

# Geophysical Abstracts 189 April-June 1962

By JAMES W. CLARKE, DOROTHY B. VITALIANO, VIRGINIA S. NEUSCHEL, and others

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G E O L O G I C A L   S U R V E Y   B U L L E T I N   1 1 6 6 - B

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



UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

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By James W. Clarke, Dorothy B. Vitaliano, Virginia S. Neuschel, and others

## INTRODUCTION

### Extent of Coverage

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

Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with limited circulations (such as dissertations, open-file reports, or memorandums) 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 184 (January-March 1961, Bulletin 1146-A) have been compiled into a single list, which may be obtained by writing to the U.S. Geological Survey, Washington 25, D. C.

Supplements to this master list have been published in each issue since Geophysical Abstracts 184. The following is an additional supplement that lists references cited in Geophysical Abstracts 189 that have not been listed previously.

- Akad. Nauk SSSR, Kom. Izucheniya Chetvertich. Perioda Byull. -- Akademiya Nauk SSSR, Byulleten' Komissii po Izucheniya Chetvertichnogo Perioda [Academy of Sciences of the U.S.S.R., Bulletin of the Commission for Study of the Quaternary Period]. Moskva (Moscow) U.S.S.R.
- Am. Jour. Physics -- American Journal of Physics. American Institute of Physics, Inc. New York, New York.
- Am. Soc. Civil Engineers Trans. -- Transactions of the American Society of Civil Engineers. American Society of Civil Engineers. New York, New York.
- Anal. Chemistry -- Analytical Chemistry. American Chemical Society. Washington, D. C.
- Appl. Spectroscopy -- Applied Spectroscopy. Bulletin of the Society of Applied Spectroscopy [New York?].
- Asoc. Geol. Argentina Rev. -- Revista de la Asociacion Geologica Argentina. Asociacion Geologica Argentina [Review of the Argentina Geological Association. Argentina Geological Association]. Buenos Aires, Republic of Argentina.
- B<sup>1</sup>lgarska Akad. Nauk Inst. Geofiz. Izv. -- B<sup>1</sup>lgarska Akademiya na Naukite. Izvestiya na Geofizichniya Institut Sofiya [Bulgarian Academy of Sciences. Bulletin of the Geophysical Institute of Sofia]. Sofiya (Sofia), Bulgaria.
- Canadian Geophys. Bull. -- Canadian Geophysical Bulletin. The Associate Committee on Geodesy and Geophysics of the National Research Council of Canada. Ottawa, Canada.
- Ceylon Geol. Survey Mem. -- Geological Survey of Ceylon Memoirs. Department of Mineralogy. Colombo, Ceylon.
- Coimbra Univ. Mus. Mineralog. Geol. Mem. e Notfcias -- Memórias e Notfcias, Publicações do Museu e Laboratório Mineralógico e Geológico. Universidade de Coimbra [Memoirs and Notices, Publication of the Museum and Labo-

- ratory of Mineralogy and Geology. University of Coimbra]. Coimbra, Portugal.
- Engenharia, Mineração e Metalurgia -- Engenharia, Mineração e Metalurgia [Engineering, Mineralogy, and Metallurgy]. Rio de Janeiro, Brazil.
- Geophysik u. Geologie -- Geophysik und Geologie. Beiträge zur Synthese zweier Wissenschaften [Geophysics and Geology. Contributions to Synthesis of the Two Sciences]. B. G. Teubner Verlagsgesellschaft. Leipzig, German Democratic Republic.
- Georgia Mineral Newsletter -- Georgia Mineral Newsletter. Georgia Geological Survey. Atlanta, Georgia.
- Iowa Acad. Sci. Proc. -- Proceedings of the Iowa Academy of Science. State of Iowa. Des Moines, Iowa.
- Jassy Univ. Analele Științ. -- Analele Științifice ale Universității "Al. I. Cuza" din Iași (serie nouă). Secțiunea II (Științe Naturale) [Scientific Annals of "Al. I. Cuza" University in Jassy (new series) Section II (Natural Sciences)]. Jassy, Rumania.
- Jour. Sed. Petrology -- Journal of Sedimentary Petrology. Society of Economic Paleontologists and Mineralogists, a Division of The American Association of Petroleum Geologists. Tulsa, Oklahoma.
- Leningrad. Univ. Vestnik, Ser. Geol. i Geog. -- Vestnik Leningradskogo Universiteta, Seriya Geologiya i Geografiya [Notes of Leningrad University, Series of Geology and Geography]. Leningrad, U.S.S.R.
- Lietuvos TSR Mokslų Akad. Darbai -- Lietuvos TSR Mokslų Akademija Darbai [Lithuanian S.S.R. Academy of Sciences Transactions]. Vilnius, Lithuania.
- Materials Research and Standards -- Materials Research and Standards, American Society of Testing and Materials. Philadelphia, Pennsylvania.
- Norges Geotek. Inst. Pub. -- Norges Geotekniske Institutt Publikasjon [Norway Geotechnical Institute Publication]. Oslo, Norway.
- Okeanologiya -- Okeanologiya. Akademiya Nauk SSSR [Oceanology. Academy of Sciences of the U.S.S.R.]. Moskva (Moscow), U.S.S.R.
- Ontario Dept. Mines, Geol. Rept. -- Ontario Department of Mines, Geological Reports. Toronto, Canada.
- Problemy Arktiki i Antarktiki -- Problemy Arktiki i Antarktiki. Arkticheskiy Nauchno-Issledovatel'skiy Institut [Problems of the Arctic and Antarctic. Arctic Scientific Research Institute]. Leningrad, U.S.S.R.
- Royal Astron. Soc. Quart. Jour. -- Quarterly Journal of the Royal Astronomical Society. London, England.
- Royal Soc. Western Australia Jour. -- Journal of the Royal Society of Western Australia Incorporated, Western Australian Museum. Perth, Australia.
- Saturday Rev. -- Saturday Review. Saturday Review, Inc. New York, New York.
- Soc. Mining Engineers Trans. -- Transactions of the Society of Mining Engineers. Society of Mining Engineers. New York, New York.
- Sovetskaya Antarkt. Exped. Inf. Byull. -- Informatsionnyy Byulleten' Sovetskoy Antarkticheskoy Ekspeditsii. Arkticheskiy i Antarkticheskiy Nauchno-Issledovatel'skiy Institut [Information Bulletin of the Soviet Antarctic Expedition. Arctic and Antarctic Scientific Research Institute]. Leningrad, U.S.S.R.
- U.S. Army Cold Regions Research and Eng. Lab. Research Rept. -- United States Army Cold Regions Research and Engineering Laboratory Research Report. Corps of Engineers. Hanover, New Hampshire.
- U.S. Atomic Energy Comm., Civil Effects Study -- U.S. Atomic Energy Commission Civil Effects Study. U.S. Atomic Energy Commission Civil Effects Test Operations, Civil Effects Study. Washington, D. C.
- Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy -- Trudy Vsesoyuznogo Nauchno-Issledovatel'skogo Instituta Metodiki i Tekhniki Razvedki (VITR) [Transactions of the All-Union Scientific Research Institute of Methods and Techniques of Exploration]. Moskva (Moscow), U.S.S.R.
- Vses. Neftegaz. Nauchno-Issled. Inst. Trudy -- Vsesoyuznyy Neftegazovyy Nauchno-Issledovatel'skiy Institut, Trudy [Transactions of the All-Union Oil-Gas Scientific Research Institute]. Moskva (Moscow), U.S.S.R.

- Vses. Neftegaz. Nauchno-Issled. Inst., Krasnodar. Filial, Trudy -- Trudy Vsesoyuznogo Neftegazovogo Nauchno-Issledovatel'skogo Instituta, Krasnodarskiy Filial [Transactions of the All-Union Oil-Gas Scientific Research Institute, Krasnodar Branch]. Moskva (Moscow), U.S.S.R.
- Washington State Inst. Technology Research Rept. -- Washington State Institute of Technology Research Report. Washington State University, Division of Industrial Research, Pullman, Washington.

## Form of Citation

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

## Abstracters

Abstracts in this issue have been prepared by J. C. Antweiler, B. R. Doe, H. Faul, V. G. Gabriel, S. S. Goldich, Ruth M. Gove, C. E. Hedge, Patricia C. Ives, Betsy Levin, L. Peselnick, A. P. Pierce, M. Rubin, A. J. Shneiderov, T. W. Stern, and J. S. Watkins, as well as by the principal authors. Authors' abstracts are used in many instances. The initials of an abstracter following the notation "Author's abstract" indicates a translation from the original language.

## AGE DETERMINATIONS

- 189-1. Davis, G. L., Tilton, G[eorge] R., Doe, B[ruce] R., Aldrich, L. T[homas], and Hart, S[tanley] R. The ages of rocks and minerals: Carnegie Inst. Washington Year Book 60, p. 190-199, 1960-61, reprinted in Carnegie Inst. Washington Geophys. Lab. Ann. Rept. of Director for 1960-61, 1961.

Minerals of the amphibole and pyroxene groups retain sufficient potassium and argon for isotope dating. In a number of samples, argon retention is greater for biotites under metamorphic conditions.

