; "accompanying" cracks parallel to both the old major faults and the new deep-seated tectonic faults; cracks due to collapse and landslides; gravitational cracks due to slipping and settling of the ground; and cracks due to hydraulic impact in areas of shallow water table.

The net movement was uplift and eastward displacement of the Gurgan-Bogdo range. Vertical displacement on the northern fault ranged from 0.8–12 m. The greatest deformation was suffered by the Ikhe-Bogdo massif, which was surrounded on all sides by fractures of the first order and traversed by numerous fractures of the second order; tremendous landslides were related to the strongest of these.

That stresses were far from relieved in the December 4 earthquake is evident from the aftershocks (still continuing as of July, 1958), which have reached an intensity of 8–9 points in the area between the Ikhe-Bogdo ranges and western part of the Pleistocene region.—*D. B. V.*

178–44. Solonenko, V. P. O seysmicheskom rayonirovanii territorii Mongol'skoy Narodnoy Respublik [On the seismic regionalization of the territory of the Mongolian People's Republic]: Akad. Nauk SSSR Doklady, v. 127, no. 2, p. 419–422, 1959.

A map of the seismic regionalization of Mongolia is presented. Distribution of epicenters is governed by neotectonic structures. The western part of the territory is highly seismic; earthquakes with intensities of 11–12 have been known. In comparison the eastern and southeastern parts appear practically aseismic, with intensities of only 4–5. Epicenters of shocks of intensity 6–7 and above are tabulated.—*D. B. V.*

178–45. Peronaci, F[rancesco]. Sismicità dell' Iran [Seismicity of Iran]: Annali Geofisica, v. 11, no. 1, p. 55–68, 1958.

The distribution of epicenters and magnitude of earthquakes in Iran were studied on the basis of compilation of observations made from 1909 to 1957. The earthquakes are related to recent orogenic movements, particularly in the ranges of southern Iran. A map of earthquake risk is given.

The strong earthquake of December 13, 1957, is studied in some detail. Intensity at the epicenter was 10; magnitude of the principal shock was calculated as 7.1 at Rome, 7.25 at Pasadena; focal energy was 6×10^{24} ergs; felt area was 4,500 km^2. The focal coordinates are calculated as $\phi_o=36°36'53''\pm47''$ *N.*, $\lambda_o=47°48'43''\pm52''$ *E.*, focal depth $h_o=7\pm5.3$ *km*, origin time $t_o=0.1^h45^m00.1_s\pm0.6^s$.—*D. B. V.*

178–46. Tandon, A. N. The Rann of Cutch earthquake of 21 July 1956: Indian Jour. Meteorology and Geophysics, v. 10, no. 2, p. 137–146, 1959.

The earthquake of July 21, 1956, shook the whole Saurashtra and parts of Gujarat State, India. An area of about 750 sq mi in central Cutch suffered the greatest damage. A total of 115 lives were lost, hundreds were injured, and in Anjar alone about 1,350 houses were destroyed and nearly 2,000 damaged. Damage was mostly confined to the eastern portion of the town, on soft rock; the western part of town, on a trap rock foundation, suffered much less. Intensity reached at least 8 (Modified Mercalli scale).

The epicenter and origin time have been determined by the method of least squares at lat 23°20′ N., long 70°00′ E., and $15^h32^m26^s$ G.M.T., respectively. Magnitude was 7, and focal depth 13–18 km. An isoseismal map is given, and instrumental data for 87 stations in various parts of the world are tabulated.—*D. B. V.*

178–47. Tsuboi, Chuji. On seismic activities in and near Japan, *in* Contributions in Geophysics (Gutenberg volume): Internat. Ser. Mon. Earth Sci., v. 1, p. 87–112, 1958.

Japan and its adjacent areas are noted for high seismic activity. Dependable descriptions, dating back to A.D. 416, of nearly 10,000 earthquakes were recorded prior to the commencement of routine seismological observations. Some 420 destructive earthquakes have taken place since A.D. 500. The probable epicenters and magnitudes have been determined for these destructive earthquakes, and it has been estimated that in 19 of them magnitudes were greater than 8. Since the beginning of instrumental observation, earthquakes in Japan have been classified into four groups on the basis of human perceptibility of the ground motion in relation to distance from the epicenter.

To determine the instrumental magnitude of Japanese earthquakes observed by seismographs other than the standard torsion seismometer, Tsuboi has devised a formula in which magnitude M is expressed in terms of maximum ground amplitude A observed at a seismological station and of the epicentral distance Δ of that station: $M=a \log \Delta+\log A+c$, the constants a and c being determined by the least squares method for six selected seismological stations in Japan. This formula seems to be more reasonable for Japan than that of Gutenberg and Richter. With this revised formula the relation between the mean annual number of earthquakes in Japan and their magnitudes is expressed by $\log N=-1.08+0.71(8-M)$. Comparing this formula with the one for the world, it is found that the number of occurrences of earthquakes of magnitude $M=8.0$—8.1 in the Japanese area is about one quarter of that for the world. In comparing the annual release of energy in shallow earthquakes for Japan with that for the world, Japan's is found to be only one-twentieth of the world and appears to be too low.

Statistical studies of the occurrences of earthquakes in neighbouring areas indicate that one continuous seismic stress field has certain upper limits in horizontal extent where Japanese earthquakes are concerned, and those areas showing sympathetic earthquake activity may be grouped into an earthquake province. Six earthquake provinces have been recognized in Japan; the average width is 150 km. Recent studies of very small earthquakes by Asada and his group show that the frequency of these small earthquakes in a certain area provides good information as to the seismicity in the area as a whole, even if observed for a relatively short time (see also Geophys. Abs. 173–66).—*V.S.N.*

178–48. Hisamoto, S. On the shallow earthquakes in western Japan [in Japanese with English summary]: Quart. Jour. Seismology [Tokyo], v. 23, no. 4, p. 15–20, 1959.

A crustal structure for western Japan has been proposed from analysis of seismological data obtained from shallow earthquakes occurring in western Japan in 1956 and 1957. Time-distance curves for these shallow earthquakes were calculated from the proposed structure.—*V. S. N.*

178–49. Takada, Michio. On the crustal strain accompanied by a great earthquake: Kyoto Univ. Disaster Prevention Research Inst. Bull., no. 27, p. 29–46, 1959.

This is a report on observations of crustal strain and tilt before and after the Yoshino earthquake of July 18, 1952, epicenter (in southern Nara prefecture), lat 135.80° E., long 34.10° N., as recorded at the Ide and Osakayama observatories, 72 km and 98 km respectively north-northeast of the epicenter, and at the Yura observatory, 60 km west-southwest of the epicenter. Results show that at all three observatories the direction of ground tilt changed about 10 days before the earthquake from a downward tilt in the direction of the epicenter to a direction parallel to the motion of the ground at the time of the earthquake; this direction was to the north at Ide and Osakayama and to the northwest at Yura.

Variations of linear strains observed at Ide and Osakayama suddenly became great in March and continued until about 10 days before the earthquake, when a reverse change occurred; this continued until mid-August, then a new variation began. The variations of linear strains from early July to mid-August are presumed to show the strains released by the earthquake. It is calculated that 63.6 percent of the strain energy stored in the earthquake nucleus is dissipated to neutralize the strain energy stored in the body outside the nucleus, and the remaining 36.4 percent is dissipated as the elastic wave energy (E) of the earthquake. It is hoped that such studies as this will lead to prediction of the time, location, and magnitude of earthquakes.—*V. S. N.*

178–50. Eaton J[erry] P., and Takasaki, K. J. Seismological interpretation of earthquake-induced water-level fluctuations in wells: Seismol. Soc. America Bull., v. 49, no. 3, p. 227–245, 1959.

Magnitudes for normal-depth earthquakes computed from the amplitude of water-level fluctuations induced in a well tapping a confined aquifer in Honolulu, Hawaii, agree closely with those assigned by Pasadena. The maximum fluctuations in the well are produced by long-period Rayleigh surface waves. The response of the well to earthquake waves diminishes rapidly as wave length decreases.—*Authors' abstract.*

178–51. Nazarov, A. G. Metod inzhenernogo analiza seysmicheskikh sil [Method of engineering analysis of seismic forces]: Yerevan, Izdatel'stvo Akad. Nauk Armyan. SSR, 188 p., 1956.

The book is written as a report on the problems of engineering seismology, and their attempted solution by means of the specially constructed multiple pendulum seismometers AIS–1 and AIS–2 for simultaneous vertical and horizontal recording.

Pointing out that a building cannot perform simultaneously the two mutually exclusive functions, those of a measuring device and of the object on which the

effect of an earthquake is measured, Nazarov recommends general adoption of an accelerometric seismic scale.—*A. J. S.*

Volarovich, M. P., and Parkhomenko, E. I. Modeling of the relationship of the disturbance of the electric field in rocks with the piezoelectric effect produced simultaneously with seismic phenomena. See Geophys. Abs. 178–158.

178–52. Stovas, M. V. K voprosu o shirotnoy zonal'nosti seysmiki Zemli [On the problem of latitudinal zonality of the earth's seismicity] : Ministerstvo Vyssh. Obrazovaniya SSSR, Nauch. Doklady Vyssh. Shkoly, Geol.-geog. nauki, v. 3, p. 19–29, 1958.

This paper discusses the effect of changes in the earth's angular velocity on seismicity. Stovas refers to earlier work by Maurain (1927), who showed that the equatorial belt and the zones between lat $\pm 30°$ and $\pm 40°$ are the most active seismically as compared with other latitudes. Gutenberg (see Geophys. Abs. 167–69) arrived at a similar conclusion for the great earthquakes of 1896–1903, assigning three seismic maximums to the zones of lat $\pm 11°$–$\pm 20°$, $\pm 31°$–$\pm 40°$, and $\pm 51°$–$\pm 60°$. According to Stovas it is no coincidence that the variations in the rotational energy of the earth and the energy of orogenesis are of the same order, 10^{28} ergs. Fluctuations in the earth's angular velocity have been correlated with the earth's volcanic activity by Nagaoka (1933). The coincidence of the maximum of nonpolar latitude variation (Kimura term) in 1918–20 with the maximum of energy release in catastrophic earthquakes in 1917–20, and with the abrupt change in yearly mean zero value in the generally rising level of the Atlantic Ocean according to Hosoyama (1952), lead to the conclusion that the earth's seismicity depends not only on the changes in the internal constitution of the earth, but also on the changes in the magnitude of tangential component of the force applied to the earth's surface due to the variation in its diurnal rotation, and consequently, to variation in the parameters of the earth's spheroid of revolution.—*A. J. S.*

178–53. Grin, V. P. K voprosu ob epitsentral'nykh zonakh [On the problem of epicentral zones] : Akad. Nauk Kirgiz. SSR Yubileynaya nauch. sess., Otdel tekh. nauk, p. 363–371, 1958.

A correlation between earthquake foci and major geotectonic features is sought and discussed in this paper. Using statistical methods, six seismically active regions—the Atoynak, Fergana, Altay, Sulyukta-Vorukh, Kok-Shaal-Tau ranges and northwestern China—were investigated. It was found that there is a correlation between the epicentral coordinates and the major axis of the correlation ellipses of the seismic regions; these coincide with the lines of major tectonic faults in the respective regions.—*A. J. S.*

178–54. Oganisyan, S. S. Svyaz' anomaliy sily tyazhesti s seysmichnost'yu [Correlation between gravity anomalies and seismicity] : Akad. Nauk Armyan. SSR Doklady, v. 26, no. 2, p. 77–80, 1958.

By comparing the gravity and seismicity maps of the Ararat depression and neighboring areas in the Armenian S.S.R., Oganisyan found that the foci of strong earthquakes in the area were located in the regions of high horizontal gravity gradients, reflecting tectonic dislocations in the crust of the earth. The established correlation opens a possibility of using the gravimetric data of a region for its seismic regionalization.—*A. J. S.*

178–55. Tamrazyan, G. P. Promezhutochnyye i glubokofokusnyye zemletryaseniya v svyazi s kosmicheskimi usloviyami zemli [Intermediate and deep focus earthquakes in their relation to the cosmic conditions of the earth]: Akad. Nauk SSSR Izv. ser. geofiz., no. 4, p. 598–603, 1959.

In previous studies on the temporal occurrence of earthquakes in their relation to cosmic factors (see Geophys. Abs. 172–29, 173–38, –183, 174–34), particularly to the position of the moon on its orbit, Tamrazyan has shown that there is a definite triggering effect of the moon on earthquakes occurring at a given point. Such correlation has been claimed for the earthquakes in the Caucasus, in the Turkmen S.S.R., and in some other regions. In the present study such a relationship is shown to exist in other places, such as numerous islands of the Pacific Ocean, in North and South America, and in southern and southeastern portions of Europe. Two cosmic factors affect the occurrence of earthquakes in a region: the position of the moon on its orbit (near the perigee or the apogee) and the phases of the moon (the full and new moon). Tamrazyan emphasizes the preponderant north-south direction of deep geotectonic fractures; this is explained by the fact that the tides circling the globe from east to west favor the displacement of the deep masses of the earth in this direction. The effect of the moon's position decreases as focal depth increases, and is obscure at depths greater than 400 km.—*S. T. V.*

178–56. Esteban Carrasco, Luis. Perfeccionamiento del método de Caloi para la localización de sismos próximos [Perfection of Caloi's method for the location of near earthquakes]: Rev. Geofísica, v. 17, no. 65, p. 1–13, 1958.

Caloi's method of determining the epicentral coordinates (see Geophys. Abs. 100–5333) of a near earthquake reduces the problem to a plane, neglecting focal depth. In this paper the approximation is improved by taking focal depth into consideration and using the methods of the geometry of contacts in space. The improved method is applied to 5 earthquakes already studied by Caloi (Tyrol, October 8, 1930; Lake Constance, January 31, 1935; Swiss Alps, June 27, 1935; North Brabant, November 20, 1932; and Cansiglio, October 18, 1936); the results obtained by Caloi and by Esteban Carrasco are compared in a table.—*D. B. V.*

178–57. Esteban Carrasco, Luis. Sobre la determinación del hipocentro de un sismo próximo por el método de Martin Romero [On the determination of the focus of a near earthquake by the method of Martin Romero]: Rev. Geofísica, v. 17, no 66, p. 143–152, 1958.

Martin Romero's graphic method of locating the focus of an earthquake is an improvement on the classic methods of Mohorovičić and Caloi. Observations are grouped in threes and for each group a geometric location is determined for the epicenter; the resulting straight lines are called determinants. These determinants are not perfectly straight lines, but rather the projections of a cone upon a plane of symmetry. If four observatories are taken into consideration, four distinct groupings of three observatories each can be obtained; their determinants will intersect in a point which is the projection of the center of the sphere tangent to the four. If the data for any of the four determinants are incompatible, the point of intersection will not correspond to the true epicenter, for it then does not correspond to the center of the tangent sphere. In such

instances some of the data should be disregarded and other possible groupings tried. An example is given.

One of the most delicate questions in the new method is the assigning of a velocity to the P wave. Each case must be studied individually. On some occasions the chord of two determinants corresponding to distant stations is used. To avoid error, it is necessary for each of these two determinants to have at least one station in common. The errors due to simultaneous earthquakes or to inaccurate recording of arrival times, are also discussed briefly.—*D. B. V.*

178–58. Tokmulin, M. Kh. Ob opredelenii polozheniya epitsentra blizkogo zemletryseniya s ochagom v zemnoy kore [Determination of local earthquake epicenter having its focus in the earth's crust]: Akad. Nauk Kirgiz, SSR, Yubileynaya nauch. sess. Otdel. tekh. nauk, p. 373–388, 1958.

Methods of determination of epicentral coordinates of a near earthquake having its focus within the crust of the earth are investigated mathematically. The methods which do not require a preliminary knowledge of the traveltime curve of the earthquake are discussed, and the problem of epicentral determination is reduced to a solution of algebraic equations of the third order. It is shown that records of at least three seismic stations are necessary to determine the epicenters unambiguously.—*A. J. S.*

178–59. Gilić, A[ndro]. The geographical location of a distant earthquake: Seismol. Soc. America Bull., v. 49, no. 3, p. 221–226, 1959.

An abridged version, in English, of a paper published previously in the Geofizički Institut Radovi of the University of Zagreb, ser. 3, no. 8, 119 p., 1957. (See Geophys. Abs. 173–54).—*D. B. V.*

178–60. Sultanova, Z. Z. Sposob isoliniy [The method of isolines]: Akad. Nauk SSSR Izv. ser. geofiz., no. 5, p. 744–747, 1959.

A new procedure of approximate determination of the position of epicenters of earthquakes is suggested. This procedure can be carried out in two modifications. The first modification presupposes the knowledge of the $S-P$ interval at three seismic stations, and uses the equation $\frac{\Delta_i}{\Delta_k}=\frac{(T_s-T_p)_i}{(T_s-T_p)_k}$, where Δ is the epicentral distance from station i or k, T_s and T_p are the arrival times of the transverse and the longitudinal waves. Similar equations can be established not only for the arrivals of waves coming direct from the epicenter, but also for waves refracted on the boundary between sediments and granite, between granite and basalt, or between basalt and ultrabasalt. The graphic construction used in this procedure is similar to that used in the method of hyperbolas.

The second modification of the procedure can be used when origin time (T_o) is also known; in this case the equations $\frac{\Delta_i}{\Delta_k}=\frac{T_{p_i}-T_o}{T_{p_k}-T_o}$ or $\frac{\Delta_i}{\Delta_k}=\frac{T_{s_i}-T_o}{T_{s_k}-T_o}$ are used. The described procedure has been applied in final determinations of the epicenters of the earthquakes that occurred in the Azerbaijan S.S.R. during the years 1911–54; the results obtained prove the complete reliability of the method.—*S. T. V.*

178–61 Savarenskiy, Ye. F., and Ayvazov, I. V. Ob opredelenii azimutov i uglov vykhoda seysmicheskoy radiatsii [The determination of the azimuths and of the angles of emergence of seismic radiation]: Akad. Nauk SSSR Izv. ser. geofiz., no. 3, p. 372–381, 1959.

The study of the angular parameters that determine the direction of emergence of seismic rays is of great practical and theoretical interest. They determine the position of the focus of an earthquake, and they serve as indicators of the properties of the crust. Savarenskiy and Ayvazov have analysed the angular parameters of the earthquakes that occurred on April 24 and 25, 1951, with a common epicenter located at lat 36.0° N. and long 28.5° E. The intensity of both earthquakes was 6¾. At sufficiently great distance from the epicenter the propagating longitudinal wave can be assumed to be plane. When such a wave strikes the earth's surface or a horizontal boundary plane underground it produces refracted and reflected waves polarized in the vertical plane passing through the epicenter and the observing station. Thus it is possible to find the azimuth toward the epicenter from the relations between the horizontal components of vibrations produced by the longitudinal waves. Error can result from incorrect determination of the parameters of the instruments of the station or from deviations of the deep refracting boundaries from the horizontal.

Determination of the angle of emergence of a seismic ray is more complicated. In the case of a perfectly homogeneous half-space the ratio of the true angle of emergence e and the apparent angle $\bar{e}$ is determined by the components of the total displacement of the incident logitudinal wave and of the longitudinal and traverse waves reflected at the free surface, but the picture is more complex due to layering of the earth. Savarenskiy and Ayvazov have computed the values of the azimuthal angles and of the angles of emergence from the data of 22 Russian stations, situated over the entire U.S.S.R. from Moscow to the Pacific Coast, and discuss the results in the light of the geologic significance of the values at individual stations.—*S. T. V.*

178–62. Glivenko, Ye. V. Ob otsenke tochnosti pri opredelenii gipotsentrov zemletryaseniy [The evaluation of the precision of the determination of the foci of earthquakes]: Akad. Nauk SSSR Izv. ser. geofiz., no. 4, p. 527–537, 1959.

The probability theory is applied to the evaluation of the precision of the determination of earthquake foci on the assumption that the errors in the determination of the foci are caused only by errors in time measurement and not by local heterogeneities in the earth. Therefore it is assumed that errors in the determination of the $S-P$ interval are purely accidental, controlled by the Gauss law with zero average value and with dispersion of the known form. The mathematical solution of the problem consists in constructing the function of possible errors due to the use of a given method of determination of the focus. The Wadati and Ichikawa methods are explicitly discussed; ellipsoids and ellipses of the dissipation of errors of these methods are constructed. The suggested method of evaluation of errors is recommended by Glivenko for any region of high seismicity with permanent seismic stations within its boundary.—*S. T. V.*

178–63. Papalashvili, V. G. Ob otsenke tochnosti opredeleniya polozheniya epitsentrov i ochagov k'avkazskik zemletryaseniy pri pomoshchi metoda zasechek [An evaluation of the accuracy of determination of the location of epicenters and foci of Caucasus earthquakes by the intersection method]: Akad. Nauk Gruzin. SSR Inst. Geofiziki Trudy, v. 15, p. 127–132, 1956.

The method of intersection is evaluated with regard to its accuracy in locating the epicenters and the foci for seismically active areas of the Caucasus. Its accuracy depends on the accuracy of the $S-P$ records and on the position of the recording station with regard to the epicenters and the foci. Assuming that the $S-P$ interval can be determined with an accuracy of ± 1 sec and that the recording stations lie between 100 and 600 km from the epicenter, the accuracy of the method is at best ± 10 km.—*A. J. S.*

178–64. Vaněk, Jiří, and Stelzner, Johannes. Bestimmung der Magnitudengleichungen für Jena [Determination of the magnitude equations for Jena]: Gerlands Beitr. Geophysik, v. 68, no. 2, p. 75–89, 1959.

Formulas for earthquake magnitude determination from body waves (*PH*, *PV*, *PPH*, *SH*) and surface waves (*MH*, *MV*) are developed for the Jena seismological station in Germany. The calibrating functions deduced in Prague for body and *MH* waves were used, and the typical values of the station constants were determined for Jena. The characteristics of these station constants are discussed. The relationships between magnitudes of the *PH*, *PV*, and *PPH* body waves and of the *MV* wave are found to be linear. In the case of *SH* waves the relationships are more complicated. The equation for magnitude from *MV* waves at Jena is $M_{MV}=\log(AT)+1.504 \log \Delta^{\circ}+3.80$. Accuracy is $\pm 1/4$ unit of magnitude.

In the derivation of the calibrating function for *MV* waves, systematic effects were observed which cannot as yet be explained completely.—*D. B. V.*

178–65. Bune, V. I. Ob ispol'zovanii metoda Golitsyna dlya priblizhennoy otsenki energii blizkikh zemletryaseniy [On the use of the method of Golitsyn for the approximate estimation of the energy of near earthquakes]: Akad. Nauk. Tadzhik. SSR Inst. seysmologii Trudy, v. 54, no. 1, p. 3–27, 1956.

Bune examines the possibility of the use of the method of Golitsyn (1915) for estimating the energy of earthquakes according to data received at near stations. The Stalinabad earthquake of February 12, 1952, is used as an example to show that this method can be so used if the stations are located at different azimuths and at different epicentral distances. Possible sources of the most substantial errors are discussed, and calculations are carried out for the energy of elastic waves from large-scale explosives.—*J. W. C.*

178–66. Iida, Kumizi. Magnitude and energy of earthquakes accompanied by tsunami, and tsunami energy: Nagoya Univ. Jour. Earth Sci., v. 6, no. 2, p. 101–112, 1958.

Earthquakes accompanied by tsunamis occurring in and near Japan from 1923 to 1957 were investigated. It was found that the magnitude of an earth quake causing a tsunami is generally larger than $M=6.42+0.017H$ and for a disastrous tsunami is more than $M=7.75+0.008H$. Shallow submarine earthquakes with magnitude greater than 7.3 are always accompanied by tsunamis.

Tsunami magnitude is classified according to its energy, which is about one tenth of seismic energy and is derived from the relationship between the magnitude and energy of an earthquake. Earthquake energy may be estimated from the dimension of the original area of the tsunami. This area has a close relationship to the scale of voluminal storage of stress energy in the earth's crust and to the aftershock area associated with the crustal deformation. The tsunami is thus believed to originate at the epicentral area of an earthquake by crustal deformation of the sea bottom.—*V. S. N.*

178–67. Byerly, Perry, and Stauder, William V. Motion at the source of an earthquake, *in* The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 255–261, 1959.

Nakano's theoretical development emphasizes the effect of seismic disturbances at large distances from the source and develops equations of first motion in *P* and *S* for several types of source mechanisms. These equations are compared to the methods of approach of various investigators, and two mechanisms in particular are singled out: a single couple, which represents motion along a fault, and a double couple, which represents a compressive and tensile stress at right angles. Methods of transformation and projection permit the application of the theory for an infinite homogeneous earth to the heterogeneous earth. Possible uses of *S* phases are noted. Single observations of the first motion of *S* offer the possibility of resolving the ambiguity in fault-plane solutions from *P* alone in which the single couple is the mechanism assumed. Identification of the second nodal surfaces of *SV* and *SH* offers a criterion for deciding which mechanism, the single couple or the double couple, is operative in particular earthquakes. Further, simple relations involving the ratios *SH/SV*,*P/SH*,*P/SV* suggest other approaches to the problem of motion at the source of an earthquake. *S* phases, however, are to be used with great care.—*Authors' abstract.*

178–68. Keylis-Borok, V. I. The study of earthquake mechanism, *in* The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 279–294, 1959.

This paper is a report of Soviet work on earthquake mechanism (type of rupture, dip and strike of fault plane, direction of motion at the surface) and is a continuation of studies reported by Keylis-Borok in 1956 (see Geophys. Abs. 172–39). The first section of the paper summarizes the methods of study and improvements in methods achieved within recent years such as simple methods of excluding the effect of discontinuities on the shape of the observed waves; a graphic method, using the Wulff stereographic projection, for determining the direction of the "straightened rays" when refracting boundaries of any number and shape are present; and additional theoretical grounds for explaining the commonly used substitution of a multipole for the focus. The second section summarizes the results of determinations of the mechanism of 300 earthquakes in the main seismic zones of the U.S.S.R. and adjoining regions: the western Pacific, the Hindu-Kush, the Pamirs and Tien-Shan, Kopet-Dag and western Turkmen S.S.R., and the Caucasus.—*V. S. N.*

178–69. Honda, Hirokichi. The mechanism of earthquakes, *in* The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 295–340, 1959.

This paper is reprinted from the Tohoku University Science Reports, ser. 5, v. 9, supplement, p. 1–46, 1957 (see Geophys. Abs. 170–48).—*V. S. N.*

178–70. Ritsema, A. R. On the focal mechanism of Southeast Asian earthquakes, *in* The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 341–368, 1959.

Focal mechanisms have been determined for 60 earthquakes in the Sunda arc, the Celebes-Philippines arc, and the New Guinea-Solomons arcs from a study of the initial motion data of *P*, *PKP*, and *S* waves from many stations all over the world. The solutions reached are tabulated. In at least 12 shocks a single couple of forces acting along the lines of fault movement was the cause of the earthquakes, but in about half the shocks no conclusive evidence could be found for a choice between the single couple and that of two opposite couples of equal magnitude acting along lines perpendicular to each other.

Transcurrent, clockwise, counterclockwise, normal, and reverse types of earthquakes were distinguished by means of fault movements. Transcurrent fault movements are about three times more common than they should be in the case of a chance distribution, and it is concluded that most of the fault displacements are directed perpendicular to the steeply dipping zones of seismic activity in the region. In the shocks in which these directions do not coincide, the plane of action still is more or less perpendicular to this zone. The coincidence means that the distribution of earthquakes in space and their fault displacements probably have a common cause. From mechanisms shown to exist in the New Guinea-Solomons arcs, it follows that seismic activity in these areas is concentrated in a zone dipping steeply under the Pacific Ocean side, and not under the continental side as is the case in the Sunda and the Celebes-Philippines arcs.—*V. S. N.*

178–71. Hodgson, John H. The null vector as a guide to regional tectonic patterns, *in* The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 369–384, 1959.

This paper is a sequel to one published earlier [see Geophys. Abs. 169–51] in which 75 solutions were summarized and discussed. Here 86 additional solutions are given from various authors making a total of 161 solutions available for discussion. Two new areas, southeast Asia and the zone from the Marianas to Japan, have been added to the two already known in which faulting is not exclusively strike slip. While there can be no doubt of the extreme importance of strike-slip faulting, it appears possible that a disproportionate number of solutions have come from areas in which faulting is exclusively strike slip, and that the importance of strike-slip faulting has thereby been overemphasized in earlier papers. Analysis of the direction of dip slip gives no support to the contraction hypothesis, either in limited areas or in the world as a whole. The null vectors for tectonically simple areas show simple patterns related to the geographic features. This inspires some confidence in the null vector as a diagnostic tool. So used, it suggests that in both the Northeast Pacific and the

Northwest Pacific a double system of failures is going on, while the Aleutians, central Asia and the Mediterranean are so tectonically complex that only limited areas of them can be considered at the same time.—*Author's abstract*

178–72. McIntyre, Donald B., and Christie, John M. The kinematics of faulting from seismic data, *in* The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 385–393, 1959.

The attitude of a fault and the nature of the slip on it can be determined from the pattern of distribution over the globe of compressional and dilatational first motions of *P* waves. The method as used by Byerly and Hodgson gives two possible solutions for each earthquake. The writers have already demonstrated (see Geophys. Abs. 169–52) that in an area showing a certain type of structural homogeneity, the ambiguity might be resolved by consideration of the geometrical relations between the pairs of solutions: it was concluded that in the Southwest Pacific the movement was on steep strike-slip faults striking parallel to the physiographic feature. In the present paper solutions from other areas are discussed. On the assumption that the ambiguity of the results of a *P* wave analysis can be resolved by study of the first motions of *S* waves, Kogan has derived unique solutions for the Northwest Pacific. It is shown that Kogan's results for the Japan-Kamchatka area differ markedly from Hodgson's solutions for the same region and time interval based on *P* wave records obtained at stations distributed all over the world. Similarly the solutions of Honda and others for the same area and time interval differ markedly from the solutions of both Hodgson and Kogan. The value of solutions for an earthquake sequence is emphasized and an analysis of a series of Greek earthquakes (1953) is attempted.—*Authors' abstract*

178–73. Benioff, Hugo. Circum-Pacific tectonics, *in* The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 395–402, 1959.

A study of the Kamchatka aftershock sequence by Båth and Benioff provided the basis for distinguishing between the two possible fault-plane solutions for the principal shock given by Hodgson. Thus, this great earthquake was generated by a right-handed slip on a 1,000 km fault segment lying parallel to the trench. With this observation, data are now available for the direction of slip on the shallow components of nearly all the principal circumpacific faults. This includes Japan, Philippines, Tonga-Kermadec, New Zealand, the Aleutian Arc, Alaska, Northwest Pacific, California, and possibly the western coast of South America. In all of these regions the principal fault lies parallel to the coast and the slip is right-handed. Secondary faulting, such as represented by the Garlock fault in California, strikes transverse to the coast line and in many cases is left-handed. Although the principal movement is strike slip in nature, smaller dip slip components also occur and these are responsible for the relief which take the form of oceanic deeps and associated mountain ranges. The circumpacific tectonic activity now in progress can thus be described as tangential, clockwise rotation of the continental margins relative to the oceanic mass, together with a radial movement of the margins toward the oceanic mass. If the tangential slip is constant around the margins, with a rate equal to that of the San Andreas, the time for a complete revolution is approximately 3×10^9 yrs.—*Author's abstract*

178–74. St. Amand, Pierre. Circum-Pacific orogeny. The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 403–411, 1959.

The distribution of faulting around the northern and eastern edges of the Pacific basin is discussed, and it is demonstrated that the faulting forms a consistent pattern which is also consistent with observations of seismologists. The faults subparallel to the Pacific coast of North America, those on the Alaska peninsula trending with the Aleutian Island arc, and those along the Aleutian arc and the Kamchatka-Kurile arc aligned with the strike of the island arcs or mountain chains are commonly right-laterial faults. It is concluded that the Pacific basin from at least Baja California to beyond the Kurile Islands is rotating counterclockwise and the rest of the Pacific basin is probably rotating in the same sense. The Rocky Mountain trench and subparallel features between it and the coast indicate that this type of movement has been active for a very long time and represents a fundamental type of orogeny.—*V. S. N.*

178–75. Hodgson, John H. Current status of fault-plane studies—A summing up, *in* The mechanics of faulting, with special reference to the fault-plane work (A symposium, John H. Hodgson, editor): Dominion Observatory Ottawa Pubs., v. 20, no. 2, p. 413–418, 1959.

This volume of papers is the first to contain contributions from each of the 4 "schools" studying the mechanism of earthquakes: 1 in Japan; 1 in Holland; 1 in the Soviet Union; and 1, of broad geographical distribution, representing followers of Byerly. From study of the symposium papers, it is concluded that there is fundamental disagreement about mechanism involving the interpretation of *S*. Agreement on interpretation of *S* should be sought through detailed studies in theoretical and model seismology and by careful examination of many seismograms.—*V. S. N.*

178–76. Ichikawa, M. A study of occurrence mechanism of an earthquake on Oct. 26, 1958 using *P* and *S* waves [in Japanese with English summary]: Quart. Jour. Seismology [Tokyo], v. 23, no. 4, p. 1–14, 1959.

Analysis of the initial motion of the *P* and *S* waves from the deep focus earthquake of October 26, 1952, near the south coast of central Honshu, Japan, indicates that the force system which best explains the earthquake mechanism is that of a double dipole with moment. This is in agreement with Honda's analysis of earthquake mechanism (see Geophys. Abs. 169–69, 170–48, –55) but not in agreement with Keylis-Borok's results; Keylis-Borok (see Geophys. Abs. 174–48) found the force system responsible for the earthquake mechanism to be a single dipole with moment.—*V. S. N.*

178–77. Lehmann, I[nge]. On phases in earthquake records at epicentral distances of 105° to 115°, *in* Contributions in Geophysics (Gutenberg volume): Internat. Ser. Mon. Earth Sci., v. 1, p. 121–134, 1958.

The study of records for various earthquakes has made it probable that the great uncertainty of the *PP*, *SKS*, and *PS* traveltimes is due mainly to a variation of the phase itself, and only to a small degree to ordinary errors of observation or to the disturbing effect of background movement. When there is very great scatter and no concentration on a central value, it is unlikely that it should be one and the same wave that is recorded everywhere; the result for *SKS*

of the Chilean earthquake of December 1, 1928, confirms the idea that in such cases the phase varies and is not marked by identical waves everywhere. This variation is probably connected with discontinuities at which the waves are refracted or reflected, or with the bordering regions. Variations of the depth of the core boundary and of the constitution of the bordering region of the mantle seem to be indicated. More fruitful studies could be made at shorter epicentral distances where well-recorded earthquakes are more frequent and where the results from various regions could be compared.—*V. S. N.*

178–78. Okura, T. The zone of abnormal seismic intensity [in Japanese with English abstract]: Quart. Jour. Seismology [Tokyo], v. 24, no. 1, p. 19–24, 1959.

Zones of abnormal seismic intensity, aside from the influence of the point of origin, are caused by the particular characteristics of the region crossed by the seismic wave paths and of the foundation on which the observatory stands. From a study of the distribution of past earthquakes, Okura has found that if seismic waves pass through a region in which earthquakes have previously occurred, then the longer the path in such a region the stronger the shock.—*V. S. N.*

178–79. Kagoshima Local Meteorological Observatory. Velocities of propagation of earth tremors and seismic waves near Volcano Sakurajima [in Japanese with English abstract]: Quart. Jour. Seismology [Tokyo], v. 24, no. 1, p. 11–18, 1959.

The velocities of propagation of earth tremors and seismic waves near Sakurajima Volcano, Kyushu, Japan, were estimated from September to November 1958, using a new moving coil type electromagnetic transducer with magnification of about 5,000. Earth tremors at two stations were recorded in parallel. The following results were obtained: velocity of surface wave caused by a ship, 0.67 kmps; velocity of surface wave caused by a bus, 0.9 kmps; *P* wave velocity of *B* type earth tremor, 1.68 kmps; and *P* wave velocity of *D* type earthquake, 1.53 kmps.—*V. S. N.*

178–80. Bolt, B. A. Seismic travel-times in Australia: Royal Soc. New South Wales Jour. and Proc., v. 92, pt. 3, p. 64–72, 1958.

Travel times of phases from nine Australian mainland earthquakes are compared with travel times from the 1956 atomic explosions at Maralinga. The comparisons indicate that the Maralinga times apply within a few seconds over other parts of Australia. The *Lg* phase is usually well recorded and travels at a surface velocity near 3.50 kmps.—*V. S. N.*

178–81. Landisman, M., Sato, Y[asuo], and Ewing, M[aurice]. The distortion of pulselike earthquake signals by seismographs: Royal Astron. Soc. Geophys. Jour., v. 2, no. 2, p. 101–115, 1959.

A numerical method for calculating the seismogram of any seismograph for an arbitrary continuous ground disturbance is used to investigate the effect of instruments with various physical constants on both theoretical and actual impulsive signals. This calculation solves the equations of motion of the pendulum-galvanometer system by a fourth-order Runge-Kutta process. Variation of instrumental constants produces conspicuously different seismograms, in several cases of practical interest.

In order to resolve the apparent discrepancy between the observations of Sato, and those of Benioff and Press for the group velocity of long period Love

waves, certain computed seismograms of the long period Love wave arrival, *G*1, from the New Guinea shock of February 1, 1938, were compared with the linear strain recording of this signal. The results of this study confirm the observations of Sato that the group velocity of Love waves is essentially flat in the long period range to several hundred seconds. The distortion introduced by instruments whose magnification changes rapidly with period is great enough to mask any small dispersion that might be associated with these pulselike signals.—*Authors' summary*

178–82. Mathey, Raymond, and Rocard, Yves. Performances de certains séismographes à courte période [Performance of certain short-period seismographs]: Acad. Sci. [Paris] Comptes Rendus, v. 248, no. 24, p. 3462–3464, 1959.

Five seismograms are reproduced, obtained with vertical seismographs of 1-sec period furnished with an electronic amplifier giving the whole apparatus an adjustable gain up to one million. Two of these seismograms record the 23-kiloton nuclear explosion of October 30, 1959, in Nevada, 8,550 km away, with a gain of 900,000. Another clearly records the accidental fall of a 1-ton "reactor" lost from an aircraft, 3.5 km from a seismograph having a gain of 600,000; this shock was not detected by instruments 33 and 40 km away. The other three seismograms are records of the Lake Nègre explosion of September 1958.

It is concluded that with electronic amplification, the limit of sensitivity of seismographs is decided by the residual movement of the earth, not by the apparatus. Explosions of 10 to 20 tons should be recordable at distances of the order of 2,300 km in favorable locations. (See also Geophys. Abs. 175–66).—*D. B. V.*

178–83. Kisslinger, Carl. A note on Benndorf's formula for the dynamic magnification of a mechanical seismograph: Seismol. Soc. America Bull., v. 49, no. 3, p. 267–271, 1959.

An investigation of the nature of the ground motion necessary to produce a sinusoidal record starting suddenly from rest reveals that Benndorf's formula for the dynamic magnification of a mechanical seismograph always yields a value for the computed maximum displacement that is smaller than the true value. The apparent period taken from the record is shorter than the true period. The computed ratio of amplitude to period, a useful damage criterion, is always greater than the true value. The discrepancies in both amplitude and period become small as the ratio of the ground frequency to the instrument frequency increases.—*Author's abstract*

178–84. Teupser, Christian. Empfindlichkeitsregler für elektrodynamische Seismographen [Sensitivity regulator for electrodynamic seismographs]: Gerlands Beitr. Geophysik, v. 68, no. 2, p. 90–103, 1959.

The magnification of an electrodynamic seismograph is reduced by a combination of three resistances. The extent to which the damping of the seismic receiver and galvanometer can be changed, and what reduction conditions are possible if damping of the galvanometer is required, are investigated.—*Author's summary, D. B. V.*

Voropinov, V. S. Volcanoes and earthquakes. See Geophys. Abs. 178–424.

EARTH TIDES AND RELATED PHENOMENA

178–85. Benioff, H[ugo], Harrison, J[ohn] C., La Coste, L., Munk, W[alter] H., and Slichter, L[ouis], B. Searching for the earth's free oscillations: Jour. Geophys. Research, v. 64, no. 9, p. 1334–1337, 1959.

Detection and identification of spectral peaks associated with the earth's free oscillation could lead to a powerful tool for studying the distribution of elastic (and anelastic) properties within the earth. Records from tidal gravimeters in California and Vietnam and an extensometer in California are analyzed. It is concluded that the amplitude of the free oscillation is less than 1/10,000 of the M_2-tidal amplitude; displacement of the earth's surface is less than 0.005 cm, or 10^{-11} of the earth's radius. These figures apply to noise level in the absence of marked seismic disturbances. They serve only as an indication of orders of magnitudes; for an actual comparison the type and modes of the free oscillations must be specified.

Improvements in both instruments since the records used were taken may reduce noise level by something like a factor of 100 (10 in amplitude) for future analyses.—*D. B. V.*

178–86. Melchior, Paul J. Sur l'effet des marées terrestres dans les variations de niveau observées dans les puits, en particulier au sondage de Turnhout (Belgique) [On the effect of earth tides on variations of level observed in wells, in particular in the Turnhout borehole (Belgium)]: Technique de l'Eau, v. 12, no. 143, p. 21–30, 1959.

Examination of water level fluctuations, measured with an accuracy of ±2 mm, in wells in Belgium and the Belgian Congo shows that the ground water table reacts like a barometer to variations in atmospheric pressure, and that superposed on this effect there is a short-period (diurnal or semidiurnal) oscillation which reflects the effect of alternate compression and dilatation of the crust due to earth tides.

Records from the well drilled at Turnhout have been subjected to mathematical analysis in two stages, the first to eliminate the irregular variations due to atmospheric pressure, the second a harmonic analysis by means of which different terms of the earth tide are distinguished. From the M_2 term, cubic dilatation D is calculated to be 2×10^{-8}.—*D. B. V.*

178–87. Benioff, Hugo. Fused-quartz extensometer for secular, tidal, and seismic strains: Geol. Soc. America Bull., v. 70, no. 8, p. 1019–1032, 1959.

A description is given of two fused-quartz extensometers located in mountain tunnels at Dalton Canyon and Isabella in southern California and designed for observing long-period seismic-wave strains, earth tidal strains, and secular strains. They consist essentially of instruments for measuring and recording variations in the separation of two piers by comparison with a length standard of fused-quartz tubing. The sensitivity for secular strains, defined as the least detachable strain increment, is approximately 10^{-7}. For tidal and seismic-wave strains, the sensitivity is higher—a 1-mm deflection of the recorder represents a strain increment of 5.2×10^{-10}. In both cases the maximum usable sensitivity is limited by ground-strain unrest or noise, generated by wind, barometric-pressure variations, temperature variations of the surface layers of the ground, and variations in ground-water saturation.—*Author's abstract*

178–88. Takada, Michio. On the observing instruments and telemetrical devices of extensometers and tiltmeters at Ide Observatory: Kyoto Univ. Disaster Prevention Research Inst. Bull., no. 27, p. 2–27, 1959.

This report describes in detail the instruments at Ide Observatory, in an abandoned mine adit at Ide, Kyoto Prefecture, Japan, used for observation of crustal deformation. A newly designed variable inductance-type extensometer which permits telemetric observations of variation of strain was installed in 1955, and since that time comparative observations have been made with the various types of instruments: variable inductance extensometer, wire resistance strain meter (F gage and U_T gage), photocell extensometer, and the super-invar-bar extensometer. Comparative observations have also been made of variation of ground tilt with tiltmeters of horizontal pendulum type and of photocell type.—*V. S. N.*

ELASTICITY

178–89. Goodier, J. N. The mathematical theory of elasticity *in* Elasticity and plasticity: New York, John Wiley and Sons, p. 3–47, 1958.