Study of the isotope ratios of lead from potassium feldspar shows that the feldspar takes up limited amounts of lead under conditions of contact and regional metamorphism. The common lead ages computed for feldspars from granitic intrusions are in good agreement with the isotopic ages for two intrusions approximately a billion years old; however, common lead ages for two younger granitic masses are in poor agreement with the isotopic ages.

Earlier isotope dilution determinations of the small amounts of uranium and lead in rocks such as dunite and eclogite were in error due to contamination with platinum ware. Modified procedures for uranium give results in better agreement with determinations by neutron activation. The radioactivity of dunite is found to be too low for material believed to constitute the shallow suboceanic mantle. The radioactivity found for eclogite is more suitable but also appears to be too low.

Radioactivity ages for minerals from rocks underlying the Moldanubian region of Bavaria, Germany, indicate that the latest crystallization of the gneisses and intrusion of the granites probably occurred early in the Carboniferous period ( $\approx 330$  m.y.).—B.R.D.

- 189-2. Aldrich, L. T[homas], Hart, S[tanley] R., Wetherill, G[eorge] W., Davis, G. L., Tilton, G[eorge] R., and Doe, B[ruce] R. The earth's crust—radioactive ages of rocks: Carnegie Inst. Washington Year Book 60, p. 250-256, 1961; reprinted in Carnegie Inst. Dept. Terrestrial Magnetism Ann. Rept. of Director for 1960-61, 1961.

A study of low potassium minerals for their suitability as age indicators by the K-Ar method has demonstrated that these minerals are usually more resistant to metamorphic events than coexisting biotites, are essentially free of inherited radiogenic argon, and have adequate potassium for measurement of ages as low as 20 m.y. In the study of metamorphic ages, the findings concerning the effects of a young intrusive on the minerals of the intruded rock essentially confirm laboratory diffusion studies of the retentivity of argon by mica, feldspar, and hornblendes. The pattern of Rb-Sr ages in micas has been studied also and in the case of biotite has been found to parallel closely its K-Ar age. Some details are reported on the following studies: (1) K-Ar dating of amphiboles and pyroxenes (mostly hornblendes) and comparisons with K-Ar and Rb-Sr dating of biotite and Pb-207/Pb-206 dating of zircon from some of the more reliably dated localities; (2) ages measured on minerals from metamorphic rocks of northern Michigan to show their distribution between 1,100 and 3,000 m.y.; and (3) mineral ages in a contact metamorphic zone in the Front Range of Colorado.— V.S.N.

- 189-3. Cherdyntsev, V. V. Opredele niye absolyutnogo vozrasta chetvertichnykh okamenelykh kostey po otnosheniyu izotopov tyazhelykh elementov [Determination of the absolute age of Quaternary fossil bones according to the isotopic ratio of the heavy elements], in *Voprosy geologii antropogena*: Moscow, Akad. Nauk SSSR, p. 85-94, 1961.

A method is discussed whereby an absolute age is determined from the disintegration products of uranium introduced into fossil bones by solutions. This method permits determination of ages up to one million years. The best results are obtained using the ratios  $I_0/UX_1$  and  $RdAc/UV_1$ . If dates from two independent determinations coincide, it can be assumed that the isotope content is not affected by the processes of migration. The isotopic composition of the uranium must also be determined because it is generally enriched in U-234 in the surface zone. Preliminary results give a value of 15,000-50,000 yr for the upper Paleolithic and 65,000-180,000 yr for the Middle Paleolithic. The age of Acheulean fossil bones is 210,000 yr or more.— J.W.C.

- 189-4. Shcherbakov, D. I. Shkala absolyutnogo vozrasta geologicheskikh formatsiy [The absolute age scale for geologic formations]: Priroda, no. 2, p. 9-17, 1961.

The basis for determination of the absolute age of geologic formations is discussed. Beginning with the relative geologic scale as determined by the stratigraphic and paleontological methods, the part which radioactive decay plays in determination of the absolute age of rocks is explained. The practical and scientific significance of the absolute age scale is discussed, and a further development of absolute geochronology is suggested.— A.J.S.

- 189-5. Wrage, Ernst G. Argonbestimmung an Kaliummineralien-VIII. Ein Näherungsverfahren zur Lösung von Diffusionsproblemen [Argon determination on potassium minerals-8. An approximate method of solving diffusion problems (with English abstract): *Geochim. et Cosmochim. Acta*, v. 26, p. 61-66, 1962.

An approximate method is developed to solve the diffusion equation for the case where diffusion takes place in a thin boundary layer close to the surface. The differential equations are presented for those problems that arise in connection with age determinations. Comparison of methods shows a satisfactory conformity when the diffusion losses are less than 30 percent.— D.B.V.

- 189-6. Fechtig, H., Gentner, W., and Kalbitzer, S. Argonbestimmung an Kalium-mineralien-IX. Messungen zu den verschiedenen Arten der Argondiffusion [Argon determination on potassium minerals—

9. Measurements concerning the different types of argon diffusion (with English abstract): *Geochim. et Cosmochim. Acta*, v. 25, no. 4, p. 297-311, 1961.

The diffusion of argon in sanidine, phonolite, augite, a moldavite tektite, and synthetic sylvite was measured using the isotopes Ar-37 and Ar-39. For the moldavite and sanidine, a plot of  $\log D/a^2$  against  $1/T$  ( $D$ =diffusion constant,  $a$ =radius of the crystal,  $T$ =absolute temperature) gives a straight line; for the other materials the results give two intersecting straight lines. One line, common to all samples, represents volume diffusion; the other requires some other mechanism, probably connected with lattice imperfections.

For all substances studied the values  $D/a^2$  for volume diffusion at room temperature are  $<5 \times 10^{-24}(\text{sec}^{-1})$ , which is so small that K-Ar ages on these materials need not be corrected. For the diffusion from lattice imperfections, however,  $D/a^2$  at room temperature may be as high as  $6 \times 10^{-18}(\text{sec}^{-1})$ . This investigation thus proves once again that sanidine and mica are the best materials for K-Ar dating, whereas other feldspars and rocks are less suitable and salts may be used only in exceptional cases.—D.B.V.

189-7. Antevs, Ernst. Transatlantic climatic agreement versus  $C^{14}$  dates: *Jour. Geology*, v. 70, no. 2, p. 194-205, 1962.

A comparison is made of the timing of late Pleistocene events from glacial deposits in North America and Europe. The 11,200 yr date by  $C^{14}$  for the Two Creeks interstadial is considered by the author to be too young by about 8,000 yr.—M.R.

189-8. Alessio, Marisa, Allegri, Lucia, and Bella, Francesco. A  $CO_2$ -proportional counter of small volume and high efficiency for low level  $\beta$ -counting: *Ricerca Sci.*, v. 30, no. 12, p. 1960-1962, 1960.

A  $CO_2$ -proportional counter designed mainly for radiocarbon dating at the University of Rome's radiocarbon dating laboratory is described. The background is 2.40 counts per min, counting rate for modern carbon is 10.43 counts per min, and efficient volume is 570 cc. Maximum measurable age is 40,000 yr, with an error of  $\pm 2$  percent to 20,000 yr and  $\pm 10$  percent at 40,000 yr.—D.B.V.

189-9. Bella, Francesco, and Cortesi, Cesarina. The  $CO_2$ -proportional counter of the carbon-14 dating laboratory of the University of Rome: *Ricerca Sci.*, v. 30, no. 12, p. 1969-1977, 1960.

The  $CO_2$  proportional counting system of the University of Rome's radiocarbon dating laboratory is described. The preparation and purification of the  $CO_2$  are carried out according to the DeVries method with a few modifications. The proportional counter has some original construction features. The background is 1.75 counts per min, counting rate for modern carbon is 12.08 counts per min, and efficient volume is 1.580 liters. Maximum measurable age is 50,000 yr, with an error of  $\pm 2$  percent up to 30,000 yr and of  $\pm 10$  percent at 50,000 yr. Diagrams and photographs are given. (See also *Geophys. Abs.* 189-8.)—D.B.V.

189-10. Serebryanny, L. P. K razrabotke absolutnoy khronologicheskoy shkaly verkhnego pleystotsena i golotsena s pomoshch'yu radiouglerodnogo metoda [On development of an absolute chronological scale of the upper Pleistocene and Holocene by the radiocarbon method]: *Akad. Nauk SSSR, Kom. Izucheniya Chetvertich. Perioda Byull.*, no. 24, p. 8-21, 1960.

Carbon-14 methods as applied to determination of absolute ages in the upper Pleistocene and Holocene by non-Russian geochronologists through 1957 are reviewed.—A.J.S.

- 189-11. Neuvonen, K. J. The apparent age pattern of the crust: [Finland] *Comm. Géol. Bull.*, no. 196, p. 445-454, 1961.

Isotopic datings are commonly low owing to diffusion of the daughter elements. The diffusion increases as the temperature rises, until at great depths in the earth's crust a level is reached at which all geochronometers should show a zero age. Owing to isostatic rise, the apparent age of the continental blocks will decrease with depth. The discrepancy between radioactive age measurements and classical field observations in Finland is discussed from this point of view.—D.B.V.

- 189-12. Bryant, Bruce, and Reed, John C., Jr. Structural and metamorphic history of the Grandfather Mountain area, North Carolina: A preliminary report: *Am. Jour. Sci.*, v. 260, p. 161-180, 1962.