Goodier reviews the mathematical research on advanced problems in elasticity for the last 10 years; no elementary theory is discussed. Particular emphasis is given to the work of the Russian applied mathematicians; several books have been published by the Russians, and a number of their problems are discussed. Selected aspects of the following advanced topics are reviewed: stress concentrations around holes of various shapes, stresses developed in punching, thermal stresses, and wave propagation and diffraction.

A comprehensive bibliography covers the literature of all countries.—*E. C. R.*

178–90. Skuridin, G. A. Printsip Dyugamel'ya i asimptoticheskiye resheniya dinamicheskikh uravneniy teorii uprugosti, I [Duhamel's principle and asymptotic solutions of dynamic equations of the theory of elasticity, part 1]: Akad. Nauk SSSR Izv. ser geofiz., no. 1, p. 3–10, 1959.

Continuing his previous studies on the physical validity of the discontinuous solutions of the dynamic equations of the theory of elasticity (see Geophys. Abs. 165–75, 166–109), Skuridin discusses the case where the asymptotic solutions show discontinuities, but none of them becomes infinite. Skuridin proves that the stated asymptotic solutions satisfy the initial system of differential equations. The treatment is vectorial. Duhamel's principle is used for evaluation of the solutions obtained. The application of Duhamel's integral is based on the previous determination of the response of the vibrating system to a unit impulse and the determination of the indicial admittance of the system, because it is based on the principal of superposition, applicable to all cases where only linear differential equations fully describe the problem. Finally, the solution is obtained; in the case of a harmonic source of vibrations this can be presented as an inverse power series. The established series are applicable to numerous boundary value problems but not to those of diffraction, because there the possibility exists of the appearance of infinite discontinuities.—*S. T. V.*

178–91. Skuridin, G. A. Printsip Dyugamel'ya i asimptoticheskiye resheniya dinamicheskikh uravneniy teorii uprugosti. II. [Duhamel's principle and asymptotic solutions of dynamic equations of the theory of elasticity, part 2]: Akad. Nauk SSSR Izv. ser. geofiz., no. 3, p. 337–349, 1959.

This is a continuation of a previous study by Skuridin, published under the same title (see Geophys. Abs. 178–90). Using the generalized solutions of the dynamic equations of the theory of elasticity, Skuridin has derived expressions for the "jumps" of discontinuous (impulse) solutions and for the "jumps" of the derivatives in reference to time, by means of which coefficients of the asymptotic series derived in the first part are expressed. These equations fulfull the conditions necessary to justify the application of Duhamel's principle to the equations of the theory of elasticity and thus show the possibility of using Duhamel's principle for obtaining asymptotic solutions of the dynamic equations of the theory of elasticity. (See also Geophys. Abs. 169–109, 173–121.)—*S. T. V.*

178–92. Takeuchi, H[itoshi]. General solutions of equations of some geophysical importance: Seismol. Soc. America Bull., v. 49, no. 3, p. 273–283, 1959.

General solutions are obtained in rectangular, circular cylindrical, and spherical coordinates for the equations of motion of a homogeneous isotropic elastic body and of the corresponding statical deformations, for the equations of slow motion of an incompressible viscous fluid and of the corresponding statical deformation, and for Maxwell's equations for a homogeneous isotropic conductor.—*D. B. V.*

178–93. Takeuchi, H[itoshi]. Torsional oscillations of the earth and some related problems: Royal Astron. Soc. Geophys. Jour., v. 2, no. 2, p. 89–100, 1959.

Variational calculus methods are applied to the problem of torsional oscillations of elastic spheres of variable densities and elasticities and the corresponding plane Love wave problem for vertically heterogeneous media. The methods work well; the phase velocity curve for Bullen's earth model and corresponding displacement distributions are shown in graphs.—*D. B. V.*

178–94. Enescu, Dumitru. Soluţia problemei Wiechert-Hergoltz în ipoteza pămîntului plan şi stratificaţiei orizontale [The solution of the Wiechert-Hergoltz problem for the case of plane earth and horizontal stratification]: Acad. Romîne Studii şi cercetări de astronomie şi seismologie, v. 2, no. 2, p. 431–438, 1957.

The method of integration proposed by Wiechert-Hergoltz assuming a spherically layered earth is adapted in this paper for the case of a plane earth and horizontal stratification. In this way the Wiechert-Hergoltz seismological problem is solved, and seismic wave velocities are determined as a function of depth from the boundary data obtained at the surface of the earth.—*A. J. S.*

178–95. Teisseyre, Roman [K.] Seismic waves in an ideal guide with an arbitrary point source: Acta Geophys. Polonica, v. 6, no. 1, p. 32–48, 1958.

Expressions are obtained for the propagation of surface and body waves in a homogeneous layer bounded by surfaces of critical velocities (zero, infinite) having an arbitrary point source and time dependence expressed by exp $(-i\omega t)$.—*D. B. V.*

178–96. Nuttli, Otto W. A note on the refraction and reflection of plane elastic waves at an interface with a large velocity contrast: Earthquake Notes, v. 29, no. 4, p. 45–46, 1958.

Noting the important effect of a layer of alluvium on the amplitude and period of the ground motion produced by earthquake waves, Nuttli has made a brief study to find how much of the observed increase in amplitude produced as a result of the presence of alluvium could be explained by the simple theory of refraction and reflection of plane elastic waves at a plane boundary. *P*-wave velocity is assumed to be ten times greater, and density twice as great as that of the alluvium. For small angles of incidence, the amplitude of the refracted *P* wave is found to be almost twice that of the incident *P* wave. Small angles of incidence correspond either to waves traveling straight up from the focus or to waves arriving at large epicentral distances. Another effect of the contrast in materials would be to cause all the refracted *P* and *SV* waves to have a nearly vertical ray path in the alluvium, regardless of the angle of incidence. Since the thickness of an alluvial layer is usually 1 km or a fraction thereof, only short-period waves (period less than 1 sec) with corresponding short wave lengths will be affected by the layer.—*V. S. N.*

178–97. Macdonald, J. Ross. Rayleigh-wave dissipation functions in low-loss media: Royal Astron. Soc. Geophys. Jour., v. 2, no. 2, p. 132–135, 1959.

A simple formula is derived relating the specific dissipation factors for Rayleigh, compressional, and shear waves in relatively low-loss materials. Calculations and a table are presented which allow an unknown specific dissipation factor to be obtained directly from the two known factors for the other types of waves. Results apply for any realizable ratio of any two of the three elastic phase velocities.—*Author's summary*

178–98. Lomnitz, C. Linear dissipation in solids: Jour. Appl. Physics, v. 28, no. 2, p. 201–205, 1957.

Starting from an equation of Boltzmann relating internal friction and creep rate, Lomnitz derives linear relations between transient creep, internal friction, and wave velocity dispersion. Assuming that the internal friction ($1/Q$) is nearly constant, the velocity dispersion is very small and the creep function is of a logarithm type. The relationships are applicable to seismology. (See also Geophys. Abs. 167–270.)—*E. C. R.*

178–99. Pekeris, C. L., Longman, I. M., and Lifson, H. Application of ray theory to the problem of long-range propagation of explosive sound in a layered liquid: Seismol. Soc. America Bull., v. 49, no. 3, p. 247–250, 1959.

In order to test the applicability of ray theory even to extremely large ranges, we have applied it to the problem of determining the exact shape of the pressure pulse received at a range r equal to 460 times the depth of the layer H, in the case of an explosion in a layered liquid. The time variation of the pressure at the source was assumed to be given by a Heaviside unit function. Comparison is made with a previous solution of this problem which was obtained, for the identical conditions, by the use of the normal mode theory. The exact ray-theory solution exhibits the well-known characteristic features of a ground wave followed by a dispersive water wave, but the pattern of the received pressure pulse is more ruffled than in the normal mode solution, in which the higher modes,

as well as branch-line integrals, were neglected. The applicability of ray theory to long-range propagation is made feasible by virtue of the mutual cancellation at long ranges of all but a group of the last-arriving rays.—*Authors' abstract*

178–100. Ambraseys, N. N. A note on the response of an elastic overburden of varying rigidity to an arbitrary ground motion: Seismol. Soc. America Bull., v. 49, no. 3, p. 211–220, 1959.

The autofrequencies of an elastic layer of soil of finite depth and of linearly varying modulus of rigidity are found theoretically in the case (*i*) when the rigidity of the material increases, or (*ii*) decreases with depth. Also, it is shown that an approximate expression for the autofrequencies based on the mean of the limiting values of the rigidities holds within a few percent of the true autofrequencies for small values of the rigidity ratio. The response equations for the overburden are also found in terms of the velocity spectrum of the region, or else in terms of a generalized disturbing function $g_0(t)$.—*Author's abstract*

Ruppeneyt, K. V. Mechanical properties of rocks. See Geophys. Abs. 178–411.

Shreiner, L. A., and others. Mechanical and abrasive properties of rocks. See Geophys. Abs. 178–412.

178–101. Nishihara, Masao. Stress-strain relation of rocks (Rheological properties of rocks 1) : Doshisha Kogaku Kaishi, v. 8, no. 2, p. 32–55, 1957.

Equations relating stress and strain according to the theory of elasticity and the theories developed for simple elastico-viscous behavior, the rheological models, are summarized. After development of the Maxwell, Kelvin, and Burger models, Nishihara applies the integrated equations for the Maxwell and Burger models at constant strain rate to the stress and strain observations of Hasmark dolomite by John Handin under 5,000 kg per cm^2 hydrostatic pressure at 30°C and 300°C, at a constant strain rate of 0.010 per min; and to the stress and strain data on Yule marble observed by D. T. Griggs under 5,000 kg per cm^2 hydrostatic pressure, at 300°C, at a strain rate of 0.015 per min. This application affords rough values for viscosity of about 2×10^{13} poises and for Young's modulus of about 4×10^5 kg per cm^2. No comparisons are made between the theoretical curves and the observed curves.

Tests were performed on marble, sandstone, and granite in uniaxial compression; one sample of marble was tested in uniaxial tension. No discussion of the data is given except the derivation of an empirical relationship between stress and strain for one test of marble; the linearity of Young's modulus with stress for small strains provides a logarithmic relation between stress and strain. The equation is not applied or discussed further.—*E. C. R.*

178–102. Hiramatsu, Yoshio, and Oka, Yukitoshi. The fracture of rock around underground openings: Kyoto Univ. Fac. Eng. Mem., v. 21, pt. 2, p. 128–153, 1959.

The conditions under which fracture of rock occurs around an underground opening were investigated by model experiments, photoelastic experiments, and field observations at various mines in Japan. Results showed that, assuming perfect elasticity for the ground, fracture takes place when the theoretical maximum tensile or compressive stress, multiplied by a factor representing the ratio of tensile (or compressive) strength to the theoretical maximum tensile (or

compressive) stress at the instant of fracture reaches the tensile (or compressive) strength of the rock. There is a great difference between the factor for tension fracture (0.45) and that for compression fracture (0.95). Many phenomena difficult to explain completely by the theory of elasticity can be explained by this theory. For example, the compression fracture often found on the side wall of a mine level in heavy ground can be explained as due to the horizontal rock pressure and the correction to be applied for the theoretical tensile stress. Moreover, the state of stress in the ground can be inferred to some extent from knowledge about theoretical stress around mine openings by observing the character of the rock fracture around an underground opening—*V. S. N.*

178–103. Iida, Kumizi, and Kumazawa, Mineo. Measurements of elastic wave velocities in volcanic rocks at high temperatures by means of ultrasonic impulse transmission. Part I: Nagoya Univ. Jour. Earth Sci., v. 7, no. 1, p. 49–64, 1959.

A new method of direct measurement of elastic wave velocities in volcanic rocks at high temperatures by utilizing the piezoelectricity of a beta-quartz crystal is described. The efficiency of transducers was not reduced at 870°C and measurements were made up to about 1,000°C, with a possibility of using direct measurements for temperatures above 1,000°C.

Measurement of longitudinal and transverse wave velocities in volcanic rock specimens collected from various localities in Japan shows that an increase of elasticity with a rise in temperature seems to be characteristic of recently erupted volcanic rocks, while a decrease in elasticity is observed in old volcanic rocks. This seems to be due to the differences in structures of volcanic rocks. A remarkably large increase in Poisson's ratio with a rise in temperature was also observed.—*V. S. N.*

178–104. Bayuk, Ye. I. Metodika opredeleniya uprugikh parametrov v obraztsakh gornykh porod [Methods of determining the elastic parameters of specimens of rocks]: Akad. Nauk SSSR Izv. ser. geofiz., no. 6, p. 895–897, 1959.

It is often important in geologic studies to know the velocity of propagation of seismic waves in rocks at high pressure and high temperature. Such determinations can be conveniently made in the laboratory only on short specimens. The elastic wave velocities in a relatively short rod and in an infinite volume are connected by known relationships which are affected by the dimensions of the rod and the seismic wave length used in the experiments. The same relationships of the theory of elasticity make it possible to determine Poisson's coefficient and other elastic parameters. Bayuk used in his experiments an ultrasonic impulse seismoscope (see Geophys. Abs. 153–14479), which made it possible to vary the wave lengths propagating along the specimen. Sandstone, syenite, and aluminum alloys were investigated. The results are in good agreement with the data obtained by other scientists in laboratory experiments and in seismological studies.—*S. T. V.*

Zalesskiy, B. V. Methods of study of physical-mechanical properties of rocks. See Geophys. Abs. 178–413.

178–105. Kalinina, P. V. Nekotoryye eksperimental'nyye dannye o vliyanii vlazhnosti na skorost' rasprostraneniya ul'trazvukovykh voln v obraztsakh porod [Some experimental data on the effect of moisture on the velocity of propagation of ultrasonic waves in rock specimens]: Razvedochnaya i Promyslovaya Geofizika, no. 27, p. 18–29, 1959.

Laboratory experiments were carried out on several rock types to determine the effect of moisture on the velocity of elastic wave propagation. The samples consisted of bituminous clay, silty clay, clayey siltstone, and sandstone from a quarry; clays with admixed sandy, silty, and limey material from a depth of 500 m in a well; and also an artificially saturated sandstone. Measurements of the physical propertes of the rocks were made during desiccation. The samples were dried gradually at room temperature, and then the air-dried specimens were brought to complete dryness at temperatures of 100°C–110°C. Measurements of the elastic wave velocities were made in directions both parallel and transverse to the bedding. The changes in velocity as well as changes in density, porosity, and water saturation are present in graphs. The velocity is related by formula to density and volume of each component and to porosity.—*J. W. C.*

178–106. Volarovich, M. P., Balashov, D. B., and Stakhovskaya, Z. I. Issledovaniye uprugikh svoystv gornykh porod pri vysokikh davleniyakh [A study of the elastic properties of rocks under high pressure]: Akad. Nauk SSSR Soveshch. ekspt. i tekh. mineralogii i petrografii, 5th, Leningrad, 1956, Trudy, p. 137–145, 1958.

Essentially the same as the paper published in the Izvestiya Akademii Nauk SSSR, ser. geofiz., no. 3, p. 310–330, 1957 (see Geophys. Abs. 170–86).—*A. J. S.*

178–107. Peterschmitt, Élie. Ondes séismiques engendrés par des effondrements dans le bassin minier de Briey [Seismic waves generated by cave-ins in the mining basin of Briey]: Acad. Sci. [Paris] Comptes Rendus, v. 248, no. 26, p. 3728–3729, 1959.

Seismic records of cave-ins in the Briey mining district of France have been obtained at various European stations. Records of the latest of these (at the Roncourt mine on January 16, 1959) from 29 stations at distances of 145–823 km have been analyzed. The *Pn*, *Pg*, and *Sg* waves and others are closely related to the mechanism of the cave-in; this mechanism, interpreted from the initial motions, is definitely less abrupt than that of tectonic earthquakes.—*D. B. V.*

178–108. Mark, J. Carson. The detection of nuclear explosions: Nucleonics, no. 8, p. 64–73, 1959.

Nuclear explosions may be detected by several methods. Contained underground explosions may best be monitored by a seismograph. Such explosions, however, must be distinguished from earthquakes. An earthquake sends out rarefaction as well as compression waves, both of which transmit as longitudinal waves. The rarefaction waves are almost always transmitted in two roughly opposite quadrants. Explosions, on the other hand, would be expected to transmit compressions in all directions. Thus the direction of the first motion observed in various directions from the epicenter should distinguish between nuclear explosions and earthquakes.—*J. W. C.*

Latter, A. L., Martinelli, E. A., and Teller, E. Seismic scaling law for underground explosions. See Geophys. Abs. 178–369.

ELECTRICAL EXPLORATION

178–109. Roman, Irwin. An image analysis of multiple-layer resistivity problems: Geophysics, v. 24, no. 3, p. 485–509, 1959.

The Kelvin method of images is expressible by a transflection at a boundary. The original source is augmented by a supplement and a complement. The supplement contributes to the potential on the same side of the boundary as the source, but it lies at the optical image position of the source in the boundary. The complement lies at the position of the source but contributes to the potential on the opposite side of the boundary.

For two or more boundaries, there are two exterior regions and one or more interior regions. For a source in the top layer, a primary sequence starts with a downward transflection and a secondary sequence with an upward transflection. To each primary sequence of transflections there corresponds a secondary sequence with an upward transflection at the upper boundary ahead of it. The exterior images are not transflected again. Successive transflections occur at adjacent boundaries, suggesting a link of two transflections. To a sequence of links, called a chain, there corresponds an associated sequence, obtained by dropping the last transflection.

Exterior images follow from interior, associated from chain, and secondary from primary. Thus, only primary, interior, chain images need to be traced.

Each potential is the sum of terms of the form m/r where m is the strength of a specific image, r is the distance of that image from the test point, and the sum includes all images contributing to that potential.

The addition of each boundary introduces images and potentials that must be added to those existing prior to the introduction, but it does not otherwise alter them.

For the three-boundary problem, the separate image strengths are determined by simple multiplication after a kernel polynomial is calculated. The latter is a finite polynomial in the reflection-factor at the middle boundary and can be tabulated. For the images of a specific potential and depth group, the strengths satisfy a recursion formula that serves as a check on direct evaluations.—*Author's abstract*

178–110. Tsekhov, G. D. Metodika rascheta mnogosloynykh krivykh elektricheskogo zondirovaniya [Methods of calculation of multi-layer curves in electrical profiling]: Moscow, Gostoptekhizdat, 92 p., 1957.

The book deals with the problem of electric profiling of geological profiles composed of four or more layers of more or less conductive rocks resting on an insulating basement. A method of computation of such theoretical curves, based on the method proposed by Stefanescu (1930) and discussed by Flathe (see Geophys. Abs. 162–72), is improved further and illustrated by examples using special tables and nomograms presented in the book. (See also Geophys. Abs. 166–149.)—*A. J. S.*

178–111. Blokh, I. M., and Shemyakin, Ye. A. Polucheniye grafikov dipol'nogo i trekh-elektrodnogo elektro-profilirovaniya pri issledovaniyakh pryamolineynoy nesimmetrichnoy ustanovkoy BAMN [The construction of graphs of dipole and three-electrode electric profiling in investigations using a rectilinear asymmetrical arrangement of electrodes, BAMN]: Akad. Nauk SSSR Izv. ser. geofiz., no. 6, p. 872–879, 1959.

With the rectilinear asymmetrical electrode arrangement BAMN, it is possible to obtain graphs of either dipole or three-electrode profiling, depending on the properties of the geoelectric profile and the dimensions of the entire installation. In the case of a profile characterized by an increase of apparent resistivity with increasing electrode separation, graphs of three-electrode profiling can be obtained with smaller ratio of l_2/l_1 (here $l_1=AO$; $l_2=A^1O$). The graphs of three-electrode profiling can be obtained with shorter distance of the current electrode from the potential electrodes *MN*. With increasing distance between *MN* electrodes it is possible to construct graphs of the three-electrode profiling with a smaller l_2/l_1 ratio.—*S. T. V.*

178–112. Blokh, I. M. Dipol'noye elektroprofilirovaniye [Dipole electric profiling]: Moscow, Gosgeoltekhizdat, 191 p., 1957.

This book compiles data on electric profiling available from the Russian ministries of geology and conservation and of the coal industry, including the data of Blokh's experimental and theoretical studies. The four chapters of the book deal respectively with the physical and mathematical basis of dipole electric profiling, the procedures of geological surveying by this method, its organization and techniques, and interpretation of the data obtained.—*A. J. S.*

178–113. Nazarenko, O. V. Metodika nepreryvnykh morskikh elektricheskikh zondirovaniy [Method of continuous marine electrical profiling]: Geologiya Nefti, no. 8, p. 40–46, 1957.

The method of continuous vertical electrical profiling (*NVEZ*) was worked out by experiments during 1954–1956. The results of tests off the Baku Archipelago in the Caspian Sea indicate that this new method may be used for offshore exploration. The instruments are housed in a long cable that is towed by a ship. The techniques of using the instrument are discussed with diagrams.

In areas of known geologic structure the results from the *NVEZ* method conform to the data of seismic exploration and drilling. In areas where seismic reflections are absent (crests of anticlines), this method may furnish the necessary data. Two structure sections are presented for which there were no seismic data but which were worked out in detail by the *NVEZ* method.—*J. W. C.*

178–114. Komarov, S. G., and Keyvsar, E. I. Opredeleniye pronitsayemosti neftenosnykh plastov po udel'nomy soprotivleniyu [Determination of the permeability of oil-bearing strata according to specific resistance]: Prikladnaya Geofizika, no. 20, p. 171–205, 1958.

The method of determination of permeability of oil-bearing strata according to specific resistance is based on a relationship between residual water saturation and permeability. It is assumed that the residual water saturation corresponds to the water saturation of oil-bearing strata, which is determined

according to electric logging. In order to use this method, it is necessary to construct a curve of the relationship of the coefficient of specific resistance (Q) to permeability (K_{pr}) for each stratum. This curve is based on permeability data of cores taken from the stratum being studied. Several curves are given, each being for an individual stratum of an oil deposit. The error connected with use of such curves is generally 30–50 percent and more.—*J. W. C.*

178–115. Shibakov, M. A. Primeneniye geofizicheskikh metodov pri poiskakh i razvedke mestorozhdeniy stroitel'nykh materialov [The application of geophysical methods in prospecting for and exploring deposits of building materials]: Razvedka i okhrana nedr, no. 1, p. 22–27, 1958.

Several examples of the application of vertical electrical sounding and resistivity profiling in exploration for deposits of limestone are described. In the first case the maximum electrode spacing was 220 m; in the other the current electrodes were 100 m apart and the potential electrodes 10 m. The resistivity methods are applicable because solid limestone without fissures and cavities has an electrical resistivity far exceeding that of clays and argillaceous deposits.—*S. T. V.*

178–116. Yoshizumi, Eizaburo; Taniguchi, Kiichiro; and Kiyono, Takeshi. Vertical sounding by central induction method: Kyoto Univ. Faculty of Eng. Mem., v. 21, pt. 2, p. 154–169, 1959.

The central induction method, originally studied by Koenigsberger, Nunier, and Stefanescu, has a distinct advantage over the apparent resistivity method in determining the structure of a horizontally stratified earth where there are four or more layers. This paper discusses the theory of the central induction method and presents numerical tables for interpreting the data. A new procedure is proposed for measuring the phase angle of the resultant magnetic field.—*V. S. N.*

178–117. Baldwin, Robert W. A decade of development in overvoltage surveying: Mining Eng., v. 11, no. 3, p. 307–314, 1959; Am. Inst. Mining Metall. Petroleum Engineers Trans., v. 214, 1959.

Overvoltage surveying, more commonly known as the induced polarization method, has been particularly successful in detecting and outlining disseminated sulfide mineralization to depths as great as 200 m. This paper discusses the history of its development since the first field tests in 1947 and 1948; field equipment and operational methods used, including the alternating current overvoltage methods; the type of curves obtained; the theoretical model developed to account for overvoltage effects; and field results.—*V. S. N.*

178–118. Seigel, Harold O. Mathematical formulation and type curves for induced polarization: Geophysics, v. 24, no. 3, p. 547–565, 1959.

A basic mathematical formulation is developed for overvoltage and other induced polarization phenomena. Starting from the fundamental representation of a volume dipolar distribution, one is led to the concept of a change in apparent conductivity due to polarization effects. The mathematical solution of induced polarization phenomena, therefore, reduces to the appropriate solution of Laplace's equation for the same geometry and conductivity distribution ignoring polarization, followed by partial differentiation of the apparent resistivity func-

tion so determined. The dielectric constants of the media are not involved in the solution.

As examples of the use of the representation, the response of a polarizable sphere and of a polarizable lower layer in a typical two-layer case are presented. Actual field results are shown illustrating the use of the latter solution.—*Author's abstract*

178–119. Kudymov, B. Ya., and Kotov, P. T. O prirode vyzvannoy polyarizatsii osadochnykh porod [On the nature of induced polarization of sedimentary rocks]: Prikladnaya Geofizika, no. 20, p. 134–140, 1958.

The results are presented of a study directed toward explaining the physical nature of induced polarization of sedimentary rocks. This is a continuation of previous work (see Geophys. Abs. 172–82). Laboratory experiments were made on induced polarization in platinum, copper, lead, and clays and the results are compared on a graph. Other tests were made on sandstones, limestones, and clayey sands. It is concluded that induced polarization of sedimentary rocks is not related to the presence of electrically conducting minerals. The principal cause apparently is the attenuation of movement of the solution in the capillaries of the rock after cutting off the current—an electro-osmotic aftereffect. According to this hypothesis the relative polarization should be intimately related to the concentration of the solution.—*J. W. C.*

178–120. Yanagihara, Kazuo. Induced polarization and earth-current [in Japanese with English abstract]: Kakioka Magnetic Observatory Mem., v. 9, no. 1, p. 65–73, 1959.

The phenomenon of induced polarization is explained in terms of concentration cells at the effective membrane formed by the capillary of clay particles. Distribution of these concentration cells in the ground determines the magnitude of the induced polarization voltage measured between the electrodes at the stationary state. Vacquier and others (see Geophys. Abs. 170–101) proposed the idea of concentration cells earlier, but their cells are formed at the capillary between sand particles to which clay adheres, and clay plays the role in ionization. According to Yanagihara's theory, the relaxation time of growth or decay of concentration cells at the capillary between clay particles would be several seconds to some minutes; these are observed decay times.—*D. B. V.*

178–121. Ward, Stanley H. Unique determination of conductivity, susceptibility, size, and depth in multifrequency electromagnetic exploration: Geophysics, v. 24, no. 3, p. 531–546, 1959.

The response of a conductive, magnetic sphere in a uniform, alternating magnetic field is a function of the conductivity, permeability, and radius of the sphere and of the frequency of the alternations. Over one range of frequencies, eddy-current density in any given sphere and secondary magnetic fields of the sphere are relatively constant and high. Over a much lower range of frequencies eddy currents are negligible, but the secondary magnetic fields may be of large constant amplitude but of polarity reversed to that of the higher frequency range. At some intermediate frequency the secondary magnetic fields will be entirely quadrature with respect to the inducing field.

Utilization of this peculiar frequency dependence and of the geometry of the secondary magnetic fields permits unique determination of the conductivity, permeability, radius, and depth to the center of a buried sphere. The procedure for obtaining these variables is described in this article.

As an added feature, it is shown that by completing a gravity survey as well as an electromagnetic survey over a dense, magnetic, conductive spherical ore body, it is possible to determine the above variables, plus density, uniquely. Precise identification of the material of the sphere is seen as a possible result of the application of this technique.—*Author's abstract*

178–122. Jankowski, Jerzy. The diffraction problem on the conducting half-plane in geophysical research: Acta Geophys. Polonica, v. 7, no. 1, p. 34–40, 1959.

In his paper on the problem of the ideally conducting half-plane in the theory of inductive methods, Teisseyre (see Geophys. Abs. 166–136) computed the diffraction of electromagnetic waves on the ideally conducting half-plane. Confining his calculation to the first approximation, he constructed the family of curves $Re\frac{HZ}{\mathring{H}Z}$. In this paper Jankowski extends Teisseyre's work by using a second order approximation of the field components, enabling him to compute the curves $Im\frac{HZ}{\mathring{H}Z}$ for a given wave number k. These curves may be used in interpretation of shallow profiles.—*D. B. V.*

178–123. Molochnov, G. V. Dipol'nyy elektromagnitnyy metod opredeleniya glubiny zaleganiya provodyashchego sloya [Dipole electromagnetic method of determination of depth of occurrence of a conducting layer]: Leningrad Univ. Vestnik, no. 10, ser. fiziki i khimii, no. 2, p. 43–48, 1959.

General views concerning the depth determination of a buried conducting layer overlain by nonconducting rocks by means of a magnetic dipole are considered. The method implies measurement of a vector inclination angle of the magnetic field which is a function of the ratio between the distance of the dipole from the point of observation and the thickness of a nonconducting layer.—*Author's English summary*

178–124. Tikhonov, A. N., and Skugarevskaya, O. A. Asimptoticheskoye povedeniye protsessa stanovleniya elektromagnitnogo polya [Asymptotic behavior of the process of building up an electromagnetic field]: Akad. Nauk SSSR Izv. ser. geofiz., no. 6, p. 804–814, 1959.

The transient period of the building up of the electromagnetic field produced by a grounded dipole can be treated as an asymptotic process. Such treatment is permissible for points situated at great distance from the source of the field. In this article the case is considered when the electromagnetic field is produced by a grounded dipole; the case when the field is produced by a magnetizing loop can be treated in a similar manner. Replacing the Bessel functions in his earlier formulas (see Geophys. Abs. 148–13473, –13477; 168–86; 175–104) by their serial expressions, Tikhonov obtains the values of the field components represented as series of inverse powers of the distance from the source generating the field. Using the relationships which follow from the asymptotic conditions, it is possible to construct sets of curves for the electromagnetic field generated in the case of equatorial as well as axial disposition of electrodes. For large distances from the source, it is possible to evaluate the conductivity σ_1 and the thickness of the stratum. This data can be of value in geophysical exploration. Two sets of such curves are given in the article.—*S.T.V.*

178–125. Skugarevskaya, O. A. Raschet konechnoy stadii protsessa stanovleniya elektricheskogo polya v trekhsloynoy srede [The computation of the final stage of the transient process of the electrical field in a three-layer medium]: Akad. Nauk SSSR Izv. ser. geofiz., no. 1, p. 59–72, 1959.

Following the method used by Tikhonov in his computation of a similar problem for a two-layer medium, Skugarevskaya (see Geophys. Abs. 142–12271) solves the problem for a medium consisting of two horizontal homogeneous and isotropic layers, overlying a perfectly insulating formation of infinite thickness.

The problem has been reduced by Tikhonov to the analysis of Maxwell equations for a guasi-stationary case. Skugarevskaya uses a vectorial treatment in the analysis. This method can also be used for solving boundary value problems and for the evaluation of the final phase of the transient of the electromagnetic field in a medium composed of any number of layers.—*S.T.V.*

178–126. Engineering and Mining Journal. Two planes speed aerial EM work: Eng. Mining Jour., v. 160, no. 4, p. 95, 1959.

The method using two airplanes for rotary-field electromagnetic prospecting is described. The advantages over the one-plane method are: higher flying speeds and operation in more turbulent conditions because short touring cable cuts motion of bird; deeper penetration, thus assuring complete investigation of the lower parts of an undulating terrain; distinct recording of anomalies even where ore body is covered by thick overburden; and no disturbances by lakes, rivers, bogs, or swamps.—*J.W.C.*

178–127. Buhle, M[erlyn] B. Six case histories of resistivity prospecting in Illinois, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 205–213, 1958.

Since the first electrical earth resistivity prospecting was conducted in Illinois by the State Geological Survey in 1932, several hundred surveys have been made, at the rate of 20–70 a year. Most of these were concerned with water supplies involving subsurface deposits of sand and gravel in the alluvium of Recent, Pleistocene, and pre-Pleistocene streams, and on the upland areas composed of drift of Kansan through late Wisconsin age.

This paper presents six case histories that demonstrate the value of this method of prospecting in various geographical and geologic environments found in Illinois.—*Author's abstract*

178–128. Crumpton, C. F., and Badgley, W. A. Utilization of earth-resistivity measurement by the State Highway Commission of Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 199–207, 1959.

Earth resistivity measurements made with the Wenner four-electrode configuration have been used by the Highway Geology Section of the State Highway Commission to supplement geologic information in Cherokee and Jewell Counties and other places in the state.—*A. J.*

178–129. O'Connor, Ralph E., and Bayne, Charles K. Electrical resistivity studies in brine pollution problems, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 209–218, 1959.

An electrical resistivity survey successfully determined the source of brine pollution of wells in Rice County, Kansas. Such a survey was unsuccessful, however, in determining the source of similar pollution in Pratt County, Kansas.—*A. J.*

178–130. Kelly, S[herwin] F. Geological studies of uranium-vanadium deposits by geophysical exploration methods, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 111–126, 1958.

Prior to 1940, no attempts had been made to apply geophysical techniques to the search for uranium-vanadium deposits in the Colorado Plateau area. Sherwin F. Kelly Geophysical Services, Inc. was employed by the U.S. Vanadium Corporation to study the possibliity of devising a geophysical attack which would be of assistance in their exploration program. This study resulted in developing a method of applying the electrical resistivity technique to the problem. This particular line of approach, developed as described in this article, has in recent years been adopted by the Atomic Energy Commission and the U.S. Geological Survey, in the exploration which they are carrying out in the Colorado Plateau.

Furthermore, prior to the time of this survey, it seems that no efforts had been made to use a Geiger counter in the exploration for the carnotite deposits in the Colorado Plateau area. The experiments described in the present article were therefore the pioneer efforts, in that area, to utilize the Geiger counter in surface exploration, in underground workings and in the study of drill cores, for the purpose of detecting the presence of carnotite. In recent years these techniques have become highly specialized and widely applied in that area.—*Author's abstract*

178–131. Huot, G. Electrical survey on a copper ore-body near Akjoujt, Mauritania, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 66–71, 1958.

The Guelbs Moghrein, near Akjoujt, Mauritania, French West Africa, are two hills of hematite rising above the desert plain. A self-potential survey recorded potentials reaching −200 mv that seem to be caused mainly by conductive magnetite. The survey did not yield much information on the shape of the ore body, but it proved that the ore of the western Guelb is on the whole conductive, the cores of magnetite and of sulfides being continuous in the carbonate gangue. Because of this continuity, standard resistivity mapping could be applied although the sulfides do not predominate.

The resistivity map encountered three conductive zones. A drill hole in the most important of these went through 80 m of unoxidized ore. Subsequent drilling of some tens of holes have established the extent of the ore body (about 60 acres). The most conductive zone is the richest in copper; the least conductive has only disseminated mineralization. A complementary survey revealed similar zones of disseminated ore in wide areas northwest and south of the Guelbs.—*D. B. V.*

King, A. J. Geophysical surveys on the Lupa goldfields in 1955 and 1956. See Geophys. Abs. 178–392.

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178–132. Rocha Gomes, A[lbertino] A[délio]. The discovery of a new orebody within the pyrite belt of Portugal by electromagnetic prospecting, *in* Geophysical surveys in mining, hydrological and engigineering projects: Leiden, European Association of Exploration Geophysicists, p. 97–110, 1958.

Between 1944 and 1949, a geophysical exploration campaign was carried out in the Portuguese part of the pyritic belt of the Iberian Peninsula. Because of the high conductivity of the ore the electromagnetic method was used almost exclusively. An area of 577 km^2 was covered, with 528,504 observation points. Several tests workings, mostly drill holes, were made at anomalous points.

A pyritic ore body was discovered at Cerro do Carrasco (Aljustrel), with 770,000 tons of proved ore and 285,000 tons of probable ore.—*D. B. V.*

178–133. Werner, S[ture]. Geophysical history of a deep-seated pyritic ore body in northern Sweden *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 3–19, 1958.

The first electrical survey of the Rudtjebacken ore body, in the Adak field in the northwestern part of the Skellefte district of Sweden, was made in 1930 using the equipotential line method. In 1932 a detail survey was made by the Turam method and in 1939 a survey by the Slingram method. In 1950 an electromagnetic investigation was made with the special object of searching for deep-seated ore, using the method of Sundberg and Hedstrom. In 1957 an airborne electromagnetic survey was made.

The equipotential line survey revealed the presence of mineralization, but according to drilling results the sulfur content was only 15 percent. The Turam survey indicated an increase in conductivity with depth. This result was confirmed by drilling, but the sulfur content was still only some 25 percent. The depth penetration of the Turam survey was about 60 m. The special survey for deep-seated ore indicated the presence of a very good conductor ranging from about 100–250 m in depth; drilling proved this to be a compact pyrite ore body.—*D. B. V.*

178–134. Törnqvist, G[östa], and Bosschart, R. A. Some recent results of geoelectrical prospecting in Sweden, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 20–31, 1958.

The increase in resolving power in interpreting geophysical surveys that results from the use of different methods is exemplified by a recent prospecting campaign in Sweden, where electromagnetic investigations were combined with magnetic and resistivity measurements. Airborne magnetic anomalies in the areas investigated could be attributed to two causes, either the pyrrhotite content of sulfide mineralization or magnetite impregnations in bedrock. Ground magnetic and electromagnetic (Turam and Slingram) surveys eliminated some areas as unpromising. More detailed magnetic and electromagnetic observations, together with resistivity profiles and sounding, indicated the probable sulfide areas. Drilling encountered mineralized zones, confirming the geophysical results.—*D. B. V.*

178–135. Flathe, H. Geoelectrical investigations on clay deposits in western Germany, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 170–185, 1958.

Resistivity surveys, using the Wenner configuration, were used in the search for and delimitation of clay deposits in western part of Germany. The results obtained in the lower Rhenish border district are described. Interpretation of the resistivity curves was made chiefly by means of theoretically computed master curves; a number of the actual and theoretical graphs are reproduced. The results show that the electrical methods can make a major contribution to the location and delineation of clay occurrences. Depending on local conditions, 10 or more soundings can be carried out per day. No damage is done to cultivated fields, and although electrical investigation does not completely replace drilling, there is a substantial saving in drilling expenditure.—*D. B. V.*

178–136. Flathe, H. Possibilities and limitations in applying geoelectrical methods to hydrogeological problems in the coastal areas of northwest Germany, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 189–204, 1958.

This is the same as the paper published in Geophysical Prospecting, v. 3, no. 2, p. 95–110, 1955 (see Geophys. Abs. 162–72).—*D. B. V.*

178–137. Breusse, J. J., and Le Masne, G. Application of geophysics to the Rhone valley hydroelectric development, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 221–231, 1958.

Electrical prospecting with its particular technique of electrical sounding, together with shallow seismic refraction method have been very helpful in solving the main problems connected with the great development projects of the Rhone valley. The main problems dealt with the search for a convenient bedrock for hydroelectric plants and sluice gates, the laying out of head- and tail-races, the study of alluvial water tables, and the effect produced upon them by opening the tail-races.

Two examples have been selected among the numerous areas explored. The first one deals with the initial development zone at Donzere-Mondragon. The results of the geophysical survey led to a new and completely different lay-out of the tail-race, then to the discovery of the St. Pierre bedrock which proved to be an excellent foundation site for the plant.

The development of the Montelimar area is the object of the second example. First, a general reconnaissance with electrical soundings established that the bedrock was primarily made of sandstones. The problem was then to differentiate the soft sandstone, easy to dredge out, from the hard sandstones which had to be avoided by the tail-race. Refraction seismic [work] was able to solve this problem, and subsequent boreholes gave a remarkable confirmation of the geophysical results.

Finally some statistical data concerning the importance of the geophysical surveys for the Rhone valley development during the last 10 years are presented.—*Authors' abstract*

178–138. Poldini, E. Étude géophysique électrique de la région de Montfleury (Canton de Genève) [Electrical geophysical study of the Montfleury region (Canton of Geneva)]: Archives Sci., v. 10, no. 3, p. 429–441, 1957.

A buried valley in the Molasse of the Meyrin-Montfleury region in Geneva Canton, Switzerland, was traced by means of an electrical resistivity survey. The specific resistivities of the different formations are approximately constant and sufficiently distinct (Würmian bottom moraine, 100–150 ohm-m, dry alluvium 800 ohm-m, water-saturated alluvium 350 ohm-m, and Molasse 30 ohm-m) that the resistivity method could be applied successfully. Subsequent well drilling confirmed the geophysical results. A resistivity map of the area is given.—*D. B. V.*

178–139. Breusse, J. J., and Huot, G. Hydrological surveys in the Catania area by means of electrical soundings, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 214–218, 1958.

This is the same as the paper published in Geophysical Prospecting, v. 2, no. 3, p. 227–231, 1954 (see Geophys. Abs. 159–80).—*D. B. V.*

Vecchia, O[rlando]. Geophysical surveys for a dam at the Lake of Molveno (Venetian Alps, Italy). See Geophys. Abs. 178–395.

Cassinis, R. Geophysical exploration of sulphur limestone in Sicily (Italy). See Geophys. Abs. 178–394.

178–140. Šumi, F[ranć], and Meisser, O[tto]. Geophysical exploration in the Kižnica and Majdanpek mining district of Yugoslavia, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 72–83, 1958.

In the Kižnica mining district of Yugoslavia, sulfide mineralization is related to an andesitic-dacitic intrusive; the ore bodes lie on a serpentine contact. Magnetic measurements indicated the presence of serpentine, and a self-potential survey exactly located the position of the mineralized contact. The zone of electrical anomalies was mined; up to the beginning of 1956, about 7 million tons of ore carrying 3.4 percent lead and 1.0 percent zinc were found.

The Majdanpek ore is a typical case of sulfide impregnation in andesite. A granite intrusion was distinguished from other rocks by magnetic measurements. Strong anomalies were caused by magnetite lenses at the contact with limestone. Self-potential surveys disclosed a zone of anomalies 5 km long, caused partly by known limonite and pyrite deposits and partly by copper sulfide impregnations. Mining operations in the zone of electrical anomalies have thus far found nearly 200 million tons of ore with 0.8 percent copper.—*D. B. V.*

178–141. Sakovtsev, G. P. Opyt geofizicheskikh issledovaniy pri poiskakh gluboko zalegayushchikh kolchedannykh mestorozhdeniy na Urale [Experience of geophysical investigations with exploration of deep-seated pyrite deposits in the Urals]: Moskov. Geologorazved. Inst. Ordzhonikidze Trudy, v. 32, p. 88–98, 1958.

During the period 1925–35 geophysical prospecting was instrumental in locating a large number of sulfide deposits in the Urals; these ore bodies were generally close to the surface and marked by strong natural electric fields. The rate of

discovery of new deposits fell off sharply after that, and a new method of exploration had to be sought.

On the basis of theoretical, laboratory, and field studies, a new and more effective combination of geophysical methods has been worked out. It consists of the methods of the superposed field and of the vertical field.

The method of the superposed field is based on the use of a unipolar instrument. This apparatus consists of two input electrodes and two receiving electrodes arranged mutually perpendicular. The reciprocal poles of the input terminals are attached to electrodes that are located at a distance 1.5 to 2 km ("infinity"). This method is intended for indirect exploration, which includes outlining regional electrically conducting zones.

The vertical field method is a simpler variation of the compensation method; it is intended for use in areas that have already been studied by the superposed field method. The vertical field method also employs a unipolar apparatus that consists of two 1,500 m line electrodes located across the strike.

Use of these methods in several mining districts is described. A number of new deposits were discovered as a result of these operations.—*J. W. C.*

178–142. Ivanov, S. A. Elektrorazvedka na vody [Electric exporation for water]: Sovkhoznoye proizvodstvo, no. 8, p. 65–66, 1958.

Vertical electrical profiling proved successful in discovering locations and depths of aquifers and lenses of fresh and saline water in the Kazakh S.S.R. The cost of this type of electrical exploration over an area of 2–3 km^2 to a depth of 150 m is 7,000 rubles on the average; total weight of the apparatus is 400–500 kg.—*A. J. S.*

178–143. Homma, Ichiro, and Ono, Yoshihiko. Electrical prospecting for the ground water in the western part of Saitama Prefecture [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 9, no. 8, p. 1–8, 1958.

A resistivity survey for ground water was made in western Saitama Prefecture, Japan. The depth and distribution of the nonpermeable Tertiary bed were determined.—*V. S. N.*

178–144. Homma, Ichiro, and Odani, Yoshitaka. Electrical prospecting for underground water at the southern part of Ogaki City, Gifu Prefecture [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 9, no. 9, p. 55–58, 1958.

A resistivity survey was made of the southern part of Ogaki City, Gifu Prefecture, Japan, to determine the distribution of ground water in relation to the subsurface structure. Three strata were identified, the second layer consisting of impermeable clay which probably acts as a dam for the ground-water reservoir.—*V. S. N.*

ELECTRICAL LOGGING

178–145. Dakhnov, V. N. Promyslovaya geofizika [Geophysical well logging]: Moscow, Gostoptekhizdat, 692 p., 1959.

A comprehensive presentation of the theory and practice of electrical logging is presented by one of the leaders in this field in the U.S.S.R. The foreword and introduction outline the capabilities of electrical logging methods in general and trace the history of their development. Russian contributions to the field are emphasized.

The book is divided into two parts. Part 1 contains 5 chapters devoted respectively to logging methods, principal measuring apparatus, logging laboratories, equipment, and foreign apparatus and equipment. These chapters are profusely illustrated with pictures, diagrams, and schematic diagrams of the various logging instruments.

Part 2 consists of 11 chapters, as follows: specific and apparent resistivity of rocks (with a theoretical discussion of sondes); theory of the method of apparent resistivity (with an extensive mathematical treatment); basic theory of methods of ground resistance, recording of current and slide contacts (this is equivalent to the laterolog); induction method of investigation of well; self-potential method (with details on the many factors involved); induced polarization method; electrical methods of determination of the angle and direction of dip of strata; special equipment and apparatus for electric logging (several cut-away diagrams of sondes are presented); making electrical measurements during study of the sections of wells; causes of distortion of measured values of apparent and effective resistivities and potentials of self- and induced polarization of rocks and their prevention; and importance and course of further development of electrical methods of study of well sections.—*J. W. C.*

178–146. de Witte, Leendert, and Gould, Roy W. Potential distribution due to a cylindrical electrode mounted on an insulating probe: Geophysics, v. 24, no. 3, p. 566–579, 1959.

The potentials around a finite cylindrical electrode can be obtained by dividing the electrode into rings of equal thickness and substituting an infinitely thin current ring for each of the slices. The field of an infinitely thin ring electrode mounted on an insulating cylindrical probe of the same diameter can be found by combining the properties of the delta function with a solution of Laplace's equation in cylindrical coordinates. Combination of solutions for the infinitely thin rings under the condition that the potential of the electrode surface be constant leads to a system of simultaneous linear equations. By increasing the number of slices, the potential around the finite electrode can be found arbitrarily close.

The problem of a cylindrical electrode on a sonde located coaxially in a conducting hole, drilled through a medium of different conductivity, is treated by the same method. This arrangement is of interest in electrical logging of drill holes.

Numerical examples have been calculated on an IBM 650 magnetic drum computer. The potential along the surface of the insulating probe, at distances larger than twice the electrode length, can be approximated with good accuracy by assuming that all of the current is emitted from an infinitely thin ring located in the median plane of the electrode.—*Authors' abstract*

178–147. Al'pin, L. M. Vliyaniye okaymlyayushchego sloya na rezul'taty kol'tsevogo karotazha [Effect of the marginal layer on the results of a collar log]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 5, p. 112–115, 1958.

This paper is a mathematical treatment of the theory involved in logging the undisturbed rock at a distance from a borehole. Normally four zones are present: the mud in the hole, the invaded zone, a zone of low resistivity beyond the invaded zone in which formation water is concentrated, and finally the

undisturbed zone. The collar logging discussed in this paper provides for a sonde with a cylindrical shield and with collar electrodes that have a diameter equal to that of the hole. The influence of the mud is thus eliminated.—*J. W. C.*

178–148. Shevkunov, Ye. N. Eksperimental'noye issledovaniye metoda mikroekranirovannogo zonda. [Experimental investigation of the method of the micro-shielded sonde]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Neft i gaz., no. 5, p. 15–21, 1959.

The microsonde method has a great disadvantage arising from the effect of the mud cake. The shielded microsonde (microlaterolog) has a greater advantage in this respect. Experiments carried out on a model show that if the mud cake does not exceed 0.75 cm, the readings by this instrument are not adversely affected. The data resulting from these experiments are presented on a graph.

The effectiveness of the method of determining the specific resistivity where there is a thick mud cake may be increased by simultaneous measurement of the apparent resistivity with both a shielded microsonde and with a microgradient sonde. A nomogram is presented for such determinations. Where the thickness of the mud cake is greater than 1.5 cm, another nomogram is proposed in which the values of the shielding (focusing) current are taken into account.—*J. W. C.*

178–149. Nesterenko, G. N., and Neyman, Ye. A. Primeneniye mikrozondov dlya vydeleniya poristykh plastov v karbonatnykh otlozheniyakh mestorozhdenii zapadnoy Bashkirii [Use of microsondes for distinguishing porous beds in carbonate sediments of the oil fields of western Bashkiria]: Geologiya Nefti, no. 8, p. 46–50, 1957.

Conventional electric logging encounters difficulties in determination of reservoir properties of carbonate rocks, particularly in locating the boundaries of porous and permeable beds. The microsonde method had proved itself most effective in distinguishing porous and permeable beds in the Upper Devonian carbonates in the oil fields in western Bashkir A.S.S.R. This is graphically illustrated in accompanying diagrams in which micrologs are compared with other standard logs.—*J. W. C.*

178–150. Petrosyan, L. G. Ob iskazheniyakh polya pri bokovom karotazhe na odnozhil'nom kabele [On the distortion of the field in connection with laterolog on a single-strand cable]: Prikladnaya Geofizika, no. 20, p. 215–220, 1958.

The effect of the field of the armored cable on laterolog measurements is treated mathematically. In order to eliminate this effect, the supply from the cable into the sonde should be a current with a frequency that is different from that fed into the current electrodes of the sonde. The measuring circuit should be supplied with available frequency filters.—*J. W. C.*

178–151. Al'pin, L. M. K teorii trekhelektrodnykh karotazhnykh zondov [On the theory of three-electrode logging sondes]: Ministerstvo Vyssh. Obrazovaniya SSSR, Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 8, p. 92–109, 1958.

This paper is a continuation of previous work (see Geophys. Abs. 178–147), but is wider in scope. Some of the formulas derived in the earlier papers are

applied here to obtain the multipliers which give the values of the apparent specific resistance from data obtained with the ring sondes. The regular and ring sondes are discussed, along with their theoretical analogs called finite or ideal theoretical sondes.—*A. J. S.*

178–152. Latyshova, M. G., and Dobrynin, V. M. Interpretatsiya diagramm potentsialov vyzvannoy polyarizatsii v neftyanykh skvazhinakh [Interpretation of diagrams of potentials of induced polarization in oil wells] : Geologiya Nefti, no 5, p. 65–72, 1957.

The logging-geophysics staff of the Gubkin Petroleum Institute in Moscow have developed an hypothesis on the nature of the phenomenon of induced polarization of sandy-clayey rocks. Each particle of sand is a nonconductor, which is surrounded by a conductor that saturates the rock. As a result of adsorption processes, a double conducting layer forms on the surface of each particle. Artifically induced polarization of sandy rocks arises as a result of deformation of this double conducting layer by an electric current. As the value of the potential of induced polarization of sandy rocks is determined by adsorption phenomena, it is a function of the specific surface of the rock.

It is concluded that the induced polarization method permits more detailed subdivision of the section than does the self-potential method. Under conditions similar to those of the Tuimazy and Grozny fields the permeability of sandy reservoirs can be determined by induced polarization; a graph is presented for such determinations. There are several diagrams in which induced polarization and self-potential curves are compared.—*J. W. C.*

178–153. Plyusnin, M. I. Novyye sposoby elektricheskikh issledovaniy v skvazhinakh na mestorozhdeniyakh polimetallicheskikh rud [New methods of electrical investigations in wells in deposits of polymetallic ores] : Moskov. Geologorazved. Inst. Ordzhonikidze Trudy, v. 32, p. 99–106, 1958.

Electric logging of drill holes in connection with ores deposits is necessary because ore may be missed due to loss of core or because ore bodies may lie between the drill holes. Experimental work in the polymetallic ore deposits in southern Kazakh S.S.R. showed that the method of induced polarization may be used for distinguishing disseminated sulfide ores in drill holes. A schematic diagram for such a circuit and an example of a log are presented.

Experiments were also carried out in these same ore deposits using various methods to locate ore bodies between drill holes. The best results were obtained by using an alternating current of low frequency. A schematic diagram of the apparatus is given. The direct current and induced polarization methods were tested and found to have little promise in this field of exploration. The radio-wave method can be used with dry holes.—*J. W. C.*

178–154. Dobrynin, V. M. Elementy teorii polya potentsialov vyzvannoy polyarizatsii v skvazhinakh [Elements of the theory of the potential field of induced polarization in wells] : Moskov. Neftyanoy Inst. Gubkin Trudy, no. 22, p. 126–141, 1958.

This is a mathematical treatment of the problem of induced polarization described by Latyshova and Dobrynin (see Geophys. Abs. 178–152). The intensity of the potential of induced polarization is shown to be dependent on the geometric shape and size of the polarized body, the resistivity of the medium, and the distance from the source of the current to the point of observation.

The intensity of the anomalies of the potential of induced polarization is dependent on the relationship of the size of the sonde to the diameter of the well and also on the thickness of the stratum; if the thickness is less than 12 times the well diameter, its influence must be taken into consideration. The intensity of the anomalies in thick strata is inversely proportional to the diameter of the well, and it increases with an increase of the resistivity of the stratum and the depth of penetration of drilling muds into the stratum.—*J. W. C.*

178–155. Plyusnin, M. I., and Postel'nikov, A. F. Karotazh razvedochnykh skvazhin na polimetallicheskikh mestorozhdeniyakh yuzhnogo Kazakhstana [Logging of exploratory wells in polymetallic deposits of southern Kazakhstan]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 3, p. 94–110, 1958.

Experimental work in logging drill holes in lead-zinc deposits in carbonates of southern Kazakh S.S.R. is reviewed. Present geophysical methods proved unfavorable; they do not solve problems such as distinguishing oxidized ores and subdividing carbonate rocks. The greatest promise lies in the combined use of induced polarization and apparent resistivity. These methods in combination may solve the following problems: distinguishing of aggregate unaltered and semioxidized sulfide ores, recognition of zones of disseminated mineralization, and distinguishing of lithologic variations that may be used for correlation.—*J. W. C.*

178–156. Kozina, E. K., and Shmarova, V. P. Zavisimost' amplitudy otkloneniya krivoy PS ot undel'nykh soprotivleniy plastovoy vody i fil'trata burovogo rastvora [Relationship of the amplitude of deflection of the *SP* curve to the specific resistivity of the formation water and to the mud filtrate]: Prikladnaya Geofizika, no. 20, p. 206–214, 1958.

Self-potential does not change in direct proportion to the log of the ratio of the mud filtrate resistivity to the formation water resistivity. These values are related to one another in a graph.—*J. W. C.*

178–157. Dakhnov, V. N. Nekotorye voprosy izucheniya litologii gornykh porod, slagayushchikh razrezy skvazhin, po dannym potentsialov sobstvennoy polyarizatsii [Some problems of the study of the lithology of rocks constituting the sections of wells according to data of the potentials of self-polarization]: Ministerstvo Vyssh. Obrazovaniya SSSR Izv. Vyssh. Ucheb. Zavedeniy, Neft i gaz., no. 7, p. 11–15, 1958.

Determination of the clay content of the section is important for estimation of reservoir properties and of the oil-gas saturation as well as for clarifying problems connected with movement of the marginal water, the oil yield of strata, and the productivity of wells. Such determination of clay content can be made by the *SP* log.

Estimation of the total clay content is better accomplished if more is known of the sandy layers interbedded with the clay. The formula for total thickness of the sandy beds is $\sum_i h_i = \frac{S_{sp}}{E_s} d_o$, where $\sum_i h_i$ is their total thickness, S_{sp} is the area between the *SP* curve and the clay base line, E_s is the static potential, and d_o is the diameter of the hole.—*J. W. C.*

ELECTRICAL PROPERTIES

178–158. Volarovich, M. P., and Parkhomenko, E. I. Modelirovaniye svyazi vozmushcheniya elektricheskogo polya gornykh porod pri piezoelektricheskom effekte s seysmicheskimi yavleniyami [Modeling of the relationship of the disturbance of the electric field in rocks, in connection with the piezoelectric effect, with seismic phenomena]: Akad. Nauk SSSR Izv. ser. geofiz., no. 1, p. 144–145, 1959.

Laboratory experiments were made on the piezoelectric effect in rocks accompanying seismic phenomena. For this purpose blocks of granite, marble, and labradorite were tested; these blocks had different dimensions but were on the order of 30×15×5 cm. Granite generally shows a piezoelectric effect due to the presence of quartz grains, whereas marble and labradorite, which are generally free from quartz, show negligible effects. Seismic shocks were imitated by pulses produced by a piezoelectric seismoscope (see Geophys. Abs. 153–14479, 160–53, 162–53). Elastic waves propagating through the tested block from the point of impact, as well as elastic waves propagating from the points where the quartz grains were present in the block, have been observed and recorded by an oscilloscope. The oscillograms show that one ray is formed by elastic waves propagating from the point of impact. Another ray consists of electric waves propagating from quartz grains inside the specimen; this is the piezoelectric effect. The electric waves are propagated with the velocity of light, whereas the elastic waves have a much lower velocity. Both types of waves can be readily observed. Volarovich and Parkomenko point to the fact that these experiments explain transient anomalies of the electric field often observed during seismic phenomena in many regions.—*S. T. V.*

178–159. Guizonnier, R., and Couteight, H. Conductibilité électrique de roches calcaires [Electrical conductivity of calcareous rocks]: Soc. Sci. phys. et nat. Bordeaux Procès-Verbaux, p. 120–132, 1957–1958.

The electrical conductivity of 13 limestone samples cut with two parallel polished faces was measured by fastening the sample between electrodes of folded aluminum foil. Currents of more than 10^{-9} amp were measured with a galvanometer, weaker currents by means of a method used before in a study of insulating liquids, sensitive to 10^{-12} amp.

A potential difference of the order of 1 v and the formation of alumina at the anode show that part of the conductivity of the rock is of electrolytic origin. When the rock is sufficiently desiccated, the relationship between initial current and temperature is exponential; from this it is concluded that the conducting particles are those which can cross a potential barrier of 0.42 ev, and it seems that this second mode of conductivity, shown when the rock contains a little moisture, is due to the presence of water.

The progressive decrease in the charging current is interpreted by the accumulation near each electrode of oppositely charged particles slow to discharge. The maximum discharging current is explained by the dispersion in the medium of the particles collected near the electrodes during charging.—*D. B. V.*

178–160. Keller, G[eorge] V., and Licastro, P. H. Dielectric constant and electrical resistivity of natural-state cores: U.S. Geol. Survey Bull. 1052–H, p. 257–285, 1959.

As part of a program to obtain basic data on the physical properties of the rock in and near uranium-mineralized zones, measurements of electrical resistiv-

ity and dielectric constant were made on parts of 27 cores from the Morrison formation in the Colorado Plateau uranium province. For frequencies between 50 cycles and 30 megacycles per second, resistivity ranged from 10^2 to 10^{12} ohm-centimeters. The water content of the cores seemed to be the controlling factor: the high resistivities were associated with low water content and the high dielectric constants with high water content.—*Authors' abstract*

178–161. McEuen, Robert B., Berg, Joseph W., Jr., and Cook, Kenneth L. Electrical properties of synthetic metalliferous ore: Geophysics, v. 24, no. 3, p. 510–530, 1959.

Ninety small cores of synthetic metalliferous ore were constructed from solid glass spheres averaging 0.5 mm in diameter, lead spheres 1.0 mm in diameter, and refractory cement. The lead content of the cores varied from 0 to 50 percent by frame volume. The effective porosity was controlled by the manufacturing pressure and ranged from 10 to 20 percent. The cores were saturated with NaCl solution. The apparent impedance of the cores was measured with a modified Wheatstone bridge as a function of frequency and current density. The low-frequency effects of induced polarization were separated from the overall decrease of impedance with increase of frequency by taking advantage of the dependence of these effects upon current density. The overall decrease of the impedance with frequency and the polarization effects were found dependent upon the effective porosity and the lead content. Both the polarization effects and the overall decrease of the impedance with frequency increased with decreasing porosity. The induced-polarization effects at 10 cycles per sec attained a maximum at approximately 15 percent lead content. The impedance of a synthetic ore with a small lead content was found to be larger than that of corresponding cores barren of lead.—*Authors' abstract*

EXPLORATION SUMMARIES AND STATISTICS

178–162. Postnikov, V. G. Nekotoryye cherty sovremennoy metodiki poiskov nefti i gaza za rubezhom [Some features of the modern methods of exploration of oil and gas abroad]: Geologiya Nefti, no. 8, p. 62–66, 1957.

A general discussion of petroleum and gas exploration and production outside the U.S.S.R. A breakdown by country of party-months for seismic and gravity exploration is given for 1956.—*J. W. C.*

178–163. Olenin, V. B. Poiski nefti na morskikh ploshchadyakh v zarubezhnykh stranakh [Exploration of oil in marine areas in foreign countries]: Geologiya Nefti, no. 7, p. 63–66, 1957.

The world picture of offshore oil is discussed, and about 30 favorable areas are indicated on a map. None of these lie within the jurisdiction of the U.S.S.R.; the offshore oil in the Caspian Sea is not included in this category.—*J. W. C.*

178–164. Klemic, Harry, Eric, John H., McNitt, James R., and McKeown, Frank A. Uranium in Phillips Mine-Camp Smith area, Putnam and Westchester Counties, New York: U.S. Geol. Survey Bull. 1074–E, p. 165–199, 1959.

This paper is essentially a discussion of the geology and economic possibilities of the uraniferous rock associated with a pyrrhotite-pyrite ore body in the

Precambrian rocks of part of the Hudson Highlands of New York. Uraninite occurs in hornblende pegmatite and in adjacent hornblende gneiss and diorite. The isotopic age of a crystal of uraninite from the hornblende pegmatite is about 920 million years and the lead-alpha age of zircon from an oligoclase-quartz pegmatite which intrudes the area discordantly is about 620 million years.

Magnetic and radioactivity surveys were made to obtain information about the occurrence and distribution of magnetic and radioactive minerals in the Phillips Mine-Camp Smith area, followed by exploratory drilling of a zone of anomalies on Camp Smith. Examination of lithologic logs of cores and gamma-ray logs of drill holes indicates that the deposit is submarginal under 1955 marketing conditions for uranium.—*V. S. N.*

178–165. Hambleton, William W., Lyden, Joseph P., and Brockie, Douglas C. Geophysical investigations in the Tri-State zinc and lead mining district, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 357–375, 1959.

Geophysical exploration for zinc and lead sulfide ore bodies in the Tri-State mining district of Kansas, Oklahoma, and Missouri is reviewed. The results of magnetic, gravity, electrical, radioactivity, geochemical, and seismic surveys are summarized. It is concluded that no satisfactory geophysical method has yet been demonstrated that can consistently locate deep zinc sulfide ore bodies that are entirely below the water table in mineralized areas of the Tri-State district.—*A. J.*

178–166. Jewett, John M., and Merriam, Daniel F. Geologic framework of Kansas—A review for geophysicists, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 9–52, 1959.

This résumé of the geology of Kansas forms a basis for the interpretation of the geophysical data presented in the other 24 articles that constitute the "Symposium on Geophysics in Kansas."—*A. J.*

178–167. Merriam, Daniel F., and Hambleton, William W. Exploration geophysics in Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 53–62, 1959.

Although much geophysical work has been done in Kansas since early 1930, few results have been published. Most of the present exploratory work is by private industry in locating petroleum reserves. Seismic techniques have proved to be the most successful of the geophysical methods. A complete bibliography on magnetic, gravity, electrical, and seismic work in Kansas is included.—*A. J.*

178–168. Wantland, Dart. Geophysical investigations on projects of the United States Bureau of Reclamation in Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 181–197, 1959.

Results of geophysical investigations by the U.S. Bureau of Reclamation in Kansas over a period of 16 years are summarized. Refraction seismograph and electrical resistivity methods were used to study possible damsites and to determine quantity of materials available for construction purposes.—*A. J.*

178–169. Canadian Geophysical Bulletin. Annual report of the Associate Committee on Geodesy and Geophysics, National Research Council of Canada: Canadian Geophys. Bull., v. 11, 57 p., 1958.

The current geophysical research of Canadian government and private agencies is reviewed by several persons. The Dominion Observatory made four regional gravity surveys, extensive pendulum surveys, isostatic studies, and laboratory work with pendulums and with vibration gravimeters. Seismologic work included instrument development, field studies of explosions off Vancouver Island, crustal thickness studies in Alberta, and detection of nuclear tests. Activity in age determinations and radioactivity of rocks is reviewed briefly. Airborne magnetometer surveys by the Canadian Geological Survey have been extended over water in the attempt to relate the geology of Newfoundland to that of the mainland. Paleomagnetism is being studied by the Geological Survey and by the University of Western Ontario.—*J. W. C.*

178–170. Oil in Canada. Exploration continues slow but steady decline: Oil in Canada, v. 11, no. 31, p. 60–62, 1959.

Exploration activity in western Canada in 1959 followed the steady though gradual decline trend which began after the peak year of 1952. The continued decline is attributed to the general oversupply of crude oil and natural gas which made exploration for new reserves less attractive. Also there is a continuing exhaustion of unexplored areas in which to carry out further geophysical exploration.—*V. S. N.*

178–171. Ward, S[tanley] H., and Barker, R. A. Case history of the Juniper Prospect: Am. Inst. Mining Metall. Petroleum Engineers Trans., v. 211, p. 100–104, 1958.

This paper describes the various geophysical methods, from reconnaissance to detail, used in locating a sulfide deposit. The Juniper area in west-central New Brunswick was selected from geologic maps as a promising area for sulfide deposits of the type found in the Bathurst-Newcastle district to the north. A helicopter-mounted electromagnetic survey, which located an anomalously conductive area coinciding with a small aeromagnetic closure, was followed by geological, geophysical (electromagnetic and gravity), and geochemical investigations on the ground. Six diamond drill holes were drilled to test the anomalies. Base metals were discovered during drilling, but the quantity of sulfides was too small for profitable exploitation.—*V. S. N.*

178–172. Collin, C. R., Sanselme, H., and Huot, G. An example of the use of geophysical methods in metalliferous mining—the Écarpière uranium mine (Vendée–France), *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 127–137, 1958.

The Écarpière uranium deposit, near Clisson in the province of Vendée, France, was discovered by a reconnaissance team of the French Atomic Energy Commission, using Geiger-Müller counters. After some initial surface work, various electrical, magnetic, radiometric, and seismic refraction surveys, and electrical and radioactivity logging were either used or tested. The electrical methods were found to be particularly suitable.—*D. B. V.*

178–173. Mathiez, J. P. Vogelgrun civil engineering problem solved by electrical, magnetic and seismic methods, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 238–247, 1958.

A geophysical survey has been carried out in the region of Vogelgrun in order to investigate the possible existence of a shallow bedrock on the left bank of the Rhine.

A grid of electrical soundings revealed an area where two simultaneous phenomena occur. These are a) a decrease of the thickness of alluvium, the depth to the conductive substratum passing rapidly from over 150 m to less than 40 m, and b) an increase of the resistivity of this substratum which in this area consists of basalt at 40 ohm-m, instead of Oligocene marls at 5 ohm-m elsewhere.

This result was confirmed by a magnetic survey. The magnetic anomalies coincide with the shallow volcanics discovered by electrical exploration. Over these anomalies the depth to bedrock was checked by refraction shooting.

The logs of four boreholes drilled after the geophysical survey are in good accord with its results. In the area of the top, two holes encountered lava at a depth of 28 m while south of Neuf-Brisach a former well had found the Oligocene under 236 m of alluvium.

The shallow igneous rock appears clearly on a map of apparent resistivities with a current line of 400 m. In simple cases (two layer problems), a theoretical curve may be easily computed which permits the rapid transformation of the resistivity map into a contour map of the basement.—*Author's abstract*

178–174. Malmqvist, D[avid]. The geophysical case history of the Kankberg ore deposit in the Skellefte District, north Sweden, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 32–54, 1958.

A geophysical survey of the area surrounding Kankberg was started in 1929, after the discovery of many ore boulders. The first indication of the Kankberg deposit was obtained in 1931 by an electromagnetic method. In addition to electromagnetic methods, magnetic, gravimetric, induced polarization and self-potential methods have been used in the area. At the end of 1952 a large amount of different geophysical data was assembled. In combination with geological data found from the borings, a good prognosis about the extent and shape of the deposit could be made.—*Author's abstract*

178–175. Kahma, A. [A.], and Puranen, M[aunu]. Geophysical case history of the Vihanti zinc ore deposit in western Finland, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 84–96, 1958.

The geophysical prospecting activities at Vihanti were carried out by the Geological Survey of Finland in the years 1945–49. The ore deposit is situated in the midle of an extensive swamp, where there are very few rock outcrops. The application of direct geological exploration methods in locating ore deposits was difficult in such conditions, and therefore geophysical methods played an important part in the history of the ore discovery.

Magnetic, electromagnetic, and gravimetric investigations were carried out in the area. The best results were achieved with magnetic and electromagnetic

measurements. The zinc ore of Vihanti was discovered as the final result of the geological and geophysical investigation and it lead to one of the largest mines now being worked in Finland. *Authors' abstract*

178–176. Stefănescu, Sabba [S.] Evolutia prospecţiunilor geofizice pe teritoriue RPR [The development of geophysical prospecting in the territory of the Rumanian People's Republic]: Acad. Romîne Bul. ştiinţ., sec. geol. şi geog., v. 2, no. 1, p. 75–86, 1957.

The principal phases of the evolution of geophysical prospecting by gravimetric, magnetometric, electrometric, seismic and radiometric methods in Rumania are given, from the sporadic efforts in the nineties of the last century to 1955. Prospects of the future development of applied geophysics in Rumania are outlined.—*A. J. S.*

178–177. Bogdanov, A. I., Komarov, S. G., and Fedynskiy, V. V. Geofizicheskiye metody razvedki na neft' i gaz v SSSR [Geophysical methods of prospecting for oil and gas in the USSR]: Geologiya Nefti, no. 11, p. 13–30, 1957.

Geophysical operations connected with oil and gas in the U.S.S.R. are divided into three main fields: regional studies of broad areas, exploration and preparation of structures for prospecting drilling, and well logging. A short historical sketch of the developments in these fields is followed by a review of the present status and future direction of activity. The broad regularities of subsurface structures of favorable areas are worked out by aeromagnetic, gravity, and electrical surveying in conjunction with refraction operations. Direct preparation of structures for prospecting drilling is accomplished by further application of reflection work.

In 1956 about 9 million km^2 had been covered by small scale aeromagnetic survey, and the whole territory of the U.S.S.R. is expected to be covered by 1960. Detailed surveying will be carried out over favorable areas.

Large scale gravity surveying is used for tectonic regionalization of broad areas and detailed operations have been successful in locating a number of third-order structures. Exploration of salt dome areas has been particularly successful using this method.

The principal electrical method of exploration used in the U.S.S.R. is that of vertical electrical probing (*VEZ*). The dipole probing (*DZ*) and telluric current (*TT*) methods appear to have a great potential.

Seismic methods are the most widely used of the geophysical methods in oil exploration. Most parties use the reflection method. Structures with an amplitude of 30–50 m at depths to 4 and 5 km can be distinguished.

Geophysical logging methods are being improved continually. An illustration is given in which the apparent resistivity log, *SP* curve, lateralog, microlog, neutron log, γ-log, and caliper log are compared for the same well.—*J. W. C.*

178–178. Fedynskiy, V. V. Geofizicheskiye metody poiskov i razvedki neftyanykh i gazovykh mestorozhdeniy v shestoy pyatiletke [Geophysical methods of exploration and prospecting of oil and gas fields in the sixth five-year plan]: Geologiya Nefti, no. 1, p. 5–11, 1957.

A short review of past activity is followed by a more detailed description of plans and goals. Activity in the field of exploration geophysics has increased

rapidly in the U.S.S.R. since World War II, and the number of field parties active in 1955 is expected to be doubled by 1960. Much attention will be given the central and northern parts of the West Siberian Lowland, eastern Siberia, the Kraznoyar district, and Kamchatka. Aeromagnetic, gravity, electrical (telluric current), and seismic surveys will be carried out. The Volga-Ural region will be the subject of extensive seismic work in preparation for deep drilling. Operations in Azerbaijan will include much offshore exploration.—*J. W. C.*

178–179. Fotiadi, E. E. Geologicheskoye stroyeniye russkoy platformy po dannym regional'nykh geofizicheskikh issledovaniy i opornogo bureniya [Geology of the Russian platform from the data of regional geophysical investigations and basic drilling]: Moscow, Gostoptekhizdat, 244 p., 1958.

Fotiadi analyzes available data from geological and geophysical investigations and deep basic drilling on the Russian platform; describes the structure of the crystlline basement of the platform; discusses the problems of geological interpretation of the geophysical data obtained by various research institutions and industrial establishments; and presents maps, graphs, and tables on the physical properties of rocks (mainly their densities and magnetic susceptibilities) to support the interpretations presented. A bibliography lists 392 references.—*A. J. S.*

178–180. Per'kov, N. A. Vydeleniye produktivnyk kollektorov v karbonatnykh razrezakh [Determination of productive reservoirs in carbonate sections]: Geologiya Nefti, no. 5, p. 58–64, 1957.

Much attention has recently been given exploration of oil-bearing Carboniferous and Devonian carbonates, which constitute a considerable part of the section of the Ural-Volga oil district. Experience has shown that the most effective methods of distinguishing oil- and gas-bearing beds in carbonates is a combination of standard electrical logging, and radioactive logging, including gamma-gamma and neutron-gamma logging. Gas logging luminescent logging, and microsonde measurements have also been used successfully here. Several examples are given in which logs of different types are compared with lithologic sections.—*J. W. C.*

178–181. Solovov, A. P., and Fursov, V. Z. Poiski nevykhodyashchikh na poverkhnost' rudnykh tel mestorozhdeniya Achisay [The prospecting of non-outcropping ore bodies of the Achisay deposit]: Sovetskaya Geologiya, no. 3, p. 126–140, 1959.

The Achisay lead-zinc deposit in the Karatau Range in the Kazakh S.S.R. is characterized by concealed ore bodies, located mainly in a massive dolomite at a depth of some 300–400 m. To increase the effectiveness of exploration, geophysical methods were applied in 1953–57 over an area of some 40 km^2 in the Achisay syncline. Electric, magnetic, and metallometric methods were used, together with data from aerial photography. Numerous sections were found with favorable prospecting features, in which drilling and mining work will be started immediately. Such preliminary geophysical surveying will increase the effectiveness of geologic prospecting.—*S. T. V.*

178–182. Vasil'yev, V. G., Veber, V. T., and Mandel'baum, M. M. Novyye dannyye o geologicheskom stroyenii i perspektivy neftegazonosnosti Zeya-Amurskogo mezhdurech'ya [New data on the geology and the prospects of oil and gas of the Zeya-Amur interstream area]: Geologiya Nefti, no. 7, p. 39–44, 1957.

The geologic section in the area between the Zeya and Amur Rivers in southeastern Siberia consists of a basement overlain by Cretaceous and Cenozoic sediments. The area has recently been subjected to an integrated geophysical investigation in which gravity, aeromagnetic, electrical, and seismic prospecting were used in combination.

Weak negative gravity anomalies correspond to zones of downwarp of the basement, weak positive anomalies correspond to zones of uplift of the basement, and strong positive anomalies correspond to zones of development of basic effusive rocks. The section as derived from electrical data consists from the base upward of a marker horizon (basement) of high resistivity (4,000 ohm-m), a complex of low resistivity (3.5–5 ohm-m) that corresponds to the Lower Cretaceous, and a unit of greater resistivity (50–1,900 ohm-m) which is the Upper Cretaceous and Cenozoic. The geophysical work located Lower Cretaceous sedimentary basins buried beneath horizontal Upper Cretaceous and Cenozoic sediments.—*J. W. C.*

178–183. Vasil'yev, V. G., Karasev, I. P., and Kravchenko, Ye. V. Osnovnyye napravleniya poiskovo razvedochnykh rabot na neft' i gaz v predelakh Sibirskoy platformy [Principal direction of exploration-prospecting operations in oil and gas within the Siberian platform]: Geologiya Nefti, no. 1, p. 11–19, 1957.

The oil and gas capability of the Siberian platform is demonstrated by a powerful gas well from Lower Jurassic sediments of the Tass-Tumus area, Yakutsk A.S.S.R. The vast area of this platform contains rocks of almost all major geologic divisions from Proterozoic through Quaternary. Cambrian units are the most important with respect to possible sources of oil.

Gravity surveying is useful in the area because of a sharp density change at the contact between the Paleozoic and Mesozoic. Aeromagnetic surveying (scale 1:1,000,000) has been carried out for a large part of the Siberian platform; it has revealed faults at depth and the approximate relief of the basement. Seismic surveying has disclosed local uplifts in the Mesozoic section. Electrical prospecting is complicated by permafrost.—*J. W. C.*

178–184. Olenin, V. B. Poiski nefti v Indiyi [Oil exploration in India]: Geologiya Nefti, no. 2, p. 63–66, 1957.

The geology and oil potential of India are briefly summarized. One favorable area is the foremountain downwarp of the Ganges basin, which extends from Kashmir across East Punjab and Uttar-Pradesh into West Bengal; this is shown on a map. Exploration here ought to be directed toward distinguishing uplifts in the Tertiary rocks, which are buried under Quaternary alluvial deposits. Seismic exploration has already begun in West Bengal.—*J. W. C.*

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GENERAL

178–185. Henrichs, Walter E. Jr. Trends in the application of geophysics: Mining Eng., v. 11, no. 7, p. 688–690, 1959.

This paper is a resume of the current status of application of the geophysical method to mining. Using mines in Arizona as examples, Henrichs discusses where, how, for what purposes, and at what costs geophysical methods of exploration should be applied.—*V. S. N.*

178–186. Svoboda, Karol. Geofysikálne metódy inžinierskeho a surovinového prieskumu [Geophysical methods of engineering and raw material prospecting]: Bratislava, Slovenské vydavatel'stvo technickej literatúry, 430 p., 1958.

This is a manual on geophysical methods of prospecting for engineers and geologists. The technical foundations of geophysics and the main geophysical methods are discussed. The first four chapters give a historical review of geophysics in general and in Czechoslovakia in particular, fundamental physical and cosmogonic concepts, and the earth's origin and constitution. The physical properties of rocks and minerals and geophysical prospecting of engineering foundations are discussed in chapters 5 and 6, respectively. Chapter 7 describes geophysical-geological methods of prospecting and the use of the auxiliary methods of geochemistry, biochemistry, and geobotany in a joint operation. Chapter 8 describes geophysical methods and measurements, their precision, and interpretation. Chapter 9 deals with gravimetric methods, chapter 10 with geomagnetic, chapter 11 with geoelectric, chapter 12 with seismic, chapter 13 with radioactivity, and chapter 14 with geothermal. In chapter 15 the problems of geophysics and the prospective development of geophysical sciences are discussed. The bibliography lists 245 titles.—*A. J. S.*

178–187. Vybornykh, S. F. Promyslovoye geofizicheskoye oborudovaniye i apparatura [Geophysical logging equipment and apparatus]: Moscow, Gostoptekhizdat, 284 p., 1958.

The book describes equipment and apparatus used in geophysical exploration and logging. Logging installations, sondes, resistometers, thermometers, caliper loggers, inclinometers, and instruments for radioactive exploration and micrologging are discussed and particular features in their designs are analyzed.—*A. J. S.*

178–188. Tarkhov, A. G. Podzemnaya geofizicheskaya razvedka [Underground geophysical prospecting]: Ministerstvo Vyssh. Obrazovaniya SSSR, Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 1, p. 107–123, 1958.

The various methods of geophysical investigations that can be used underground in mines are reviewed. The radio-wave method has proved very effective. The results of its use in several areas are described, and two diagrams of mine workings are presented in which the effect of ore bodies on radio waves is illustrated. Other methods of underground exploration are evaluated in general terms. Extensive experiments with gravity measurements have been conducted underground using known ore bodies to test the techniques and instruments. The elevated temperature in the vicinity of some ore bodies is a basis of thermo-

metric exploration. The possibilities for underground magnetic surveying are undoubted; mine installations, however, hamper this method. Finally, measurements of cosmic radiation may be useful in underground exploration; an ore body between the surface and the mine workings may absorb deeply penetrating cosmic rays and thereby cause an anomalous low in the measurements made in the mine.—*J. W. C.*

178–189. McCollum, E. V. Geology, a geophysical tool: Am. Assoc. Petroleum Geologists Bull., v. 43, no. 7, p. 1503–1504, 1959.

The importance of geology in the planning and execution of a geophysical survey, and in interpretation of the data, is emphasized.—*D. B. V.*

178–190. Godin, Yu. N. Regional'nyye geofizicheskiye issledovaniya [Regional geophysical investigations]: Geologiya Nefti, no. 6, p. 7–15, 1957.

Regional and local structures are believed to reflect tectonic activity that has taken place at great depth; these depths lie beyond the reach of the drill and must be studied by geophysical methods. The initial tasks are the solution of the problems of the regional tectonics of the oil-gas regions of the U.S.S.R., the tectonic regionalization, mapping of the surface of the basement, distinguishing unconformities and individual stratigraphic stages, construction of isopach and facies maps of the principal stratigraphic units, study of the character of deep layers in the crust, and determining the origin and rules of distribution of structures. The gravity, aeromagnetic, seismic, electrical, and geochemical methods are reviewed. As these methods furnish only indirect information on facies changes and on oil potential, they should be supplemented by drilling and geological investigations.—*J. W. C.*

178–191. Landsberg, H. E. Data processing in geophysics, *in* Contributions in Geophysics (Gutenberg volume): Internat. Ser. Mon. Earth Sci., v. 1, p. 210–227, 1958.

The reduction and analysis of large quantities of observed data is important in geophysics. Early methods utilized tables, charts, nomograms, slide rules, logarithms, and desk calculators. With the development of automatic high speed computers, the older methods have been superseded except for basic investigations. Specific problems and machines are listed in this article, but geophysical problems are applicable to nearly all of the general purpose computers and these have been augmented by special purpose machines.

Types of application include calculation of correlation coefficients, Fourier analysis, least squares analysis, information storage and retrieval, operations research on alternate hypotheses for interpretation, the use of orthogonal polynomials, quality checks on observations, frequency distributions, summarization, iteration, statistical study and parameter determination, solution of systems of linear equations, summation of series, differential equations, differentiation, and integration in one or more variables.

Some of the problems for which data processing have been used are: prediction of tides, weather forecasting, determination of properties of the earth's interior, atmospheric turbulence, nuclear fallout studies, International Geophysical Year data, satellite and rocket data, gravity, figure of the earth, wave action, flood prediction and control, geomagnetism, seismology, and tidal oscillations of the earth.

There is a need to design measuring equipment to prepare data in a form to be used as input for the calculators, such as punching cards or tape, and preparing magnetic tape, with or without a written copy of the data.

Many historical details are included in this article, with specific reference to the machines, personnel, and problems involved.—*I. R.*

178–192. Klushin, I. G. O vydelenii geofizicheskikh anomaliy men'shikh sredekvadratichnoy pogreshnosti izmereniya [The distinguishing of geophysical anomalies smaller than the root mean square of the errors of measurement]: Akad. Nauk SSSR Izv. ser. geofiz., no. 2, p. 189–196, 1959.

Certain questions concerning the accuracy of geophysical observations are discussed as well as the question of the possibility of distinguishing specific characteristics of geophysical fields in the presence of disturbances. The errors that are related to the method of measurement and processing of observations are analyzed. The accuracy of geophysical observations is measured by the root mean square value of the errors of measurement. Using the method of observational calculus, Klushin arrives at the following conclusions: if the measurements are made at separate points and the errors have a random character, then it is possible to reduce the absolute value of these errors substantially by means of filtering. To separate with full assurance the anomalies that have amplitudes smaller than the mean square value of the errors of the measurements, a sufficiently dense network of observations is necessary to provide a difference between the spectral representation of the anomaly and the error. The question whether it is necessary to make a greater number of observations in comparison with the existing norms, can be solved only on the basis of an analysis of a given geophysical problem. There are cases when such an increase would be superfluous.—*S. T. V.*

178–193. Belousov, V. V. Geologicheskaya otsenka nekotorykh sovremennykh geofizicheskikh predstavleniy [Geological consideration of certain modern geophysical ideas]: Moskov. Obshch. Ispytateley Prirody Byull., v. 63, Otdel geol., v. 33, no. 4, p. 5–13, 1958.

Recent findings by researchers in global geophysics are critically discussed and their geological interpretations evaluated. Certain inconsistences, such as a rise of the Caucasus massif against isostatic forces, are brought out. Deep seismic sounding reveals two opposing processes: The thickening of the crust and granitic layer simultaneously with the thinning of the crust; and an evolution from the continental to the oceanic type of crustal structure. Benioff's findings on the periodicity of catastrophic earthquakes are mentioned and an analysis of the earthquake "concatenation" phenomenon is suggested. The paradox of equal heat flow from the ocean floor and from land surface is attributed to a possible difference in the vertical distribution of radioactive material in and under the continental and oceanic crusts, both nevertheless having the same amount of radioactivity per unit area. In a discussion of geomagnetic phenomena Belousov requires a plausible physical explanation for the vertical motion of matter in the outer core, to substantiate the hydrodynamic theory of geomagnetism. The paleographic assertions of continental drift are considered as a premature and dangerous fad.—*A. J. S.*

178–194. Bullen, K. E. Geophysics in Russia and China: Australian Jour. Sci., v. 21, no. 7, p. 205–207, 1959.

The present article contains Bullen's impressions of some of the geophysical work going on in the U.S.S.R. and China, mainly in seismology; the sources of information are official documents supplemented by first-hand observations and discussions. For the most part material used from documents was verified at first hand.

The Institute of Earth Physics in Moscow has four departments devoted exclusively to seismology. The first is devoted to seismological observatories and their instrumentation; the second to study of crustal movements and structure, including explosion seismology; the third to seismic regionalization; and the fourth to seismic prospecting, including work on ice thicknesses in polar regions. Four other departments of the institute include seismological work as part of their activity (departments of geodynamics, mathematical physics, registering instruments, and geophysical stations); four more are concerned explicitly with the interior of the earth (departments of evolution of the earth, internal structure of the earth, high pressure laboratory, and theoretical department). The three remaining departments (aerogravimetric laboratory, and departments of electrometry and magnetometry) have no immediate connection with seismology.

Seismological research in China is much less well developed. The chief problem is lack of trained personnel.—*D. B. V.*

178–195. Morelli, C[arlo]. L'osservatorio geofisico sperimentale di Trieste [The experimental geophysical observatory of Trieste]: Boll. Geofisica teor. ed appl., v. 1, no. 1, p. 3–26, 1959.

The observatory at Trieste was founded in 1841 but has had several different names during its long history. This article outlines its history, organization, and activities. Research on the physics of the earth is divided into seismology, gravimetry, magnetics, meteorology, analysis of periodicities, radioactivity, geothermometry, and glaciology. Applied geophysics consists of seismology, gravimetry, magnetics, geoelectricity, radioactivity prospecting, thermal prospecting, chemical prospecting, and geophysics of the sea. A bibliography of 100 papers published by the observatory since 1949 is appended.—*J. W. C.*

178–196. Schlumberger Well Surveying Corporation. Introduction to Schlumberger well logging—Schlumberger document no. 8: Ridgefield, Conn. Schlumberger Well Surveying Corp., 176 p., 1958.