In a discussion of the history of the Grandfather Mountain area of northwest North Carolina, radiometric age determinations, previously published by Tilton and others (see *Geophys. Abs.* 184-25), are given which establish a 1,000-1,100 m.y. age of the plutonic metamorphism. An additional previously unpublished zircon age by Tilton of  $U-238/Pb-206=990$  m.y.,  $U-235/Pb-207=1,010$  m.y.,  $Pb-207/Pb-206=1,055$  m.y., and  $Th-232/Pb-208=1,000$  m.y. is given. Age determinations previously published by Long, Kulp, and Eckelman (see *Geophys. Abs.* 179-5) indicate a 350 m.y. age for an episode of metamorphism affecting the rocks of the Blue Ridge thrust sheet.—T.W.S.

- 189-13. Ruhe, Robert V. Age of the Rio Grande Valley in southern New Mexico: *Jour. Geology*, v. 70, no. 2, p. 151-167, 1962.

The ancestral course of the Rio Grande in southern New Mexico is highly conjectural. The Rio Grande is now entrenched northwest-southeast below the Jornada-La Mesa surface and is bordered by a stepped sequence of geomorphic surfaces, the youngest of which is less than  $2,620 \pm 200$  yr old by radio-carbon dating. It is concluded that the river valley at maximum is mid-Pleistocene in age and has been emplaced in the same general axial position since that time.—P.C.I.

- 189-14. Russell, R. D. Isotopic studies and geochronology; VIII: Canadian *Geophys. Bull.*, v. 14, p. 105-108, 1961.

Isotopic studies and age determinations in progress at various Canadian laboratories are summarized. Lead isotope studies form a major part of the Canadian isotopic investigations. Several laboratories are engaged in age determinations by the K-Ar, Rb-Sr, and C-14 methods. Stable isotope studies in a number of laboratories are currently centered on the elements sulfur, magnesium, boron, selenium, and the rare gases from uranium and thorium ores.—B.L.

- 189-15. Neale, E. R. W., Beland, J., Potter, R. R., and Poole, W. H. A preliminary tectonic map of the Canadian Appalachian region based on age of folding: *Canadian Mining Metall. Bull.*, v. 54, no. 593, p. 687-694, 1961.

A new style of tectonic map based on the age of folding largely substantiated by K-Ar dates is presented in preliminary form for the Canadian Appalachian region as part of the Tectonic Map of Canada Project. This style of map provides a clearer picture of the tectonic history of the Canadian Appalachian region than any method previously attempted. It shows at a glance the areal extent of Paleozoic orogenies and areas subjected to two or more periods of deformation; the type and areal extent of igneous intrusion associated with each period of deformation; and the flat-lying rocks that rest unconformably on folded zones. The next edition on a larger scale, 1 inch = approx. 31 miles, will show much greater structural detail.—V.S.N.

- 189-16. Ginn, R. M. Geology of Porter township: Ontario Dept. Mines, *Geol. Rept.*, no. 5, 36 p., 1961.

The Precambrian consolidated layered rocks of the Porter township, Ontario, are classified into two groups. The older group containing volcanic rocks is overlain by sedimentary rocks, which also appear to rest unconformably on a mass of granite. The K-Ar age of mica from the granite is about 2,200 m.y. Variations in the ages of samples suggest that metamorphism of the granite by basic intrusive rock occurred about 1,300 m.y. ago. Analytical data are not given.—R.M.G.

- 189-17. Burwash, R. A., Baadsgaard, H[alfdan], and Peterman, Z. E. Precambrian K-Ar dates from Western Canada sedimentary basin: *Jour. Geophys. Research*, v. 67, no. 4, p. 1617-1626, 1962.

Potassium-argon mica dates obtained as part of a continuing research program on the Precambrian basement of the western Canada sedimentary basin indicate an extensive geologic province (Churchill) affected strongly by the Hudsonian orogeny at 1,650-1,850 m.y. The subsurface extent of this province can be roughly outlined. 'Survival' values characterize the contact zones between the Churchill province and the older cratons and suggest a possible pre-Hudsonian complex in west-central Alberta. Post-Hudsonian minor basaltic magmatic activity is present within the Churchill province and is possibly regionally time-related to the Keweenaw of the Lake Superior region (1,000-1,200 m.y.).—Authors' abstract

- 189-18. Fahrig, W. F. The geology of the Athabasca formation: Canada Geol. Survey, Dept. of Mines and Tech. Surveys Bull., no. 68, 41 p., 1962.

Geochronometric data place the age of the Athabasca formation between 400 and 1,800 m.y. Two discordant U-Pb ages on pitchblende from Stewart Island in Lake Athabasca indicate that the Athabasca formation is older than 400 m.y. Regional metamorphism and granitization in the Beaverlodge area at 1,800 m.y. is suggested by the age of monazite, and the Athabasca formation post-dates this regional metamorphism.—T.W.S.

- 189-19. Washburn, A. L., and Stuiver, Minze. Radiocarbon-dated postglacial deleveling in northeast Greenland and its implications: *Arctic*, v. 15, no. 1, p. 66-73, 1962.

Radiocarbon dating of driftwood and of shells from emerged marine deposits is the basis for the conclusion that the Mesters Vig district in northeast Greenland was deglaciated in part by 9,000-8,500 B.P. and has remained largely free of glaciers since 8,500 B.P. Emergence is related primarily to ice thinning and to isostatic adjustment. It is postulated that a high initial rate of emergence, of the order of 9 m per 100 yr, decreased to approximately 0.6 m per 100 yr for the interval from 9,000 to 6,000 B.P. and probably to as little as 9 cm per 100 yr since 6,000 B.P. Radiocarbon ages are summarized in a table, and the data are shown in graphs.—P.C.I.

- 189-20. Bass, Manuel, and Shagam, Reginald. Edades Rb-Sr de las rocas cristalinas de los Andes meridionales, Venezuela [Rb-Sr ages of the crystalline rocks of the Merida Andes, Venezuela]: *Cong. Geol. Venezolano*, 3d, Caracas, 1959, v. 1, p. 377-381, 1960.

The ages of 5 minerals from the Sierra Nevada formation and 1 phyllite from the Mucuchachí formation from the Merida Andes of Venezuela were determined by the Rb-Sr method. The value  $\lambda = 1.39 \times 10^{-11}$  was used for the decay constant of Rb-87. According to the geologic evidence the gneisses, schists, and granitic rocks of the Sierra Nevada formation are the oldest rocks in the area, and the Mucuchachí formation overlies them unconformably.

The results show that the last appreciable metamorphism of the Sierra Nevada formation occurred about 234 m.y. ago. An apparent age of  $420 \pm 105$  m.y. for the phyllite is difficult to interpret. The detrital mica in the phyllite may contain older radioactive strontium inherited from the source from which the

original sediments were derived. The field evidence indicates that the Mucuchachí formation was metamorphosed at the same time as the Sierra Nevada but less intensively.—D.B.V.

- 189-21. Lineras, Enrique. Los métodos geocronológicos y algunas edades de minerales de la Argentina, obtenidas por medio de la relación plomouranio [The geochronological methods and some ages of minerals of the Argentine, obtained by means of the lead-uranium ratio (with English abstract)]: *Asoc. Geol. Argentina Rev.*, v. 14, no. 3/4, p. 181-217, 1961.

The various methods of age determination based on radioactivity are discussed briefly with emphasis on the Pb/U method. Results obtained from determinations on minerals chiefly from La Rioja, San Luis, and Córdoba provinces using Pb/U ratios from both chemical and isotopic analyses are tabulated. Ages of uraninites from various pegmatites of the Sierras Pampeanas, San Luis and Córdoba provinces, range from late Precambrian to Middle Cambrian and confirm the Precambrian age of the granitic rocks of this structural unit. An average age of  $310 \pm 15$  m.y. (Early Devonian) was found for samples from the San Victorio deposit in La Rioja province. This confirms De Alba's hypothesis that this vein deposit is associated with the intrusion of the Famatina granite.—V.S.N.

- 189-22. Moorbath, S. Lead isotope abundance studies on mineral occurrences in the British Isles and their geological significance: *Royal Soc. London Philos. Trans., Ser. A*, v. 254, no. 1042, p. 295-360, 1962.

The Holmes-Houterman's model-ages of three suites of galenas agree excellently with the radioactivity ages of genetically associated igneous rocks: about 370 m.y. for ores near the Shap granite, England; about 280 m.y. for galena associated with Hercynian granites, England; and about 250 m.y. for sulfides in the Oslo igneous province, Norway.

The isotopic compositions of the normal leads in the British Isles suggest six periods of mineralization ranging in age from early Paleozoic to late Mesozoic. The two most important periods are associated with the Caledonian and Hercynian orogenies. Twelve localities contain lead with model-ages demonstrably older than the true age of mineralization; no localities have yielded negative, or anomalously young, model ages. The leads with anomalously old model-ages probably arise by localized remobilization from metamorphic complexes with high lead/uranium ratios, or low radiogenic lead content.—B.R.D.