The instrumentation and techniques of well logging are comprehensively reviewed. Chapter 1 discusses the relationships between resistivity and such factors as water salinity, rock structure, and fluid content. Chapter 2 deals with self-potential; the subjects treated are the origin of *SP*, circulation of *SP* current, static *SP*, effect of interstitial shales on *SP*, factors influencing the shape and amplitude of the *SP* peaks, and determination of *Rw* from *SP* logs. Chapter 3 describes induction logging; this is regarded as the best method for investigation of true formation resistivity provided the resistivities to be measured are not excessively high. Chapter 4 deals with conventional resistivity methods. The "limestone sonde" is also described here. Chapter 5 discusses the laterolog; it is considered as best suited in hard-rock territories. Chapter 6 treats the general subject of microdevices. The microlog is a nonfocusing instrument which can discriminate very thin beds. The microlaterolog is a focusing device that reduces the effect of the mud cake. Chapter 7 is devoted to radiation logging. Gamma-

ray and neutron logging are discussed from the standpoint of theory, field operation, calibration, interpretation, and application. Chapter 8 describes sonic logging; the equipment is described and a field example given. Chapter 9 deals with the practical applications of electrical, radiation, and sonic logs. Chapter 10 discusses side-wall sampling; Chapter 11 concerns dipmeter and directional surveys; Chapter 12 deals with caliper logs; and Chapter 13 describes temperature surveys. The work is amply illustrated by diagrams, photographs, and schematics.—*J. W. C.*

178–197. Dakhnov, V. N. Blizhayshiye zadachi geofizicheskikh metodov issledovaniya razrezov skvazhin [Forthcoming problems of geophysical methods of investigation of sections of wells]: Geologiya Nefti, no. 2, p. 23–29, 1957.

The electrical, radioactive, and temperature methods of well logging are briefly discussed and the following general recommendations are made: wide testing of the potential sonde and lateral electrical potential sonde in a number of oil fields; wide use of the microelectric method for detailed study of sections, particularly of carbonates; increasing the quality of registration; development of inductive methods for study of wells drilled with oil-base muds; wide testing and commercial introduction of the method of induced potential aimed at distinguishing reservoirs and studying their permeability; study of the quantitative content of radioactive elements in the rocks; study of the porosity of rocks by the gamma and neutron methods; and use of thermal logging in conjunction with other methods.—*J. W. C.*

178–198. Bubleynikov, F. Tayny zemli [Riddles of the earth]: Moscow, Moskovskiy Rabochiy, 136 p., 1958.

This popular book on descriptive geology and geophysics covers a broad range of topics: the helical orbits of the earth and the moon in space, the origin, temperature and rigidity of the earth, crustal structure, formation of continents, earthquakes, volcanic phenomena, geological structures and bodies, geochronology, the origin of coal and oil, geologic and geophysical prospecting, and geophysical instruments.—*A. J. S.*

GEODESY

178–199. Molodensk[i]y, M. S. New methods of studying the figure of the earth: Bull. géod., no. 50, p. 17–21, 1958.

In the last 10–12 years Soviet geodesists have become convinced that in studying the shape and external gravitational field of the earth, considerable accuracy can be obtained only by constructing a theory which does not involve reduction problems. They do not study the geoid proper, but a surface approximating it called a quasi-geoid.

The shape of the earth's surface can be studied by purely geometrical methods by linear and angular measurements on it. The distance H of a point on the earth's surface above the reference ellipsoid is expressed by the formula $dH = dH + (\xi, \cos A + \eta \sin A)\, dl$, where dH is a whole differential for a displacement on the surface in azimuth A at a distance whose horizontal projection is dl, and dh is the measured levelling elevation, and ξ and η are the components of the angle of plumbline deviation from the normal to the reference ellipsoid. To apply this formula it is necessary to have the same frequency of astronomic stations as for correctly planned astronomic levelling.

The problem of subdividing the height H into parts corresponding to orthometric heights and geoid heights in the usual theory is treated by the introduction of two new values, normal height H_n and a quasi-geoid height. The normal height is computed by the increment of the potential measured in the real field in such a way as if the field were normal; the quasi-geoid height is obtained by a formula similar to Bruhn's formula, but in which all the values are taken on the surface.

Calculations carried out for plumbline deviations for a model of a conical mountain and for the mountainous part of the Crimean Peninsula show the advantage of the new methods. In the Crimea the old methods gave very poor agreement between astrogeodetic and gravimetric deviations of the plumbline, but with the new methods it was possible to attain an accuracy of the same order ($\pm 1.2''$) as in flat regions for the gravimetric survey of approximately the same density.—*D. B. V.*

178–200. Bragard, L[ucien]. Méthodes de détermination du géoïde [Methods of determination of the geoid]: Bull. géod., no. 50, p. 31–35, 1958.

It is shown that determination of the geoid from the reference ellipsoid can be done either directly, without isostatic hypotheses, or in two stages, with the intermediate cogeoid. Whichever procedure is used, cartography of topographic relief is indispensable to calculations either of the disturbing potential or of the density of topographic condensation. Because of complications which are discussed, it seems advisable to use the direct procedure. A choice of two formulas is then possible, both of which require knowledge of densities of the topographic relief. These could be determined with sufficient precision from borings, if a borehole gravimeter can be developed.—*D. B. V.*

178–201. Gromov, S. V. K voprosu o sovmestnom opredelenii massy i figury Zemli po astronomo-geodezicheskim i gravimetricheskim dannym [A joint determination of the mass and the figure of the earth using astronomical-geodetical and gravimetric data]: Leningrad Univ. Vestnik, no. 1, ser. mat., mekh. i astron., no. 1, p. 111–118, 1959.

Using Molodenskiy's quasi-geoid theory of the figure of the earth (see Geophys. Abs. 134–10228), Gromov gives a solution for the major semiaxis a_o, eccentricity e_o, and oblateness α of the earth's spheroid of revolution E_o, which is closest geodetically to the quasi-geoid. Gromov simplifies Molodenskiy's formula for the differences of the distance ζ between the surfaces of the earth's general spheroid and of the quasi-geoid, and after determining the correction $\delta f m$ of the product of the gravitational constant and the approximate value of the earth's mass m from gravimetric and astronomical-geodetical data, arrives at a corrected value of ζ. This results in a system of two equations which gives the values of a_o, α_o, and e_o accurate to the sixth power of e.—*A. J. S.*

178–202. de Graaff-Hunter, [James]. Report of Study Group No. 8: Bull. géod., no. 50, p. 1–16, 1958.

A model earth, E, with smoothed topography of height H, is proposed as a basis for geodetic work. The corresponding gravity anomaly, Δg=Bouguer anomaly + AH, serves either the Stokes integral or the Integral Equation. Thus

$$\delta U = N_E^N = (a'/4\pi)\int \Delta g_E f \, d\omega = \tfrac{1}{2}a' \int \Delta \bar{g}_E f \sin\psi \, d\psi = \int (2R\Delta\bar{g}_E + 3\delta\overline{U}) d \sin\tfrac{1}{2}\psi,$$

upper bars indicating averages with respect to constant ψ. This scheme gives a complete scheme of reduction of observed gravity, entirely free from hypothesis, and fully answers the task allotted to Special Study Group No. 8 of the International Association Geodesy.

It is recommended that his model earth scheme be adopted, that world charts of H be produced, that the best procedure be studied in view of incomplete knowledge of the earth's gravity field, and that the free-air reduction be recognized as applicable to the reference system and as yielding the "ground level anomaly."

Details are given in an appendix on the reference system for the earth, integral equation between Δg and N, the earth model with smoothed topography, and several cases of practical application of doublets (see Geophys. Abs. 176–153).—*D. B. V.*

178–203. Bhattacharji, J. C. An earth model and the reduction of gravity observations for use in Stokes' integral: Royal Astron. Soc. Geophys. Jour., v. 2, no. 2, p. 136–139, 1959.

The application of de Graaff–Hunter's earth model in the reduction of gravity observations for use in the Stokes integral is discussed (see Geophys. Abs. 176–153 and 178–202). It is shown that there are practical difficulties in using the new surface anomaly $g-\gamma_B$ in the Stokes integral, which limit the promise of the new anomaly in the field of geodesy.—*D. B. V.*

178–204. Ledersteger, Karl. Gedanken zu einen hypothesenfreien Ableitung des mittleren Erdellipsoides und der Undulationen des Geoides [Opinions on a hypothesis-free derivation of the mean earth ellipsoid and of the undulations of the geoid]: Bull. géod., no. 50, p. 22–30, 1958.

A hypothesis-free solution of the problem of the figure of the earth is described. The two major parts of the task, determination of the physically unequivocally defined mean earth ellipsoid and determination of the actual geoid with respect to the earth ellipsoid, can be solved only alternately in successive approximations. The series of operations is outlined: choice of reference ellipsoid; calculation of gravity distribution on the free air geoid and its elevation above the true geoid; calculation of gravity disturbances, flattening of the pertinent niveau-spheroid, and departure of the niveau-spheroid from the ellipsoid of rotation; calculation, by means of Stokes' integral of elevations N of the free-air geoid above the niveau-spheroid; gravimetric determination of the flattening of the earth ellipsoid with the aid of gravimetric heights, giving the definitive undulations of the true geoid and exact gravity formula for the mean earth ellipsoid; projection of different continental networks on a reference ellipsoid from the axis of the International Ellipsoid and flattening of the earth ellipsoid, whereby the relative deflection of the vertical in the fundamental zero point can be fixed; comparison of absolute or astronomic-gravimetric deflections of the vertical to give the axes of the earth ellipsoid and the network that is true to nature. If the method is applied to the networks of two continents separated by the ocean, the absolute positions are obtained with a precision surpassing that of all other methods.

Essentially, the two parts of the problem can be reversed; the deviations of the geoid from the strictly physically defined ellipsoid must be known before the flattening of the earth ellipsoid can be calculated, and on the whole the undulations of the geoid with respect to the earth ellipsoid must be given before its axes can be ascertained.—*D. B. V.*

178–205. Arnold, Kurt. Vergleiche zwischen verschiedenen Definitionen des mittleren Erdellipsoids [Comparison between different definitions of the mean earth ellipsoid]: Gerlands Beitr. Geophysik, v. 68, no. 3, p. 129–136, 1959.

A comparison between the two usual definitions of the best-fitting earth-ellipsoid—the definition in the sense of Helmert that refers to the best approximation to the geoid and the definition concerning the normal spheroid—shows that both definitions are equivalent if the uncertainty of the observations is neglected.—*Author's English summary*

178–206. Stovas, M. V. Potentsial deformiruyushchikh sil i yego izmeneniye s izmeneniyem rotatsionnogo rezhima ellipsoida [The potential of deformation forces and its variation with variation in the rate of rotation of an ellipsoid]: Leningrad Univ. Vestnik, no. 1, ser. mat., mekh. i astron., no. 1, p. 119–129, 1959.

Effects of the total deformation Force F_2 acting on the surface of the earth's ellipsoid due to acceleration or deceleration of its axial rotation are discussed in this paper. Latitudes ±35° were found to be critical in the sense that F_2 at those latitudes is fully tangential to the surface of the earth and directed along meridians, the normal component F_n of the force F_2 being zero. The force F_2 was found to have three maximums, one at the equator and one at each pole. A variation of the earth's angular velocity results in a variation in the radial deformation force F_2 and consequently in variation in the dimensions of the ellipsoid. Numerical values of the deformation forces are tabulated in terms of varying angular velocity and latitudes (see Geophys. Abs. 178–52, –207).—*A. J. S.*

178–207. Stovas, M. V. Deformatsiya parametrov ellipsoida s izmeneniyam szhatiya [Deformation of the parameters of an ellipsoid of variable compression]: Leningrad Univ. Vestnik, no. 13, ser. mat., mekh. i astron., no. 2, p. 121–136, 1959.

Variations in the dimensions of an ellipsoid of revolution of constant volume, caused by variations in the velocity of its axial rotation, are given as a function of the oblateness of such a spheroid. The following elements are considered: latitude radius ρ, ordinate y, radius-vector r, radius of curvature of the first vertical N, mean radius of curvature R, radius of curvature of a meridional cross-section M, length of a meridional arc S, and the areas of the latitude zones $\triangle z$. Analyzing this problem mathematically, Stovas shows that there are seven critical parallels, or latitudes of maximum deformation: $\varphi=0$, ±20°, ±35°, ±48°, ±62°, ±65°, and ±90°; of these the 35° zone is most important (see Geophys. Abs. 178–52, –206).—*A. J. S.*

178–208. Lejay, [Pierre], and Coron, S[uzanne]. Deviation absolue de la verticale: Méthode et resultats à Paris, Nice et Guelt-es-Stel [Absolute deflection of the vertical: method and results at Paris, Nice, and Guelt-es-Stel]: Bull. géod., no. 50, p. 56–74, 1958.

Absolute deflection of the vertical has been calculated, using isostatic anomalies, for three points—the Paris observatory, the Mont Gros observatory near Nice (where the deflection is particularly marked because of the proximity of the Alps and Mediterranean deeps), and Guelt-es-Stel in North Africa. First the deflection of the vertical was calculated on the isostatic geoid, that is, on

a smoother earth on which isostatic compensations of topography were suppressed. Then the supplementary deflection introduced by restoring topographic masses and isostatic compensation was calculated.

The results are tabulated. At Paris the vertical is deflected slightly to the northeast, at the other stations to the southeast. At Mont Gros deflection is very strong, and is due more to the Alps than to the Mediterranean deeps. At Guelt-es-Stel the deflection is caused by the dissymmetry between the positive anomalies on the west and the broad negative anomalies covering the Chotts region, especially on the southeast.

The precision of the results is discussed. In an appendix a chart is presented for evaluating mean anomalies of distant regions; the importance of near anomalies, and the effect of major topographic and gravimetric features on deflection of the vertical at each station are discussed.—*D. B. V.*

178–209. Levallois, J[ean]-J[acques]. Sur une equation intégrale très générale de la gravimétrie [On a very general integral equation of gravimetry]: Bull. géod., no. 50, p. 36–49, 1958.

Definitions of geoid and of altitude are shown to go together, the definition of one depending on the calculation of the other. Altitude is defined by calculating the variable H such that $\int g dH = \gamma'_m \cdot H$, the value attained on the topographic surface. The perturbing potential ΔW is such that $N = \frac{\Delta W}{\gamma_o} - \frac{W_o - U_o}{\gamma_o}$. The general equation can be applied to the type of geoid characterized by the altitude chosen and is defined with respect to the gravimetric reference which is given. The integral equation takes external matter into account; it is true for every reference system having constant curvature; its use is relatively simple, involving successive approximations; it is absolutely independent of the sectoring chosen for the surface; and it will accommodate itself very well to abandonment of spherical zones centered on the potential point.—*D. B. V.*

178–210. Boaga, Giovanni. Confronti fra i vari tipi di livellazione geometrica di precisione ottenuti con i valore delle gravità osservate nei singoli caposaldi [Comparison between the different types of geometric precise levelling obtained with the gravity values observed at individual points]: Accad. Naz. Lincei Atti, Cl. Sci. fis. mat. e nat. Rend., v. 25, no. 5, p. 254–259, 1958.

The geopotential heights, calculated on the basis of observed gravity values, are compared with the dynamic and orthometric heights, based on theoretical gravity values, for 10 consecutive stations on the Italian national precise levelling network (Genoa-Tortona). Four tables give, respectively, the location of the stations; the gravity values observed at each, Faye and Bouguer reductions, mean gravity along the line of force P–P′ normal gravity calculated from the international formula, and Faye and Bouguer anomalies; differences in level (Δz_i) between successive stations, mean gravity ($g_{m/i}$), product of $g_{m/i} \cdot \Delta z_i$, and geopotential (C), dynamic (Q), and orthometric (H) heights; and finally, the differences $C-Q$, $C-H$, and $Q-H$. The difference between geopotential and dynamic and between geopotential and orthometric heights are more appreciable; the differences between dynamic and orthometric heights are less than 5 cm, with the dynamic always the larger.—*D. B. V.*

GEOTECTONICS

178–211. Birot, Pierre. Morphologie structurale [Structural morphology]: Paris, Presses Universitaires de France, v. 1, p. 1–168, and v. 2, p. 169–464, 1958.

The object of this work is the study of the relationship of topography to geologic structure. The first volume treats static structures, which express the present distribution of resistant and unresistant rock masses and describe the elementary structural forms. The second is concerned with structures in movement, or tectonics, which are responsible for the emplacement of the static structures.

The second volume is subtitled "Types of evolution of the relief; orogenic theories". Its three major subdivisions concern the Paleozoic and Precambrian basements and their cover (sedimentary basins of Hercynian time, the Hercynian and Caledonian massifs, and the old Precambrian shields); the Alpine domain (types of evolution of the relief of the outer and of the inner zones); and individualization of the orographic units of the first order, and the great orogenic theories.—*D. B. V.*

178–212. Khain, V. Ye. Nekotoryye osnovnyye voprosy sovremennoy geotektoniki [Some fundamental problems of modern geotectonics]: Akad. Nauk SSSR Izv. ser. geol., no. 12, p. 47–60, 1957.

Khain analyses and reevaluates the fundamental problems of the earth's tectonics, and discusses the current geotectonic theories in the light of modern geophysical data. The first section of the paper concerns the age and origin of the oceans and continents. The Pacific Ocean basin, Gondwanaland, and Laurasia are considered to be the oldest features of the earth's surface, dating at least from Precambrian times. The central Arctic, middle and South Atlantic, and eastern Indian Ocean basins have been present since the beginning of the Paleozoic era. Gondwanaland disintegrated and the Arctic and Atlantic Oceans expanded and deepened to their present state during the end of the Paleozoic an beginning of the Mesozoic eras. Expansion and deepening of the Pacific Ocean took place at the end of the Mesozoic and in the Neogene especially. These changes seem to follow the first- and second-order cycles of earth history (500–600 and 150–200 million years, respectively).

A new classification of second-order tectonic elements is proposed in the second section of the paper. According to Khain, the historic-genetic sequence of these elements is: stable oceanic zones, mobile geosynclinal zones, stable continental zones (platforms), and mobile geoanticlinal zones. In the third section Khain discusses the transformation of platforms into geosynclines and vice versa. In the fourth he analyzes the two orders of tectonic oscillations, the general undulations common to platforms and geosynclines and the local shorter period oscillations superimposed on the former.

The fifth section discusses the causes and mechanism of folding, using data from numerous boreholes and geophysical surveys. A strong interrelation is established between the folding of upper and deep strata. The sixth section discusses geofractures and geosutures. "Open" geofractures can be found on the ocean floors; one such fracture, described by Menard (see Geophys. Abs. 162–220), extends for a quarter of the earth's circumference. Some "open" geofractures reach the earth's surface in geosynclines and are manifested by intrusions, folding, and nappes which camouflage the rupture. "Blind" geofractures, covered by

sedimentary strata, are present in both geosynclines and platforms and are related to zones of high seismicity.

In the seventh section Khain proposes a new classification of tectonic movements; based on depth of genesis he subdivides them into: upper crustal movements, or folding in sedimentary strata; crustal movements involving the granitic-metamorphic and basalt layers that correspond to the wave movements of current classification; subcrustal movements, originating in the mantle, that are responsible for the formation of continents, oceans, mobile and stable zones, geofractures, and are accompanied by deep-focus earthquakes; and "submantle" movements, originating in the upper part of the core, that cause the general undulations, pulsations, and oscillations of the earth as a whole.

In the eighth and last section the causes of the earth's tectonic development are discussed. The sources of energy are gravitation, radiogenic heat, and energy of rotation, with isostasy as a regulator of geotectonic movements. Khain supports the contraction hypothesis, and believes that the tectonic development of the earth is due to the following forces, in order of importance: contraction, differentiation of material, radioactivity, rotation, and isostasy.—*A. J. S.*

178–213. Reitan, Paul H. An hypothesis accounting for a two-phase orogenic cycle: Jour. Geology, v. 67, no. 2, p. 129–134, 1959.

This paper presents a modification of the subcrustal thermal convection hypothesis of mountain building to allow for an orogenic cycle of two phases, first tensional and then compressional. Reitan assumes that the increase in density in the mantle between the depths of 100 and 400 km is due primarily to a gradual change in composition, such that the intrinsic density of the material increases with depth; that thermal convection in the mantle is possible; and that convection cells operate to a depth of about 350 km. When thermal convection begins, triggered by horizontal temperature variation in the mantle below the boundary of a continent, a gradual sinking with lateral flow away from the continent occurs and initiates a rising current below the continental boundary. Hot material brought from depth to the top of the mantle, although of greater density than the cold material brought down to the 400-km level, will be gravitationally stable at the top of the mantle as long as it remains hot. Tangential force exerted by the flowing of the underlying mantle puts the crust under strong tensile stress causing it to be thinned or necked-down plastically to form a geosyncline. The second phase of the orogenic cycle begins after the material at the bottom has gained heat from the deeper layers and the material at the top has lost heat, producing a new distribution of densities which are gravitationally unstable. At this point "rock-back" of the convection cell will occur, that is, flow will occur along essentially the same lines as before but with the direction reversed, producing strong tangential force on the crust which causes the geosyncline to be strongly compressed. When gravitational equilibrium is achieved in the crust, "rock-back" ceases and during the ensuing period of subcrustal quiet, the folded geosynclinical sediments rise to achieve isostatic equilibrium.—*V. S. N.*

178–214. Khain, V. Ye. O glybovo-volnovoy (skladchato-glybovoy) strukture zemnoy kory [On the block-wave (fold-block) structure of the earth's crust]: Moskov. Obshch. Ispytateley Prirody Byull., v. 63, Otdel. geol., v. 33, no. 4, p. 87–99, 1958

Believing the block and fold concepts of tectonic processes to be inconsistent when considered separately, Khain proposes a "block-and-fold" hypothesis, in which the earth's crust is broken into large blocks which participate in global

undulatory movements of the crust; mountain ridges are formed on the crests and geosynclines in the troughs of such undulations. In the process of shifting and bending, vertical movements take place along the boundaries of the blocks or form new faults in crustal strata. According to Khain, this concept can explain certain features in the structure and development of mountain systems and geosynclines.—*A. J. S.*

178–215. Egyed, László. Zsugorodás, tágulás vagy magmaáramlások? [Shrinking, expansion, or magmatic currents? (with English summary)]: Földrajzi Közlemények, v. 83, no. 1, p. 1–20, 1959.

A number of geological and geophysical phenomena are compared from the points of view of the shrinking earth, expanding earth, and convection current hypotheses. These include the secular decrease of angular velocity of the earth, the dip of the focal plane of earthquakes, the depth-frequency distribution of earthquakes, the relationship between deep-sea trenches and deep-focus earthquakes, the origin of the continental crust and ocean basins, continental drift and polar wandering, the formation of geosynclines and orogenesis, and the periodicity of geological phenomena and crustal movements.

It is concluded that expansion of the earth's radius at a rate of 0.4–0.8 mm per yr offers a clear and simple quantitative explanation of all these problems, whereas the other two theories are based partly on unwarranted auxiliary hypotheses, and cannot explain some of the problems at all.

The amount of expansion and the energies involved are so great that it is impossible to derive them from the usual thermal processes. A possible explanation is that the inner and outer core and the mantle represent three phases of an essentially homogenous silicic mass; the inner phases are unstable and continuously decompose towards the outer phase, involving a decrease in density and therefore an increase in volume. Another possibility is based on Dirac's conclusion that the gravitational coefficient varies inversely with time, which would result in a steady decrease in pressure within the earth. This would cause the pressure-dependent transition surface which is the core boundary, and also the inner core boundary, to shift towards the center, and this in turn would result in a decrease in density, or expansion, of the earth.—*D. B. V.*

178–216. Vening Meinesz, F. A. The geophysical history of a geosyncline, *in* Contributions in Geophysics (Gutenburg volume): Internat. Ser. Mon. Earth Sci., v. 1, p. 193–199, 1958.

This is a discussion of the series of phenomena associated with deformation of the earth's crust in zones of weakness (geosynclines) accounted for only by assuming episodically occurring periods of uniaxial horizontal compression in the earth's crust brought about by currents in the mantle. The theory is more fully developed in chapters 10 and 11 of the book by Heiskanen and Vening Meinesz, "The earth and its gravity field" (see Geophys. Abs. 175–191).—*V. S. N.*

178–217. Carey, S. Warren [Convener]. Continental drift. A symposium: Hobart, Univ. Tasmania Geology Dept., 375 p., 1958.

This symposium was held at the University of Tasmania in March 1956 with Professor Chester R. Longwell of Yale University as principal guest. The following papers are included in the book:

a. Longwell, Chester R. My estimate of the continental drift concept: p. 1–12. The various lines of evidence for continental drift are appraised critically.

b. King, Lester [C.]. A new reconstruction of Laurasia: p. 12–23. A new reconstruction of the protocontinent Laurasia has been made, using curved continental shapes on a globe. The pattern of Paleozoic mountain chains around the Arctic and North Atlantic Oceans becomes comprehensible if these ocean basins were nonexistent at the time the ranges were formed, that is, if Laurasia was a single landmass.

c. Irving, E. Rock magnetism: a new approach to the problems of polar wandering and continental drift: p. 24–61. Paleomagnetic data are strikingly consistent with certain aspects of the continental drift hypothesis. If the dipole "assumption" should ever be discarded, however, the basis of the argument is destroyed.

d. King, Lester [C.]. The origin and significance of the great suboceanic ridges: p. 62–102. The distribution and constitution of the suboceanic ridges are outlined, and the competency of each of six mechanisms proposed for their origin is reviewed. The six mechanisms are primitive crustal differentiation and convective concentration of light differentiates, vertical uplift, vertical subsidence of adjacent regions, lateral compression, effusion of volcanic material along fissures, and tension letting down strips of sial between separating continents or at the seaward edge of a drifting continent. The last is considered most plausible, and the bulk of the paper is devoted to a detailed analysis of the ridges in the light of continental drift.

e. Gill, Edmund D. Australian Lower Devonian paleobiology in relation to the concept of continental drift: p. 103–122. It is concluded that it is not possible on present paleobiological evidence to decide whether the present geographic distribution of Lower Devonian faunas is the result of migration or continental drift or both.

f. Brunnschweiler, Rudolf O. Indo-Pacific faunal relations during the Mesozoic: p. 128–133. Results of macropaleontologic and stratigraphic studies in the Australian Mesozoic are compatible with the hypothesis of continental drift.

g. Evans, J. W. Insect distribution and continental drift: p. 134–161. The distribution of insect faunas suggests that up to some time during the middle or late Mesozoic era, Tasmania, Australia, New Zealand, South America, and to some extent South Africa and Madagascar either were in direct contact with one another or were part of a large continental mass that included Antarctica.

h. Voisey, Alan H. Some comments on the hypothesis of continental drift: p. 162–171. Although continental drift does not now appear to be as unlikely from the geophysical viewpoint as was thought 20 years ago, the biological arguments favoring it have weakened and alternative hypotheses have gained strength. So many geologic facts are common to all continents, and the matching of geology from continent to continent admits of so much selection, that arguments based on such comparisons are rejected. It is too soon to evaluate the contribution made by paleomagnetic results. Studies in the Atlantic Ocean so far seem to indicate that the ocean floor is older (at least Lower Cretaceous) than has been claimed by supporters of the drift hypothesis. Much depends now on the study of the deposits of the Atlantic Ocean bottom.

i. Stirton, R. A. The relationships and origin of Australian monotremes and marsupials: p. 172–174. Stirton favors the conclusion that marsupials reached Australia after it had been separated from the mainland of Asia, some time in the Mesozoic.

j. Carey, S. Warren. The tectonic approach to continental drift: p. 177–355. By reversing all deformations and strains of post-Paleozoic age, the early Mesozoic paleogeography is reproduced. Carey introduces the idea of the orocline

as a major tectonic feature, and works out the geographic relationships in detail on a large-scale globe. The picture that finally emerges does not differ greatly from Wegener's Pangaea.

If the orocline hypothesis is valid, the history of the earth probably has been as follows: The earth began as a cold dust cloud and its temperature and volume have been steadily increasing. At an early stage the earth's crust was uniform, its diameter was less than half the present diameter, its surface area was less than a quarter of its present surface, its mean density was more than 8 times the present density, surface gravity was 4 times the present gravity, and the rate of rotation was correspondingly great. Changes deep in the interior, causing expansion, have taken place at an accelerating rate; only phase changes involving intra-atomic arrangement can explain the order of the volume changes required. An early (late Precambrian) crack widened into the Pacific Ocean, and the rest of the crust developed smaller dilatation zones which became internal orogens and basins. Widening of the equatorial sea—the Tethys—divided Pangaea equatorially. Subsidiary dilatation zones tended to spread from the north pole equatorward and clockwise, and from the south pole equatorward and counterclockwise. The Alpine stage began early in the Mesozoic differing from earlier stages only in its accelerated tempo; Pangaea opened along the Arctic, Atlantic, and Indian Oceans, and expansion also occurred in the Pacific.

k. Longwell, Chester R. Epilogue: p. 356–358. Brief statement summarizing the symposium.—*D. B. V.*

178–218. Pronicheva, M. V. O proyavleniyakh noveyskey tektoniki v Severnom Prikaspii [On the manifestation of recent tectonics in the North Caspian area]: Geologiya Nefti, no. 3, p. 34–40, 1957.

Geomorphology is useful to the oil geologists where the structural elements with which the oil is related have continued to develop and are reflected in the relief. This situation exists today in the area north of the Caspian Sea. Structural contours on the base of the Quaternary sediments reveal several active uplifts and downwarps; these are shown on a map. The Quaternary uplifts correspond in general to aeromagnetic maximums, and the downwarps to minimums. There is also a spatial relationship between gravity anomalies and the Quaternary structures. The coincidence of geophysical anomalies with the Quaternary structures indicates that the latter also reflect the structure of the pre-Quaternary sediments.—*J. W. C.*

GRAVITY

178–219. Heiskanen, W. A., and Uotila, U. A. Some recent studies on gravity formulas, *in* Contributions in Geophysics (Gutenberg volume): Internat. Ser. Mon. Earth Sci., v. 1, p. 200–209, 1958.

The gravity anomaly Δg, used in geophysical or geodetic studies, is the difference between the observed value g_o (reduced to sea level) and normal gravity γ, $\Delta g = g_o - \gamma$. The observed gravity value used now is based on absolute gravity measurements made in 1903–06 in Potsdam, Germany. The internationally used normal gravity value, derived from gravity observations throughout the world, was determined from a formula derived by Heiskanen in 1928. Since that time a large amount of additional gravity material has been collected around the world, including the oceans, and thus it has been necessary to derive new parameters for the gravity formula. Computations were made using mean

gravity anomalies of 1°×1° squares and also of 5°×5° squares. The study showed that the international formula needs only small corrections $d\gamma$ and $d\beta$, and a table showing these corrections for different longitude zones is given.

The large amount of additional gravity observations now available does not confirm the triaxiality of the earth; this is no longer a problem because the undulations of the geoid can be gravimetrically computed. Heiskanen and Uotila have computed the tentative geoid of the Northern Hemisphere and the undulations seem not to exceed ±80 m.—*V. S. N.*

178–220. Lukavchenko, P. I. Gravimetricheskaya razvedka na neft' i gaz [Gravimetric exploration for oil and gas]: Moscow, Gostoptekhizdat, 336 p., 1956.

The book is a manual of gravimetric exploration. It consists of five chapters on gravimeters in general, some particular types of gravimeters, the methods and techniques of gravimetric surveying, and interpretation of field data after their reductions and evaluations. Tables, nomograms, and graphs for correction and reduction of the field data are given in an appendix. Bibliography of 59 titles.—*A. J. S.*

178–221. Vajk, R[aoul], and van der Sleen, N. Standardization of gravity procedures: Geophysics, v. 24, no. 3, p. 479–484, 1959.

Standardization of gravity datum, gravity meter calibration, latitude correction, elevation datum, average density correction factor, map scale and grid, and gravity bench mark information between companies working in the same area prior to execution of the surveys is recommended to facilitate future trades of information. Governmental agencies, geodesists, and earth scientists will also benefit by such standardization.—*Authors' abstract*

178–222. Raspopov, O. M. O primenenii formuly Numerova dlya gravitatsionnoy razvedki [Application of Numerov's formula in gravity exploration]: Leningrad Univ. Uchenyye Zapiski, no. 249, p. 243–247, 1958.

After its transformation and reduction to a form convenient for the determination of local gravity anomalies, Numerov's formula is applied to the anomalistic vertical gradient $\Delta\theta$ of gravity field on a plane. The calculations were performed for the maximum point Δg directly over the center of a spherical disturbing body, using the formula $\Delta\theta = \Delta\theta_{l_0} + (\Delta g_0/l_0) - (1/2\pi)\int_0^{2\pi} d\alpha \int_{l_0}^{R} (\Delta g/l^2)\,dl$, where l_0 is the radius of the central zone, and R is the external radius of integration.—*A. J. S.*

178–223. Klushin, I. G., and Nikol'skiy, Yu. I. Razdeleniye gravitatsionnogo polya na regional'nuyu i lokal'nuyu sostavlyayushchiye pri pomoshchi schetno-reshayushchego ustroystva [Subdivision of the gravity field into regional and local components by means of computers]: Prikladnaya Geofizika, no. 22, p. 86–99, 1959.

A computer designed for solution of problems of gravity and magnetic prospecting is discussed; a picture and a schematic diagram of the instrument are presented. The Kyzyl-Kum area in central Asia is used as an example of practical application.—*J. W. C.*

178–224. Fajklewicz, Zbigniew. The use of cracovian computation in estimating the regional gravity: Geophysics, v. 24, no. 3, p. 465–478, 1959.

The method of least squares in cracovian form (a variant on matrices) and second order polynomials are used for estimating the regional gravity field. Expressions yielding the regional field are obtained very rapidly by using the inverse cracovians of the coefficients as given in the present paper. Electronic digital computers are not necessary. Using this method, the equivalent of the entire work done by such a computer in constructing the formula for the regional field takes no more than 20 minutes. Examples are given of the treatment of two gravity anomalies in Poland.

Electronic computers adapted to the use of cracovians may be used; they are far more versatile than the usual electronic computers, especially those used in typical geodetic work.—*D. B. V.*

178–225. Sandberg, C. H. Terrain corrections for an inclined plane in gravity computations: Geophysics, v. 23, no. 4, p. 701–711, 1958.

When making terrain corrections in gravity surveys, some geometric form readily amenable to mathematical computations is used as an approximation to the terrain. In many instances an inclined plane offers a better approximation to topographic features than does a series of cylindrical compartments. This is especially true for the area in the immediate vicinity of a station. Combinations of the terrain effect of inclined planes through various terrain zones, as represented on accompanying tables, can be used to approximate easily and quickly such familiar landforms as valleys, ridges, and hillsides.—*J. W. C.*

178–226. Lundberg, Hans T., and Ratcliffe, John H. Airborne gravity meter—Description and preliminary results: Mining Eng., v. 11, no. 8, p. 817–820, Tech. Paper 4815L, 1959.

This is a discussion of further developments in instrumentation and practical application of the airborne gravity meter (see Geophys. Abs. 169–153, 174–192, –193). General principles, theoretical considerations, details of instrumentation, results of field application, and future developments are discussed. The present instrument has a sensitivity, when all components of the gradiometer are functioning with perfect precision, capable of detecting a change of about 25 Eötvös units in the first vertical derivative of gravity. Data from the instrument are recorded by a standard automatic recording milliammeter. Only changes in vertical gradient of gravity are recorded, not true gravity values. It is possible, however, to indicate where the gravity gradient is positive and where it is negative.

The airborne gravity meter is still in its infancy. Lundberg and Ratcliffe hope, in the near future, to produce an instrument that will record the true value of gravity gradient thus permitting a more accurate contour pattern and a mathematical analysis of results.—*V. S. N.*

178–227. Worzel, J. Lamar. Continuous gravity measurements on a surface ship with the Graf Sea Gravimeter: Jour. Geophys. Research, v. 64, no. 9, p. 1299–1315, 1959.

Gravity measurements were made aboard the surface vessel U.S.S. *Compass Island* (EAG 153) with the Graf Sea Gravimeter mounted on a stabilized platform. Reported observations along a line of gravity measurements previously made in submarines showed discrepancies of the order of the navigational varia-

tions. Many additional measurements agree satisfactorily with nearby previous submarine measurements.

It was demonstrated that the swell is the principal limitation to the measurements on *Compass Island*. When the vertical heave becomes too large, the boom of the instrument strikes the walls of its case, making observations impossible. On a 5-week cruise to the Mediterranean during March and April, 1958, observations were made 50 percent of the time in the Atlantic and 90 percent of the time in the Mediterranean.

The problem of measuring the Eötvös correction is more severe on a surface ship than on a submarine because of the larger effects from winds and currents to which the surface ship is subjected. This problem and the problem of locating the observation lines are the most serious difficulties encountered in making gravity measurements at sea.

The value of continuous gravity observations is demonstrated by examples of anomalies observed over seamounts, across the Mid-Atlantic, over the Canary Basin, in the Tyrrhenian Sea, and through the Strait of Gibraltar. Continuous observations reduce the chance of computational errors, prevent overlooking unanticipated features, provide a more representative gravity anomaly for an area, and provide more definitive data for the curve fitting that is required for geological interpretation of anomalies.

The Graf Sea Gravimeter in conjunction with a stable platform initiates a new era in the measurement of gravity at sea. Areas which are too hazardous for submarine observations can now be readily investigated.—*Author's abstract*

178–228. Dolbear, D. W. N. Design considerations of a bore-hole gravimeter: Geophys. Prosp., v. 7, no. 2, p. 196–201, 1959.

The purpose, limitations (imposed by nature, environment, and industry), and effect of errors in the use of borehole gravimeters are discussed. It is shown that accuracy must be comparable to that of the best surface gravimeters. Borehole versions of some surface instruments are considered; none is found suitable without substantial modification. A successful borehole gravimeter is likely to be a completely new instrument.—*D. B. V.*

178–229. Inghilleri, G[uiseppe]. Time variations of the calibration of the Worden gravity meter: Geophys. Prosp., v. 7, no. 2, p. 141–145, 1959.

Precision calibration tests were carried out with a Worden gravimeter under environmental conditions as varied as possible. It was found that the secular relative variation was appreciable in the first year of life of the instrument, precisely 1.3×10^{-3} in 13 months, but was practically zero the second year; this is ascribed to the fact that at the beginning of operations the instrument had just arrived from the factory with its measuring body renewed. A temperature difference of 24°C between two series of determinations caused a variation of 0.0022 of the value of the calibration, therefore the variation is 1 percent for each 10°C of temperature variation.—*D. B. V.*

178–230. Saxov, S. Variation of the Worden gravimeter small dial scale factor with time [with discussion]: Geophys. Prosp., v. 7, no. 2, p. 146–157, 1959.

A series of repeat observations during a period of 5 years reveal a variation with time of the Worden gravimeter No. 142 small dial spring system. A possible change in the gravity difference concerned is ruled out. It is shown that the

small dial scale factor has diminished by about 0.25 percent within the last 2 years against about 0.5 percent 4 to 5 years ago. The ratio of *L.D.* to *S.D.* has been analysed and the results obtained show confirmation of the change in the small dial system and prove a consistency in the large dial system.—*Author's abstract*

178–231. Woollard, G[eorge] P[rior]. The relation of gravity to geology in Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 63–103, 1959.

An analysis of gravity anomaly variations in Kansas is presented in terms of known geologic features such as the thickness and nature of the sedimentary rocks, the configuration and composition of the crystalline basement rock complex, probable but as yet unknown lithologic variations within the basement complex as suggested by magnetic studies as well as gravity measurements, and probable variation in crustal thickness and composition. Because the basal portion of the stratigraphic column in Kansas consists chiefly of limestone whose density equals or exceeds that of the average crystalline basement rock material, the configuration of the basement rocks is for the most part effectively masked. Where there are apparent correlations with basement structure, as over the central Kansas uplift and part of the Nemaha anticline, the gravity effect must be attributed to probable mafic rocks at depth, most of which do not reach the surface of the crystalline rock floor. The mean density of the geologic column down to the —3,000 ft level (lowest sediments) shows a progressive decrease from about 2.67 g per cm^3 to 2.54 g per cm^3 from east to west across the state, and this decrease seems to correlate with the regional east-west gravity anomaly gradient of about 65 mgal, but the geologic effect actually computes to be only about 6 mgal. The isostatic effect, on the other hand, for the change in elevation of about 3,000 ft demands a regional gravity change of about 90 mgal. As the net observed change after correcting for the surface geology is only about 50 mgal, the change in crustal thickness seems to be considerably less than that implied by isostatic theory. This is substantiated by average negative isostatic anomalies of about 20 mgal over the eastern part of the state. Residual gravity anomalies as well as the magnetic anomally pattern suggest a crystalline basement mosaic embodying about 20 major and numerous minor areas of abnormality. Most of these are not known from more than 1,600 wells penetrating to basement, which suggest a much more nearly homogeneous basement although rocks ranging in composition from acidic to basic, as well as schists, gneisses, and quartzites, are present.—*Author's abstract*

178–232. Jopling, Don W., and Cashion, Kendall. Regional gravity of Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 121–133, 1959.

A Bouguer gravity anomaly map of the state is presented on a geologic structure base. Major anomalies and their related geologic structure are discussed. Three gravity profiles and their related geologic cross sections are also shown and discussed. From these relationships it is concluded that: the Otto-Dexter-Beaumont area, between the east flank of the Nemaha anticline and the Cherokee basin; the southern extension of the Forest City basin; the Salina basin; and the Hugoton embayment all warrant exploration for possible oil accumulations.—*A. J.*

178–233. Lyons, Paul L. The Greenleaf anomaly, a significant gravity feature, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 105–120, 1959.

A gravity maximum anomaly, which attains a relief of almost 140 mgal, Bouguer, traverses the Salina basin of Kansas, extending southward into Oklahoma and northeastward into the Lake Superior area. It represents an ancient tectogene arc about 1,100 miles long and is perhaps related to the Nemaha Uplift to the east. It is interpreted to represent unusually dense rocks at or near the surface of the Precambrian floor, extending the Lake Superior elements far to the south. Continued adjustment of this crustal element has contributed to basin development and structures in the overlying sediments. The anomaly implies that "iron ranges" similar to those of the Superior region may underlie areas flanking its trace in Iowa, Nebraska, Kansas, and Oklahoma.—*Author's abstract*

178–234. Greenwood, Robert, and Lynch, Vance M. Geology and gravimetry of the Mustang Hill laccolith, Uvalde County, Texas: Geol. Soc. America Bull., v. 70, no. 7, p. 807–826, 1959.

A detailed gravity survey of the Mustang Hill intrusion, 1 of about 90 small intrusions in Cretaceous sediments paralleling the Balcones fault zone in central Texas, justifies the name laccolith for this quasi-concordant mass. The highest point on the asymmetrical anomaly (2.2 mgal of Bougeur relief) is in the southwest portion of the exposed igneous rock. The anomaly drops off sharply to the southwest but has a relatively gentle gradient to the northeast. The general shape of the anomaly suggests that the high point is associated with an igneous feeder, and the gentle gradient to the northeast is probably associated with a tabular body tapering away from the feeder.—*D. B. V.*

Joesting, H[enry] R., and Byerly, P. Edward. Regional geophysical investigations of the Uravan Area, Colorado. See Geophys. Abs. 178–306.

Joesting, H[enry] R., and Plouff, Donald. Geophysical studies of the Upheaval Dome area, San Juan County, Utah. See Geophys. Abs. 178–307.

178–235. Thiel, E[dward], Ostenso, N. A., Bonini, W[illiam] E., and Woollard, G[eorge] P[rior]. Gravity measurements in Alaska: Arctic, v. 12, no. 2, p. 67–76, 1959.

This paper is an abstract of a longer mimeographed report published earlier (Thiel and others, 1958, Woods Hole Oceanog. Inst. Tech. Rept. Ref. 58–54) and giving the principal facts and station descriptions for 513 gravity stations established in Alaska since 1950. Approximately one-third of the stations are located at airports and the balance constitute traverses with a 5- to 10-mile station spacing following the highway system, the Alaska Railroad, and part of the Yukon River. Coverage was detailed enough in only two areas to permit construction of accurate regional anomaly maps: the Naval Petroleum Reserve No. 4 in northwestern Alaska, and southeastern Alaska which is characterized by a prominent decrease in anomaly from coast to interior suggesting a thickening of the crust or, in seismic terms, a downward dip in the Mohorovičić discontinuity. Other pronounced gravity features in Alaska are a great gravity low (—125 mgals) occupying Cook Inlet in contrast to other embayments which show positive or zero readings; positive Bouguer anomalies of nearly 200 mgals

over the Aleutian Chain; an average positive anomaly of 17 mgals on the Yukon-Kuskokwim delta; an anomaly of +7 mgals centering on Nenana in the interior. A graphic comparison of gravity, topography, and geology along two north-south sections is given and, where observations are complete, the mean value of the free air anomaly is given for 1°×1° rectangles.—*V. S. N.*

178–236. Innes, M. J. S. Gravity measurements in Canada, January 1, 1954 to December 31, 1956: Dominion Observatory Ottawa Pubs., v. 19, no. 1, 14 p., 1957 (Internat. Union Geodesy and Geophysics, Internat. Assoc. Geodesy Gen. Assembly, 11th, Toronto, 1957, Rept.).

This report discusses the absolute determination of gravity acceleration being carried out by the National Research Council in Ottawa by the free-fall method; the establishment of precise pendulum stations over the latitude range of North America to provide a uniform standard for calibration of gravimeters; the international gravity connections; the Canadian national gravity network; the application of gravity measurements to structural, isostatic, and geoidal studies; and improvements developed in pendulum apparatus, in the vibration gravimeter, in a calibration device for North American gravimeters, and in the airborne gradiometer.—*V. S. N.*

178–237. Thompson, L. G. D., and Garland, G. D. Gravity measurements in Quebec (south of latitude 52° N.): Dominion Observatory Ottawa Pubs., v. 19, no. 4, 167 p., 1957.

This report presents results for more than 1,700 gravity meter observations made from 1945 to 1954 in the province of Quebec south of lat. 52° N. and west of long. 62° W., and includes an interpretation of Bouguer anomalies in the area. Observations from the airborne survey in 1951 cover the greater part of the area under consideration. The general anomaly pattern is discussed and an interpretation is presented. No gravitational features were found along the northern boundary of the Grenville subprovince that could be related to the presence of the presumed Huron-Mistassini thrust fault. Large anorthosite bodies, less dense than the surrounding granitic rocks, are characterized by negative gravity anomalies. Positive anomalies in the Eastern Townships and Gaspé are believed to be associated with a belt of ultrabasic rock at moderate depth that crops out in the Richmond-Thetford and Gaspé districts.—*V. S. N.*

178–238. Thompson, L. G. D., and Miller, A. H. Gravity measurements in southern Ontario: Dominion Observatory Ottawa Pubs., v. 19, no. 9, 378 p., 1958.

The results of over 1,000 gravity observations made in southern Ontario up to 1952 have been adjusted to a common datum and are presented in the form of tables of principal facts and two Bouguer anomaly maps. A general analysis of the anomaly pattern is given which leads to the conclusion that the overlying Paleozoic rocks have little effect on the regional gravity pattern and it is believed that the major anomaly trends are caused by belts of different densities in the Precambrian basement.—*Authors' abstract*

178–239. Garland, G. D., and Tanner, J. G. Investigations of gravity and isostasy in the southern Canadian Cordillera: Dominion Observatory Ottawa Pubs., v. 19, no. 5, 222 p., 1957.

A regional gravity investigation of southern British Columbia and southwestern Alberta is described. The values of gravity are obtained from a network of closed circuits, subjected to a least squares solution, while instrumental calibration is made with reference to stations established with the Cambridge pendulums. Maps of Bouguer and isostatic anomalies for the region are presented, and the compensation of the mountain systems is discussed. An Airy form of compensation appears reasonable, although certain features such as granitic batholiths show considerable isostatic anomalies. Detailed measurements over the Rocky Mountain Trench indicate a considerable thickness of lighter fill in some sections, but do not strongly suggest a major crustal dislocation beneath it.—*Authors' abstract*

178–240. Harrison, J[ohn] C., and Brisbin, W. C. Gravity anomalies off the west coast of North America. I: Seamount Jasper: Geol. Soc. America Bull., v. 70, no. 7, p. 929–934, 1959.

Various possible interpretations are considered for the gravity anomaly associated with Seamount Jasper, an approximately conical peak rising 1,900 fathoms from an irregular bottom of about 2,200 fathoms average depth, about 320 nautical miles southwest of San Diego, California. For any geologically plausible value for density of the seamount, it is possible to find a mass beneath the seamount to explain the Bouguer anomaly field. For a density of 2.3 g per cm^3 (a value in good agreement with Woollard's value for the island block beneath Oahu) there is no need to assume any anomalous mass beneath the seamount.

The free-air and isostatic anomalies at the stations around the seamount are uniformly negative, with a mean value of −20 mgal relative to the International Gravity Formula. The problem of these negative anomalies is not an isolated one, but has been encountered in the Atlantic and elsewhere in the Pacific Ocean. The idea that regional variations in bathymetry and gravity field are possibly associated with the formation of magma is an interesting one for further consideration when more gravity and seismic data become available.—*D. B. V.*

178–241. Lomnitz, Cinna. Investigaciones gravimétricas en la región de Chillán [Gravimetric investigations in the Chillán region]: Chile Inst. Inv. Geol. Bol. no. 4, 19 p., 1959.

The Bouguer map drawn on the basis of a gravity survey of the Chillán region in the Central Valley of Chile indicates a nearly vertical fault parallel to the eastern edge of the Coast Range; the gravity difference across the fault is of the order of 40–60 mgal. The vertical displacement is calculated to be about 2,000 m. Complete data are tabulated for 120 stations along cross sections between lat 36° and 37° S. As a result of this survey the coal, petroleum, and gas possibilities of the area are considered to be more promising than hitherto believed.—*D. B. V.*

178–242. Coron, Suzanne. Grandes variations de pesanteur dans la région des Alpes occidentales [Large variations of gravity in the region of the western Alps]: Acad. Sci. [Paris] Comptes Rendus, v. 248, no. 22, p. 3193–3195, 1959.

The gravity survey of the Alps has been completed; observed values of the recently completed part were referred to the Chambery station, part of the national gravity net of France. Bouguer anomalies have been calculated with a precision about 1 mgal. The gravity map shows an incontestable mass deficit under the Alps (−150 mgal) which in first approximation is independent of local relief; topographic corrections do not eliminate these anomalies. The deficit is situated at no great depth. In France the Bouguer anomalies are a function of mean altitude of the area surrounding each observation point. Isostatic anomalies (Airy, T=30 km) are close to zero except for a positive strip along the margin of the Po plain.—*D. B. V.*

Nevolin, N. V., Galaktionov, A. B., and Serova, A. D. Geology of the Aktyubin area adjacent to the Urals. See Geophys. Abs. 178–313.

178–243. Vasil'yev, V. G., Gushkovich, S. N., and Lishnevskiy, E. N. K voprosu interpretatsii gravimagnitnykh materialov na yuge vostochno-Sibirskoy platformy [On the problem of interpretation of gravity and magnetic data in the south of the East Siberian platform], *in* Geologiya i Neftegazonosnost' Vostochnoy Sibiri: Moscow, Gostoptekhizdat, p. 475–487, 1959.

Gravity and magnetic data are used largely to distinguish structures of the the first and second order and to a lesser extent for structures of smaller scale. In order to evaluate these methods for use in locating local structures, observations were made in the southern part of the East Siberian platform along profiles across known structures. Gravity surveying was not successful here in locating local structures. Magnetic surveying was more successful where rocks of basaltic composition occur. Ground magnetic observations in areas of basalts are recommended to supplement the aeromagnetic survey, which has covered almost all the East Siberian platform.—*J. W. C.*

178–244. Kononov, A. I. Novyye dannyye po tektonike yugovostochnoy chasti Sibirskoy Platformy [New data on the structure of the southeast part of the Siberian platform], *in* Geologiya i Neftegazonosnost' Vostochnoy Sibiri: Moscow, Gostoptekhizdat, p. 356–433, 1959.

The southeast part of the Russian platform has been the object of recent intensive geological and geophysical operations designed to locate oil deposits. This is the Irkutsk region that lies northwest of Lake Baikal. The gravity field of the interior of the Irkutsk amphitheater is negative on the whole. On this general negative background are disposed individual zones of maximum and minimum; these are shown on a map. The magnetic maximums and minimums correspond respectively to the gravity maximums and minimums.

The attempt has been made to determine depth to the disturbing masses, which are taken to be the Archean rocks of the basement. This depth is about 4.4 km in the Pri-Sayan depression, 3 km in the Nukutsk depression, and 3.8 km in the Pri-Baikal-Lensk area.

The stratigraphy and structure of the region is described in detail and several structure maps and profiles are included. Salt tectonics have played an important role here.—*J. W. C.*

Nevolin, N. V. Geologic significance of gravitational and magnetic anomalies of the central and eastern regions of the Russian platform. See Geophys. Abs. 178–314.

178–245. Tatevosyan, L. K. Ispol'zovaniye detal'noy gravimetricheskoy s" yemki pri izuchenii glubinnogo stroyenniya zemnoy kory v Armenii [Use of a detailed gravimetric survey in the study of the deep structure of the earth's crust in Armenia]: Akad. Nauk Armyan. SSR Doklady, v. 26, no. 4, p. 229–234, 1958.

A quantitative geological interpretation of gravity anomalies along a deep profile from the city of Yerevan to Lake Sevan in the Leninakan depression in the Armenian S.S.R. is given, and the zones of high horizontal gradients of gravity in the area studied are indicated. On the basis of these data, the mean densities of the main formations and their boundaries in the crust of the earth are estimated for the area.—*A. J. S.*

Oganisyan, S. S. Correlation between gravity anomalies and seismicity. See Geophys. Abs. 178–54.

178–246. Iida, Kumizi, and Aoki, Harumi. Gravity anomalies and the corresponding subterranean mass distribution, with special reference to the Nobi plain and its vicinity, Japan: Nagoya Univ. Jour. Earth Sci., v. 6, no. 2, p. 113–142, 1958.

A theoretical formula for calculating subterranean mass distribution from the gravity values at the earth's surface is presented. The formula is approximately expressed by a linear combination of gravity value and its first and second vertical derivatives at the earth's surface. The evaluation of the vertical derivatives involved was examined by a characteristic equation connected with wave length, with special reference to the formulas given by Elkins, Henderson and Zietz, and Kato.

This method of calculation was applied to the gravity values determined for 539 points in the Nobi plain and its vicinity in south-central Honshu, Japan. The Bouguer anomaly distribution and the calculated subterranean mass distribution were obtained for an average depth of 1 km beneath the surface of the earth. The main structures for both the Nobi plain and Mikawa plain are interpreted.—*V. S. N.*

178–247. Lazarev, G. Ye., and Ushakov, S. A. Opyt opredeleniya moshchnosti l'da v Antarktide po gravimetricheskim dannym [Attempt at determination of ice thickness in the Antarctic according to gravimetric data]: Akad. Nauk SSSR Doklady, v. 126, no. 2, p. 299–302, 1959.

Because the density contrast between ice (0.9 ± 0.02 for a thickness of 600–700 *m*) and rock (2.8 ± 0.05) is sufficiently great, an attempt was made by the Soviet Antarctic Expedition to determine the thickness of the ice cap by gravimetric means. Results are presented in a graph which shows the surface of the ice sheet, and the bedrock surface according to gravimetric (reduced to sea level, and with Bouguer anomalies reduced to 5 km altitude) and according to seismic data.

It is concluded that gravity surveys should be used systematically in conjunction with seismic surveys for ice thickness measurements; not only does this increase the accuracy of the results but it also gives information on the constitution of the crust under the ice.—*D. B. V.*

HEAT AND HEAT FLOW

178–248. Baranov, V[ladimir] I., and Serdyukova, A. S. Radiogennoye teplo [Radiogenic heat] : Priroda, no. 3, p. 29–34, 1959.

The historical evolution of ideas on terrestrial heat is outlined. This is followed by a discussion of geothermal gradient and escape of heat by conduction; data are cited for several places on land and in the oceans of the world. Heat flow associated with volcanic eruptions and with earthquakes is also discussed. Energy derived from the sun and generated by gravity is considered and discounted. The heat generated by the natural radioactive isotopes and by the principal rock types and meteorites is presented in tables. Calculations for the earth as a whole show that with normal heat conductivity of rocks it is difficult to expect an accumulation of heat that would produce a molten layer at relatively shallow depth. Local accumulation of a considerable quantity of heat is possible, however. No connection between volcanism and radioactivity has been established; the products of volcanism are similar to ordinary rocks with respect to content of radioactive element, and volcanic gases do not contain an increased amount of helium. This indicates that lavas do not form at the expense of anomalously high radioactivity of volcanic rocks. Thermal anomalies in zones of radioactive ore deposits show, however, that weakly expressed local thermal anomalies are possible.—*J. W. C.*

178–249. Lyubimova, Ye. A. Termicheskaya istoriya i temperatura Zemli [Thermal history and temperature of the earth] : Moskov. Obshch. Ispytateley Prirody Byull., v. 63, Otdel. geol., v. 33, no. 4, p. 39–49, 1958.

The paper reflects the changing trend in the concept of the temperature distribution in the interior of the earth, and discusses the earth's thermal history. Calculations based on the electrical conductivity of the upper mantle to 1,000–1,200 km depths (by Coster, Rikitake, Hughes, Magnitskiy, and Zharkov) give temperatures of 2,000°K at 600 to 900 km and more than 3,000°K at 1,000 km (see Geophys. Abs. 133–10079, 161–195, 163–66, 172–128, 173–246). Lyubimova considers that radioactive elements, especially radioactive potassium, are present throughout the globe and are the main contributors to the earth's thermal balance. Lyubimova believes that the temperature increases in the interior of the earth whereas the upper 50–100 km are cooling by radiation of heat into space. Subsequently the expanding earth ruptures its crust, and presses molten magma through the fissure so formed. Lyubimova considers that the C layer, of higher seismic velocities and increased electrical conductivity, is the result of transition from an ionic to an electronic state.—*A. J. S.*

178–250. Zharkov, V. N. Temperatura plavkeniya obolochki zemli i zheleza pri vysokikh davleniyakh [The melting temperature of the earth's mantle and of iron under high pressure) : Akad. Nauk SSSR Izv. ser. geofiz., no. 3, p. 465–470, 1959.

Uffen's attempt to evaluate the temperature of the terrestrial mantle, using Lindemann's formula, was a gross approximation because Lindemann's formula gives values that are in good agreement only with the experimental data for monoatomic solids, whereas the mantle consists of silicates with very complex crystalline structure. In the present paper, Zharkov attempts to find more ac-

curate formulas for the unknown temperature; he uses theoretical studies of numerous physicists based on studies by Einstein and Debye. Some of Zharkov's results are in agreement with the data obtained theoretically by others.—*S. T. V.*

Subcommittee on Nuclear Geophysics. Cosmological and geological implications of isotope ratio variations. See Geophys. Abs. 178–269.

178–251. Benseman, R. F. Estimating the total heat output of natural thermal regions: Jour. Geophys. Research, v. 64, no. 8, p. 1057–1062, 1959.

The natural flow of heat from a thermal region is a first indication of the amount of steam that might be continually drawn from bores to generate electric power. It can be assessed readily provided a limited degree of accuracy is acceptable. All avenues of heat loss—steaming ground, geysers, springs, fumaroles, and underground seepage of hot water to nearby streams or lakes—can be measured by methods that require neither elaborate equipment nor extensive sets of observations. The sequence of measurements should be adapted to suit the circumstances, but an overall knowledge of the area comes first and helps to show where shortcuts can be adopted. Tedious measurements on small sources of heat should be avoided.—*D. B. V.*

178–252. Benseman, R. F. Subsurface discharge from thermal springs: Jour. Geophys. Research, v. 64, no. 8, p. 1063–1065, 1959.

Individual hot springs in thermal regions have only a fractional discharge at the surface because a large proportion of the water leaves by underground paths. A new and more realistic concept of the activity of a spring is the "turnover rate" (R), which allows the water throughput to be defined without reference to the surface discharge. A method for determining R is described.—*Author's abstract*

178–253. Donaldson, I. G. Temperature errors introduced by temperature-measuring probes: British Jour. Appl. Physics, v. 10, no. 6, p. 252–255, 1959.

Calculations are made of the thermal disturbance produced in hot ground by the presence of probes that are thermally conducting. It is found that temperatures measured with metal probes with a length per radius ratio of up to 100:1 may be considerably in error. Wooden probes are, however, quite satisfactory. For measurements of high accuracy, thermocouple wires alone, i.e. not enclosed in any supporting probe, are quite satisfactory although copper wires should be replaced by manganin if possible. The work has a bearing on surveys being made of the heat flow from thermal regions in New Zealand.—*Author's abstract*

178–254. Salaruddin, M. A portable instrument for determining soil temperatures at various depths: Indian Jour. Meteorology and Geophysics, v. 10, no. 2, p. 199–202, 1959.

A portable instrument using thermocouples for measuring soil temperatures has been designed and constructed. The instrument as constructed can record temperatures at depths of 5, 10, 15, and 30 cm and also at depths of 10, 15, 20, and 35 or 15, 20, 25, and 40 cm by inserting it into the soil to different points. The instrument can be installed by simply driving it into the soil without materially disturbing the soil packing or the vegetation cover and reliable readings can be obtained within a short time of its insertion unlike in the case of ordinary soil thermometers.—*Author's abstract*

178–255. Pearce, D. C., and Gold, L. W. Observations of ground temperature and heat flow at Ottawa, Canada: Jour. Geophys. Research, v. 64, no. 9, p. 1293–1298, 1959.

Observations were made at a site in Ottawa, Canada, on the thermal regime of the ground and the heat flow 10 cm below the ground surface. Close agreement was found between the thermal diffusivities calculated from the depth dependence of the temperature amplitude and the depth dependence of the phase angle. It was also found that the annual component of the rate of heat flow was out of phase with the annual component of the ground temperature by 45.8°. These observations showed that for the Ottawa site the annual wave of ground temperature and the annual component of the rate of heat flow are consistent with the simple theory of periodic heat flow in a one-dimensional, semi-infinite, homogeneous medium. In accordance with this theory, thermal constants for the soil at the test site were calculated from the observations.—*Authors' abstract*

178–256. Haites, T. Binnert. Banff thermal springs, a fascinating problem: Alberta Soc. Petroleum Geologists Jour., v. 7, no. 2, p. 23–32, 1959.

Sundance Creek is thought to be the source for the water discharged by the thermal springs at Banff. The water could descend from Sundance Creek along the Bourgeau fault to its intersection, at 21,000 ft below the surface, with the Sulphur Mountain fault; it then could rise along the latter fault to reappear on the surface as hot springs in the Spray River valley. Assuming the Rocky Mountain temperature gradient to be 1°F per 100 ft in depth, the water could attain a temperature of 210°F at the point of intersection of the two faults. Admixture of cold water during the ascent to the surface would reduce the temperature of the water and also explain the temperature variation of the various springs. Upper Hot Spring has the highest temperature, normally 115°F.—*V. S. N.*

178–257. Benthaus, Fritz. Die Gebirgstemperatur im Grubenfeld der Gewerkschaft Auguste Victoria, Marl [The rock temperature in the mine workings of the Auguste Victoria Mining Company, Marl]: Glückauf, v. 95, no. 14, p. 875–879, 1959.

Natural rock temperatures have been measured in the Auguste-Victoria coal mine in the Marl-Huls region, northwest of Recklinghausen, Germany; the results are presented in a series of geoisothermal maps and profiles. The highest temperature, almost 53°C, was observed at 1,120 m depth in the core of the Auguste-Victoria saddle. Toward the troughs the temperature decreases; toward the Lippe trough, for instance, it drops 10°C in 2.5 km. Future development of the 1,125 m level will be guided by the maps obtained; the feasibility of mining the inner core of the saddle, with temperatures of more than 50°C. is seriously questioned.—*D. B. V.*

178–258. Nakamura, Hisayoshi. Geothermal conditions in the Onikobe basin, Miyagi Prefecture, Japan: Japanese Assoc. Mineralogists, Petrologists, Econ. Geologists Jour., v. 43, no. 3, p. 158–166, 1959.

Geothermal features in the Onikobe basin are distributed in two areas: the fumarolic area confined to a volcanic crater and the hot spring area which lies outside but encloses the fumarolic area. Test drilling in the basin shows that the fumaroles and the hot springs have their source in a natural steam reservoir

in a fractured zone of basement rocks overlain by impermeable agglomerate and tuff. In the hot springs area along the Fukiage and Miya Rivers, the natural steam flows through a permeable zone where it heats ground water which in turn ascends through fractures as hot springs and in some cases geysers. It is possible that this natural steam reservoir can be developed for industrial purposes; in any case the studies conducted in this basin should be a valuable guide in the exploitation of other geothermal areas in Japan.—*V. S. N.*

178–259. Cooper, L. R., and Jones, C. The determination of virgin strata temperatures from observations in deep survey boreholes: Royal Astron. Soc. Geophys. Jour., v. 2, no. 2, p. 116–131, 1959.

When a survey borehole is drilled downwards from the surface of the earth the temperature is disturbed by the circulating drilling fluid, but fluid and adjacent strata gradually attain the local virgin strata temperature when drilling is stopped. Temperature equilibrium is approached most quickly near the bottom of the hole where the time of disturbance has been the least. Observations of the fluid temperature at this position may be made over a period of a day during a normal weekend break in drilling. Cylindrical heat flow theory is used in this paper to show that, with a knowledge of the thermal properties of the fluid and surrounding strata, the virgin strata temperature at the depth reached can be calculated from such observations. New and inexpensive equipment using a thermistor temperature measuring probe has been developed for making the observations of temperature, and it has been tested successfully down to depths of 1,060 m (3,480 ft) in Hopton Pool Borehole in the Cannock Chase area. The paper also describes the equipment and gives the virgin strata temperatures for the Hopton Pool Borehole. It also gives observations of the temperature of the borehole fluid at various depths taken on one day several days after the borehole drilling had ceased and shows that these could not be regarded as reliable measures of the virgin strata temperature.—*Authors' summary*

INTERNAL CONSTITUTION OF THE EARTH

178–260. Kapustinskiy, A. F. O vnutrennem stroenii zemnogo shara [On the internal constitution of the earth]: Moskov. Obshch. Ispytateley Prirody Byull., v. 63, Otdel. geol., v. 33, no. 4, p. 51–56, 1958.

This paper is essentially a short version of Kapustinskiy's papers published previously in Geokhimiya, no. 1, p. 51–61, 1956 (see Geophys. Abs. 175–235), and Akad. Nauk SSSR, Voprosy geokhimmi i mineralogii, p. 37–71, 1956 (see Geophys. Abs. 176–221).—*A. J. S.*

178–261. Lovering, J. F. Frequency of meteorite falls throughout the ages: Nature, v. 183, no. 4676, p. 1664-1665, 1959.

Examples are given of meteorite falls as far back as Eocene time. Recent determinations of cosmic-ray ages show that meteorites have probably been available to fall on the earth since at least early Paleozoic times. Most meteorites, however, are unstable on the earth's strongly oxidizing surface; it would be most unlikely therefore that they would be preserved in recognizable form in sediments older than Tertiary. As cosmic spherules are already largely fused and oxidized, they might perhaps be preserved in sediments considerably older than Tertiary.—*D. B. V.*

178–262. Kosminskaya, I. P. Stroyeniye zemnoy kory po seysmicheskim dannym [Structure of the earth's crust by seismic data]: Moskov. Obshch. Ispytateley Prirody Byull., v. 63, Otdel geol., v. 33, no. 4, p. 25–38, 1958.

Seismologic evidence on the structure of the earth's crust under continents and oceans is reviewed. The results of deep seismic sounding in six regions of the U.S.S.R. (northern Tien Shan, western Turkmen S.S.R., the Pamir-Altay zone, Caspian Sea, Volga-Ural region, and Far East) are given in greater detail. A correlation of data from deep seismic sounding and from earthquakes with gravimetric data confirms the generally accepted division of the crust into continental and oceanic masses, and suggests relationships between structures of the deep crust and of the upper crust, depending on the geological history of the regions. A thickening of the crust under mountains (mountain roots) is confirmed. A great diversity was found in the contemporaneous fold systems. A comparison of profiles through platform regions, mountain ranges, and large contemporary depressions shows a regularity in the transition of one type of structure into another. (See also Geophys. Abs. 175–251.)—*A. J. S.*

178–263. Magnitskiy, V. A. O volnovodakh v zemnoy kore i podkorovom sloye [On wave guides in the earth's crust and the subcrustal layer]: Moskov. Obshch. Ispytateley Prirody Byull., v. 63, Otdel. geol., v. 33, no. 4, p. 15–23, 1958.

To explain the difference in seismic wave velocities obtained by measuring the macroseisms from earthquakes and from artificial explosions in the same region, it is assumed that the seismic wave velocities are reduced during their passage through a layer in the basaltic upper mantle (80 km deep), and another in the lower part of granitic layer. It has been surmised that the low velocity layer in the mantle consists of melted rock, and that isostatic compensation takes place in this layer. Every such layer of reduced seismic velocity represents a guide for seismic waves.

To explain the fact that there are several seismic wave guides in the crust and the subcrust, which requires an alternation of solid and liquid layers, Magnitskiy finds that at depths of 5–10 km the pores in the rock close under increasing confining pressure and increasing temperature; it is possible that dv/dh becomes zero at the depth h=8 km. The liquid outer layer of the mantle has been explained by assuming a temperature gradient of 7° –10° C in a dunite upper mantle, in which case dv/dh of the outer layer can become zero. However, such a steep thermal gradient differs by an order of magnitude from the gradient derived on the basis of electric conductivities at h of 100–400 km. Magnitskiy suggests a peridotite composition for the subcrustal layer and, on the assumption of a transformation of orthorhombic enstatite into protoenstatite, arrives at a lower ratio of bulk modulus to density, which in turn results in 2–3 percent lower seismic velocities for this layer.—*A. J. S.*

178–264. Savarenskiy, Ye. F., and Sikharulidze, D. I. Opredeleniye moshchnosti zemnoy kory po nablyudayemoy dispersii voln Lyava [The determination of the thickness of the crust from the observed dispersion of Love waves]: Akad. Nauk SSSR Izv. ser. geofiz., no. 6, p. 880–883, 1959.

Savarenskiy analyzes the dispersion of Love waves propagating from the epicenters of several earthquakes that occurred in east Africa, central Asia,

China, Japan, and the Pacific area. Seismograms of the Tbilisi seismic station were used, together with records of numerous other Russian and West European stations. Crustal thickness is greatest (55 ± 5 km) in the direction toward the Himalayas, Tibet, Pamir and China. In a second trace, representing earthquakes at epicentral distances between 39° and 52°, the thickness is 45 ± 5 km, and in the third, toward east Africa, it is 35 ± 5 km. In some directions the structure of the crust has been investigated by means of observations of near earthquakes and artificial explosions. The results are in satisfactory agreement with those obtained from near earthquake and explosion data, where available.—*S. T. V.*

178–265. Demetrescu, G[heorghe]. Despre determinarea grosimilor straturilor scoarţei terestre [On determination of thicknesses of the earth's crustal strata]: Acad. Romîne Studii şi cercetări de astronomie şi seismologie, no. 1, p. 123–128, 1958.

This is essentially the same paper as that published in Československá Akad. Věd Studia Geophys. et Geod., v. 2, no. 3, p. 293–295, 1958 (See Geophys. Abs. 175–249).—*A. J. S.*

178–266. Enescu, D[umitru], and Radu, C. Structura scoarţei terestre in regiunea Bucureşti [Structure of the earth's crust in the region of Bucharest]: Acad. Romîne Studii şi cercetări de astronomie şi seismologie, no. 1, p. 129–132, 1958.

Thicknesses of 4.5 km, 30.5 km, and 28 km for the surface, granitic, and basaltic layers of the crust, respectively, are calculated from the data of the earthquake of July 10, 1943, in the Vrancha mountain region, Rumania, as recorded at the Bucharest seismic station (see Geophys. Abs. 175–249).—*A. J. S.*

178–267. Yevseyev, S. V. Despre hodograful seismic si structura scoartei terestre din regiunea Carpaţilor pe raza materialelor furnirate de două cutremure [On the seismic traveltime curve and structure of the earth's crust in the Carpathian region based on the data of two earthquakes]: Acad. Romîne Analele Romîno-Sovetice, ser. geol.-geog., v. 1(38), p. 87–94, 1958.

Essentially the same paper as that published in the Akademīya Nauk Ukrayin. RSR Heol. Zhur., v. 18, no. 1, p. 68–74, 1958 (see Geophys. Abs. 173–251).—*A. J. S.*

Hisamoto, S. On the shallow earthquakes in western Japan. See Geophys. Abs. 178–48.

178–268. Eiby, G. A. The structure of New Zealand from seismic evidence: Geol. Rundschau, v. 47, no. 2, p. 647–662, 1958.

The New Zealand region is characterised by a crust 20–25 km in thickness, and a subcrust extending to at least 370 km. These are separated by a transition layer extending from the base of the crust to a depth of about 100 km. The crust is divided into blocks by steeply dipping faults. Some blocks are seismically active and others stable. The region is bounded by the Pacific Basin to the east, and the Tasman Basin to the west. Both of these areas have oceanic crusts about 5 km thick. The subcrust is traversed by a major wedge-shaped structure within which the deep focus seismicity is confined. This has

been named the "Sub-Crustal Rift," and its activity is apparently an extension of that associated with the Kermadec Trench. It follows a roughly southwest course from the Bay of Plenty to Farewell Spit, when it turns abruptly south-southeast, and finishes close to the Alpine Fault. Faults with both northeast and northwest trends are at present active. The most important of the northwest faults appears to run through Cook Strait. It is considered that the main crustal faults could have developed as the result of successive positioning above the Sub-Crustal Rift. Stable blocks have not been fractured in this way. There is some evidence for a difference in crustal structure on opposite sides of the Rift. The western portion is about 5 km thicker, and contains a layer in which the *P*-velocities exceed 7 kmps. No velocities above 6½ kmps have been observed in the eastern part. There is no evidence of arcuate structure. All the crustal and subcrustal features appear to follow linear trends.—*Author's summary*

ISOTOPE GEOLOGY

178–269. Subcommittee on Nuclear Geophysics. Cosmological and geological implications of isotope ratio variations: [U.S.] Natl. Acad. Sci.–Natl. Research Council Pub. 572, Nuclear Sci. Ser. Rept. no. 23, 187 p., 1958.

This report embodies the proceedings of the third informal conference on nuclear processes in geological settings, held at the Massachusetts Institute of Technology, June 13–15, 1957. The discussion at the five sessions is given verbatim. The first session, on meteorites, covered four topics: time dependence of universal "constants," uranium content of iron and stony meteorites, natural thermoluminescence of silicate meteorites, and cosmic ray effects on meteorites. The second session was devoted to the significance of variations in isotopic composition of lead from terrestrial samples, including a report on anomalous leads.

The third session concerned heat balances of the earth. The fourth discussed isotope abundances in oceanographic studies, including a report on the distribution of radiocarbon and tritium and the production rate of natural tritium. The last session was devoted to the isotopic abundances of the lighter elements, with papers on the geochemistry of the stable isotopes of nitrogen and sulfur.—*D. B. V.*

178–270. Lal, D. Cosmic ray produced radioisotopes for studying general circulation in the atmosphere: Indian Jour. Meteorology and Geophysics, v. 10, no. 2, p. 147–154, 1959.

The radioactive isotopes sulfur–35, beryllium–7, phosphorous–33 and –32, and sodium–22 are produced continuously and constantly in the atmosphere by cosmic rays at a rate strongly dependent on latitude and altitude and independent of meteorological factors. As their half lives are comparable to the time scales involved in atmospheric circulation, they can possibly be used for investigating the nature of air circulation in the troposphere and the detailed mechanism of exchange between stratosphere and troposphere.

The results of experimental work at Bombay on the use of the first four of these isotopes, determining their concentrations in rainwater, are summarized in this paper. It is concluded that beryllium–7 and phosporus–32 activities observed in rainwater are consistent with their being of predominantly cosmic ray origin; that an appreciable part of the sulfur–35 must have been contributed by nuclear bombs; and that the available data are insufficient to warrant drawing any conclusions about phosphorus–33.—*D. B. V.*

178–271. Vinogradov, A. P. Meteorites and the Earth's crust (Geochemistry of isotopes): United Nations Internat. Conf. on Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 255–269, 1958.

The development of the earth's crust is discussed in the light of geochemical data on meteorites and on rocks of the crust. The isotopic ratio of a number of elements in minerals indicates the temperature of formation of the mineral and whether the environment was oxidizing or reducing. Data on the S^{32}/S^{34}, O^{16}/O^{18}, and C^{12}/C^{13} ratios are presented in tables for meteorites and for common igneous rock types. The ratios for each element are very similar for all types of meteorites and ultramafic igneous rocks. In all three cases there is an increase in the heavy isotopes toward the silicic rocks. It is possible to say that the formation of meteorites took place under reducing conditions and at higher temperatures than those which we observe in the processes of magmatic differentiation. (See also Geophys. Abs. 175–254.)—*J. W. C.*

178–272. Signer, P., and Nier, A[lfred] O. An upper limit for radiogenic A^{38} in potassium minerals: Geochim. et Cosmochim. Acta, v. 16, no. 4, p. 302–303, 1959.

The A^{40}/A^{38} ratio was investigated in two feldspars of known age. The ion intensity ratio was extrapolated back to the time of admission of the sample to the mass spectrometer for A^{40}/(36 peak), A^{40}/(38 peak), and (A^{40}/A^{38}). When correction was made for residual hydrocarbons and air present, lower limits of 70×10^4 and 270×10^4, respectively, could be set for the A^{40}/A^{38} ratio in the two samples. These results support those found by Wasserburg and Bieri (see Geophys. Abs. 175–255) rather than those of Gerling, Levskiy, and Afanas'yeva (see Geophys. Abs. 177–253).—*D. B. V.*

178–273. Vogel, J. C. Über den Isotopengehalt des Kohlenstoffs in Süsswasser-Kalkablagerungen [On the isotope content of the carbon in fresh-water lime deposits]: Geochim. et Cosmochim. Acta, v. 16, no. 4, p. 236–242, 1959.

An attempt is made to interpret the observed C^{13}/C^{12} ratio in fresh-water carbonates in terms of the origin of the carbon and the isotope exchange constants involved. Measurements of the isotope ratio of the inorganically dissolved carbon in hard ground waters are reported. It appears that the average depletion in carbon-13 content of about 14 permil compared with Solnhofen limestone can be explained quite satisfactorily on this basis. It is shown that the expected isotope ratio of calcium carbonate precipitated from such water is compatible with that of sinter. A few measurements of sinter samples are given and the results on a number of loess samples are discussed. Although considerable caution is necessary when applying isotopic data to geological problems it is felt that with a better understanding of the mechanisms valuable conclusions can be drawn from the C^{13}/C^{12} ratio of carbonates.—*Author's abstract*

178–274. Boyle, R. W. Some geochemical considerations on lead-isotope dating of lead deposits: Econ. Geology, v. 54, no. 1, p. 130–135, 1959.

The validity of age determinations based on the lead-isotope ratios of galena or other lead minerals in deposits is questioned. A few simple examples are given to show that fractionation of lead isotopes in geochemical processes is probable. The geochemical processes through which lead has passed must be considered in detail before an age can be assigned to a lead deposit.—*Author's abstract*

178–275. Russell, R. D. Some geochemical considerations on lead-isotope dating of lead deposits: Econ. Geology, v. 54, no. 5, p. 951–953, 1959.

Russell takes issue with statements by Boyle (see Geophys. Abs. 178–274) on the interpretation of lead isotope data. Russell states that fractionation of lead isotopes in the usual sense is thought to be insignificant. Further, the isotope ratios of lead appear to be a function of age.—*J. W. C.*

178–276. Stanton, R. L., and Russell, R. D. Anomalous leads and the emplacement of lead sulfide ores: Econ. Geology, v. 54, no. 4, p. 588–607, 1959.

This is a continuation of work by Russell and others in which the isotopic composition of lead is used to trace geochemical history of lead ores (see Geophys. Abs. 157–134, 165–313, 170–21, 175–258). Leads from several large conformable deposits are ordinary, that is, they are not contaminated by radiogenic lead. Leads from vein or replacement deposits are anomalous, that is, they contain leads of radiogenic origin. This regularity is taken to indicate that lead-bearing sulfide ore bodies of the conformable type are syngenetic; the lead came directly from a deep source and was deposited before it had a chance to be contaminated by radiogenic lead in the crust. True orthomagmatic leads in mafic rocks should also be regular, and distinguishable from replacement material in the same way.—*J. W. C.*

178–277. Adler, H[ans] H. Application of isotopic data to problems of uranium geology: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 224–229, 1958.

The use of isotopic analyses of lead in various secondary minerals formed in the zone of oxidation of ore deposits is suggested as a geochemical prospecting technique for uranium. Where weathering processes have stripped uranium from rock exposures, radiometric reconnaissance and shallow sampling may be useless. Geochemical guides to uranium, however, may be useful in such areas.

During oxidation the uranium minerals are attacked by acid solutions formed by decomposition of sulfides. In this environment, preferential leaching of uranium with respect to radium and radiogenic lead may result in high Ra/U and Pb^{206}/U^{238} ratios. This leads to a high Pb^{206}/Pb^{204} ratio in the supergene lead. This enrichment in radiogenic lead should be looked for in pyrite or marcasite below the water table in areas where leaching of uranium is suspected.—*J. W. C.*

178–278. Ault, W. U., and Kulp, J. L[aurence]. Isotopic geochemistry of sulphur. Geochim. et Cosmochim. Acta, v. 16, no. 4, p. 201–235, 1959.

The isotopic composition of sulfur has been determined for a large number of specimens representing the important geochemical phases in which sulphur is present. The most significant process that causes sulphur isotopic fractionation is the reduction of dissolved sulphate by bacteria, although other processes such as distillation of volcanic emanations, oxidation-reduction of H_2S, SO_2 and S during volcanism and sulphide-sulphate equilibrium under magmatic or hydrothermal conditions can be locally important.

The new data are combined with earlier work in an attempt to define the range and average S^{32}/S^{34} ratio of the various sulphur-bearing phases of the crust. The most important averages are meteorites 22.21, ocean sulphate 21.76, mafic rocks 22.16, plutonic silicic rocks 22.13, hydrothermal sulphides 22.13 and sedimentary sulphide 22.49 and post-Cambrian evaporite sulphate 21.80. A material balance calculation of the sulphur isotopes in the crust, although subject to con-

siderable uncertainties, points to an average crustal composition of sulphur heavier than that for meteorites.

No age effect is found for at least the last 2×10^9 years. Finally, a geochemical theory is described to account for the apparent distribution of sulphur isotopes in the lithosphere.—*Authors' abstract*

178–279. Jensen, M[ead] L[eRoy]. Sulfur isotopes and hydrothermal mineral deposits: Econ. Geology, v. 54, no. 3, p. 374–394, 1957.

This is a continuation of Jensen's studies of the S^{32}/S^{34} ratios in sulfides (see Geophys. Abs. 169–209, 175–266). The ratio, permil value, and a short description of 67 specimens are presented in a table; these are new analyses. The specimens are from Butte, Montana; La Prieta Mine, Parral, Mexico; Kennecott, Alaska; Bristol, Connecticut; Buchans Mine, Newfoundland; Mercur, Utah; Minnesota (Duluth gabbro); and Wisconsin (Mellen gabbro).

Those deposits in which the S^{32}/S^{34} spread is relatively narrow are regarded as magmatic hydrothermal. The ratios from Butte, Montana, have a small range. Little evidence has yet been found anywhere for isotopic fractionation of sulfides during hypogene mineralization.

Deposits characterized by a spread in the S^{32}/S^{34} values are believed to have been deposited from solutions that were generated by mobilization of the more volatile constituents of rocks undergoing regional metamorphism; a heterogeneous source area is reflected in the spread of the ratios. Kennecott, Alaska, is suggested as a deposit of this type.

On the basis of extremely high ratio values and on the moderate spread in these ratio values of even juxtaposed samples of sulfides from sandstone-type uranium deposits, Jensen (see Geophys. Abs. 175–266) suggested that hydrogen sulfide gas derived from anerobic bacteria may have been the source of the sulfur. The chalcocite deposits at Bristol, Connecticut, are suggested as an example of such an origin.—*J. W. C.*

178–280. von Buttlar, Haro. Ground water studies in New Mexico using tritium as a tracer, 2: Jour. Geophys. Research, v. 64, no. 8, p. 1031–1038, 1959.

The monitoring of the tritium concentration of rainwater and ground water samples in New Mexico has been continued. A third peak in the rainwater was found in the summer of 1957. By comparison of the tritium content of a ground water sample with that of the rainwater, hydrologic quantities such as the age and velocity of flow of the ground water could be determined. The tritium method shows considerable promise as a hydrologic tool.—*Author's abstract*

178–281. Knutson, Gert, and Ljunggren, Knut. Studies of groundwater flow using radioactive isotopes, preliminary report: Geol. Fören. Stockholm Förh., v. 81, no. 2, p. 405–409, 1959.

This is a preliminary report on a study undertaken to compare the suitability of various radioactive tracers for the study of undisturbed ground water flow. The tracers used were iodine–131, chromium–51, and tritium; the observation site was a gravel pit in the Nybro esker southwest of Kalma, Sweden. The procedure and instruments used are outlined briefly.

The results indicate that the isotopes and experimental technique used seem to be suitable for such work. The half life of iodine–131 (8 days) is somewhat short compared to the duration of this type of investigation. Velocity of groundwater flow in the region investigated seems to be 0.1 m per day.—*D. B. V.*

MAGNETIC FIELD OF THE EARTH

178–282. Siebert, Manfred. Die Zerlegung eines lokalen erdmagnetischen Feldes in äusseren and inneren Anteil mit Hilfe des zweidimensionalen Fourier-Theorems [The separation of a local geomagnetic field into outer and inner part with the aid of the two-dimensional Fourier theorem]: Akad. Wiss. Göttingen Abh., Math.-Phys. Kl., Internat. Geophys. Jahr Beitr., no. 4, p. 33–38, 1958.

The methods developed in earlier works (see Geophys. Abs. 165–253, 172–157) for separating the outer and inner parts of a horizontal geomagnetic profile are applied to the analysis of a magnetic field observed in a horizontal plane. This is done with the aid of the two-dimensional Fourier theorem and leads to expressions like those found by Scheube, who used an entirely different approach (see Geophys. Abs. 178–283).—*D. B. V.*

178–283. Scheube, Hans-Georg. Die Lösungen der Dirichletschen und Neumannschen Randwertaufgaben als Hilfsmittel zur Behandlung von Problemen des Erdmagnetismus [The solution of the Dirichlet and Neumann boundary value problems as an aid in treating problems of geomagnetism]: Akad. Wiss. Göttingen Abh., Math.-Phys. Kl., Internat. Geophys. Jahr Beitr., no. 4, p. 1–32, 1958.

Geomagnetic problems which can be treated as boundary value problems are the separation of the geomagnetic field into its inner and outer parts, necessary for a thorough understanding of the variations; the continuation of the magnetic field, or its calculation at a level above or below the earth's surface, important for determining the depth and form of disturbing bodies as well as their effect on aerial navigation; and the calculation of one component of the earth's field from another at the same level, that arises if for any reason only one component is measured. In this work special attention is given to the first of these problems; the second and third can be treated on the basis of the equations that are derived for the first.