- 189-23. Long, L[eon] E. Some isotopic ages from south-west England, in *Some aspects of the Variscan fold belt: Manchester, England*, Manchester University Press, p. 129-134, 1962.

Potassium-argon and rubidium-strontium measurements on the Dartmoor granite of southwest England give an age of  $278 \pm 10$  m.y., which is in agreement with a previously published U-Pb age of  $290 \pm 10$  m.y. on uraninite from the Cornwall mineralized area. The field relationships of the Dartmoor granite indicate that this age defines the boundary between the Carboniferous and Permian periods.—B.L.

- 189-24. Miller, J[ohn] A., and Green, D. H. Age determinations of rocks in the Lizard (Cornwall) Area: *Nature*, v. 192, no. 4808, p. 1175-1176, 1961.

Potassium-argon measurements were made on five samples of hornblende and one of biotite from gneisses and schists of the Lizard area in southwest England. An age of 360-390 m.y. is indicated for intrusion of the Kennack gneiss. The intrusion was accompanied by partial or complete loss of argon from hornblendes in the pre-existing metamorphic assemblages. (See also *Geophys. Abs.* 186-35.)—A.P.P.

- 189-25. Chessex, R[onald], de Montmollin, F., Ferrara, G., and Longinelli, A. Measurements of the age of the Vallorcine granite (Switzerland): *Nature*, v. 193, no. 4822, p. 1279, 1962.

The Rb-Sr age of a biotite from the Vallorcine granite is 286 m.y.—C.E.H.

- 189-26. Miller, J[ohn] A., and Mudie, J. D. Potassium-argon age determinations on granite from the Island of Mahe in the Seychelles Archipelago: *Nature*, v. 192, no. 4808, p. 1174-1175, 1961.

Potassium-argon ages of 511 and 519 m.y. were obtained by the whole rock method on samples of two amphibolite granites from Mahe Island. Biotite isolated from one of the granites yielded an age of 654 m.y. It is concluded that the Seychelles Archipelago was formed during the late Precambrian; although there is evidence of more recent uplifting.—A.P.P.

- 189-27. Vitanage, Piyadasa W. Geology of the country around Polonnaruwa: *Ceylon Geol. Survey Mem.*, no. 1, 75 p., 1959.

The bedrock of the area around Polonnaruwa, Ceylon, is Precambrian and consists largely of gneisses, amphibolites, migmatites, and charnockites. Petrographic descriptions and chemical analyses of 16 igneous or metamorphic rocks and 11 limestones are given. Isotopic age determinations, all previously published, range from 510 to 630 m.y.—R.M.G.

- 189-28. Aswathanarayana, U. Age of the Cuddapahs, India: *Nature*, v. 193, no. 4814, p. 470, 1962.

Lead isotope analyses are reported for three samples of galena from veins and disseminations in the Cuddapahs system and related rocks. Precambrian model ages of 840 and 720 m.y. are obtained for two of the samples. The isotopic composition of the third sample ( $Pb-206/Pb-204=57.96$ ;  $Pb-207/Pb-204=20.11$ ;  $Pb-208/Pb-204=49.87$ ) shows it to be a most extreme variety of J-type lead.—A.P.P.

- 189-29. Krummenacher, Daniel. Déterminations d'âge isotopique faites sur quelques roches de l'Himalaya du Népal par la méthode potassium-argon [Determinations of isotopic age made on some rocks of the Himalayas of Nepal by the potassium-argon method (with English summary)]: *Schweiz. Mineralog. Petro. Mitt.*, v. 41, no. 2, p. 273-283, 1961.

Fifteen K-Ar age determinations on micas from metamorphic rocks of the Himalayas of Nepal are reported. The Alpine metamorphism in this region was concluded about 13 m.y. ago. A Precambrian metamorphism is indicated at  $728\pm 12$  m.y. The K-Ar ages of catazonal rocks are younger than those of epizonal origin.—J.W.C.

- 189-30. Miller, John A., and Shibata, Ken. Potassium-argon age of Ryoke granite from Obatake, Yamaguchi Prefecture: *Japan Geol. Survey Bull.*, v. 12, no. 8, p. 89-90, 1961.

Two biotites from the Ryoke granite indicate K-Ar ages of 82 and 84 m.y. The total volume of argon was measured in a McLeod gauge, and the atmospheric correction was made by measuring the Ar-40/Ar-36 ratio with a mass spectrometer.—C.E.H.

- 189-31. Péwé, Troy L. Age of moraines in Victoria Land, Antarctica: *Jour. Glaciology*, v. 4, no. 31, p. 93-100, 1962.

The well-developed series of moraines in front of a lobe of Taylor Glacier in the lowlands of McMurdo Sound, Antarctica, are older than the 50-100 yr age suggested by others. The photographic records shows little or no ice front

retreat in the last 50 yr; radiocarbon dates of mummified seal carcasses suggest no retreat for at least 1,000 yr, and that of algae from extinct ephemeral ponds on the youngest moraines (in many places ice-cored) indicate the moraines to be at least 6,000 yr old. The well-developed sand-wedge polygons with interpolygon furrows 1-2 m wide found on the morainal surfaces would require a glacial-free area for hundreds if not thousands of years.—V.S.N.

Khain, V. Ye. Main stages of development of the crust (in the areas of the present continents). See *Geophys. Abs.* 189-250.

Murthy, V. Rama, and Patterson, C[laire] C. Primary isochron of zero age for meteorites and the earth. See *Geophys. Abs.* 189-53.

#### COSMOGONY

189-32. Wood, John A. Chondrules and the origin of the terrestrial planets: *Nature*, v. 194, no. 4824, p. 127-130, 1962.

An understanding of the origin of chondrules probably provides the key to the history of meteorites. It seems clear that they were once dispersed molten droplets. It is shown that in the models of Hoyle (see *Geophys. Abs.* 189-33) or Cameron (in press), chondrites could be surviving condensations dating back to the origin of the solar system; if this is so, it is not unreasonable to suppose that the whole system of terrestrial planets accreted from "planetesimals" of this type. Such a process provides an opportunity for chemical fractionation among the planets; qualitatively, the nature of the condensate would vary with distance from the sun just as the planetary densities seem to require. Two accretion mechanisms are possible: magnetism and electrostatic attraction.—D.B.V.

189-33. Hoyle, F[red]. On the origin of the solar nebula: *Royal Astron. Soc. Quart. Jour.*, v. 1, no. 1, p. 28-55, 1960.

A consideration of star formation from the interstellar gas shows that primitive solar condensation was probably endowed with angular momentum very much greater than now possessed by the sun. It is found that the initial angular momentum agrees with that possessed by the primeval planetary material; this suggests that the angular momentum of the solar nebula was transferred to the planetary material. As the latter acquired angular momentum it moved farther away from the solar condensation. Low-volatility materials left behind as they condensed out of the gas became the terrestrial planets. Various subsidiary problems, such as the formation of satellites and the escape of gas from the periphery of the solar system are briefly discussed.—D.B.V.

189-34. Lyttleton, R. A. Dynamical calculations relating to the origin of the solar system: *Royal Astron. Soc. Monthly Notices*, v. 121, no. 6, p. 551-569, 1960.

It is shown that the dynamic aspects of certain hypotheses of the formation of planets can be represented closely by a restricted three-body system, and accurate machine integrations of the equations of motion have been carried out on such a basis to test the hypothesis. It is also shown that the collisional and tidal mechanisms could not result in any particles going into orbit outside the sun. In the case of collision of two stars, only a negligible quantity of material would escape and be available for capture by the sun; the amount could rise to planetary order only if the relative speeds of the colliding stars when widely separated were several hundred km/s. Rotational break-up of a companion star to the sun might fulfill such a condition.

The rotational instability of a primitive planet growing from a disk of material moving around the sun would probably result in disruption into two main pieces with high mass ratio and separating with hyperbolic speed. The motion of small particles formed in the stream of material drawn out between the separating main masses can also be investigated by means of a restricted

three-body analogy; it is shown that satellite orbits are possible as a result of the great elongation possessed by the last Jacobi figure together with the high relative velocity of the separating pieces. It is suggested that the rotational stability of the great planets has been reached in this way, and their principal satellites produced by the same means. Smaller main pieces resulting from the break-up would have sufficient terminal speed to escape from the solar system.—D.B.V.

- 189-35. de Turville, C. M. Terrestrial accretion and the solar wind: *Nature*, v. 190, no. 4771, p. 156, 1961.  
 Wasson, J. T., and Junge, C. E. Terrestrial accretion and the solar wind: *ibid.*, v. 194, no. 4823, p. 41-42, 1962.  
 de Turville, C. M. Terrestrial accretion and the solar wind: *ibid.*, v. 194, no. 4823, p. 42, 1962.

In the first paper, de Turville calculates the total accretion of hydrogen by the earth from the solar wind to be  $1.70 \times 10^{23}$  g. Complete oxidation of this hydrogen would yield  $1.53 \times 10^{24}$  g of water, which is in close agreement with the known ocean mass of  $1.42 \times 10^{24}$  g. It is suggested that the seas have formed gradually by accretion of solar hydrogen at a rate of about 1.5 tons per sec.

Wasson and Junge discuss three main points, the combination of which indicates that no more than a minor fraction of the ocean water has resulted from accretion of protons from the solar wind.

In the last paper, de Turville mentions that new observations relevant for the hydrogen accretion rate and deuteron production have led to the conclusion by Fowler and others (see *Geophys. Abs.* 189-36) that terrestrial deuterium was produced in place by neutron irradiation of terrestrial hydrogen at an early stage in the evolution of the solar system. In view of these considerations the earlier proposal concerning the origin of the oceans loses all plausibility and is withdrawn.—D.B.V.

- 189-36. Fowler, William A., Greenstein, Jesse L., and Hoyle, Fred. Deuteronium. Synthesis of deuterons and the light nuclei during the early history of the solar system: *Am. Jour. Physics*, v. 29, no. 7, p. 393-403, 1961.

Abundances in terrestrial and meteoritic matter indicate that the synthesis of deuterons and of the isotopes of Li, Be, and B occurred during an intermediate stage in the early history of the solar system, a stage in which the planetary material had become largely separated from the hydrogen that was the main constituent of primitive solar material. The synthesis occurred in solid planetesimals of the order of 10 m in size, consisting of silicates and oxides of the metals in an icy matrix, through spallation and neutron reactions induced in the outer layers by bombardment of high-energy charged particles. Anomalous abundance of Xe-129 and Ag-107 in meteorites can be attributed to decay of radioactive I-129 and Pd-107 produced in the planetesimals. The time interval between irradiation of the small planetesimals and formation of larger bodies in the solar system could not have exceeded  $10^7$ - $10^8$  yr.—D.B.V.

- 189-37. Jobert, Georges. Tensions non hydrostatiques dans une planète gravitante [Nonhydrostatic tensions in a gravitating planet]: *Acad. Sci. [Paris] Comptes Rendus*, v. 253, no. 10, p. 1163-1165, 1961.

The nonhydrostatic stresses are calculated for a planet formed by the capture of identical solid particles. The simple case is examined where the law of the variation of density with depth does not change as the external radius increases. Applied to the moon, the maximum differential stress is calculated as  $1.04 \cdot 4 \times 10^6$  cgs, reached at a depth of 512 km.—D.B.V.

- 189-38. Jobert, Georges. Nonhydrostatic stresses in a gravitating planet: *Jour. Geophys. Research*, v. 67, no. 4, p. 1579-1585, 1962.

By following the evolution of the stresses in a gravitating homogeneous planet during its accretion, it is possible to evaluate the differential stress in its interior if the compressibility and the rigidity of the substance are known functions of the density. The superficial layers are assumed to be in hydrostatic equilibrium. The radial pressure everywhere exceeds the horizontal pressures. The stress difference is null at the center of the planet, reaching its maximum at a depth of about one-third of the external radius. This value is roughly proportional to the fourth power of the external radius and inversely proportional to the superficial rigidity.— Author's abstract

- 189-39. Arnold, James R. Nuclear effects of cosmic rays in meteorites, in *Annual Review of Nuclear Science*, v. 11: Palo Alto, California, Annual Reviews, Inc., p. 349-370, 1961.

The information that can be obtained concerning the origin, age, and original size and shape of meteorites, as well as on the nature of the cosmic rays themselves from a study of the nuclei produced by cosmic-ray bombardment of meteorites is reviewed. The history of research on rare gases and radioactivity in meteorites, and the experimental methods of study are mentioned briefly followed by a more detailed discussion of the determination of the cosmic ray or bombardment age of meteorites and the interpretation of the information obtained, the terrestrial age of meteorites, the types of nuclear reactions, the variation of helium and other rare gases with depth and size of a meteorite, and space and time variations in cosmic ray intensity.— V.S.N.

- 189-40. Fesenkov, V.G. Nekotoryye problemy meteoritiki [Some problems of meteoritics]: *Akad. Nauk SSSR Meteoritika*, v. 20, p. 16-26, 1961.

This is a descriptive paper dealing with: (1) properties of the surface of meteorites in interplanetary space, (2) collection and study of meteoric dust, (3) properties and origin of tektites, (4) fall and recovery of large meteorites, and (5) study of the composition of meteorites. Emphasis is placed on the importance of study of meteorites with regard to the earth's formation by accumulation of cold solid and gaseous substance.— A.J.S.

- 189-41. Hawkins, G[erald] S. Asteroidal fragments: Lunar and Planetary Explor. Colloquium Proc., v. 2, no. 4, p. 5-10, 1961.

Assuming that meteorites are remnants of asteroidal collisions, statistical data on asteroids and asteroidal collisions are derived from a study of the meteorite data in the Prior and Hey "Catalogue of Meteorites" (1953). The mass of material recovered at the surface of the earth is estimated, and equations are obtained to estimate the mass distribution of meteorites after passage through the atmosphere and the mass distribution in interplanetary space. The number of meteorites per unit volume in the space surrounding the earth is determined from the estimated influx rate at the surface of the earth based on observed falls. The influx rate is further examined by study of the observed rate of bright fireballs, and from this it is concluded that the earth encounters one asteroidal fragment with mass equal to or greater than  $13 \times 10^6$  kg every 100 yr. Such an asteroid would have a diameter of 14 km and a mean density of 3.5. Equations are derived to deduce the number of meteorites per cubic centimeter in space. Observations of asteroids in space and meteorites on the ground indicate a fourth-power law for the distribution according to size. This distribution is compared with that obtained in the mechanical crushing of terrestrial rock, and results support the conclusion that the observed mass distribution of meteorites and asteroids indicates a large number of collisions between these bodies. It is assumed that this process of attrition is still in progress in the asteroid zone. From the difference in distribution of the iron and stone meteorites it is deduced that at least one of the original asteroids must have been between 2,000 and 4,000 km in diameter.— V.S.N.

- 189-42. Schilling, G. F. (chm.). Meteorites—Their origin and properties: Lunar and Planetary Explor. Colloquium Proc., v. 2, no. 4, p. 19-36, 1961.

The main speakers for this group discussion on the origin and properties of meteorites were Anders and Brown. Anders discussed virtually the same material as given in the paper by Fish and others (see Geophys. Abs. 184-85).

Brown discussed the fact that meteorites do not represent a continuum but rather a number of discrete families which differ measurably from one another; meteorites within one given family are relatively homogeneous, and their compositions with respect to specific elements can be predicted a priori. Time variations in the rate of observed meteorite falls and the falls themselves are investigated with respect to specific types of meteorites. It is shown that changes have occurred in the rates of fall of particular types of meteorites; when regarded on a monthly basis evidence is found of special groupings within the solar system. There seem to be preferential months for the fall of iron meteorites, but enstatite chondrites show no evidence of monthly preference. Curves are plotted for the most sensitive elements in order to find terrestrial analogies for the various known meteorite groups. The application of this to lunar surface materials is discussed. It is shown that by using very few elements differences between the individual groups of meteorites and between terrestrial and achondrite groups can be quickly established. Discussion of the two talks by members of the Colloquium is included.—V.S.N.

- 189-43. Fesenvov, V. G. O kometnoy prirode Tunguskogo meteorita [On the comet nature of the Tungus meteorite]: Astron. Zhur., v. 38, no. 4, p. 557-592, 1961.

A detailed analysis is presented of data on the fall of the Tungus meteorite of June 30, 1908 at Vanovara in central Siberia. On the basis of the absence of meteoritic matter and craters in the area, the great fall of the forest in radial directions, the anomalous illumination of the sky, and the decrease in transparency of the earth's atmosphere indicate that the object was a comet. The nucleus of a comet with a mass of a million tons or more of small particles is considered to have penetrated the atmosphere to an altitude of 5-6 km; it approached the earth's surface at an inclined trajectory and disintegrated in three or more subsequent explosions.—A.J.S.

- 189-44. Fesenvov, V. G. O prirode Tunguskogo meteorita [On the nature of the Tungus meteorite]: Akad. Nauk SSSR Meteoritika, no. 20, p. 27-31, 1961.

The Tunguska River phenomenon of 1908 is considered to have been a comet which entered the earth's atmosphere with a velocity of 40-50 km/s and released about  $10^{25}$  ergs of energy during its disintegration. A retrograd orbital motion of the body is indicated by the magnitude of the destructive force. This suggests a comet. An additional and independent evidence of the comet nature of the Tungus catastrophe is seen in the abrupt perturbation in the magnetic field of the earth recorded by the Irkutsk Magnetic Observatory and at other observatories immediately after the explosion. The fact that no meteoritic fragments were found in the area of the fall is considered as a final proof that the Tungus catastrophe was due to the collision of the earth with a comet.—A.J.S.

- 189-45. Yudin, I. A., and Obotnin, N. F. Mineragraficheskoye i rentgenostruktornoye issledovaniye uglistykh chondritov Migei, Staroye Boriskino i Groznaya [Mineralographic and X-ray study of the carbonaceous chondrites of Migei, Staroye Boriskino, and Groznaya]: Akad. Nauk SSSR Meteoritika, no. 20, p. 163-170, 1961.

X-ray and mineralographic analyses of minerals in three carbonaceous chondrites are reported. Troilite, ferronickel, and chromite are present in

quantities less than 3.4 percent. Troilite and ferronickel are replaced partially by a gray mineral of apparent terrestrial origin. No crystalline carbon was detected in the analysis.—A.J.S.