Investigation of bay disturbances on the basis of data from only two stations gives a merely qualitative picture of the local anomalies of conductivity for north Germany. The question of the minimum number of stations necessary for such analysis is tested on a plate model of these same anomalies, and found to be five.—*D. B. V.*

178–284. Kaboki, Tadao, and Kurusu, Kibuo. Supplementary report on intercomparison observation at Kakioka and Memambetsu by means of *QHM* magnetometers during 1952–1953; Kakioka Magnetic Observatory Mem., v. 9, no. 1, p. 1, 1959.

Results of the intercomparison observations described in a previous paper (see Geophys. Abs. 173–278) are corrected for changes in the logarithmic constant.—*D. B. V.*

178–285. U.S. Coast and Geodetic Survey. Magnetograms and hourly values. Cheltenham, Maryland, 1955: U.S. Coast and Geod. Survey Serial MHV–Ch55, 146 p., 1959.

The records of the Cheltenham Magnetic Observatory for 1955 are presented in the form of reproductions of the magnetograms and tables of hourly mean

values of the magnetic elements—declination (D), horizontal intensity (H), and vertical intensity (Z). Three magnetographs were used: an Eschenhagen that consisted of D, H, and Z variometers of high sensitivity with one recorder for all three; an Adie that consisted of D and H variometers of high sensitivity and a Z variometer of low sensitivity with a separate recorder for each variometer; and a LaCour that consisted of D and H variometers of low sensitivity with one recorder. All operations of this observatory were transferred to the Fredericksburg Magnetic Observatory, Virginia, on January 1, 1956.—*J. W. C.*

MAGNETIC PROPERTIES AND PALEOMAGNETISM

178–286. Taychinov, R. S. Issledovaniye temperatur ferromagnitnogo prevrashcheniya gornykh porod s malym soderzhaniyem ferromagnitnoy komponenty [An investigation of the temperature of ferromagnetic transformation of rocks with a small content of ferromagnetic component]: Akad. Nauk SSSR Izv. ser. geofiz., no. 6, p. 898–904, 1959.

A method is suggested and described in detail for determining the Curie point of the ferromagnetic fraction of weakly magnetic rocks by means of the temperature at the point of inflexion on the curve $1/\chi = f(T)$. This is the consequence of the fact that in rocks the difference between the Curie points of the paramagnetic and ferromagnetic fractions, $\theta_p - \theta_z$, is very small. It is shown that the usual procedure is not always accurate due to the presence in natural rocks of a significant ferromagnetic fraction.

The Curie point has been determined for several weakly magnetic rocks, such as siltstone, shale, and red sandstone. Some types of siltstone may possess paramagnetic properties. The Curie temperature determined on different volumes of specimens of magnetic quartzite can differ by as much as 15° C; this is explained by heterogeneity in distribution of ferromagnetic substance throughout the mass. This phenomenon was especially marked in rocks containing TiO_2. Ferromagnetic components of some of the rocks investigated showed phase transformations when undergoing temperature variation. It is possible to state that the sedimentary rocks are more homogeneous than the eruptive rocks. For sedimentary rocks the Curie point is a good characteristic for determining the nature of the ferromagnetic component.—*S. T. V.*

178–287. Kawai, N[aoto]; Kume, S[hoichi]; and Yasukawa, K. Exsolution of titanomagnetite and its time effect on rock-magnetism. 1. Change of exsolution phase with geologic age: Japan Acad. Proc., v. 32, no. 7, p. 455–458, 1956.

This is a continuation of a study of solid solution in titanomagnetite (see Geophys. Abs. 160–36, 161–41, 163–40, –48). About 400 specimens from active and extinct volcanoes were studied. Determination was made of the vector of natural remanent magnetism I_r and the intensity of saturation magnetism I_s and the relationship of these values to temperature. The directions of I_r are roughly parallel or opposite to the present geomagnetic field around them. Curves were determined for the relationship of magnetic saturation to temperature and breaks in these curves showed the coexistence of polyphase titanomagnetites varying in Curie point. These were then classified into four time groups: Present, Historical, Quaternary, and Tertiary. A single phase is more common than polyphases in rocks of the present, whereas polyphases are the rule in older rocks. This may be regarded as an annealing experiment with titanomagnetite over a time of more than 10 million years.—*J. W. C.*

178–288. Akimoto, Syun-iti, and Katsura, Takashi. Magneto-chemical study of the generalized titanomagnetite in volcanic rocks: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 3, p. 69–90, 1959.

Chemically analysed specimens of homogeneous titanomagnetites separated from various volcanic rocks were examined magnetically and crystallographically. Care was taken not to use the titanomagnetite carrying exsolved ilmenite-hematite series minerals. About 80 percent of the present specimens possesses the chemical composition situated in a magnetite-ulvöspinel-ilmenite compositional field in a FeO–Fe_2O_3–TiO_2 ternary system. Natural occurrence of the homogeneous titanomagnetite of which chemical composition enters into a magnetite-ilmenite-hematite compositional field was also found in some volcanic rocks. The concept of the generalized titanomagnetite, i.e. the spinel phase in the FeO–Fe_2O_3–TiO_2 system with varying vacancy in the metal ion site of the crystal structure, was applied for the magneto-chemical study of these natural titanomagnetites. The magnetic and crystallographic properties of the present specimens are interpreted successfully by making use of the equal lattice parameter diagram and equal Curie temperature diagram on the FeO–Fe_2O_3–TiO_2 system both of which have been determined from the synthetic experiments. A remarkable character that the titanomagnetite in some volcanic rocks is separable to an ensemble of the single phase grains of which chemical composition varies grain by grain nearly along the reduction-oxidation line was also found. *Authors' abstract*

178–289. Kobayashi, Kazuo. Chemical remanent magnetization of ferromagnetic minerals and its application to rock magnetism: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 3, p. 99–117, 1959.

The remanent magnetization generated by chemical reactions has been studied on both natural and synthetic specimens. Chemical remanent magnetization (*C.R.M.*) may be generated during two kinds of reactions, reduction of α-Fe_2O_3 to Fe_3O_4 and oxidation of Fe_3O_4 to maghemite; these are examined in the first part of the paper. It is concluded that *C.R.M.* is intermediate in intensity between isothermal remanent and thermoremanent magnetization, and that its magnetic and thermal stability is similar to that of thermoremanent but much higher than that of isothermal remanent magnetization.

In the second part the magnetic properties of several natural rocks and ores containing maghemite are examined systematically. The specimens fall into two groups according to the magnitude of the ratio of their natural remanent to induced magnetization. In the first group the ratios are large, reaching 100; in the second they are quite small. The greater part of the natural remanent magnetization of the first group is attributable to the *C.R.M.* of maghemite, which is considerd to result from oxidation of magnetite probably by weathering at nearly atmospheric temperature. The natural remanent magnetization of the specimens of the second group is found to be merely isothermal remanent. The two groups are compared petrologically. It is concluded that the magnitude of *C.R.M.* depends on the mode of precipitation of the ferromagnetic minerals.—*D. B. V.*

178–290. Akimoto, S[yun-iti], Horai, K., and Boku, T. Magnetic susceptibility of orthopyroxenes: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 1, p. 7–11, 1958.

The magnetic properties of a series of orthopyroxenes (x $FeSiO_3$. $(1-x)$ $MgSiO_3$) separated from different kinds of rocks were examined. Paramagnetic

susceptibility was determined from the slope of the straight line part of the magnetization curve. An empirical formula was obtained for the molecular magnetic susceptibility of the orthopyroxenes with varying x. Using this experimental value and assuming that there is no interaction between Fe^{+2} ions embedded separately in the crystal, the effective Bohr magneton number of the Fe^{+2} ion was estimated from Curie's law to be 5.14. This value is within the range of accepted values (5.1–5.55) of ferrous ions in the crystal; therefore, the simple calculation presented seems to be justified.—*D. B. V.*

178–291. Bichan, W. James. Correlation of aeromagnetic data with source mineralogy: Econ. Geology, v. 54, no. 3, p. 512–515, 1959.

Problems in aeromagnetic surveying that parallel those encountered by Balsley and Buddington (see Geophys. Abs. 175–293) were encountered in the Baie Verte Peninsula, Newfoundland. Chrysotile asbestos occurs in an ultramafic host rock that does not give rise to a magnetic anomaly. The explanation is that the iron oxide present in the ultramafic rock is in the form of hematite exclusively. The rock contains no titanium; this accounts for the absence of any reverse remanent magnetization.—*J. W. C.*

178–292. Irving, E. Magnetic "cleaning": Royal Astron. Soc. Geophys. Jour., v. 2, no. 2, p. 140–141, 1959.

The results given by As and Zijderveld (see Geophys. Abs. 176–265) do not cast suspicion on what has been done previously in paleomagnetic measurements, but on the contrary confirm it. The techniques of magnetic "cleaning" of rocks provide a means of dissecting out unwanted secondary components which often mask the primary components in the natural state; this increases by many times the range of rocks that may be used. The mood is one of optimism for the future, not reserve about the past.—*D. B. V.*

178–293. DuBois, P. M. Palaeomagnetism and continental drift: Royal Soc. Canada Trans., ser. 3, v. 52, sec. 4, p. 17–26, 1958.

Paleomagnetic measurements from several different continents are discussed. If the earth's magnetic field, averaged over a long period of time, is assumed to be that of a central dipole oriented along the earth's axis of rotation, then comparisons between paleomagnetic measurements from different continents indicate that large relative movements between the continents have taken place. The basic assumpion about the axial and dipolar nature of the earth's average magnetic field is theoretically reasonable and is supported by the experimental results from the Tertiary.—*Author's abstract*

178–294. Kropotkin, P. N. Znacheniye paleomagnetizma dlya stratigrafii i geotektoniki [The significance of paleomagnetism in stratigraphy and geotectonics]: Moskov. Obshch. Ispytateley Prirody Byull., v. 63, Otdel. geol., v. 33, no. 4, p. 57–86, 1958.

A review of the status of modern studies on paleomagnetism is given, and the possibility of correlating stratigraphic profiles by means of the natural remanent magnetization in rocks is discussed. Paleomagnetism can help solve various problems in stratigraphy, paleoclimatology, paleontology, geotectonics, and paleovolcanism. The problem of lateral displacements of the earth's crust is discussed, and polar wandering and the continental drift are considered in the light of paleomagnetism.—*A. J. S.*

178–295. Nairn, A. E. M., and Kürsten, M. Mitteilung über paläomagnetische Untersuchungen an Basalten des Siebengebirges und seiner Umgebung [Report on paleomagnetic investigations on basalts of the Siebengebirge and its vicinity]: Neues Jahrb. Geologie and Paläontologie Monatsh., no. 8, p. 348–352, 1959.

The results of paleomagnetic measurements on basalts of the Siebengebirge in Germany are summarized briefly and presented in a sketch map. Intrusive pipes are found to be negatively magnetized, whereas the basalts emplaced along the Rhine border faults are positively magnetized. This suggests a difference in age; geologic surveys lead to the conclusion that the latter are younger. Petrographic differences between normally and inversely magnetized basalts are now being investigated.—*D. B. V.*

178–296. Gus'kova, Ye. G. Paleomagnitnyye issledovaniya osadochnykh porod Yugo-vostochnoy Turkmenii [Paleomagnetic investigations of sedimentary formations of southeastern Turkmenia]: Akad. Nauk SSSR Izv. ser. geofiz., no. 3, p. 460–469, 1959.

The results of the magnetic investigation of some 200 specimens of sedimentary rocks from southeastern Turkmen S.S.R. are presented. The specimens were taken from five outcrops and consist of clays of different colors, yellow and gray standstones, and siltstones. The sandstones are the most magnetic, the clays the least. According to A. V. Khramov the rocks from which the specimens were taken should be considered magnetically stable. For all specimens the intensity of remanent magnetization and the magnetic susceptibility were determined, as well as the angle of inclination and declination. A graph of the variation of the angle of declination shows an alternation of positive and negative values during the Paleocene differing by almost 180°. The pole positions determined from these data are in good agreement with the determinations of other geophysicists.—*S. T. V.*

178–297. Singh, Jagdeo, and Rao, M. Krishna. Magnetization of a metadolerite dyke in relation to its petrography: Current Sci., v. 28, no. 4, p. 157–158, 1959.

Portions of a metadolerite dike exposed in and near Dhaiya village, Dhanbad, India, were surveyed magnetically with a vertical variometer, and in the laboratory oriented specimens were studied petrographically and their permanent and susceptibility polarizations and direction of magnetization were determined. Preliminary results show a remarkable change in magnetization with feldspathization. Magnetization of the feldspathized portions is nearly one-fifth that of the non-feldspathized; that of the former is 80 to 90 percent remanent, that of the latter is chiefly induced. Detailed studies of the magnetic properties and petrography of these rocks are in progress.—*D. B. V.*

178–298. Momose, Kan-ichi. Palaeomagnetic researches for the Pliocene volcanic rocks in Central Japan (1): Jour. Geomagnetism and Geoelectricity [Kyoto], v. 10, no. 1, p. 12–19, 1958.

All rock samples collected from the Middle Pliocene Komoro and Shigarami groups of Japan have shown marked polarization in a westward direction ranging roughly from N. 60° W. to N. 10° W. The pole positions indicated by these specimens lies between lat 32° N. and lat 35° S.

A series of volcanic rocks ranging from Lower to Upper Pliocene and including the above groups seems to indicate that the pole position shifted continuously from lat 75° N. to lat 70° S. during Pliocene times.—*D. B. V.*

MAGNETIC SURVEYS

178–299. Affleck, James. Interrelationships between magnetic anomaly components: Geophysics, v. 23, no. 4, p. 738–748, 1958.

The relationships between the various magnetic anomaly components are developed from fundamental theory. A symbolism is introduced which permits expression of the relationships in algebraic form. These techniques have been found useful in predicting anomaly shapes for any magnetic latitude and in simplifying calculations of aeromagnetic or other component intensity anomalies for rock masses. Two examples of the application are shown.—*Author's abstract*

178–300. Celmiņš, Aivars. Comments on "Interrelations between magnetic anomaly components": Geophysics, v. 24, no. 2, p. 366–369, 1959.

The behavior of magnetic anomalies caused by homogeneous magnetized bodies which Affleck states can be treated in airborne surveying as either the vertical or horizontal component anomaly if true magnetization is replaced by a pseudomagnetization of other direction and intensity (see Geophys. Abs. 178–299), is here formulated more precisely. The interdependence between directions of magnetization and direction of the normal magnetic field can be expressed by a rather simple formula.—*D. B. V.*

Klushin, I. G., and Nikol'skiy, Yu. I. Subdivision of the gravity field into regional and local components by means of computers. See Geophys. Abs. 178–223.

178–301. Levanto, A. E. A three-component magnetometer for small drill-holes and its use in ore prospecting: Geophys. Prosp., v. 7, no. 2, p. 183–195, 1959.

A 3-component fluxgate magnetometer has been built for use in 1½-inch drill-holes. It has an accuracy of 1 milligauss. It requires 2 to 3 men to operate it, and they can take measurements in up to three 100-meter holes in one day. The instrument has definitely proved its worth in describing the "general" geology of an ore body, and it is now used on a routine basis.—*Author's abstract*

178–302. Merriam, Daniel F., and Hambleton, William W. Relation of magnetic and aeromagnetic profiles to geology in Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 153–173, 1959.

Seven east-west magnetic and aeromagnetic profiles in eastern and nothern Kansas, two of which extend across the state, cross the Forest City basin, Cherokee basin, Salina basin, Hugoton embayment, Nemaha anticline, Cambridge arch, and central Kansas uplift. In northwestern Kansas the Cambridge arch is reflected as a magnetic high, and in southeastern Kansas structural highs are reflected as magnetic lows. Thinning of sedimentary rocks is associated with a rise in the magnetic gradient. Most magnetic anomalies in Kansas may be due to lithologic changes in the Precambrian basement complex.—*A. J.*

178–303. Agocs, W[illiam] B. Comparison of basement depths from aeromagnetics and wells along the northern border of Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 143–152, 1959.

Aeromagnetic data obtained by Aero Service Corporation in 1948 were analyzed to determine the depth and structure of the Precambrian basement rocks. The depth thus determined is in good general agreement with depths obtained from well logs, considering that the magnetic control from only a single profile was used.—*A. J.*

178–304. Agocs, W[illiam] B. Airborne magnetometer profiles, Morris and Wabounsee Counties, Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 175–180, 1959.

Two aeromagnetic profiles across parts of Morris and Wabounsee Counties show a marked susceptibility contrast on the western approach to the Nemaha ridge and probably indicate that the basement west of the Nemaha ridge consists of mafic igneous rock and the Nemaha ridge of granite.—*A. J.*

178–305. King, Elizabeth R. Two aeromagnetic profiles across western Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 135–141, 1959.

Two aeromagnetic profiles were made by the U.S. Geological Survey in 1950–51, one westward from Salina and one across the southwest corner of Kansas. The magnetic pattern consists of a series of large anomalies modified by several minor features, superimposed on a slight positive regional gradient to the east. Depth analyses indicate that several of the broad anomalies originate deep within the Precambrian complex. Several of the smaller features are probably due to variations in magnetic susceptibility of the rocks extending downward from the top of the Precambrian layer.—*A. J.*

178–306. Joesting, H[enry] R., and Byerly, P. Edward. Regional geophysical investigations of the Uravan area, Colorado: U.S. Geol. Survey Prof. Paper 316–A, p. 1–17, 1959.

This report discusses the interpretations of aeromagnetic and regional gravity surveys conducted in the Uravan area in the east-central Colorado Plateau physiographic province. Interpretations are based on available surface and subsurface geologic information and on geophysical data. Magnetic and gravity trends are generally parallel to the northwest-trending regional structural features. South of Uravan, however, the regional gravity trend is normal to the present structural trend, probably because of rocks of high density within the basement. The larger magnetic anomalies are related to changes in magnetization and probably in composition of the basement rocks and to faults involving large displacements of the basement. On the basis of magnetic patterns, the area is divisible into three parts: the Uncompahgre uplift to the northeast; the part southwest of Gypsum Valley where the basement has apparently been uplifted; and the central part, where the basement rocks are at greater depths. Major gravity anomalies are related to variations in the thickness of salt deposits in the Paradox member of the Hermosa formation and to differences in the density of the basement rocks.—*V. S. N.*

178–307. Joesting, H[enry] R., and Plouff, Donald. Geophysical studies of the Upheaval Dome area, San Juan County, Utah: Intermoutain Assoc. Petroleum Geologists, Guidebook to Geology of Paradox Basin, 9th Annual Field Conference, p. 86–92, 1958.

Aeromagnetic and gravity surveys were made in the vicinity of Upheaval Dome near the junction of the Green and Colorado Rivers, as a part of a larger geophysical study to aid in the interpretation of the regional geology of the Colorado Plateau and the Paradox salt basin. No obvious relation was found between the major structural trends in the Upheaval Dome quadrangle and the west-northwesterly magnetic and gravitational trends; the latter probably reflect structural trends in the basement rocks. Two prominent magnetic highs, one centered at Upheaval Dome, the other 6 miles southeast at Grays Pasture, are caused by masses of relatively magnetic rock about 5 miles across and are thought to represent structural uplift of the basement that occured before deposition of the Upper Permian now exposed near Upheaval Dome and Grays Pasture. Gravity highs coincide with the magnetic highs. Local magnetic and gravity anomalies over Upheaval Dome, too large to be explained in terms of a salt dome, indicate a small intrusive mass of magnetic material which had little or no role in producing the dome structure. Upheaval Dome is too small to be the entire cause of the broad magnetic and gravity highs centering at the dome although it is possible that the uplift of the basement exerted control over the position of the dome. A geologic history is postulated to reconcile qualitatively the geologic, magnetic, and gravity evidence.—*V. S. N.*

Bichan, W. James. Correlation of aeromagnetic data with source mineralogy. See Geophys. Abs. 178–291.

178–308. Garland, G. D., and Bower, Margaret E. Aeromagnetic anomalies in northeastern Alberta: Oilweek, v. 10, no. 18, p. 32–40, 1959.

An aeromagnetic map, compiled from sheets published by the Geological Survey of Canada, is presented for an area of some 40,000 sq mi in notheastern Alberta. The area overlaps the exposed Precambrian shield, but for the most part is situated in the western Canadian sedimentary basin. A separation of the magnetic anomalies into regional and local effects is made by fitting a third-order surface to the observations. Estimates of depth to the Precambrian basement beneath the sedimentary rocks are made from the local anomalies. In general, these estimates agree with the known depth to the Precambrian where it has been reached in wells. Between the wells, they provide more information on the character and topography of the Precambrian surface.

Both regional and local trends are interpreted in terms of variations in basement lithology. By reference to properties of Precambrian samples from wells, and to aeromagnetic observations over the exposed shield, the positive magnetic effects are interpreted to represent bands of volcanic and metasedimentary rocks in a background of granite or granite gneiss. Faulting in the Precambrian rocks is suggested by offsets or truncations in these bands, and two systems of important faults can be traced beneath the area. The relation between these Precambrian structures and petroleum exploration is indirect, but in the case of at least two types of petroleum accumulation the basement structure and lithology could be important. The area includes the McMurray tar sands, which may be the result of oil migration from sources lower in the sedimentary column along faults or other fractures, and the latter may parallel Precambrian trends. The second application is in exploration for the "granite

wash" type of reservoir just above the basement surface. The localization of these detrital reservoirs is probably controlled by both Precambrian lithology and structure.—*Authors' abstract*

178–309. Lehmann, Martin. Die erdmagnetische Vermessung von Nordwestsachsen [The geomagnetic survey of northwest Saxony]: Zeitschr. angew. Geologie, v. 5, no. 6, p. 250–254, 1959.

A regional magnetic survey was made of northwestern Saxony, Germany, in 1954–57. Results are presented in a magnetic map on a 1:100,000 scale, and a geological interpretation of the anomalies is attempted. Many problems of interpretation can be solved only by further detail measurements in conjunction with a number of borings.

The pyroxene-quartz porphyry, the pyroxene granite porphyry, and the augite syenite are undoubtedly the cause of the larger anomalies. The structural boundary of the porphyry sheet can be recognized from the magnetic picture. The different quartz porphyry flows cannot be distinguished magnetically, as their susceptibility values are similar. Smaller anomalies are provoked by pitchstone, porphyrite and melaphyrs.—*D. B. V.*

178–310. Törnqvist, G[östa]. Geophysical history of the iron mine at Forsbo, Sweden, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 55–65, 1958.

The paper gives an example showing how prospecting for iron ore is carried out in Sweden. Deposits of high grade magnetite ore have been known for a long time within the leptite formation near Forsbo, but mining has been very restricted on account of the small size of the ore-bodies. A new magnetic ground survey disclosed a weak but extensive anomaly on the side of the zone in which deposits were known to occur, an anomaly which could be interpreted as being due to a magnetic body at about 100 m depth. Drilling was recommended and an economically workable deposit was found. Mining had, in 1955, reached a stage when a comparison between the interpertation of the magnetic data and the ore reserves could be attempted. A short description of the procedures for determining the extension in depth of magnetic bodies and a diagram showing the influence of topography on magnetic measurements are also included in the paper.

An electromagnetic survey was carried out within the same area and the type of indication obtained over magnetite ore is shown.—*Author's abstract*

Törnqvist, G[östa], and Bosschart, R. A. Some recent results of geoelectrical prospecting in Sweden. See Geophys. Abs. 178–134.

178–311. Małoszewski, Stanisław. Anomalie magnetyczne w Pieninach [Magnetic anomalies in the Pieniny Mountains (with English summary)]: [Poland] Inst. Geol. Muzeum Ziemi Prace, no. 1, p. 104–113, 1958.

Vertical and horizontal magnetic measurements in the Pieniny Mountains of Poland are described and interpreted. The survey was carried out in two stages. The first covered 60 km^2 with observation points set up on a 200-m grid; it was designed to locate areas for more detailed work. The second covered anomalous areas at points 2.5–20 m apart on profiles spaced 15–50 m. Vertical and horizontal isogram maps are presented. On the basis of the anomalies, 41 andesite dikes were differentiated and their approximate thickness and dip determined.—*J. W. C.*

178–312. Airinei, Stefan. Cercetări magnetice regionale în Dobrogea, Moldova de sud şi estul Cîmpiei Romîne (Geologia regiunii în lumnia magnetismului terestru) [Regional magnetic studies in Dobrogea, southern Moldavia and eastern Rumanian Plain (Regional geology in the light of terrestrial magnetism)]: Acad. Romîne Bul. stiinţ., sec. geol. şi geog., v. 7, no. 1, p. 155–175, 1955.

The paper presents the results of magnetic investigations in the regions in question and discusses their geological structure in the light of the earth's magnetism. In the vertical magnetic survey carried out on the territory in 1950–52, 2,200 stations were occupied; the results are compiled in a magnetic map of Rumania. The magnetic anomalies indicate that the Dobrogea horst is found in central Dobrogea, rather than northern Dobrogea.—*A. J. S.*

178–313. Nevolin, N. V., Galaktionov, A. B., and Serova, A. D. Geologicheskoye stroyeniye aktyubinskogo priural'ya [Geology of the Aktyubin area adjacent to the Urals]: Prikladnaya Geofizika, no. 22, p. 129–156, 1959.

The first part of the paper treats the porosity and density data assembled from tests on 974 specimens; these were taken from drill holes and from outcrops in Aktyubin. The rocks range in age from Carboniferous to Triassic.

The second section deals with gravity and magnetic anomalies. The smooth magnetic field of the area indicates the absence of volcanic rocks in the upper parts of the section. The overall negative gravity background of the Aktyubin area is complicated by local anomalies. The regional gravity anomlies are due largely to petrographic and structural inhomogeneities of the Precambrian basement, whereas the relief of the pre-Kungur (salt) surface has little effect. Local gravity anomalies are caused by the relief of the pre-Kungur surface, by the relief of the Kungur, and by the relief of the Permo-Triassic.

The structure of the area is described in the third section.—*J. W. C.*

178–314. Nevolin, N.V. Geologicheskoye znacheniye gravitatsionnykh i magnitynkh anomaliy tsentral'nykh i vostochnykh rayonov Russkoy platformy [Geologic significance of gravitational and magnetic anomalies of the central and eastern regions of the Russian platform]: Geologiya Nefti, no. 3, p. 18–25, 1957.

The gravity field of the Russian platform is governed by several factors, which include the effects of depth, the structure and petrography of the basement, and the thickness and structure of the sedimentary cover. Nevolin concludes that regional anomalies are intimately related to recent tectonic movements connected with subcrustal distribution of mass; great lows in the gravity curves correspond to positive structural elements, and large gravity maximums to depressions, in the Precambrian basement. Local anomalies are due to petrographic and structural factors. Local maximums correspond to gneisses, gabbros, and norites in the basement, local minimums to granitic intrusions. The effect of the thickness of the sedimentary cover is reflected only in a reduction of the overall level of gravity anomalies.

The sedimentary rocks of the Russian platform are practically nonmagnetic; the magnetic effects must therefore be related to the basement. The weak anomalies appear to correspond to areas made up of granitic rocks and biotite-garnet-sillimanite gneisses. Local magnetic maximums are apparently related to gabbro and diabase intrusives and to amphibolites. (See also Geophys. Abs. 171–187.)—*J. W. C.*

Vasil'yev, V. G., Gushkovich, S. N., and Lishnevskiy, E. N. On the problem of interpretation of gravity and magnetic data in the south of the East Siberian platform. See Geophys. Abs. 178–243.

Kononov, A. I. New data on the structure of the southeast part of the Siberian platform. See Geophys. Abs. 178–244.

178–315. Agocs, W[illiam] B., Paton, J. R., and Alexander, J. B. Airborne magnetometer and scintillation counter survey over parts of Kedah and Perlis (Area 6) : Federation of Malaya Geol. Survey Econ. Bull., no. C–1.6, 39 p., 1958.

This is one of a series of publications reporting the results of an airborne magnetometer and scintillation counter survey conducted during 1956–57 over nearly 16,000 sq mi of Malaya. The purpose of the survey was to locate possible sites of tin deposits, sulfide mineralization, and concentrations of uranium and thorium minerals. The report includes: a discussion by Paton of the general geology and mineral resources of the Federation of Malaya, in particular of Area 6 which covers 1,458 sq mi in the northwest corner of Malaya ; an interpretation by Agocs of the magnetic and radioactive results in Area 6; and an interpretative summary by Alexander. A zone of intense anomalies in the southwestern part is interpreted as being due to basic intrusive rocks, and zones of low-amplitude anomalies in the north-central and southeast parts as being due to acidic igneous rocks. An enlarged map of the southwest portion is included to show the major zones of intense anomaly that are likely to be of economic interest; iron deposits already known to occur within the southwest area are spotted and areas to be investigated further by ground surveys are indicated.—*V. S. N.*

Sano, Shun'ichi; Saito, Tomosaburo; and Hatase, Yasuhiko. Geophysical prospecting at placer deposits in Naegi region, Gifu Prefecture. See Geophys. Abs. 178–343.

MICROSEISMS

178–316. Iyer, H. M., and Hinde, B. J. Microseismic research at the National Institute of Oceanography: Nature, v. 183, no. 4675, p. 1558–1560, 1959.

The new microseismic station installed at the National Institute of Oceanography at Wormley, Surrey, England, has two sections, the seismographs and the automatic analyzer. Electronic feedback seismographs of the type developed by Tucker are used; these have a very high magnification (up to 18,000) and flat response from 1–10 sec period. Both east-west and north-south components are incorporated in the same instrument, reducing overall size of the station; a vertical seismograph on the same principle has also been designed and is in operation. Concerning the operation of the analyzer, it is mentioned that the correlation coefficients are calculated by using the meters in two different channels, to indicate automatically at regular intervals whether the arms are deflected in the same or opposite directions. A three-channel recorder has been provided for earthquake seismological purposes. A photograph, schematic diagram, and sample microseism and earthquake records are given.—*D. B. V.*

178–317. Gynkina, N. M., and Masarskiy, S. I. Mikroseysmy ozera Issyk-Kul, [Microseisms of Lake Issyk-Kul] : Akad. Nauk SSSR Izv. ser. geofiz., no. 6, p. 884–890, 1959.

In addition to the usual microseismic vibrations with a period of 5–7.5 sec, microseisms with a period of 1.8–3.0 sec are observed from time to time on the seismograms of the geophysical station of Alma-Ata in the Kazakh S.S.R. These vibrations persist for 1 to 2 days and are more often observed during the cold months (October–March). It is impossible to attribute these vibrations to some industrial effect. After studying the meteorological conditions accompanying the appearance of the short-period microseisms, Gynkina and Masarskiy conclude that the conditions favorable to their generation are strong west winds on the western shore of Issyk-Kul and east winds on the eastern shore. Such winds produce standing waves in the water of Issyk-Kul. In contrast to long-period microseisms, the short-period microseisms extend over a rather limited area. Thus the seismograms of the Semipalatinsk station, located about 800 km from Lake Issyk-Kul, do not show these microseisms.—*S. T. V.*

178–318. Hatherton, T., and Orr, R. H. Microseisms at Scott Base: Nature, v. 183, no. 4677, p. 1760–1761, 1959.

The seismological station operating since March 1957 at Scott Base (lat 77°51′ S., long 166°48′ E.) on Ross Island was installed mainly to determine the local seismicity, but a preliminary examination of microseismic periods and amplitudes has been made following some interesting qualitative observatons. The weekly mean amplitudes of 6-hourly microseismic activity on the short-period component of the vertical seismometer are shown in a graph. The microseisms are of 1–4 sec period and, as is normal, periods increase with amplitude. Abnormally, however, the maximum amplitudes occur during summer; in winter microseisms are virtually absent on this component. This seasonal variation must be related to the presence of ice in the Ross Sea. There is little doubt that the 1–4 sec microseisms are due to events within the Ross Sea.

Microseisms of the 4–10 sec type appear throughout the year on the north-south component of the 10-sec galvanometer. These may show a seasonal variation with a minimum in the summer, but the data are insufficient to establish this fact. Their origins probably lie in the cyclones over the oceans surrounding the Antarctic continent, and it seems impossible that wave or surf action at this coast could play any part in their generation or transmission.—*D. B. V.*

RADIOACTIVITY

178–319. Rosholt, John N. Radioactive disequilibrium studies as an aid in understanding the natural migration of uranium and its decay products: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 230–236, 1958.

Equilibrium in natural uranium and thorium series is set up after elapse of 500,000 years, provided losses of neither parent nor daughter elements occur. Such losses result in deviations of four general types; daughter deficiency, thorium-230 deficiency, exclusive radium-actinium isotope occurrences, and daughter excess. Radioactive age determinations can be made on a basis of the ratio of parent uranium to intermediate daughter products provided no deviations of the type outlined above have taken place, and also provided that the parent uranium was free of decay products and the rate of deposition was not too slow compared with the rate of growth of daughter products.—*J. W. C.*

178–320. Whitaker, W. W., Valastro, S. Jr., and Williams, Milton. The climatic factor in the radiocarbon content of woods: Jour. Geophys. Research, v. 64, no. 8, p. 1023–1029, 1959.

Past research has shown significant variations in radiocarbon contents of woods from different environments and in the degrees to which theses radiocarbon contents reflect dilution of atmospheric carbon dioxide by carbon dioxide from fossil fuels. The present work attempts to relate these variations to climatic factors. Comparison of radiocarbon contents of individual tree rings with thicknesses of the rings and, in some cases, with meteorological records suggests that the radiocarbon contents of rings produced in years of heavy rainfall may be relatively low and that the contents of rings added in times of drought may be comparatively high. The year-to-year fluctuations in radiocarbon content observed in individual trees probably cannot be ascribed to rainfall alone, but likely also depend upon other factors. The apparent dependence of radiocarbon content on climate seems to be a result of a varying contribution to the tree of carbon from the pedosphere.—*Authors' abstract*

178–321. Deutsch, S[arah], Picciotto, E[dgard] [E.], and Houtermans, F. G. Alpha radioactivity of iron meteorites (second letter): Geochim. et Cosmochim. Acta, v. 14, no. 1/2, p. 173–174, 1958.

The α-activity of 4 iron meteorites—Carbo, Toluca, Tamarugal, and Thunda—was investigated by exposing disks 2 cm in diameter and 0.5 cm thick to photographic emulsion for 4 months at −35° C in a nitrogen atmosphere. Results are tabulated. The average effect is 1.5×10^{-7} α per cm^2 per sec at its maximum, corresponding to 0.9×10^{-9} g per g uranium in equilibrium with its daughters; this is much lower than expected from the measurements on thorium and uranium by Dalton and others and confirms the fact that their results were erroneously high. (See also Geophys. Abs. 165–306, 167–234.)—*D. B. V.*

178–322. Hayase, Ichikazu. The radioactivity of rocks and minerals studied with nuclear emulsion VI. Radioactivity of some Japanese liparites: Kyoto Univ. Coll. Sci. Mem., ser. B, v. 25, no. 2, p. 81–87, 1958.

The radioactivity of some Japanese liparites is measured by the nuclear emulsion technique and the characteristic distribution of radioactive elements in acid volcanic rocks is observed from study of the liparite samples. The radioactive materials in igneous rocks are contained in the main rock-forming minerals and in the glassy matrix; in liparite feldspar, the colored minerals (biotite, hornblende, and chlorite), and the glassy matrix are the major source of radioactive elements with the matrix showing the highest radioactivity. The zircon in liparite is transparent, feeble in radioactivity, and occurs only in the matrix. This absence of zircon in biotite and feldspar indicates the later origin of liparitic zircon. The highly radioactive minerals common in granites, such as uranothorite or uraninite, have not been found in liparites. (See also Geophys. Abs. 172–206, 174–300, 175–345.)—*V. S. N.*

178–323. Tsutsumi, Tokudo. Distribution of radioactive minerals in the granite of Gyojayama, Kyoto Prefecture, Japan: Kyoto Univ. Coll. Sci. Mem., ser. B, v. 25, p. 89–95, 1958.

The paragenetic relationship between radioactive minerals and major constituents in the Gyojayama granite, Kyoto Prefecture, Japan, is discussed. The radioactive minerals, most of them idiomorphic, occur in biotite, quartz, and

feldspar and also occur frequently on the boundaries between biotite and feldspar and between biotite and quartz. From this distribution of the accessory minerals, it is concluded that the crystallization of the accessories is earlier than that of the main constituents and that they continue to crystallize even after the crystallization of the main constituents has ended.—*V. S. N.*

178–324. Hatuda, Zin'itiro, and Nishimura, Susumu. Variation in radioactivity across igneous contacts (The second report) : Kyoto Univ. Coll. Sci. Mem., ser. B, v. 25, no. 2, p. 115–123, 1958.

Seventy-three traverses were made of the distribution of radioactive elements across igneous contacts. It was found that the profiles of radioactivity are not at random but are reducible to four types presumably corresponding to the conditions under which the contact phenomena took place. In the later stage of solidification of granite magma, the distribution of radioactivity depends upon the migrating power of radioactive elements and may be inferred to show the mode of migration of volatile matter. The several types of radioactive distribution implies the existence of differences in grade of melting of the invading masses, that is, whole or partial melting or, as an extreme, metasomatism in solid state.—*V. S. N.*

178–325. Grylgewicz, Zofia. Badania promieniotwórczści granitów ze Strzelina i Kudowy [Investigation of radioactivity of granites from Strzelin and Kudowa (with English summary)] : Acta Geophys. Polonica, v. 7, no. 1, p. 50–54, 1959.

The uranium and thorium concentrations in the Strzelin granite, 2 Kudowa granites, and the Strzelin granite gneiss were determined by exposing tablets made of the pulverized rock to nuclear emulsion plates. The thorium and uranium concentrations were determined from the length of α-particle tracks, traces 39μ or longer being assigned to thorium and those between 32μ and 39μ to uranium. Results are tabulated. The Th/U ratio is 2.3 for the Strzelin granite, 2.2 for the granite gneiss, and 2.2 and 2.3 for the two Kudowa granites, respectively.—*D. B. V.*

178–326. Heide, F., and Proft, G. Der Urangehalt des Saalewassers [The uranium content of the water of the Saale] : Naturwissenschaften, v. 46, no. 10, p. 352–353, 1959.

Fluorimetric measurements made on samples of water from the Saale River in Germany show only slight monthly fluctuations that range from 0.42μ to 0.92μ g per liter. The variation in uranium content of the material in suspension is greater (0.05μ to 0.95μ g per liter) and corresponds to fluctuations in load. Regionally, the uranium content increases gradually downstream from 0.54μ g per liter in Eichich to 4.40μ g per liter in Calbe. Each year 24.73 tons of uranium are carried into the Elbe by the Saale, corresponding to the removal of 0.1μ g of uranium per cm^2 of the drainage area.—*D. B. V.*

178–327. Szabó, Árpád. Concentrarea în radon şi radiu metalic a izvoarelor şi depozitelor minerale de la Băile Borsec şi Toplița (Transilvania), VIII [Concentration of radon and metallic radium in mineral springs and their mineral deposits at Băile Borsec and Toplitsa (Transylvania), part 8]: Acad. Romîne Bul. ştiinţ., sec. de ştiinţe matematice şi fizice, v. 9, no. 2, p. 537–544, 1957.

In his investigations of radioactivity of mineral springs and their deposits in Transylvania, Rumania, Szabó finds that the water from Pierre Curie spring at Borsec has 19.91 mache units of radon and 8.2×10^{-12} g per litre of radium. Radioactivity of the springs "Horea," "Cloşca," "Caprei," and "Templului" varies from 2.5 to 3.5 mache units. Deposits of tufa were found to contain $(1–6)\times 10^{-12}$ g per g of dry mineral at 100° C. The source of the radioactivity found is considered to be the mica schist which contains grains of radioactive ore, and through which the spring water runs.—*A. J. S.*

178–328. Morinaga, Hiroshi. Radioactive springs in Japan: Okayama Univ. Balneological Inst. Pamphlet, 11 p., 1958.

Of the 8,452 springs on record in Japan up to December 1954, 3,719 have been chemically analysed; of these 139, or 3.74 percent, are radioactive. Most of them are radon springs, although some are high in thoron. Tables are given to show the temperatures and the amounts of radon, thoron, and radium in the waters of some of the better known radioactive springs. Extensive medical research is being conducted to determine the therapeutic value of the waters. It has been observed that fluctuations in the chemical contents of spring waters are caused by changes in weather, marked seasonal changes, and changes in the water level of the river.—*V. S. N.*

178–329. Shevchenko, N. F. K voprosu ob izmenenii soderzhaniya emanatsii v pochvennom vozdukhe [On the problem of variation in emanation content in soil air]: Sredneaziatskiy Univ. Trudy aspirantov, no. 5, p. 69–74, 1958.

Radon concentration in the soil air under conditions of the intensely continental climate of central Asia is a function of atmospheric pressure and wind velocity. Samples of soil air were taken from depths of 0.5, 1.0, and 1.5 m by a SG–11 apparatus. It was found that the concentration of radon in the soil air taken from a depth of 1.0 to 1.5 m decreases when atmospheric pressure increases, and vice versa.—*A. J. S.*

RADIOACTIVITY SURVEYING AND LOGGING

178–330. Melkov, V. G., and Pukhal'skiy, L. Ch. Poiski mestorozdeniy urana [Prospecting for uranium deposits]: Moscow, Gosgeoltekhizdat, 219 p., 1957.

The first part of the book presents the fundamental mineralogy and geology of uranium deposits. The second part is devoted to discussions of ground, carborne, and airborne methods of prospecting for uranium by various radiometric techniques, such as the emanation and gamma methods. Systems of radiometers and emanometers are described, and the necessary apparatus and auxiliary equipment are suggested.—*A. J. S.*

178–331. Ministerstvo Geologii i Okhrany Nedr. Radiometricheskiye metody poiskov i razvedki uranovykh rud [Radiometric methods of prospecting and exploration for uranium ore]: Moscow, Gosgeoltekhizdat, 610 p., 1957.

The first part of this book gives general physical and geological-geochemcial foundations of radiometric methods. The basic methods of radiometric laboratory and field measurements, data on designs of the instruments and apparatus, and the methods of interpretation of data are discussed in the second part. The third part is devoted to the field methods and techniques of radioactivity prospecting for uranium; and in the fourth part an application of combined geophysical methods under different conditions and at different stages of geological exploration for radioactive ores is given.—*A. J. S.*

178–332. Berbezier, J., Blangy, B., Guitton, J., and Lallemant, C. Methods of car-borne and air-borne prospecting: The technique of radiation prospecting by energy discrimination: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 799–814, 1958.

The experience of radioactivity prospecting by various French private and government groups is reviewed. It was found that the carborne prospecting equipment is much more sensitive than portable equipment; it is used in metropolitan France. Airborne operations are the rule elsewhere in the French Union.

Deformation of the spectra of anomalies as a function of the thickness of an air layer and of a water layer was studied experimentally and also calculated. The characteristic radiation from naturally radioactive elements that is least absorbed by the earth and air is as follows: for potassium, γ-rays of 1.46 Mev from potassium-40; for uranium, γ-rays of 1.76 Mev from radium-C (bismuth-214); and for thorium, γ-rays of 2.61 Mev from thorium-C'' (thallium-208).—*J. W. C.*

178–333. Grammakov, A. G., Kvashnevskaya, N. V., Nikonov, A. I., Sokolov, M. M., Sochevanov, N. N., Suppe, S. A., and Tafeyev, G. P. Some theoretical and methodical problems of radiometric prospecting and survey: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 732–743, 1958.

Theoretical problems of gamma logging and testing are discussed as well as problems relating to field radiometric methods. Graphs are presented showing the spectral distribution of scattered γ-radiation in water, sand, diorites, and pyrite ore. Ground gamma-prospecting requires recording both γ- and β-radiation where anomalous equilibria are present. The techniques of ground operations are also discussed. The emanation method is widely used; the emanation concentration is related by formula to rate of gas flux, diffusion coefficient of radon, radon decay constant, emanation of alluvia at surface, and change of emanation with distance. Scattering haloes above uranium deposits are discussed and three genetic types are illustrated; the agents producing the latter are denudation, solution by waters, and diffusion and convectional transfer of gases.—*J. W. C.*

178–334. Page, Lincoln R. Some new mineralogical, geochemical and geologic aids in uranium exploration: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d Geneva, 1958, Proc., v. 2, p. 123–125, 1958.