- 189-46. Bernal, J. D. Significance of carbonaceous meteorites in theories on the origin of life: *Nature*, v. 190, no. 4771, p. 129-131, 1961.

The results of mass spectrographic analysis of carbonaceous material from the Orgueil meteorite led Nagy and others to conclude that biogenic processes occur and life exists beyond the earth. A crucial question now is whether this carbonaceous material can be imitated by radiation in atomic piles or high-energy machines. If so, the carbonaceous meteorites might be the primary accumulation of elements and free energy for the first synthesis of life on this earth rather than the end products of chemical evolution on some other celestial body.—D.B.V.

- 189-47. Urey, Harold C. Origin of life-like forms in carbonaceous chondrites: *Nature*, v. 193, no. 4821, p. 1119-1123, 1962.

Possible extraterrestrial origins of the life forms (if indeed they are such) recently reported in carbonaceous chondrites (see *Geophys. Abs.* 189-48) are discussed. The most probable origin would seem to be that the moon became contaminated temporarily with water and life-forms from the earth early in its history, that these forms were preserved there, and that they are now returning to the earth. This conclusion requires that the lunar surface consist of materials having a composition and physical structure similar to those of stone meteorites; it also requires that processes capable of transferring water to the moon existed at a remote time and that processes capable of removing objects from the moon exist at the present time.—D.B.V.

- 189-48. Fitch, Frank, Schwarcz, Henry P., and Anders, Edward. "Organized elements" in carbonaceous chondrites: *Nature*, v. 193, no. 4821, p. 1123-1125, 1962.

New observations shed some light on the nature of the organized elements reported in the Orgueil and Ivuna meteorite samples. Three types of spherical particles are described. It is concluded that all three types are droplets of troilite and of supercooled sulfur and hydrocarbons. The organized elements described by Claus and Nagy (see *Geophys. Abs.* 187-60) are either identical with one of these types, or are so scarce in the specimen studied as to be below the threshold of detection.—D.B.V.

- 189-49. Briggs, Michael H., and Kitto, G. Barrie. Complex organic microstructures in the Mokoia meteorite: *Nature*, v. 193, no. 4821, p. 1126-1127, 1962.

Examination of the Mokoia carbonaceous chondrite from New Zealand reveals the presence of complex organic microstructures of extraterrestrial origin; a minority of these resemble unicellular organisms but most are present as unorganized fragments. The evidence is compatible with either a biogenic or an abiogenic origin, but whatever the origin, the parent body of the meteorite must have had an atmosphere and a hydrosphere and therefore was at least of lunar size.—D.B.V.

- 189-50. Bernal, J. D. Comments: *Nature*, v. 193, no. 4821, p. 1127-1129, 1962.

Whatever its outcome, the controversy concerning the organized elements in carbonaceous chondrites has multiplied interest in the nature and origin of the carbonaceous material in meteorites, whether it is in fact a product of life processes or merely a possible source for the origin of organized life. It can no longer be assumed that life originated on the earth. The greatest difficulty in explanations suggested so far is the fact that the "organisms" are not sim-

ilar in shape to terrestrial single cell organisms, but nevertheless appear to have the same biochemistry. Either life is a complex of phenomena which for intrinsic necessity only follow a very narrow range of chemical reactions, or there is only one sequence of evolution of life and the forms observed in the meteorites and here are genetically related. The first alternative seems inherently improbable, but the second strains the imagination as to how transfers have been effected.—D.B.V.

- 189-51. Nagy, Bartholomew, Claus, George, and Hennessy, Douglas J. Organic particles embedded in minerals in the Orgeuil and Ivuna carbonaceous chondrites: *Nature*, v. 193, no. 4821, p. 1129-1133, 1962.

Four types of additional experiments were performed in order to evaluate the "organized elements" reported earlier in the Orgeuil and Ivuna carbonaceous chondrites (see *Geophys. Abs.* 187-60), and to define their nature and origin more specifically: (1) Chemical and physical experiments (treatment with acids, density separations and treatment with organic solvents, heat treatment, and magnetic separation) suggest that these are organized organic particles, and quite certainly not those described by Fitch and others (see *Geophys. Abs.* 189-48). (2) Examination of powdered samples of two other carbonaceous chondrites, Tonk and Alais, under the microscope showed that these also contain identical types of organized elements. The distance between falls renders most unlikely the possibility of contamination by identical terrestrial microorganisms. (3) The possibility of contamination in the museum was investigated by examining samples of Orgeuil from different museums; of dust from various storage rooms, laboratories, and the investigators' residences; and of the water supply system. No microorganisms identical with the organized elements were found. (4) Thin section examination of Orgeuil and Ivuna shows organized elements embedded in magnesium sulfate, indicating that they are indigenous to the meteorite parent body.

These results seem to indicate that the particles in question are fossilized organic, organized structures that are not likely to be minerals, organic artifacts, or terrestrial microbiological contaminations.—D.B.V.

- 189-52. Gallant, R. Frequency of meteorite falls throughout the ages: *Nature*, v. 193, no. 4822, p. 1273-1274, 1962.

Many astronomers have claimed that comets, asteroids, and meteorites have a common origin; thus, contrary to the opinions of Paneth and of Dingle (see *Geophys. Abs.* 186-56), there is no reason not to suppose that meteorites fell on the earth before Late Quaternary time. Several metallic bodies have been found that could be pre-Quaternary meteorites. Recent determinations of the terrestrial age of meteorites support this view.—D.B.V.

- 189-53. Murthy, V. Rama, and Patterson, C[laire] C. Primary isochron of zero age for meteorites and the earth: *Jour. Geophys. Research*, v. 67, no. 3, p. 1161-1167, 1961.

The present values for the isotopic composition of primordial lead in iron meteorites are  $Pb-206/Pb-204=9.56$ ,  $Pb-207/Pb-204=10.42$ , and  $Pb-208/Pb-204=29.71$ . The primary isochron of zero age (geochron) for meteorites, calculated by using the above estimate of the isotopic composition of primordial lead and the isotopic compositions of leads in some stone meteorites, has a slope of  $0.59 \pm 0.01$ . The isotopic composition of primordial lead in the earth appears to be identical to that in meteorites. From a consideration of Quaternary marine lead data and ore lead data, the terrestrial geochron is shown to have the same location as the meteorite geochron. The ratio of  $Th-232/U-238$  in stone meteorites is 3.8.—C.E.H.

- 189-54. Macleod, W. N., and Jefford, G. The Akwanga meteorite: *Nigeria Geol. Survey Recs. for 1959*, p. 15-20, 1961.

The Akwanga meteorite fell on July 2, 1959, 2 miles from the village of Gaji, Akwanga Division of the Plateau Province, Nigeria. It weighs approximately 3 kg and made a hole about 18 in. deep at the point of impact. The noise of descent and impact was heard up to a distance of 3 miles. The meteorite is a typical chondritic aerolite with a ratio of silicate minerals to iron-nickel alloy of 6 to 1. Petrographic, chemical, and spectrographic data are given.— V.S.N.

- 189-55. Chao, E. C. T., Fahey, J. J., and Littler, Janet. Coesite from Wabar Crater near Al Hadida, Arabia: *Science*, v. 133, no. 3456, p. 882-883, 1961.

The third natural occurrence of coesite, the high pressure polymorph of silica, is reported from the Wabar meteorite crater, Saudi Arabia. Natural coesite has thus far been found only in materials associated with craters of presumed impact origin where shock pressure exceeding 20 kilobars is thought to have occurred. The Wabar crater is by far the smallest of the three at which coesite has been found.— V.S.N.

- 189-56. Holm, Donald August. New meteorite localities in the Rub' al Khali, Saudi Arabia: *Am. Jour. Sci.*, v. 260, no. 4, p. 303-309, 1962.

Sixteen localities in the Rub' al Khali of southern Arabia are known to have produced meteoritic materials, but only the centrally located al-Hadida has craters. The remainder of the specimens must be assumed to have fallen as fragments of meteoritic showers. Eight of the localities lie on a straight line oriented on an azimuth of 300°; others lie on either side of the line but not all at random. Many of the specimens are thoroughly oxidized although Ni-Fe metallic meteorites occur. The rare mineral coesite has been found in glass collected from the crater at al-Hadida (see *Geophys. Abs.* 189-55).— V.S.N.

- 189-57. Shaposhnikov, D. P. K izucheniyu meteorita Lipovskiy Khutor [Study of Lipovskiy Khutor meteorite]: *Akad. Nauk SSSR Meteoritika*, no. 20, p. 171, 1961.

The Lipovskiy Khutor meteorite, found in 1904 in the Don River area, is described, and the results of metallographic and spectrographic analysis are given. The meteorite initially weighed 3,832 g, was 10×10×12 cm in size, and belongs to the group of iron-stone pallasites.— A.J.S.

- 189-58. Utech, Karl. Über das Vorkommen magnetischer Kügelchen im norddeutschen Buntsandstein, ihren stratigraphischen Wert und die wahrscheinliche Herkunft [On the occurrence of magnetic spherules in the Buntsandstein of north Germany, their stratigraphic value and probable origin]: *Neues Jahrb. Geologie u. Päläontologie Monatsh.*, no. 8, p. 432-436, 1961.

Investigation of Buntsandstein sediments from oil wells in north Germany reveals the presence of small magnetic spherules that are similar in size and shape to cosmic spherules (see *Geophys. Abs.* 173-234). Three kinds are found. The most numerous are 0.08 to 0.12 mm in diameter and contain mainly Fe and Si, with smaller amounts of Mn and Mg, still less of Al, Zn, and Pb, and traces of Cu, V, Cr, Ga, Sb, and Bi. The second kind is about the same size and contains the same elements, but with a higher proportion of Si. The third type is rare; they are larger (up to 1.5 mm) and contain mainly Fe, Si, and Mn, with somewhat less Mg, Cr, Ni, Al, and Cu, much less of Ga, Ge, Mo, Sn, and Co, and traces of Ca and V. Most are hollow. The curves of abundance of spherules in different wells show that the maximums constitute very accurate time markers.

All three types are considered to be of cosmic origin. Cosmic spherules are present in variable amounts in other formations, and may be absent in none. The general lack of Ni and Co in the Buntsandstein spherules in contrast to their presence in those of younger deposits needs explanation.— D.B.V.

- 189-59. Schwarcz, Henry P. A possible origin of tektites by soil fusion at impact sites: *Nature*, v. 194, no. 4823, p. 8-10, 1962.

It is demonstrated that soil is a possible parent rock for tektites. Soil forms a discrete, geochemically well defined family of rock types which, with some modifications (such as reduction of ferric to ferrous iron on heating), matches the family of tektite compositions. Unlike the various mixtures of sedimentary or igneous rock types that have been proposed up till now, soil is ubiquitous. A test of the soil hypothesis would be some correlation between the chemical composition of the soil at an impact site and that of the resultant tektites. The Ivory Coast tektites and Libyan desert glass have the compositions to be expected, respectively, of a tropical or subtropical soil and of mature dune sand.—D.B.V.

- 189-60. Schilling, G. F. (chm.). Origin of tektites: Lunar and Planetary Explor. Colloquium Proc., v. 2, no. 4, p. 37-47, 1961.

This group discussion was opened with remarks by Chapman on the aerodynamics and re-entry aspects of tektites. Laboratory experiments have shown that Australian and Java tektites have obvious aerodynamic markings, and at least 98.6 percent of the Australian tektites are found to be aerodynamically stable only in descent; secondary melting in certain directions on the tektite faces are compatible with this. Australian tektites show a second period of melting that occurred on one surface only. The same unique feature has been reproduced in the laboratory by ablation of synthetic tektite glass models. This is discussed and a photographic comparison is made between the synthetic and the Australian tektites. Another line of evidence is found in the ring waves formed on glasses ablated in a hypersonic stream and common to natural tektites. The amount of ablation and the thickness of the thin secondary layer on the Australian tektites is compatible with a re-entry velocity on the order of 10 to 13 km/s. As the escape velocity from the earth is 11 km/s, it is concluded that the tektites may be extraterrestrial material that is different from meteorites. The moon is proposed as the source of tektites, and this is discussed further by C. Sagan, G. S. Hawkins, and H. S. Brown. A brief abstract of a paper entitled "Tektites versus terrestrial rocks" is presented by its author, P. D. Lowman, Jr. The scatter and composition of tektites is compared with that of sedimentary and igneous rocks, and it is concluded that the restriction of tektite sizes and their distribution indicate that they come from the moon, possibly by ablation of blocks of ejecta blown off the moon by meteoritic impact.—V.S.N.

- 189-61. Clarke, Roy S., Jr., and Henderson, E. P. Georgia tektites and related glasses: *Georgia Mineral Newsletter*, v. 14, no. 4, p. 90-114, 1961.

Georgia tektites and other glassy objects are reviewed. Potassium-argon ages are summarized; Georgia tektites and Martha's Vineyard, Mass., tektites are dated at 33 m.y. Excellent plates of tektites from many localities are included.—R.M.G.

- 189-62. Baker, George. A naturally etched Australite from Narembeen, Western Australia: *Royal Soc. Western Australia Jour.*, v. 44, pt. 3, p. 65-68, 1961.

A large, boat-shaped australite weighing a little over 100 g from Narembeen, Western Australia, has been naturally etched to produce abundant solution grooves on all surfaces. It is one of the very few among some 40,000 known specimens of australites that shows a sculpture pattern with prominent straight, circular, and vermicular grooves resembling the U-shaped grooves on some specimens of billitonites and "gouttières" on some indochinites. The pits and grooves are primarily the result of solution-etching along bundles of schlieren in the tektite glass.—V.S.N.

- 189-63. Fielder, Gilbert. Small-scale explosion craters, impact craters, and the physical structure of the moon's surface: Royal Astron. Soc. Monthly Notices, v. 123, no. 1, p. 15-26, 1962.

A comparison of the forms of experimental explosion craters and the observed forms of lunar craters leads to the conclusion that parts of the moon may be covered to a depth between 0.3 and 1-3 km with a layer of material having the physical properties of gravel. The lunar rays were ejected from craters at relatively low angles and probably consist of small secondary craters and many more small bright particles. The primary ray craters were probably produced by near-surface meteoritic impacts in which explosive-type violence and crushing both played parts. In the small secondary craters crushing would predominate. If domes and conical craters are found together the domes are probably igneous phenomena.

Comparison of photographs of bomb craters and explosion craters in lead with lunar craters shows that both small-scale and lunar-size craters may display approximately radial patterns outside their walls, and these patterns indicate that the stresses associated with their formation were of similar type and distribution on the two different scales.— D. B. V.

- 189-64. Fiedler, Gilbert. Structure of the moon's surface: New York, Pergamon Press, 266 p., 1961.

Pertinent observational data about the moon is assembled that brings lunar studies up to date and stresses the importance of certain features of the moon that have been frequently disregarded in the past. Part 1 reviews and summarizes important physical problems including librations of the moon, height determinations, figure of the moon, luminous intensity and luminescence of lunar rocks, color of moonlight and composition of the moon's surface, polarization of light reflected by the moon, temperature of the moon, the moon's atmosphere, and probable nature of the moon's surface and changes that occur. Part 2 discusses relatively new facts or ideas about ray systems; the grid system and lattice patterns; rilles, faults, and wrinkle ridges; crater distribution and frequency; and conditions relating to the origin of the moon's surface structure. In the final chapter conclusions are based on facts drawn from the rest of the book and do not favor any particular preexisting theory.— V.S.N.

- 189-65. Urey, H[arold] C. (chm.). Lunar physics and topography: Lunar and Planetary Explor. Colloquium Proc., v. 2, no. 3, p. 1-15, 1961.

Urey introduces the subject by a discussion of the origin of the moon and the evidence that supports capture of the moon by the earth. Shoemaker relates how geologic evidence for the rate of meteoritic infall on earth is consistent with the hypothesis of mare formation very early in the moon's history. He concludes that if the pre-mare craters are impact craters the rate of impact must have been much higher in the early period of lunar history; this is interpreted as either a terminal record of the planetesimal infall in the formation of the moon, or a record of the moon's moving out and sweeping up a sediment ring as proposed by Kuiper. The latter point is further supported by Kuiper. Alter reviews his theories on the formation of the moon and the lunar eccentricity presented earlier (see Geophys. Abs. 186-84). This is discussed at some length by several members of the colloquium including Green, who favors a volcanic origin for the major lunar surface features; a table of lunar surface features supporting this hypothesis is included with Green's remarks. The colloquium is concluded with remarks by Kuiper and Carder on cartographic studies of the moon.— V.S.N.

- 189-66. Nakada, M. P., and Mihalov, J. D. Accretion of solar wind to form a lunar atmosphere: Jour. Geophys. Research, v. 67, no. 4, p. 1670-1671, 1962.

It is shown that, although the solar wind may provide the principal removal mechanism for heavier residual lunar gases, it may also be a strong source for whatever atmosphere does exist.— D.B.V.

- 189-67. Shoemaker, Eugene M. Exploration of the moon's surface: *Am. Scientist*, v. 50, no. 1, p. 99-130, 1962.

The motivations for lunar exploration are reviewed briefly; lunar science and the scientific objectives of lunar exploration, including an examination of the geodesy and the accumulated information about the topography of the moon, are discussed in some detail; some problems of strategy in exploring the moon are outlined; and the probable sequence of events in the American program of the near future is forecast.— V.S.N.

- 189-68. Hédervári, Péter. Some selenomorphological remarks to the problem of the hypsometric and hypsographic curves of the moon: *Gerlands Beitr. Geophysik*, v. 70, no. 5, p. 259-265, 1961.

The hypsometric curve of the moon presented by Joksch in 1957 and the revised hypsometric curve presented by Brockhaus and Joksch in 1960 (see *Geophys. Abs.* 184-119) are interpreted selenographically according to the method used in geomorphology. The older curve appears to be a better approximation of reality.— D.B.V.

#### EARTHQUAKES AND EARTHQUAKE WAVES

- 189-69. Tocher, Don. The Hebgen Lake, Montana, earthquake of August 17, 1959, MST:—Introduction: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 153-162, 1962.