Disequilibrium relationships of radioactive isotopes may be used as a guide in prospecting for uranium deposits. Four general types of radioactive disequilibrium involving the uranium series have been found in deposits in sedimentary rocks. Type 1 has a deficiency of all daughter products, and U>ePa^{231}>eTh^{230}>eRa^{226}; type 2 has a deficiency of Th^{230} and generally eAc^{227}>U>eRa^{226}>>eTh^{230}; type 3 is almost entirely Ra^{226} and its immediate daughter products or combinations of Ra^{226} and Ra^{228} or Ra^{226} and Ac^{227}; and type 4 has a deficiency of uranium and much larger equivalent amounts of its daughter products. The significance of the various types with respect to the nature of the supergene activity is discussed.—*J. W. C.*

178–335. Moxham, R[obert] M. Geologic evaluation of airborne radioactivity survey data: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d Geneva, 1958, Proc., v. 2, p. 815–819, 1958.

Recent development of large-volume crystal detectors for aerial radioactivity surveying now permit geologic evaluation of regional surveys whereas previous methods were generally limited to direct ore-finding techniques. Tests with the new equipment and procedures were carried out in three areas.

A rectangle extending 150 miles inland from the Gulf of Mexico and containing commercial uranium deposits was flown along lines spaced at 1-mile intervals across the strike. Some units exhibit well-defined radiation patterns whereas others do not. It is notable that the most prolific aquifer in the Coastal Plain region, the Carrizo sand, is marked by a striking radiation low. Large radiation highs associated with ore deposits are believed to have originated by mechanical and chemical dispersion rather than by radon migration.

No manifestation of the uranium deposit associated with the Palangana salt dome, Texas, was recognized by the aerial survey.

Flight lines over the thorium beach placer at Anastasia Island, Florida, indicate that the best quantitative results can be obtained from lines at high angles of incidence to the trend of the deposit.—*J. W. C.*

178–336. Mårtenson, Carl. Prospekteringsinstrument för uran och torium [Prospecting instrument for uranium and thorium]: Geol. Fören Stockholm Förh., v. 81, no. 2, p. 399–400, 1959.

This is a brief description of the scintillation outfit 1181 B constructed by the Atomic Energy Research Establishment at Harwell, England, and of the Universal Logger Model 5 manufactured in the United States.—*D. B. V.*

178–337. Hartenberger, R. A. A radioactivity survey over Rose Dome, Woodson County, Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 219–224, 1959.

Two radioactivity traverses over Rose Dome indicated the presence of granite in the dome.—*A. J.*

178–338. Harrison, J. E., and Wells, J. D. Geology and ore deposits of the Chicago Creek area, Clear Creek County, Colorado: U.S. Geol. Survey Prof. Paper 319, 89 p., 1959.

This paper contains a short description of mines and mine dumps that contain radioactivity of at least twice the background on a rate meter with a 6-inch beta-gamma probe. Assay data are presented in a table.—*J. W. C.*

178–339. Bowie, S. H. U., Miller, J. M., Pickup, J., and Williams, D. Airborne radiometric survey of Cornwall: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 787–798, 1958.

A test airborne radiometric survey was undertaken in 1956 in Cornwall over a selected area of approximately 40 sq mi that had been previously surveyed in detail on the ground. All the known radioactive occurrences were detected during this survey and a number of new anomalies were found that had not been noted by the ground survey. The success of this survey led to a decision to survey a much larger area the following year; this second survey is the subject of the present paper.

Variations of gamma flux with height over a small source area and over an infinite plane source are discussed and presented on graphs. The instruments used are described and schematics given for four of them. The methods of surveying, reduction of data, interpretation of data, and correlation of airborne and ground observations are treated in separate sections of the paper. Four isorad maps are included.

The radioactivity data obtained have shown that a scintillation counter with a sensitivity of the order to 500–2,000 counts per sec at a height of 500 ft over average sedimentary rock is essential for locating smaller anomalies generally associated with outcropping or near-surface lodes.—*J. W. C.*

178–340. Lecoq, J. J., Bigotte, G., Hinault, J., and Leconte, J. R. Prospecting for uranium and thorium minerals in the desert countries and in the equatorial forest regions of the French Union: United Nations Internat. Conf. on the Peaceful Uses of Atomic Energy, 2d, Geneva, 1958, Proc., v. 2, p. 744–786, 1958.

A general discussion of exploration for radioactive deposits in the forbidding desert and forest areas of the French Union. Instruments and procedures are described.—*J. W. C.*

178–341. Afonin, V. I., Koposov, I. A., Romanov, Yu. A., and Chernyayeva, V. G. Opyt primeneniya nazemnoy radiometricheskoy s"yemki v Nizhnem Povolzh'ye i Predkavkaz'ye [Experience in the use of ground radiometric survey in the Lower Volga area and the Ciscaucasus]: Geologiya Nefti, no. 6, p. 48–52, 1957.

The results of a ground radiometric survey made in 1956 by the institute of petroleum of the Academy of Sciences of the U.S.S.R. in the Lower Volga and Ciscaucasus areas are presented. The instrument used was an AGR–SS–56 auto-γ-radiometer. Profiles across the Korobkov gas-oil field showed the presence of anomalously low values of γ-radiation over the deposits. Similar low values were recorded for the deposits of the Kazin fields. Both these fields occur on anticlines. An anomalously low γ-radiation is recorded over an area

that lies on the southeast flank of the Petrushin uplift; the meaning of this relationship has not yet been established. Increases in intensity of γ-radiation in passing from sandy to clayey rocks are also described.—*J. W. C.*

178–342. Yermakov, V. I., and Shatsov, A. N. Radiometricheskaya s"yemka v neftenosnykh rayonakh Zapadnoy Turkmenii [Radiometric survey in oil-bearing regions of West Turkmenia]: Geologiya Nefti, no. 8, p. 34–39, 1957.

The results of ground radiometric surveys in western Turkmen S.S.R. are reviewed. An auto-γ-radiometer, model AGR–SS–56, was mounted in an automobile that traveled 15–20 km per hr. The Kum-Dag and Kizyl-Kum oil fields were the main objects of exploration.

The Kum-Dag structure, a dome in Neogene sediments, was traversed on a 1,000 m grid. A zone of decreased values of γ-activity conforms to the oil deposit; this is shown on a map. The Kizyl-Kum field displays a similar correspondence.

Other factors besides oil exert an effect on the intensity of γ-activity. Lithology and surface features are reflected quite well in the background count. A map shows correlation of γ-activity with shorelines and terraces along the Caspian Sea. Another map shows how an increase in background is related to a facies change from sandy to clayey rocks.—*J. W. C.*

Agocs, W[illiam] B., Paton, J. R., and Alexander, J. B. Airborne magnetometer and scintillation counter survey over parts of Kedah and Perlis (area 6). See Geophys. Abs. 178–315.

178–343. Sano, Shun'ichi; Saito, Tomosaburo; and Hatase, Yasuhiko. Geophysical prospecting at placer deposits in Naegi region, Gifu Prefecture [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 9, no. 7, p. 17–22, 1958.

Radioactivity and magnetic surveys were carried out at Koketsu-yama and Nishi-obara in Fukuoka, Gifu Prefecture, Japan, for the purpose of locating placer deposits of radioactive minerals. No remarkable anomalies were found and geologic and mineralogic studies indicated no economic concentrations of radioactive minerals.—*V. S. N.*

178–344. Barsukov, O. A., Blinova, N. M., Vybornykh, S. F., Gulin, Yu. A., Dakhnov, V. N., Larionov, V. V., and Kholin, A. I. Radioaktivnyye metody issledovaniya neftyanykh i gazovykh skvazhin [Radioactive methods of investigation of oil and gas wells]: Moscow, Gostoptekhizdat, 314 p., 1958.

This is a textbook designed for students in the Soviet petroleum schools. It is well illustrated with diagrams, logs, detailed schematic diagrams of apparatus, tables, pictures, and equations. The introduction reviews the history of the development of radioactive logging. This is followed by chapters on the physical basis of radiometry of wells, radioactive properties of rocks, methods of radiometry of wells, radiometric apparatus, principles of the theory of the γ-method of investigation of wells, interpretation of the results of measurements by the natural radioactive method, interpretation of diagrams of the method of dispersed γ-radiation, principles of the theory of the neutron-neutron and the neutron-gamma methods of investigation of wells, interpretation of diagrams of the

neutron-neutron and neutron-gamma methods, use of the neutron methods for differentiating reservoirs according to oil and water saturation, method of operations and interpretation of diagrams of the tracer element methods, and use of radioactive methods in exploration and prospecting for other natural resources.—*J. W. C.*

178–345. Alekseyev, F. A. Ispol'zovaniye radioaktivnykh izlucheniy i izotopov v geologii nefti [Use of radioactive emanations and isotopes in the geology of oil]: Geologiya Nefti, no. 5, p. 1–12, 1957.

The present and potential uses of radioactivity logging are reviewed. The value of this method for wells that have been cased is emphasized. Subdivision of the section may be accomplished in some wells where electric logging falls short; this is particularly true where carbonates and salt are present. The water-oil and gas-liquid interfaces can be determined in cased wells during production. Radioactive methods are also used for study of the dynamics of subsurface water.—*J. W. C.*

178–346. Filippov, Ye. M. Issledovaniye spektra rasseyannogo γ-islucheniya v gornykh porodakh raslichnogo mineralogicheskogo sostava i razlichnoy plotnosti [An investigation of the spectrum of scattered γ-radiation of rocks of different mineralogical composition and different density]: Prikladnaya Geofizika, no. 19, p. 230–244, 1958.

Curves of the dispersion of γ-radiation in rocks are drawn on the basis of measurements on rocks of various compositions and density. The energy spectrum of scattered γ-radiation shows an accumulation of softer rays. A decrease of the effective atomic number and of the density of the substance produces a shifting of the spectrum toward smaller energies of scattered radiation and vice versa. An increase in density of the substance and in its effective atomic number causes a decrease in intensity of γ-radiation. In addition to soft rays the spectrum shows a considerable portion of rays with energies ranging from 1.25 to 0.212 Mev. Housings of gamma-gamma logging instruments should therefore be of materials which do not block the softer γ-rays (for instance duraluminum walls less than 1 cm thick or steel less than 0.6 cm thick). In such cases all γ-rays with energies down to 0.03 Mev will be registered. The use of the differential γ-spectrometers permits the distinguishing of rocks and ores according to their mineralogical content.—*S. T. V.*

178–347. Czubek, J., and Juber, A. Uwagi na temat ilościowej interpretacji krzywych profilowania gamma [Remarks on the subject of quantitative interpretation of gamma-logging curves (with English summary)]: Acta Geophys. Polonica, v. 7, no. 1, p. 41–49, 1959.

This paper presents a new method of evaluating the effect of absorption and radioactivity of drilling mud on gamma well logs. Two fundamental assumptions are made: that the mass attenuation coefficient is constant for all sedimentary rocks, and that the contribution to γ-ray intensity from the volume element of a rock (or drilling mud) is equal to the contribution to γ-ray absorption from this element. Formulas are derived for the activity of the drilling mud; graphs based on these formulas show the relationship of γ-ray intensity to mud density and absorption.

Calculation of the intensity in the borehole of the γ-rays of radioactive layers of thickness is simplified by assuming that there is no drilling mud in the bore-

hole; two formulas are given, valid for a point detector and for a detector of length l, respectively. These formulas can also be applied when mud is present in the borehole.—*D. B. V.*

178–348. Larionov, V. V. Vliyaniye pogloshchayushchikh svoystv kollektorov na opredeleniye ikh poristosti neytronnym gamma-metodom [Effect of adsorption properties of reservoirs on the determination of their porosity by the neutron-gamma method]: Geologiya Nefti, no. 9, p. 52–60, 1957.

The neutron-gamma method of well logging has encountered difficulties in porosity determinations due in part to the fact that adsorption of the reservoirs had been discounted. It had been assumed that in view of the anomalously high capacity of hydrogen to slow down neutrons, the principal effect on the readings is the deceleration properties of the rocks, that is, their hydrogen content. Studies by the Gubkin Petroleum Institute in Moscow show that the adsorption properties of rocks have a considerable, and in some cases decisive effect on the value of the intensity of the γ-radiation. The presence of chlorine in the rock has a particularly great effect.

Larionov concludes that readings by the neutron-gamma method are determined by two simultaneous and opposing factors; the slowing down and the adsorption properties of the rock. This limits the use of the method. With low mineralization of the formation water, in cases of its displacement by mud filtrate, and also where carbonates are being investigated, the main effect on the readings is the slowing properties of the rocks. In this case the estimation of the porosity ought to be made according to the hydrogen content. In sandy-silty sediments impregnated by highly mineralized formation water, the main effect on the readings is the adsorption properties of the rocks. There is almost a linear relationship between the porosity of these sediments and the neutron-gamma readings; an increase of porosity is accompanied by an increase in γ-radiation.—*J. W. C.*

178–349. Kron, F. Ts., Odinokov, V. P., Ovanesov, M. G., and Shcherbinskiy, V. G. Opredeleniye poristosti porod metodom neytron-neytronnogo karotazha po nadteplovym neytronam (NNK–N) [Determination of porosity of rocks by the method of neutron-neutron logging with epithermal neutrons (NNK–N)]: Geologiya Nefti, no. 10, p. 52–58, 1957.

Porosity determinations by electrical logging methods are not sufficiently accurate with certain muds or where the strata are oil-bearing. Neutron-neutron logging promises to overcome these difficulties. Laboratory investigations show that the relationship of the density of epithermal neutrons to porosity is exponential for both low and high porosities. The porosity readings are affected by an eccentric position of the instrument in the hole, by the layer of water surrounding the instrument and by the length of the sonde. The laboratory data are summarized on graphs.

The neutron-neutron method using epithermal neutrons (NNK–N) was field tested in the Bavly and Tuymazy oil fields. The value of this method for determination of porosity of carbonate rocks is emphasized. An NNK–N log is compared with more common logs for one well, and a graph illustrates the relationship of NNK–N readings to porosity.—*J. W. C.*

178–350. Burov, B. M., Darvoyd, G. N., and Kron, F. Ts. Metod neytron-neytronnogo karotazha dlya izucheniya geologicheskogo razreza skvazhin [Method of neutron-neutron logging for study of the geologic section of wells]: Geologiya Nefti, no. 12, p. 60–66, 1957.

Neutron-neutron logging (NNK) is based on the registration of the density of thermal and epithermal neutrons along the shaft of a well. This method has a number of advantages over the neutron-gamma method: NNK readings, particularly for epithermal neutrons, are more sensitive to the hydrogen present in the pores; the background of natural γ-radiation is not recorded; wells contaminated by radioisotopes can be logged; and small sondes can be used. Field testing of this method is described and examples of logs are illustrated. NNK logging is particularly useful for investigation of limestone sections, distinguishing of porous zones, and quantitative determinations of porosity.—*J. W. C.*

178–351. Oilweek. New nuclear log detects chlorine content in oil wells: Oilweek, v. 10, no. 15, p. 27, 1959.

A new nuclear logging system, designated as the "Spectral Log", is being successfully used to detect salt water behind the casing in oil wells and thus conversely detects the presence or absence of oil in a formataion. This information permits establishment of oil-salt water interfaces and transition zones even with chlorine concentrations as low as 12,000 ppm. The instrument consists of a highly sensitive down-hole nuclear spectrometer to measure the amount of secondary γ-ray emitted by the chlorine in the salt after neutron bombardment. When adjusted to detect only 7 Mev γ-rays, the instrument may be used as a continuous logging device to cover many formation zones.—*V. S. N.*

178–352. Gorskiy, Ya. Ya. Portativnyy gamma-karotazhnyy radiometr PGKR–57 [Portable γ-logging radiometer PGKR–57]: Razvedochnaya i Promyslovaya Geofizika, no. 27, p. 43–58, 1959.

The PGKR–57 is an improved modification of the PGKR model which was introduced in 1955. The instrument is designed for γ-logging of slim holes in areas of difficult accessibility. It can be used in boreholes of 2½ inch diameter at temperatures of 50°C and pressures of 75 kg per cm^2. The range of measurement is 750, 1,500, 3,000, 6,000, and 12,000 impulses per min. The probe is 4.5 cm in diameter, 145 cm long, and weighs 10 kg. A schematic and a cutaway diagram of the probe are given. A schematic diagram of the surface recorder is also given. Finally, the directions for operating the instrument are presented.—*J. W. C.*

178–353. Vaughn, W[illiam] W., Barnett, R. H., and Wilson, E. E. Drill core scanner proved in field: Mining Eng. v. 11, no. 6, p. 617–620, Tech. Paper 48021, 1959, also in Am. Inst. Mining, Metall., Petroleum Engineers Trans., v. 214, 1959.

A solid phosphor scintillation drill core scanner has been constructed and proven in the field to be a reliable and rapid method of scanning large amounts of drill core for radioactivity. The drill core is scanned as it is automatically moved through a high-sensitivity chamber and a continuous graph of radiation intensity along the length of the core is plotted. The equipment has the advantages of simple and automatic operation, high sensitivity, and low long-term

drift characteristics. A detailed description of the design and construction, the physical assembly, and the calibration of the instrument is given. The paper is well illustrated.—*V. S. N.*

SEISMIC EXPLORATION

178–354. Gamburtsev, G. A. Osnovy seysmorazvedki [The principles of seismic exploration]: Moscow, Gostoptekhizdat, 277 p., 1959.

This is the second edition of Gamburtsev's "Seismic methods of exploration" which appeared in two volumes in 1937 and 1938. This noted book was written as a textbook for students of geophysics and practicing geophysicists. It contained 16 chapters covering the theory of seismographs of different types, and of amplifiers, transducers, filters, and recording apparatus; discussion on the basis of geometric optics of the propagation of various seismic waves when undergoing reflection or refraction on plane and curved boundaries; different questions of the interpretation of traveltime curves of direct, reflected, and refracted waves; and other problems of seismic exploration. Characteristic of the book is the great number of pages devoted to the discussion of the theory of the instruments measuring different waves. In this section Gamburtsev also included a detailed and rigorous discussion of electromechanical analogues and of the application of this theory to the construction seismographs and to the interpretation of seismograms.

In the present edition, the entire material of the first edition is preserved and the value of the book substantially increased by the inclusion of some 15 articles written in recent years by Gamburtsev, or by Gamburtsev in collaboration with his colleagues at the Institute of Earth Physics, on different questions of the theory of instruments used in seismic exploration and on some new methods of exploration such as deep seismic sounding, high frequency seismic exploration, and several other important additions.—*S. T. V.*

178–355. Ballakh, I. Ya., and Mirchink, M. F. O vozmozhnosti primeneniya seysmorazvedki dlya pryamykh poiskov zaleszhey nefti i gaza [On the possibility of appplication of seismic surveying for direct prospecting for deposits of oil and gas]: Akad. Nauk SSSR Doklady, v. 126, no. 6, p. 1239–1241, 1959.

The effect of the presence of oil and gas in rocks on their elastic properties is examined mathematically. The values obtained suggest the possibility of delineating oil- and gas-bearing parts of a formation within the surrounding rocks on the basis of elastic properties. In this way seismic surveys can be used not only for exploring the structural shape, but also for direct detection of oil and gas pools and their outlines—in other words, for primary prospecting for oil and gas.—*D. B. V.*

178–356. Kirby, Calvin. Exact true dip for a single constant-velocity reflector: Geophysics, v. 24, no. 3, p. 598–603, 1959.

Methods are known for determining true dip or velocity or both when velocity is constant. The dip can be found exactly when the sines of the angles of dip are known for two spreads in line with the shotpoint and at right angles; an exact extension of this result to two spreads not at right angles is simple, although apparently the equations have not been published. A slightly more general case in which at least two detectors are assumed to be in line with the

shotpoint can also be solved by elementary means. The general case in which no two detectors are in line with the shotpoint has not been published.

For the special cases mentioned, a treatment is given in this paper that is more general inasmuch as the detectors are not required to be in a level plane, as in previous methods. The present work is general in part by being three dimensional and including the dip. The wave front is not assumed to be planar.

The number of independent measurements of generalized true dip at one shotpoint for a plane reflection is given by the number of combinations of n detectors taken four at a time. Six detectors, suitably spaced, provide 15 combinations. Improvement in precision of a single determination will be more profitable than increasing the number of combinations of detectors.—*D. B. V.*

178–357. Opitz, Dietrich. Über reflexionsseismische Geschwindigkeitsmessungen [On seismic reflection velocity measurements]: Zeitschr. angew. Geologie, v. 5, no. 5, p. 223–226, 1959.

The importance of accurate determinations of seismic velocities in reflection surveys for petroleum is emphasized. Zeuch's evaluation of relative error for different depths to the reflecting horizon and different geophone spacings is quoted, and finally two methods of determining velocities are outlined: Gurvich's method, which requires two boreholes (see Geophys. Abs. 161–75), and Opitz's, which requires only one well (see Geophys. Abs. 174–328).—*D. B. V.*

178–358. Hagedoorn, J. G. The plus-minus method of interpreting seismic refraction sections: Geophys. Prosp., v. 7, no. 2, p. 158–182, 1959.

This is an English version of the paper published earlier in Dutch in "Geologie en Mijnbouw", v. 20, no. 11, p. 406–417, 1958 (see Geophys. Abs. 175–367).—*D. B. V.*

178–359. Mining Engineering. Seismic analysis aids in overburden removal: Mining Eng., v. 11, no. 8, p. 803–804, 1959.

Seismic refraction surveying forms an inexpensive method of determining the consolidation, structure, and thickness of individual layers of overburden in surface mining operations. This seismic analysis makes it possible for the mine operator to select the most economical method of removing the overburden: dozing and scraper loading, ripping and scraper loading, or drilling and blasting for shovel loading.—*V. S. N.*

178–360. Zverev, S. M. Ispol'zovaniye zapisey zvuka dlya opredeleniya rasstoyaniy pri rabotakh po glubinnomu seysmicheskomu zondirovaniyu na more [The utilization of a sound recording for the determination of distances in deep seismic sounding operations at sea]: Akad. Nauk SSSR Izv. ser. geofiz., no. 4, p. 560–568, 1959.

During 1957 investigations by the method of deep seismic sounding were carried out over the southern portion of the Sea of Okhotsk and adjacent part of the Pacific Ocean. The method of movable shot points and fixed observation points was used. The distance between the shot points was kept about 5 km; the charges were 100 kg of TNT. The frequency of sound waves ranged from 25 to 200 cycles per sec. Zverev presents a detailed analysis of sound trajectories determined by the depth of the ocean and the distance between the ships, taking into account the variation of the velocity from 1,450 kmps near the

open surface of water to 1,500 kmps at a depth of 5.8 km. In some cases the sound waves were observed 66 km from the shot point. It was possible to determine distances with an error not exceeding 0.4 percent. With certain simplifications of the procedure the accuracy of the measurements was still as high as 0.7 percent.—*S. T. V.*

178–361. Sergeyev, L. A. Ul'trazvukovoye ekholotirovaniye dlya geofizicheskikh tseley [Ultrasonic echo sounding for geophysical purposes]: Prikladnaya Geofizika, no. 20, p. 141–154, 1958.

An improved method of ultrasonic echo sounding for better interpretation of reflections from sediments on the sea floor is described. Echo-sounding devices NEL–3 and NEL–4 with magnetostriction emitters and receivers of the band type were used. A schematic diagram of the NEL–3 is given. The echo-sounding operations were carried out in conjunction with electrical profiling; comparison of the data derived by the two methods is presented in a graph.

The ultrasonic signal reflected from the sediment of the sea floor is distinctive of the composition of the sediment. Examples of signals are given for gravels, gravel-pebble beds, sands, and clays; these differ markedly from one another. The experiments indicate that the upper 10 m of the sediments on the sea floor can be studied very well by a combination of echo sounding and electrical profiling.—*J. W. C.*

178–362. Oklahoma Geophysical Society. Symposium on continuous velocity logging: Shale Shaker, v. 9, no. 9, p. 3–21, 1959.

The symposium includes the six papers abstracted below; results of a discussion period and a selected bibliography on acoustic logging are included at the end.

a. Breck, Howard R. Continuous velocity logging method: p. 3–4. This is essentially a review of the papers by Summers and Broding, and Vogel on velocity logging methods published in Geophysics, v. 17, no. 3, 1952 (see Geophys. Abs. 150–13964, –13965).

b. Robinson, W. B. Presentation of a velocity mis-tie: p. 7–9. Continuous velocity logs covering most of the Springer shale section of the Gulf Daisy McKinney well, Anadarko basin, Oklahoma, are presented and discussed as an illustration of a mistie, that is, a disagreement between the CVL and standard seismic velocity survey check shots. The error in the CVL is ascribed to swelling and flaking of the shale as the montmorillonite in the shale absorbs water from the drilling fluid. This error in the continuous velocity log points up the importance of making check shots. Two factors are necessary for accurate check shots: good sharp arrivals on the seismic record and precision in depth measurements.

c. Nolting, Robert P. Areas where mis-tie occurs between two-receiver velocity log data and check shot data: p. 10–11. Three general areas which tend to show shale damage type error and where selection of a proper two-receiver tool is necessary to insure correct analysis of velocity variations are: the Anadarko basin, the gulf coast from western Florida to southern Texas, and the northern and western fringes of the central basin platform in western Texas and eastern New Mexico.

d. Broding, R. A. Possible causes of velocity mis-ties: p. 12–13. The most potential sources of error in CVL are in the sonde position in the hole and the acoustic hole diameter for a given transmitter-to-first receiver spacing. Any

differences in log data in excess of 2 percent are considered to be in error and careful appraisal of the log data with the check shots will generally indicate the sources of the error.

e. Kokesh, F. P. Limits of accuracy of present sonic logging equipment: p. 15–16. Discusses hole conditions, instrumentation, and the human element as sources of error in sonic logging. Present sonic equipment is capable, under favorable field conditions and with proper operation, of measuring total travel time across a section of open hole with an error of no more than 1 percent.

f. Hicks, Warren [G.]. Adjustment of velocity logs to tie geophone surveys: p. 17–20. Two methods of adjusting velocity logs to geophone survey are presented: the parallel shift method of adding a constant time shift to the log to force it to conform; and the multiplier method of introducing a multiplier term rather than an additive term as in the former method.—*V. S. N.*

178–363. Puzyrev, N. N. Izmereniye seysmicheskikh skorostey v skvazhinakh [Measurement of seismic velocities in boreholes]: Moscow, Gostoptekhizdat, 80 p., 1957.

The problems related to the measurement of propagation velocities of elastic waves in rocks by means of borehole seismographs are discussed in detail in this book. The observation methods are based on the recording of the first arrivals received by seismographs placed in the borehole at different depths. The necessary data on the theory of vertical traveltime curves, and on the methods of observation with the standard instrument now in use are given; and the problems of interpretation and evaluation of the records, obtained in regard to their accuracy are discussed in detail. The book is intended for engineers and technicians of geophysical services in the oil industry.—*A. J. S.*

178–364. Zhbanov, G. I. Seysmokarotazh vzryvnykh skvazhin pri pomoshchi udara [Seismic logging of shot wells by means of a hammer]: Razvedochnaya i Promyslovaya Geofizika, no. 27, p. 14–18, 1959.

Knowledge of the velocity of seismic waves in the upper part of the section is very important for working out gentle structures. Such knowledge can be gained by seismic logging of shot wells. Zhbanov reverses the usual procedure by placing the geophones 3 m apart on a cable down the well and supplying an impulse from the surface in the form of a blow from a 15-kg hammer at 5 m from the well. Seismograms and traveltime curves are presented which indicate that the method works well.—*J. W. C.*

178–365. Hicks, Warren G. Lateral velocity variations near boreholes [with discussion]: Geophysics, v. 24, no. 3, p. 451–464, 1959.

Difficulties occur in obtaining accurate two-receiver velocity logs in formations sensitive either to damage by exposure to drilling mud or to mechanical stress relief. Some shales are so altered by the drilling operation that their elastic properties are modified. Vertical velocity measured immediately adjacent the boreface is lower than if it were measured at a greater radial distance from the bore. These damaged shales require relatively deep penetration by the acoustic signal; consequently, the transmitter-to-first-receiver spacing in a two-receiver velocity logging system should be long enough to refract the sound waves through virgin formation. Experiments in one predominantly shaly section show a difference of almost 10 percent between times measured using

transmitter-to-first-receiver spacing of 4.3 ft compared to 8.8 ft. A limited amount of field data suggest that sodium montmorillonite is the clay type most sensitive to hydration and swelling. Studies of areal prevalence of the shale damage problem are incomplete.—*Author's abstract*

178–366. Holste, W. Problems and results with refraction seismics in boreholes (Determination of salt-flanks and other interfaces) : Geophys. Prosp., v. 7, no. 2, p. 231–244, 1959.

Recently, quite good determinations of interfaces have been made by means of seismic well surveys. These were carried out for various oil companies in northwest Germany, especially on salt domes, and in southern Germany, and in the area of the Upper Rhine Valley. It was the purpose to determine the configuration and position of salt flanks and important planes of stratification in the neighborhood of deep wells, and thus to reduce the risk of expensive wells.

For the delineation of the boundary surfaces the method described by Gardner in "Geophysics 1949" was applied.

The problems arising and the results obtained are discussed in connection with some interesting examples. From them we see, above all, that a knowledge as precise as possible of the seismic velocities of all media involved in the measurement is very important. A good idea of the general stratification in the area of deep wells seismically surveyed will make possible a rational and adequate planning of the survey program and will facilitate the interpretation.—*Author's abstract*

178–367. Pickhardt, H. E., and Holly, L. M. Sonic log proves valuable porosity tool: World Oil, v. 149, no. 4, p. 65–68 and 120, 1959.

The sonic log has become an established method of well logging in the Oklahoma and Kansas areas. Porosity is determined effectively; a linear relationship between porosity and the recorded curve facilitates computation in both high and low porosity ranges. Formation changes are delineated sharply and correlations are good.—*J. W. C.*

178–368. Howell, Benjamin F., Jr. Ground vibrations near explosions II: Earthquake Notes, v. 28, no. 4, p. 21–28, 1957.

This paper is a continuation of previous work by Howell and others (see Geophys. Abs. 140–11822, 159–125, 160–89, 164–279). The objective of the program was to obtain an increased understanding of the generation of seismic pulses and of the manner of their transmission in the first few hundreds feet from the source. Emphasis was on three phases of the problem: the variation of seismic pulse shape with distance from the explosion; the effect of depth of burial of the charge on the pulse generated; and division of seismic energy into separate pulses such as compressional, shear, Love, and Rayleigh waves. Explosions of dynamite were used to generate the waves, and all experiments were conducted in the field under natural conditions. Data derived from the experiments emphasize the important role played by the weathered layer both in generation and transmission of seismic waves; even a few tens of feet of transmission through the weathered layer can greatly alter the character of a seismic pulse.—*V. S. N.*

178–369. Latter, A. L., Martinelli, E. A., and Teller, E. Seismic scaling law for underground explosions: Physics of Fluids, v. 2, no. 3, p. 280–282, 1959.

Observations indicate that the amplitudes of distant seismic signals from underground nuclear explosions are approximately proportional to the total energy release. It is shown that these observations can be accounted for by a simple model which assumes that the nonlinear region close to the explosion is similar for all explosions and that the linear region transmits only low-frequency waves.—*Authors' abstract*

Mark, J. Carson. The detection of nuclear explosions. See Geophys. Abs. 178–108.

178–370. Kupalov-Yaropolk, I. K. Vzryvnyye raboty pri seysmicheskoy razvedke [Explosion work in seismic exploration]: Moscow, Gostoptekhizdat, 146 p., 1958.

This book contains general information on geology, geophysical methods of exploration, and the use of explosives in seismic exploration. Explosives, their properties, and application in seismic exploration are discussed, and regulations for their safekeeping, transportation, and deactivation are given.—*A. J. S.*

178–371. Hammond, Joseph W., and Hawkins, James E. Getting the most out of present seismic instruments: Geophysics, v. 23, no. 4, p. 795–822, 1958.

Much of the present seismic work is being carried out in areas where results are difficult to obtain. The paper outlines the requirements for seismic instruments for these operations. The particular characteristics desired for specific problems are illustrated, and the instrument factors that affect these characteristics are outlined. Examples of the effect of instrument adjustment are shown. The attainment of optimum results with present equipment under diversified field conditions may require modifications according to area, in shooting techniques, geophones, amplifiers, galvanometers, recording, and record presentation. The discussion of the advantages of magnetic recording assumes that the best field techniques have been applied.—*Authors' abstract*

178–372. Gurvich, I. I. O chastotnoy selektsii seysmicheskikh kolebaniy [On the frequency selection of seismic oscillations]: Ministerstvo Vyssh. Obrazovaniya SSSR, Izv. Vyssh. Ucheb. Zavedeniy, Geologiya i razvedka, no. 8, p. 110–125, 1958.

The theory and methods of frequency selection in recording seismic oscillations, in order to detect the useful wave against the background of interference, are discussed on the basis of signal transformation in a seismic wave guide. The problem was worked out earlier by Antokol'skiy, Frank, and Ricker (see Geophys. Abs. 132–9777, 154–14665, 155–14870). It was found that the optimum amplitude resolution of a seismic record is achieved when the intensity of the signal on entering the wave guide is equal to the square of the maximum ratio of the amplitude spectrum of the useful waves to that of the interfering waves.—*A. J. S.*

178–373. Yepinat'yeva, A. M., and Ivanova, L. A. Primeneniye vysokochastotnykh fil'tratsiy dlya podavleniya mnogokratnykh otrazhennykh voln [The use of high-frequency filters for the suppression of multiple reflections]: Akad. Nauk SSSR Izv. ser. geofiz., no. 3, p. 361–371, 1959.

The results of the use of high-frequency filters in seismic investigations of regions characterized by the appearance of multiple reflections are presented. Medium- and high-frequency recording stations were used. Yepinat'yeva and Ivanova present the following summary of their work. The use of high-frequency filters considerably decreases the intensity of different types of multiple reflections. Some high-frequency filters suppress almost completely the strongest doubly reflected waves and some of the multiple reflections. The set of filters provided for an average medium-frequency station does not suffice to suppress all multiple reflections. One of the factors producing the suppression of multiple reflections by high-frequency filters is the difference in the frequency spectra of singly and multiply reflected waves. The suppression of strong multiple reflections by the use of high-frequency filters makes possible to bring forth more details as well as to reach greater depth of the surveying. The article contains numerous reproductions of seismograms obtained under various conditions of recording.—*S. T. V.*

178–374. Oilweek. "Sparker" powerful tool in seismic exploration: Oilweek, v. 10, no. 26, p. 17–18, 1959.

The "Sparker", a marine exploration tool, is being used this summer to cover more than 1,000 miles of rivers and lakes in the Northwest Territories of Canada. The instrument provides a continuous and detailed geological profile to a depth of from 400 ft to 1,200 ft beneath the surface of the water, as well as an accurate profile of the river or lakebed; it works by recording sound waves from a 12,000-volt electric spark unit which is towed with the hydrophone; it weighs 900 lb, requires a two-man crew, and can be used in comparatively small boats. Because of its limited depth penetration it is considered to be complementary to rather than competitive with seismic shooting.—*V. S. N.*

178–375. Woollard, G[eorge] P[rior], Bonini, W[illiam] E[mory], and Meyer, R. P. A seismic refraction study of the sub-surface geology of the Atlantic Coastal Plain and Continental Shelf between Virginia and Florida: Univ. Wisconsin Dept. Geology, Geophysics Sec., Tech. Rept., Contract no. N7onr–28512, 128 p., 1957.

Under contract with the Office of Naval Research, the University of Wisconsin during the middle 1950's made a seismic refraction study of the configuration of the basement rock surface beneath the Atlantic coastal plain of North Carolina, South Carolina, and Georgia. This study constitutes one part of a larger integrated program of gravity, seismic, magnetic, and geologic subsurface studies of an area that apparently is being actively deformed.

Locations of seismic stations and of deep wells to basement are shown on an outline map of the three states. Other pertinent station and well data are tabulated, and traveltime curves are given in an appendix. The seismic refraction method, the observational procedure, the reduction of raw data, and the method of computation are described.

The results of this seismic study combined with those of other investigators and deep-well data are compiled in a map showing the pre-Cretaceous surface

beneath the entire Atlantic coastal plain from the Grand Banks of Newfoundland to the Mississippi Embayment in the gulf coast. The general lithology of the basement rocks is also indicated.—*A. J.*

178–376. Glover, Robert H. Techniques used in interpreting seismic data in Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 225–240, 1959.

Eight problems, or conditions, in Kansas that introduce errors into conventional seismic methods of computation are: irregular topography, varied outcropping formations, thick Pleistocene or Tertiary mantle, regional lateral velocity changes, the Wellington salt, the Blaine salt, reference plane relief, and the Arbuckle unconformity. Although many of the problems of seismic interpretation cannot be solved by any single method, eight methods employed in Kansas are discussed, giving the advantages and disadvantages of each and the limit of error involved.—*A. J.*

178–377. Brewer, Ralph R., Jr. A geophysical case history of the Lindsborg pool, McPherson County, Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 287–295, 1959.

The Lindsborg pool, on the southern edge of the Salina basin, was discovered through seismic exploration in 1938. Its discovery indicated that there were other accumulations of oil in the Salina basin and that it was possible to discover them by seismic surveys.—*A. J.*

178–378. Care, John L., Brooks, Lee, and Wallace, Charles H. Geophysical case history of the Engel pool, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 281–286, 1959.

The Engel pool on the central Kansas uplift was discovered through the seismic method, using a 20-acre grid pattern and isotime maps.—*A. J.*

178–379. Beebe, B. W. A case history of the Koelsch Southeast pool, Stafford County, Kansas, a study in microseismics, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 249–274, 1959.

After unsuccessful seismic surveying over a period of more than 25 years, the Koelsch Southeast pool was discovered in 1952 through the combined efforts of geologists and geophysicists using a correlation method of seismic investigation. The investigation is described. The report is accompanied by 12 large scale maps of the area, which permit comparison and correlation of various subsurface geologic and seismologic data. Also shown are comparisons of electric log and seismic records.—*A. J.*

178–380. Brewer, John E. Geophysical problems on Pratt anticline, Pratt County, Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 275–280, 1959.

Three major problems are encountered in a geophysical program in Pratt County: the selection of a suitable reference plane marker for isotime mapping, correct correlation of reflections where section thickening produces additional reflections, and correct correlation of reflections in areas of complex faulting and truncation. The base of the Wellington salt was found to be a stable marker

for isotime mapping. The other two problems can best be solved by construction of subsurface isopach maps encompassing the interval from the Lansing to the Arbuckle and structure contour maps on the Arbuckle. For areas of poor record quality, suspected faulting, or rapid thickening, continuous profiling should replace spot correlation shooting.—*A. J.*

178–381. Rupnik, John J. Case history of the Dunes pool, Pawnee County, Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 297–308, 1959.

The Dunes pool was discovered in 1953 as a result of coordinated subsurface and seismic exploration. Beginning in 1951 an initial reconnaissance network of correlation shotpoints was laid out and shot throughout a large part of Stafford and Pawnee Counties, including shotpoints especially placed to provide seismic tie points to the various test wells. Several time-interval maps were made, two of which are presented in this report.—*A. J.*

178–382. Smith, M. W. History of the Windom pool, McPherson and Rice Counties, Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 309–320, 1959.

The Windom pool was discovered in 1953 through the use of continuous seismic profiles to localize a suspected anticline. Since discovery the pool has been mapped in detail by seismograph closely correlated with a drilling program. The success of this procedure is demonstrated by a record of 27 producing wells as against 4 dry holes.—*A. J.*

178–383. Bass, B. L., and Lukert, L. H. Geophysical history of the Fall Creek pool, Sumner County, Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 321–333, 1959.

The Fall Creek pool was discovered in 1950 through a semidetailed continuous profiling seismic survey. The report includes a combined stratigraphic section and composite well log, reflection seismic maps, isochrone maps, subsurface structure maps, isochore map, and a subsurface geologic cross section.—*A. J.*

178–384. Winchell, Richard L. Law Southeast pool—a successful seismic discovery in Graham County, Kansas, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 335–349, 1959.

The Law Southeast pool was discovered in 1955 as a result of seismic exploration. The report includes nine maps—structural, seismic, isotime, and isopach—and several well logs; it compares seismic interpretation before drilling with geologic interpretation after drilling to show successful results of seismic exploration.—*A. J.*

178–385. Koester, Edward A. A successful seismic program on the Central Kansas Uplift, *in* Symposium on geophysics in Kansas: Kansas Geol. Survey Bull. 137, p. 351–355, 1959.

A successful geophysical exploration program conducted in 1935 and 1936 in Ellis, Rooks, Trego, and Rush Counties resulted in the discovery of 14 oil pools.—*A. J.*

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178–386. Widess, M. B., and Taylor, G. L. Seismic reflections from layering within the Precambrian basement complex, Oklahoma: Geophysics, v. 24, no. 3, p. 417–425, 1959.

Reflections from within the Precambrian basement complex were recorded in the vicinity of the Wichita Mountains in southwestern Oklahoma. The reflections, of good quality and persistence, depict a section in excess of 20,000 ft of igneous rocks that appears like a seismic section of sedimentary formations.

A well in the area drilled 4,000 ft of this Precambrian section, encountering alternating layers of silicic and gabbroic igneous rocks exhibiting high contrast in density. Precambrian outcrops of much of the Wichita Mountains, comprising comparable types of rocks, display sheetlike, gently dipping layers, some of which persist for several miles. The seismic reflections are thus produced by the igneous layers of differential acoustic properties. An abrupt change of direction of dip occurring at about mid-depth of the seismic section precludes the possibility that the seismic events are multiple reflections.—*Authors' abstract*

178–387. Biggs, W. P. Sonic logging in South Texas: Gulf Coast Assoc. Geol. Soc. Trans., v. 8, p. 34–39, 1958.

The Sonic Log has proven itself a valuable aid to reservoir evaluation and fluid detection in South Texas. Use of the short-spacing, two-receiver device provides a sharply detailed, continuous velocity log that is not affected by hole size or mud type. Porosity resolution of the Sonic Log is excellent, particularly in limestone and compacted sand formations. The linear relation between porosity and the recorded interval transit time facilitates scaling and reading of the log. In the less consolidated zones, corrections are applied for lack of compaction, presence of hydrocarbons, and presence of shale. In high porosity sands of South Texas, gas saturation has been strikingly indicated by cycle skipping. Also in these zones, a qualitative comparison of resistivity measurements and formation velocities has readily distinguished gas, oil, and water levels.—*Author's abstract*

178–388. Wood, A. B. A comparison of well velocity methods in South Texas: Geophysics, v. 24, no. 3, p. 443–450, 1959.

This velocity study is limited to data from one well in South Texas. Two short-interval velocity logging methods compared with conventional seismic geophone data show large discrepancies. The Shell short-interval velocity log agrees within close limits to the conventional seismic data except for the lower 4,000 ft. The indicated delay times for the upper 2,000 ft of this 4,000 ft interval are short by 6.5 percent, and indicated delay times for the lower 2,000 ft are short by 4.0 percent. The Schlumberger Sonic Velocity Log, limited in this survey to the bottom 4,200 ft of hole, indicated delay times larger than the seismic time by more than 5 percent. There is a difference of approximately 9 percent between the two velocity logs, even though the tools were of similar dimensions. The spacing between detectors was 3 ft, and the distance from transmitter to near receiver was 4 ft for the Shell tool and 3 ft for the Schlumberger tool.

An analysis of the basic data is necessary to resolve these discrepancies. There is no check on the Sonic data in its present form, but a thorough study of the Shell Oscillogram Log and conventional seismic data for errors fails to explain the 6.5 percent and 4 percent discrepancies in the Shell short-interval velocity data. The conclusion must be drawn that these discrepancies are real.

This survey demonstrates the necessity to check short-interval velocity logging with conventional seismic shots to maintain acceptable seismic well velocity standards.—*Author's abstract*

178–389. Blundun, G[eorge] J. The Mississippian in the Alberta plains and the reflection seismograph: Geophysics, v. 24, no. 3, p. 426–442, 1959.

Mapping of the eroded Mississippian surface, the major unconformity in the province of Alberta, is very important because the Mississippian may be productive of hydrocarbons or may cloak the attitude of deeper, possibly producing sediments. This paper suggests techniques of recording and presentation of reflection data for the definition of this surface.

To obtain best quality data, the recording instruments should be operated with as little activation of automatic volume control as possible, a reasonable broad filter pass band, and minimum-size dynamite charges; playback sections from magnetic tape should be most useful. A regionally correct depth map of the surface should be constructed, measured in feet. Evidence of thinning of the Cretaceous coincident with erosional highs should be sought by reference to at least the Colorado-Mississippian isopach. An Elkton or Post-Shunda thickness map should be constructed for evaluation purposes. Adequate reflection seismic control is mandatory.—*D. B. V.*

178–390. White, R. J., and Charles, W. W. The Innisfail oil field—a case history: Alberta Soc. Petroleum Geologists Field Conf., 8th, p. 129–148, 1958.

A seismic reflection survey in conjunction with subsurface geologic studies led to the discovery in June 1958 of the Innisfail oil field between Edmonton and Calgary in Alberta, Canada. The geology, exploration, development, and reserves are discussed.—*V. S. N.*

178–391. Higgins, G. E. Seismic velocity data from Trinidad, B.W.I., and comparison with the Caribbean area: Geophysics, v. 24, no. 3, p. 580–597, 1959.

The results of velocity surveys on four deep (±10,000 ft) wells in Trinidad are reported, together with summaries of lithologic and stratigraphic data for the wells. An unusual velocity inversion of 5,000 ft per sec is reported in one well (Moruga 15) between 2,500 and 5,000 ft depth. The recorded data from the well surveys and from refraction surveys shot near the metamorphosed Northern Ranges in Trinidad are compared with published data on refraction surveys in the Caribbean Sea, the Venezuelan waters near Trinidad, and Barbados [see Geophys. Abs. 172–212], and with the results and refraction surveys in British and Dutch Guiana; possible correlations are pointed out.—*D. B. V.*

178–392. King A. J. Geophysical surveys on the Lupa goldfields in 1955 and 1956: Tanganyika Geol. Survey Recs., v. 6, p. 64–68, 1956 (1958).

Seismic and resistivity surveys were made in the area of the Lupa goldfields in Tanganyika for the purpose of locating drainage channels which might carry placer gold deposits, now buried under the superficial cover of remnants of old land surfaces. No buried channels were found and it is unlikely that channels of large enough dimensions to be of economic importance could remain undetected by the surveys.—*V. S. N.*

178–393. Dunoyer de Segonzac, P., and Laherrere, J. Application of the continuous velocity log to anisotropy measurements in northern Sahara; results and consequences: Geophys. Prosp., v. 7, no. 2, p. 202–217, 1959.

Anisotropy measurements were carried out in two wells 300 km apart in the northern Sahara in order to improve the intrepretation of seismic refraction surveys. The measurements were based on the shortening of experimental oblique travel times with respect to theoretical travel times computed by disregarding anisotropy. As exact knowledge of velocity distribution was required to eliminate all influence of refraction, a continuous velocity log was indispensable. Results in the two wells agreed, showing that anisotropy is essentially a function of lithology.

From the values obtained (sandstones and sands, $k=1$; salt, $k=1.00$–1.05; limestone, $k=1.08$–1.12; anhydrite, $k=1.15$–1.20), it is shown that in refraction surveying, depths computed without anisotopy are too small by 8 to 9 percent (about 300 m) and error on offsets may reach 70 percent, and that satisfactory depth computations may be made on the basis of anisotropy factors assigned at sight of lithology. For reflection work, it should be noted that velocity profiles yield velocities closer to horizontal than to vertical velocities. Both refraction and reflection interpretation are significantly influenced by high-velocity, highly anisotropy formations such as anhydrite.—*D. B. V.*

178–394. Cassinis, R. Geophysical exploration of sulphur limestone in Sicily [Italy], *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 157–169, 1958.

The sulphur deposits in Sicily occur in a geological series comprising gypsum and limestone layers. Geophysical methods have been applied to determine the depth and the configuration of these layers. The methods used are the electrical sounding method, the reflection seismic method, and the refraction seismic method to correlate the reflecting layers with the outcrops. The application of these methods and their results are illustrated by two examples.—*Author's abstract*

178–395. Vecchia, O[rlando]. Geophysical surveys for a dam at the Lake of Molveno (Venetian Alps, Italy), *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 248–261, 1958.

The lake's outlet and its surroundings were surveyed by seismic refraction. While it was hoped to find the bedrock very near to the surface its depth proved to be 100 m and more. The seismic survey was extended also under the lake, when this had been emptied, but the bedrock was found to be here even deeper than the lake's bottom.

Attempts were also made to ascertain the permeability of the overburden, which is responsible for maintaining the level of the lake, in order to investigate subterranean losses. During the refilling of the lake, vertical resistivity measurements were made in 4 points along the planned axis of the dam and were repeated 10 times each, viz. every 9 m of rise in the level of the lake. The electric measurements showed that the lower part of the overburden is not made of glacial clay as was hoped.

Two galleries and many wells confirm the results obtained by the seismic surveys and by the electric measurements.—*Author's abstract*

178–396. Mathiez, J. P., and Astier, J. L. Sault-Brenaz damsite refraction seismic survey, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 232–237, 1958.

In the upper Rhone valley a damsite survey was carried out by seismic refraction prospecting in order to determine the contours of a limestone bedrock under the alluvial overburden. The velocity in alluvium being about 2,000 m per sec and in limestone 5,000 m per sec, these conditions were especially favorable for the application of refraction seismic exploration.

Two buried canyons were surveyed on a total length of 2 km and a third one was discovered. These channels are over 50 m deep and their width is often only about 15 m. About 600 m upstream from the former boreholes, three new holes were drilled on a 60 m long profile. Two of them encountered limestone at depths of less than 15 m, while the third one was stopped at 53 m still in alluvium, thus confirming the geophysical results.—*Authors' abstract*

178–397. Riel, W. J. van. The exploration of a Dutch coal basin, a historical review, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 138–156, 1958.

This is an English version of the paper published in Geologie en Mijnbouw, v. 19, no. 3, p. 53–61, 1957 (see Geophys. Abs. 169–140).—*D. B. V.*

178–398. Wyrobek, S. M. Well velocity determinations in the English Trias, Permian and Carboniferous: Geophys. Prosp., v. 7, no. 2, p. 218–230, 1959.

To obtain inferences useful in predicting the overburden velocities, a statistical study of velocity data was undertaken on 46 well velocity surveys confined mainly to eastern England. Five formations were particularly studied: Keuper, Bunter, Permian, Coal Measures, and Millstone Grit. Their interval velocities plotted against the mean depth of the interval below the surface supplied five equations of the form $V=k\cdot H^{1/n}$, which cover the range of depth explored down to 7,000 ft. Comparison of these results shows that the interval velocities increase with depth and in the Keuper and Permian attain a maximum value nearly twice that in the remaining three formations. The interval velocities of these formations are confined within a relatively narrow band of 9,000–12,000 ft per sec and the formations cannot be distinguished satisfactorily by their interval velocities alone. More practical results were obtained considering the relation between the vertical time and depth to the top of the Permian, Coal Measures, Millstone Grit, and Carboniferous Limestone. For each of these a linear relation $T=k\cdot H+T_o$, was obtained from which the vertical time T can be predicted from the known depth with a probable error of $\pm$ 4 millisecs.—*Author's abstract*

178–399. Wilson, C. D. V. Geophysical investigations in the Vale of Clwyd: Liverpool and Manchester Geol. Jour., v. 2, pt. 2, p. 253–270, 1959.

A seismic refraction survey was made in the Vale of Clwyd, which extends from northwest of Ruthin to Rhyl in North Wales, and three of the four seismic lines were coordinated with an earlier gravity survey by Powell (see Geophys. Abs. 164–172). Seismic results show three layers below the drift: Triassic, Upper Carboniferous, and Carboniferous limestone, respectively. The Vale of

Clwyd fault bordering the northeast margin of the vale is shown to be continuous, but a series of north-trending normal faults on the west margin divide the vale into several basins of Triassic sediments.

Detailed analysis of results where a seismic line crossed one of the faults shows that travel times can be explained by the simple ray theory and that throw and dip can be found within close limits if it is a single fault; if there are several closely spaced step-faults, however, the nature of each is obscure.—*V. S. N.*

178–400. Ruehmkorf, N. A. Prospection séismique en Campine belge [Seismic prospecting in Belgian Campine]: Annales des Mines de Belgique, no. 5, p. 535–542, 1959.

A seismic survey was carried out in the Campine area of Belgium, a coal district. Several seismic profiles are presented and discussed. The examples cited indicate that only one reflecting horizon is persistent throughout the area; this is the base of the Tertiary. The base of the Cretaceous, Red Beds, and Carboniferous have no notable or constant quality. In order to recognize these latter horizons, other characteristics such as stratigraphic discordance or velocity of refracted waves must be used.—*J. W. C.*

178–401. Welin, E. Seismic refraction survey of a hydro-electric plant site in northern Sweden, *in* Geophysical surveys in mining, hydrological and engineering projects: Leiden, European Association of Exploration Geophysicists, p. 262–270, 1958.

The seismic method for depth-to-bedrock determination has during the last decade had an ever-increasing and widespread application in Sweden, especially as a reconnaissance method for the advance planning of hydroelectric projects. This paper described such a survey which was carried out for a projected power plant at Gulsele in northern Sweden. Three alternatives for tunnel lines and damsites were surveyed, the total length of profile investigated amounting to 16 km. Some twenty holes were then drilled through the glacial drift (depths down to 19 m) and into the bedrock, affording a good confirmation of the results of the seismic work. The costs for the power station amount to $12 million of which only $12 thousand (0.1 percent) are costs for the seismic investigation. Through this comparatively small expenditure it was possible to choose the best alternative for tunnel line and damsite.—*Author's abstract*

178–402. Shneyerson, M. B. K otsenke tochnosti raznostnogo sposoba interpretatsii dannykh KMPV v usloviyakh Russkoy platformy [Evaluation of the accuracy of a differential method of interpretation of data of KMPV under the conditions of the Russian platform]: Razvedochnaya i Promyslovaya Geofizika, no. 27, p. 3–14, 1959.

Use of the refraction correlation method in the eastern regions of the Russian platform has demonstrated the advantage of this method over the reflection method for exploration of gentle structures. This paper attempts to evaluate the accuracy and usefulness of a differential method of interpretation of refraction correlation data. Two varieties of the method are examined. The first is based on interpretation of reduced traveltime curves, obtained by subtracting the normal traveltime curve from the observed traveltime curve; this method

was used largely in treatment of transverse traveltime curves of refracted waves. The second consists of construction of lines t_o for two waves and then lines of difference of t_o; the change of thickness of the bed between the two refracting boundaries is determined according to the change of the difference of t_o.—*J. W. C.*

178–403. Klubov, V. A. Effektivnost' seysmorazvedki v zapadnoy Bashkirii i vostochnoy Tartarii [Effectiveness of seismic prospecting in western Bashkiria and eastern Tatary] : Geologiya Nefti, no. 1, p. 24–34, 1957.

From 1948 to 1954 a total of 53 seismic prospecting parties and 8 seismic logging parties were active in the Bashkir A.S.S.R. and the Tatar A.S.S.R. Six seismic marker horizons are recognized. Structural contours based on seismic surveying and on drilling data show only slight discrepancy in absolute depth. The picture presented by the two methods is sometimes different, however, for amplitude, dip of the flanks, and position of the crest of uplifts. Several maps show the seismic structural contours superposed on those based on drilling. Sesimic exploration is most effective for those uplifts with amplitudes of 20–25 m for the Carboniferous and 30–35 m for the Devonian.—*J. W. C.*

178–404. D'yakov, B. F. Skhema tektonicheskogo stroyeniya i perspektivy neftenosnosti poluostrova Mangyshlak [Outline of the tectonic structure and oil prospects of the Mangyshlak Peninsula] : Geologiya Nefti, no. 7, p. 27–38, 1957.

The structure of the Mangyshlak Peninsula, which lies on the east side of the Caspian Sea, is described. Seismic profiles to a depth of 4,500 m are illustrated. Areas within the region are classified as very favorable, favorable, little favorable, and not favorable.—*J. W. C.*

178–405. Tuyezov, I. K. Primeneniye metoda otrazhennykh voln dlya razvedki II strukturno-tektonicheskogo etazha v yuzhnoy chasti Zapadno-Sibirskoy nizmennosti (Sredneye Priirtysh'ye) [Use of the method of reflected waves for prospecting the second structural-tectonic stage in the southern part of the West Siberian Lowland (Central Pri-Irtysh)] : Razvedochnaya i Promyslovaya Geofizika, no. 27, p. 29–43, 1959.

The West Siberian Lowland is divided structurally into three stages. Within the Middle Pri-Irtysh area these are as follows: first, a basement composed of slightly metamorphosed but intensively deformed Paleozoic and pre-Paleozoic rocks; second, gently dipping sediments and volcanics largely of Rhaetic-Lias age; and third, almost horizontal sandy clayey sediments that range in age from Early Jurassic to Quaternary, inclusively.

The formation velocity in units of the third stage is 1.6–1.7 kmps for Tertiary sediments, 2.2–2.4 kmps for Upper Cretaceous, 3.1–3.3 kmps for Lower Cretaceous, and 3.7–3.9 kmps for Jurassic. The boundary velocities for refracting horizons range from 1.6–1.8 kmps in the upper part of the section to 4.0–4.3 kmps in the Jurassic sediments. Formation velocities in units of the second stage range from 3.35–4.5 kmps. Boundary velocities in the first stage are 5.0–5.6 kmps. A seismic section is presented that illustrates the character of the deformed sediments of the second structural stage; it extends to a depth of more than 4,000 m.—*J. W. C.*

178–406. Tal'virskiy, D. B. Seysmorazvedka fundamenta v yuzhnoy chasti Tobol'skoy zony Zapadno-Sibirskoy Nizmennosti [Seismic prospecting of the basement in the southern part of the Tobol zone of the West Siberian Lowland]: Prikladnaya Geofizika, no. 22, p. 3–23, 1959.

Seismic operations using the refraction correlation method were carried out in the Tobol tectonic zone in the eastern part of the West Siberian Lowland near the Urals. This work was designed to study the relief of the basement. Velocity characteristics of the rocks are based largely on data of seismic logging of exploratory wells. The rocks of the first structural stage (Paleozoic basement) have formation velocities on the order of 5,000–5,500 m per sec and boundary velocities of 5,000–6,500 m per sec. The rocks of the second structural stage (Permo-Carboniferous in some areas, Permo-Triassic in others) have formation velocities from 3,200 to 4,000 m per sec and boundary velocities from 3,000 to 4,000 m per sec. The rocks of the third structural stage (Mesozoic and Cenozoic) have velocities that range from 1,600 to 2,300 m per sec. A seismic profile for the west of the West Siberian Lowland is illustrated.

The seismic data formed the basis for further elucidation of the nature of the surface of the basement in the area under study. Two well-expressed uplifts separated by a downwarp are distinguished; these are shown on a structure map. Further work will be designed not only to study the surface of the basement but also its interior. In order to accomplish this, the low frequencies must be registered; this will permit an increase in the length of the traveltime curve without increasing the explosive charge.—*J. W. C.*

178–407. Shablinskaya, N. V. Tektonicheskoye stroyeniye vtorogo strukturnogo etazha Vagay-Ishimskogo mezhdurech'ya po seysmicheskim dannym [Tectonic structure of the second structural stage of the Vagay-Ishim interfluve according to seismic data]: Vses. neftyan. nauchno-issled. geol. razved. inst. Trudy, no. 131, p. 169–181, 1959.

The West Siberian Lowland is characterized by three structural stages: a Paleozoic basement composed of strongly deformed sedimentary and igneous rocks, an intermediate stage of less deformed extrusive and sedimentary rocks, and finally a Meso-Cenozoic sedimentary cover that formed under platform conditions. Seismic exploration in the area of the Vagay-Ishim interfluve has revealed many details of the structure of the upper and middle stages; these are presented on a cross section along a 135-mile profile. Two more detailed seismic profiles are also presented.

Data of seismic logging are presented for four wells. The formation velocities for stratigraphic units of the intermediate structural stage range from 4,000 to 4,400 m per sec. Data on several structures of the second and third order are presented in a table; they include size, trend, closure, and dip.—*J. W. C.*

178–408. Ninagawa, Shinji, and Tanaka, Akiyoshi. Seismic prospecting of Takikawa district, Hokkaidō [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 9, no. 11, p. 35–42, 1958.

This paper reports the results of a refraction survey of the northern part of the Ishikari plain near Takikawa, Hokkaidō, Japan. Eight velocity layers were calculated and correlated with known geologic formations. Results also indicated a sharp change in rock structure between the east and west parts of the plain.—*V. S. N.*

Shor, George G., Jr. Reflexion studies in the eastern equatorial Pacific. See Geophys. Abs. 178–420.

178–409. Mather, K. B., and Goodspeed, M. J. Australian Antarctic ice thickness measurements and sastrugi observations, Mac-Robertson Land, 1957–58: Polar Rec., v. 9, no. 62, p. 436–445, 1959.

The principal activity by the Australian Antarctic expedition at Mawson station during 1957–58 was the determination of ice thickness along a section of the Antarctic plateau. A seismic traverse was made southward from Mawson approximately along the meridian 62°08′ E. for over 400 miles (643 km). Ice thickness was measured by the seismic reflexion method at 25 stations along the traverse. Seismic velocities near the surface were studied at each station and at two, where the ice was close to maximum depth, velocities at depth were determined by full-scale refraction methods. Gravity readings were also made. A preliminary profile is shown including altitude and seismic ice depth measurements. Preliminary gravity results and study of reflection records suggest that solid rock is overlain in places by morainelike material. The most conspicuous feature of the ice profile is the decrease in altitude southwards from Mile 200 (south of Mawson). Apparently the northerly flow of the ice from the center of the continent is blocked by the southwesterly spur of the Prince Charles Mountains and associated nunataks.

A study was also made of the sastrugi along the traverse as a measure of the katabatic wind direction.—*V. S. N.*

STRENGTH AND PLASTICITY

178–410. Hodge, P. G., Jr. The mathematical theory of plaicity *in* Elasticity and Plasticity: New York, John Wiley and Sons, p. 51–127, 1958.

Hodge develops a mathematical theory of plasticity from a few postulated relations between stress, strain, and strain rate, but without considering creep or applications to real solids. Three chapters are devoted to the plasticity theory extended to models involving strain hardening; perfect, linear plasticity; and minimum potential or complementary energy. A few particular problems are treated: a circular plate under uniform normal pressure, a circular cylindrical shell, beams, and plane strain and stress. A separate chapter gives brief comments on important Russian contributions of the last two decades. Hodge points out that although the Russian treatment of problems in plasticity is based on a deformation theory of plasticity, their methods of solution may be quite useful in attacking the problems from the more realistic flow theory.

A comprehensive bibliography covers the literature of all countries.—*E. C. R.*

178–411. Ruppeneyt, K. V. Mekhanicheskiye svoystva gornykh porod Mechanical properties of rocks): Moscow, Ugletekhizdat, 324 p., 1956.

In pursuing his purpose of establishing a nomenclature of mechanical characteristics of rocks under the conditions of complex stresses and strains prevailing in nature, and of developing methods for laboratory determination of the rock parameters of strength, stability, and deformation, Ruppeneyt presents a monograph which generalizes the existing fundamental data on evaluation of the solidity and mechanical properties of rocks, and draws inferences on the mechanism of rock deformation. After an introductory chapter on the mechani-

cal parameters of rocks, he discusses the selection of approximate parameters and methods of solution of practical problems of rock behavior under given conditions. Then in a review of 39 publications dealing with studies of mechanical properties of rocks, he suggests a program of experimental work for determining the ensemble of the characteristics.

The fourth chapter describes experimental laboratory studies of the physical-mechanical properties made on 500 samples of 23 types of rocks, conducted by the All-Union Coal Research Institute in 1952–53. The fifth chapter deals with the methods of determination of those properties, especially cohesion and field strength. The methods of determining the elastic constants and strength of rocks are presented in the sixth chapter, where a case is described of a rock sample torn apart transversely to the pressure applied without any tensile stress. In the seventh chapter methods of study of rock strength (rock salt, sylvite, and carnallite) under shearing stress are given. The eighth and last chapter gives an analysis of the Mohr theory of rock strength; the Mohr condition of strength is treated as the section of the surface of destruction. In the nine supplements to the monograph, a description of the rock samples, their geometrical dimensions, their proportionality moduli, Poisson's coefficients, and ultimate strength under compression, tension, bending, and shear are given.— *A. J. S.*

178–412. Shreiner, L. A., Petrova, O. P., Yakushev, V. P., Portnova, A. T., Sadilenko, K. M., Klochko, N. A., Pavlova, N. N., Balandin, P. S., and Spivak, A. I. Mekhanicheskiye i abrazivnyye svoystva gornykh porod [Mechanical and abrasive properties of rocks]: Moscow, Gostoptekhizdat, 201 p., 1958.

Determination of the mechanical properties (hardness, plasticity, and Young's modulus) of rocks by the die impression method is discussed in the book, and an apparatus for automatic recording of deformation graphs is described. The mechanical properties of clay, sandstone, siltstone, limestone, dolomite, gypsum, anhydrite, rock salt, chert, and a variety of metamorphic and igneous rocks have been determined and the results tabulated. A classification of sedimentary rocks according to their mechanical properties is given. One chapter deals with the effect of liquid media on the mechanical properties or rocks, and another discusses the effect of temperature on the mechanical properties. Sixty-five pages are devoted to the abrasive properties or rocks and their classification according to those properties.— *A. J. S.*

178–413. Zalesskiy, B. V. Metody issledovaniya fizikomekhanicheskikh svoystv gornykh porod [Methods of study of physical-mechanical properties of rocks]: Akad. Nauk SSSR, Inst. Geologii Rudn. Mestorozhdeniy, Petrografii, Mineralogii i Geokhimii Trudy, no. 13, p. 3–9, 1958.

A general discussion of the geological-petrographical criteria of the strength and stability of rocks preceded by a brief historical review of the subject up to 1958. Various methods used in determination of the strengths and stabilities of rocks under different mechanical (elasticity, plasticity), physical (porosity, water saturation, temperature), and chemical (chemical attack by sulfates, carbon dioxide, and other chemical compounds) conditions are mentioned, and suggestions for an effective plan of investigation of the subject are given.— *A. J. S.*

178–414. Delitsin, I. S., and Rozanov, Yu. A. Eksperimental'nyye dannyye po polucheniyu plasticheskoy deformatsii v kvartsite [Experimental data on the obtaining of plastic deformation in quartzite] : Akad. Nauk SSSR Izv. ser. geol., no. 6, p. 103–108, 1959.

Cylindrical samples of quartzite 15 mm in diameter and 24–26 mm long were deformed under hydraulic pressure of 300 tons at temperatures of 160°C–200°C. The deformation of a sample could take place only with deformation of the cylindrical steel container walls, which were thinner in the middle. Details of deformation in different parts of the sample as shown by optical orientation of the quartz cyrstals are described.—*D. B. V.*

SUBMARINE GEOLOGY

178–415. Fedynskiy, V. V. Geofizicheskiye issledovaniya v morskoy geologii [Geophysical investigations in marine geology] : Akad. Nauk SSSR Izv. ser. geol., no. 6, p. 3–15, 1959.

Study of the constitution and development of the earth's crust by geophysical methods in the regions of the world oceans is one of the most important problems in marine geology. Besides the general investigation of crustal structure by geophysical methods in remote parts of the world oceans, more detailed geophysical operations in continental shelf areas are conducted for prospecting and surveying petroleum deposits and sometimes in connections with the solution of engineering-geological problems.

In this paper the status and possibilities of magnetic, gravity, electrical, and seismic work at sea are described and illustrated by examples carried out in the Soviet Union.—*Author's abstract, D. B. V.*

178–416. Anders, Edward, and Limber, D. Nelson. Origin of the Worzel deep-sea ash : Nature, v. 184, no. 4679, p. 44–45, 1959.

The possibilities of cometary or asteroidal origin and two other cosmic sources—galactic dust clouds and the moon—for the Worzel deep-sea ash (see Geophys. Abs. 177–375, –376) are examined, and it is concluded that an extra-terrestrial origin is highly improbable. Yet its apparently world wide distribution is difficult to explain in terms of a terrestrial origin. Data on dispersal of H-bomb debris and volcanic ash indicate that the distribution of particles in the 70μ–200μ range is limited to distances of the order of 10^3 km or less. It will be of interest to establish its origin in a single event by chemical analysis of samples from widely scattered locations.

A volcanic eruption of this magnitude would have two other observable effects. It would carry enough μ-sized dust particles into the stratosphere to reduce the amount of sunlight reaching the earth, possibly enough to initiate a period of glaciation; paleotemperature measurements above and below the ash layer may provide a clue in this respect. Furthermore, the mass deficit at the eruption site would produce a negative gravity anomaly that may not yet have been obliterated by isostatic compensation.—*D. B. V.*

178–417. Heezen, Bruce C. Dynamic processes of abyssal sedimentation : erosion, transportation, and redeposition on the deep-sea floor : Royal Astron. Soc. Geophys. Jour., v. 2, no. 2, p. 142–163, 1959.

The concept of a quiet, nearly motionless, and certainly currentless deep-sea floor lacking the processes of erosion so prevalent in shallower seas was well

ingrained in scientific thought until discoveries of the past decade revised this serene and static picture. The new concept is a more dynamic one in which submarine landslides, raging turbidity currents, internal tides, deep-sea current scour, and submarine post-depositional solution and alteration play a part in shaping the sea floor, in disturbing and nurturing its fauna and which produce sedimentary structures and distributions formerly thought to be the exclusive mark of shallow water deposits. The concepts involved are still in a critical state of flux with many conflicting viewpoints as to the processes involved and their relative importance. The development of the major concepts is traced and the principal variant viewpoints are briefly reviewed.—*Author's summary*

178–418. Northrop, John, Blaik, Maurice, and Frasseto, Roberto. Bathymetry of the Gibbs Hill area, Bermuda: Deep-Sea Research, v. 5, no. 4, p. 290–296, 1959.

The use of high-resolution echo sounder data and precise navigation made it possible to map the true shape of ocean bottom features south of Gibbs Hill, Bermuda. Soundings corrected for both sound velocity and slope show that a steep-sided submarine spur extends SSE from the shelf break off Gibbs Hill. The spur has a topographic relief of 300 fathoms and is about 3 miles long and ½ mile wide; at the 1,000 fathom curve it broadens into a platform which extends 12 miles seaward to the 2,000 fathom curve. True slopes along the steep portion of the spur are as high as 50°. The steep slopes associated with this spur suggest that it was formed by lava outpourings from a volcanic pipe, several of which are known in Bermuda. Coring attempts in the area resulted in empty and bent tubes, indicating a hard rock bottom.—*V. S. N.*

178–419. Day, Alan A. The continental margin between Brittany and Ireland: Deep-Sea Research, v. 5, no. 4, p. 249–265, 1959.

The continental slope between Brittany and Ireland is steep and cut by many canyons, with the exception of the central region which forms a broad spur. Scarps up to 110 miles in length border the continental margin and these, together with the steep areas of the slope, are believed to be the result of faulting. There is no regional evidence that horizontal tectonic forces are operating in this area; therefore, the faulting is explained as the result of vertical forces and the effects of tension. Core and bottom samples from the area are mainly Recent and Pleistocene in age, except for three which are Tertiary or possibly Cretaceous.—*V. S. N.*

178–420. Shor, George G., Jr. Reflexion studies in the eastern equatorial Pacific: Deep-Sea Research, v. 5, no. 4, p. 283–289, 1959.

A limited seismic reflection survey was made of an area in the equatorial Pacific near long 125° W., lat 3°30′–13°30′ N., in conjunction with coring operations. The area is shielded from turbidity-current deposition from land and is on the boundary between clay deposition on the north and carbonate deposition on the south. The seismic profiles show that the carbonate deposits are decidely thicker than the clay deposits and that there is a greater rate of accumulation in valleys than on hills. The thickening of carbonate sediments to the south accounts for the shallower average ocean depth south of the Clipperton fracture zone and implies that the shoaling in this area is a result of carbonate deposition rather than the reverse.—*V. S. N.*

178–421. Menard, H[enry] W. Geology of the Pacific sea floor: Experientia, v. 15, no. 6, p. 205–244, 1959.

The various kinds of submarine topography are reviewed. The largest is the broad, essentially continuous median elevation which extends through the Atlantic, Indian, Antarctic, and South Pacific Oceans for a total distance of about 30,000 km. The form of abyssal plains; oceanic trenches and island arcs; seamounts and abyssal hills; and their distribution in the Pacific Ocean are discussed. It is concluded that the ocean basins are essentially permanent. Island stepping-stones, represented by guyots and atolls, may always have been present.—*D. B. V.*

178–422. Brodie, J. W. Structural significance of sea-floor features around New Zealand: Geol. Rundschau, v. 47, no. 2, p. 662–667, 1958.

The oceanic highs and deeps around New Zealand exhibit a marked linearity and fall into three groups whose features trend NW., E.-W., and NNE. These groups are recognized as structural provinces—the Northwestern, Chatham and Kermadec Provinces respectively, with both age and geographic differences.

The New Zealand land mass occupies a position at the meeting of the three structural trends and the relief is taken to be a function of this conjunction of trends.

No signs of late structural activity along trends referable to the Northwestern and Chatham provinces have been observed in New Zealand, and the submarine relief could be of pre-Tertiary age.

Active movement on the Kermadec province trend has taken place up to Recent time and the submarine features of this region are considerably younger.—*Author's summary*

VOLCANOLOGY

178–423. Naboko, S. I. Vulkany [Volcanoes]: Moscow, Goskul'tprosvetizdat, 13 p., 1957.

A popular pamphlet describing volcanoes, volcanic phenomena, and the associated phenomena of fumarolic activity, mud volcanoes, geysers, and hot springs. The balneological and economic applications of such associated activities are discussed. Six colored plates are given.—*A. J. S.*

178–424. Voropinov, V. S. Vulkany i zemletryaseniya [Volcanoes and earthquakes]: Irkutsk, Irkutskoye Knizhnoye Izdatel'stvo, 96 p., 1958.

A semipopular book on volcanism and earthquakes. Volcanism in Siberia, earthquakes in Siberia and the Far East, and the origin and age of the earth (with geochonological chart) are discussed, and a brief dictionary of geological terms is included.—*A. J. S.*

178–425. Hantke, Gustav. Übersicht über die vulkanische Tätigkeit 1954–1956 [Review of volcanic activity, 1954–1956]: Bull. volcanol., v. 20, p. 3–33, 1959.

World-wide volcanic activity in the period 1954–56 was generally weaker than in 1951–53. The most important manifestation was the eruption of Bezymyanny (Kamchatka) in 1955–56, climaxed by a Katmai-type explosion on March 30,

1956. A large maar-crater was created in southern Chile by an explosion in July 1955. Merapi (Java), Ngauruhoe (New Zealand), Izalco (El Salvador), and Kilauea (Hawaii) were also conspicuously active during the period in question.

Altogether, 32 volcanoes were active in 1954, 14 of which were effusive; 34 in 1955, with 9 effusive; and 19 in 1956, with 8 effusive. These are described briefly under the general headings America, Pacific Ocean, East Asia, Antarctic, Africa, Atlantic Islands, and Europe. A bibliography of 69 items is appended.—*D. B. V.*

178–426. Coats, Robert R. A geologic reconnaissance of Gareloi Island, Aleutian Islands, Alaska: U.S. Geol. Survey Bull. 1028–J, p. 249–256, 1959.

Gareloi Island, one of the smaller of the western Aleutian Islands, is a composite volcano and is remarkable chiefly as one in which activity was resumed at a single center after a long period of erosion and apparent quiescence, without substantial change in composition of the lava. The older rocks are a sequence of olivine basalt flows and scoria; the younger lava flows are olivine basalt, generally porphyritic in texture. The first reported activity of Mount Gareloi was in 1760, and the most violent eruption of recent times apparently was that of 1929. The eruption was initially phreatic; a number of small craters were formed, some of them erupting glassy pumiceous andesite tuff followed by blocky, highly viscous andesite lava flows. Active emission of sulfur dioxide continues in the northern summit crater.—*V. S. N.*

178–427. Parsons, Willard H. The Puna eruption of Kilauea Volcano: Cranbrook Inst. Sci. News Letter, v. 27, no. 2, p. 29–38, 1957.

The Puna eruption of Kilauea Volcano in Hawaii was heralded by earthquake activity and ground tilt for nearly a year in advance. Two strong earthquakes in March 1954 perhaps mark the start of events leading to the eruption. The number of shallow earthquakes increased to 67 during November 1954, and their frequency rose rapidly thereafter—185 in January 1955, 350 between February 1 and 23, 13 on February 23, 130 on February 24, 350 on February 25, 600 on February 26, and 700 on February 27. On the morning of February 28 the first lavas appeared, at the eastern end of the Puna rift zone; within 5 min there was a line of 50-ft lava fountains a quarter of a mile long, and very active pahoehoe flows were spreading outward at a rate of about 40 ft per min.

In some respects the 1955 activity resembled three separate eruptions, each with its own premonitory earthquakes. Activity died down between March 6 and 12 and for 2 weeks in mid-April. When activity finally ceased on May 26, approximately 6 sq mi were covered by lava. The estimated volume of new lava is 120 million cu yd. (See also Geophys. Abs. 165–383.)—*D. B. V.*

178–428. Pough, Frederick H., and Mulford, John W. The Cranbrook Central America volcano expedition: Cranbrook Inst. Sci. News Letter, v. 27, no. 2, p. 10–29, 1957.

An expedition was undertaken by the Cranbrook Institute of Science in 1957 in order to make a survey of the chain of Central American volcanoes and give a general picture of the character of the volcanic structures in Guatemala, El Salvador, Nicaragua, and Costa Rica. A secondary objective was the observation of volcanic activity in connection with a study of normal eruptions from

volcanoes of this type. At the time of the expedition, most of the active volcanoes were active only in the sense of steam and gas emission; lava was being emitted only at Izalco in El Salvador and at Fuego and Santiaguito in Guatemala. Nicaragua had five steaming or sublimating vents. The eruptive history and present state of the active volcanoes is reviewed briefly.

The expedition was unbelievably fortunate in being on hand for the brief (1-week) eruption of Fuego, its most violent since 1880 and its first since 1932. In this eruption the momentum of glowing avalanches was observed to depend on gravity alone. As seen repeatedly, the events are as follows: a viscous gas-saturated lava mass is forced up in the tube; as it rises it tends to topple over, and eventually does; almost explosively saturated with gas, but not liquid enough to let it bubble out, it promptly shatters into many fragments which roll down the slope, breaking into smaller and smaller pieces. Clouds of dust and rising gas escape from the front as the avalanche fans out on the slope; the volume and force of these clouds made them similar in appearance to the dust column that escapes from the crater of a normal explosive volcano.—*D. B. V.*

178–429. Tazieff, H. L'éruption 1957–1958 et la tectonique de Faial (Açores) [The eruption of 1957–58 and the structure of Fayal (Azores)]: Soc. belge Géologie, Paléontologie et Hydrologie Bull., v. 67, no. 1, p. 13–36, 1959.

The eruption of Capelinhos off the tip of Fayal in the Azores, which began on September 27, 1957 and built a peninsula 1 km^2, was characterized by unusually violent pseudovulcanian explosions. The kinetic energy liberated was more than 10^{17} ergs per sec. At the time of writing this paper, the duration (more than 4½ months) was exceptional for such a powerful eruption.

The eruption occurred from a prehistoric eruptive center, not from a new volcano. This center lies on the N. 60° W. alinement of one of the block faults that characterize the topography of Fayal. These faults form a small but very well defined graben. The profile of this graben shows relatively wide horizontal steps on both sides of a narrower central trench; this shape does not agree with the idea of epeirogenic origin, that is, block-faulting of the keystone of an anticlinal bulge. (See also Geophys. Abs. 173–361; 175–409, –410.)—*D. B. V.*

178–430. Magnée, I[van] de. Première exploration géophysique du volcan Nyiragongo (Kivu). (Note Préliminaire) [First geophysical exploration of the volcano Nyiragongo (Kivu). (Preliminary note)]: Acad. royale Sci. coloniales Bull., v. 5, no. 2, p. 379–401, 1959.

Nyiragongo volcano, on Lake Kivu in Africa, has been active almost continuously in historic times. It is estimated that in the last 15,000 years, at least, some tens of billions of cubic meters of basic lava have been erupted by this volcano and its neighbor Nyamuraagira. During the International Geophysical Year Nyiragongo was studied by a party from the Institut pour la Recherche scientifique en Afrique centrale; the results of their investigations are outlined briefly in this paper.

Temperature measurements, made with an optical pyrometer on the most luminous fountains in the lava lake in the crater, gave readings of 1,020° C–1,060°C. Vertical and horizontal movements were distinguished in the lava lake. A vertical magnetic survey, with stations 20 m apart around the central pit, showed a marked minimum (in absolute value) in the northern part of

the platform. Subtracting local anomalies, the total anomaly is of the order of 3,000 γ. Declination varies about 8° between extremes. Oriented specimens were collected for paleomagnetic measurements.

Geophones were installed around the vent, but the equipment available was not sensitive enough to give usable records. According to the measurements made with a Geiger-Müller counter, the radioactivity of fumarolic exhalations was normal, confirming the fact that the water is of meteoric origin. Petrographic study is in progress on samples collected from recent and ancient lavas. Gravimetric and levelling surveys are recommended for the future.—*D. B. V.*

178–431. Murozumi, Masayo [Masayoshi]. Geochemical investigation of the self-destruction of Gongensawa geyser [in Japanese with English summary]: Jour. Geography [Tokyo], v. 68, no. 1, p. 1–17, 1959.

This paper reports on a geochemical study of the Gongensawa geyser in the Noboribetsu thermal area in southwestern Hokkaido, Japan, conducted from 1949 through the dying phases of the geyser in 1952. The Gongensawa geyser was active over a period of 100 years and unlike other hot springs in the area its waters were very low in sulfuric acid. In November 1951, increased activity in Showajigoku, an old crater near the geyser, disturbed the conduits leading to the geyser and reduced the energy of the geyser waters. In March 1952 when the volcanic activity began to decrease, a fundamental alteration of thermal activity also took place and the geyser decreased in activity, first becoming a hot spring and, with introduction of sulfuric acid waters, finally ceasing activity completely in August 1952.—*V. S. N.*

178–432. Yoshimatsu, Takasaburo. Changes of earth-current potentials at Kanoya and activities of the volcano Sakurajima [in Japanese with English abstract]: Kakioka Magnetic Observatory Mem., v. 9, no. 1, p. 57–63, 1959.

Abnormal changes of the monthly mean values of earth-current potentials observed at Kanoya, Japan, were studied in relation to the activity of Sakurajima volcano, 27 km to the northwest. The last moderate eruption occurred on October 13, 1955, followed by many minor eruptions and microtremors up to the middle of March 1957.

It was found that the deduced values of earth potentials show an intimate connection with the volcanic activity; this may be responsible for changes in state of magma in the deeper part of the volcano.—*D. B. V.*

178–433. Sekiya, H. An analysis of volcanic activity of Mt. Asama (1st paper) [in Japanese with English abstract]: Quart. Jour. Seismology [Tokyo], v. 24, no. 1, p. 1–10, 1959.

This is a report on the secular variation and periodicity of eruptions of Asama Volcano, Japan, from 1869 to 1958. Results of anlyses are given in tables and figures showing the number of eruptions, the secular variation of explosion energy, and the duration and periodicity of activity. In recent years, the predominant period between groups of volcanic activity is about 57 months. This periodicity of activity occurs not only in the vulcanian type, such as Asama Volcano, but also in the strombolian type, such as Aso Volcano.—*V. S. N.*

178–434. Gorshkov, G. S. Gigantic eruption of the Volcano Bezymyanny: Bull. volcanol., v. 20, p. 77–109, 1959.

An English version of the description of the eruption of Bezymyanny in Kamchatka in 1955–56, one of the most violent in history, similar in character to that of Katmai. Total energy of the eruption is calculated as 2.2×10^{25} ergs. The energy of the March 30, 1956 explosion was 4×10^{23} ergs; volume and weight of material ejected in the latter, 1.0 km^3 and 2.4×10^9 tons, respectively; volume and weight of the agglomerate flow, about 1.8 km^3 and 4.3×10^9 tons; initial velocity of the explosion, up to 500–600 m per sec; and initial pressure, up to 3,000 atm. (See also Geophys. Abs. 175–417.)—*D. B. V.*

178–435. Tanaka, Y[utaka]. Investigation of volcanic activity of Torishima (I). On the volcanic activities during the period from 1947 to 1957 [in Japanese with English summary]: Quart. Jour. Seismology [Tokyo], v. 23, no. 4, p. 21–36, 1959.

Routine observation of the Torishima volcano, an island in the Pacific Ocean at lat 30.5° N., long 140.5° E., were made 3 times a month by members of the weather station during the 10 year period 1947–57. Three periods of volcanic activity were noted: from July to October 1949, intrusion of magma at shallow depth produced an upheaval of the ground for 1 m or more at the base of the central cone; from April to May 1952 numerous shallow earthquakes were recorded and were probably related to motion of the magma; from January to March 1956 activity of the trapped volcanic gases and other substances associated with the cooling shallow magma produced renewed upheaval of the ground at the base of the central cone and resulted in formation of two mounds several meters in height.—*V. S. N.*

178–436. Ivanov, V. V. Present-day hydrothermal activity within the Kurile-Kamchatka island arc and its relation to volcanicity: Bull. volcanol., v. 20, p. 137–154, 1959.

As in other regions, the hydrothermal activity in the Kurile-Kamchatka volcanic zone is manifested in three main forms: hot gases, thermal waters of different origin and composition, and steam jets. Their chemistry and distribution are discussed. The waters are almost entirely of atmospheric origin.—*D. B. V.*

178–437. Gorshkov, G. S. Catalogue of the active volcanoes of the world including solfatara fields: Part 7, Kurile Islands: Naples, Internat. Volcanol. Assoc., 99 p., 1958.

Essential data are given on all active volcanoes of the Kurile Islands, including location, form and structure, volcanic activity, and petrography. There is also a bibliography of previous studies. Of the 39 volcanoes listed, 33 have erupted in historic times and 6 are in the solfatara or fumarole stage. (See also Geophys. Abs. 173–365, 176–373).—*V. S. N.*

178–438. Ustinova, T. I. Kamchatskiye geyzery [Kamchatka geysers]: Moscow, Gosudarstvennoye izdatel'stvo geograficheskoy literatury, 120 p., 1955.

This is a monograph on Kamchatka geysers published by the Geographic Institute of the Academy of Sciences of the U.S.S.R. Kamchatka is the only unexplored geyser region in the U.S.S.R., with the possible exception of the hot springs area in the Kurile Islands. Most of the geysers are located in the valley of the Geyzernaya River on the east side of the peninsula; smaller geysers are known among the Pauzhetka River hot springs, at the southern tip of the peninsula. Ustinova describes 25 active geysers, giving their dimensions (openings and depths), duration of their active periods and eruptions, temperatures, heights of water and steam jets, and other pertinent data. Temperatures of the Kamchatka geysers range from 94.5°C to 98.9°C. The highest water jet is 50 m. General characteristics of the Geyzernaya River basin are given, and the mechanism of geyser action and origin of their water are discussed. Both geyser areas are located within a region of active volcanism.—*A. J. S.*

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