The Hebgen Lake earthquake was the greatest ever recorded for Montana. The main shock at 11:37 p.m. (MST) was felt over 600,000 sq mi; the maximum intensity was 10 (Modified Mercalli scale) and the Richter magnitude was 7.1. The high intensity rating near the epicenter is justified by the extensive topographic changes: spectacular vertical fault scarps, severe warping of the ground around Hebgen Lake, and landslides of various types. The aftershock record, although limited by the scarcity of seismograph stations in the Rocky Mountain region, indicates that the aftershocks are decreasing in frequency and severity in the irregular fashion usual for an event of this magnitude.— D.B.V.

- 189-70. Witkind, Irving J., Myers, W. Bradley, Hadley, Jarvis B., Hamilton, Warren, and Fraser, George D. Geologic features of the earthquake at Hebgen Lake, Montana, August 17, 1959: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 163-180, 1962.

This is virtually the same paper as that published in *Billings Geol. Soc. 11th Ann. Field Conf. for 1960, West Yellowstone-Earthquake Area*, p. 31-44, 1960; also the paper by Hadley, *ibid.*, p. 45-48 (see *Geophys. Abs.* 186-128, -129).— D.B.V.

- 189-71. Steinbrugge, Karl V., and Cloud, William K. Epicentral intensities and damage in the Hebgen Lake, Montana, earthquake of August 17, 1959: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 181-234, 1962.

An extensive fault scarp system was formed during the Hebgen Lake earthquake of August 17, 1959. Bedrock beneath the lake warped, rotated, and caused a seiche. Small unit masonry structures as well as wooden buildings along the major fault scarps generally survived with little damage when subjected only to vibratory forces. Intensity at the major scarp has been given a rating of 10 (Modified Mercalli scale); however, the maximum intensity ratings based on vibratory motion even a few feet away from the scarps were 7 to 8.

Within the limits of observation there was little or no reduction in vibratory intensity 5-10 miles away compared to that at the fault. This is not to say that the ground motions were similar. At the closest strong-motion seismograph station, 58 miles away, maximum recorded acceleration was about 7 percent gravity. The earthquake was felt in about a 600,000-sq-mi area, mostly north of the instrumental epicenter. The earth-fill Hegben Dam was within 1,000 feet of a major scarp. It was significantly damaged but continued to be effective.—D.B.V.

- 189-72. Ryall, Alan. The Hebgen Lake, Montana, earthquake of August 18, 1959: P waves; *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 235-271, 1962.

The instrumental epicenter of the Hebgen Lake earthquake is found to lie within the region of surface faulting. The depth of focus had a maximum value of 25 km. Times of P are studied in detail for epicentral distances less than 13°. The apparent scatter of arrival times from 700 to 1,400 km can be explained by variations of the  $P_n$  velocity between the physiographic provinces of the western United States. Comparison of observations for the earthquake with published times for blasts in Nevada and Utah indicates that the  $P_n$  velocity in the central and eastern Basin and Range is about 7.5 km/s, and that the crust in that region thickens toward the east and thins toward the south. Comparison of apparent velocities in northern California in directions parallel and transverse to the structure indicates that the crust thins by about 19 km from the edge of the Sierra Nevada to the Pacific Ocean.

A discontinuity is observed in the traveltime curve at a distance of 24°-25°. P-wave arrivals in the range 65°-128° fall into two parallel traveltime branches; this multiplicity may be related to repeated motion at the source. Travel-times of PKIKP appear to deviate from published curves. The fault-plane solution for the Hebgen Lake earthquake, together with a consideration of first motion at Bozeman, Mont., indicates a focal mechanism of the dipole type. The strike and dip of the instrumental fault plane agree well with observed ruptures at the surface.—D.B.V.

- 189-73. Wiegel, R. L., and Camotim, Data. Model study of oscillations of Hebgen Lake; *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 273-277, 1962.

One effect of the Montana earthquake of August 17, 1959, was the oscillation of Hebgen Lake for nearly 12 hr with a period of about 17 min. A distorted model was made of the lake to see if these oscillations could be reproduced when one end of the model was dropped suddenly to simulate the impulse of an earthquake. Time histories of the water surface were measured by parallel wire wave meters on a 6-channel oscillograph, and further information on the water motions was obtained by placing aluminum powder on the surface, which helped estimate the location of the nodal lines. Results are tabulated. The fundamental period of the oscillation was calculated to be from 41 to 46 1/2 min, which does not agree at all with observation; the first harmonic for this simple model would be from 13 1/2 to 15 1/2 min, which does agree with the observations. In the prototype, the first harmonic oscillation probably was the one observed; the largest drop occurred at about the location of the maximum vertical motion of the first harmonic, which would tend to excite a large first harmonic oscillation.—D.B.V.

- 189-74. Utsu, Tokuji. On the nature of three Alaskan aftershock sequences of 1957 and 1958: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 279-297, 1962.

The frequency distributions with respect to magnitude and time in three Alaskan aftershocks sequences which occurred during 1957-58 have been studied. The results show that the magnitude-frequency relation is independent of

time and that the time-frequency relation is independent of magnitude. The variation of frequency in the time-frequency distribution is nearly random. The mode of aftershock occurrence in the aftershock area varies with geography from sequence to sequence.—D.B.V.

- 189-75. Duda, Seweryn. Phänomenologische Untersuchung einer Nachbensenrie aus dem Gebiet der Aläuten-Inseln [Phenomenological investigation of an aftershock series from the Aleutian Islands region (with English summary)]: *Zeitschr. Geophysik*, v. 27, no. 4/5, p. 207-214, 1961.

Investigation of the aftershock sequence in the Aleutian Islands that began on March 9, 1957 shows that the intensity of strain release oscillated during the time of the aftershocks. The increase of the period of this oscillation with time throws light on the rheological behavior of the material in the fault zone. Apparently, the ratio of the Kelvin shear coefficient to the Kelvin viscosity coefficient increases during strain accumulation, reaching a maximum immediately before the strain is released in a shock.—D.B.V.

- 189-76. Rothé, J[ean] P[ierre]. Les séismes du Chili (21 mai-22 juin 1960) [The earthquakes of Chile (May 21 to June 22, 1960)]: *Rev. Étude Calamités*, no. 37, p. 3-17, 1961.

A general discussion of the earthquakes that occurred in Chile from May 21 to June 22, 1960 is presented. The distinguishing characteristic of this series of earthquakes in comparison with former severe earthquakes in Chile is the large size of the area involved in simultaneous release of energy—a belt 1,300 km long between lat 36° and 48°S. The earthquakes are described briefly, and the resulting changes in coastal relief, landslides, volcanic eruptions, and tsunamis are discussed. A map locates the epicenters of the 59 major shocks, the areas of coastal subsidence and elevation, the landslides in the mountains, and the active volcanoes. A bibliography of 19 items is included, and a table lists the time, location, number of stations recording, and the magnitude for the 59 major shocks.—V.S.N.

- 189-77. Ambraseys, N[icholas] N. A note on the chronology of Willis's list of earthquakes in Palestine and Syria: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 77-80, 1962.

In Willis' (1928) list of earthquakes in Palestine and Syria, 30 entries are dated about six centuries too early because Muslim dates were not converted into AD in the translation of As-Soyuti, an Egyptian authority cited. Willis' list has been copied by others, with the result that many earthquake catalogues now contain nonexistent events. In this paper the dates in question are converted into AD, and a short account of the effects of the earthquakes listed by As-Soyuti is also given.—D.B.V.

- 189-78. Kirov, K. T., Grigorova, E. I., and Ilev, N. P. Prinosa k"m seysmichnostta na B"lgariya [Contribution to the seismicity of Bulgaria]: *B"lgarska Akad. Nauk Inst. Geofiz., Izv.*, v. 1, p. 137-183, 1960.

Studies of earthquakes stronger than 6 points on the Forel-Mercalli scale that occurred in Bulgaria from 1892 to 1959 are reported. The investigation was based on the method of isoseismic maps prepared but not published in this paper for technical reasons. Elements of 350 earthquakes, 14 of which were of 8 or more intensity points, were macroseismically determined; the deepest focus was not more than 40-50 km. In the catalog of these earthquakes appended to the paper the following data are given: date and time; location, geographical coordinates, and intensities at epicenters; depth; and radius and area of the macroseismic regions.—A.J.S.

- 189-79. Nersesov, I. L., and Khalturin, V. I. Karateginskoye zemletriya-seniye 7 I 1958 [The Karategin earthquake of January 7, 1958]: Akad. Nauk Tadzhik. SSR Inst. Seysmostoykogo Stroitel'stva i Seysmologii Trudy, v. 7, p. 87-96, 1960.

Instrumental and macroseismic data on the earthquake of January 7, 1958 in the Garm region of the Tadzhik S.S.R. are presented. The earthquake had an intensity of 6 points and was recorded at 6<sup>h</sup>05<sup>m</sup> Greenwich time. The depth was 3-5 km and the epicentral coordinates were 38°54' N. and 70°54' E. The energy flux through a reference sphere of 10 km radius was determined to be approximately 10<sup>20</sup> ergs. The time distribution of strong and weak earthquakes in the Garm region is discussed.— A.J.S.

- 189-80. Kukhtikova, T. I., and Barinova, A. Ya. Mekhanizm dvizheniy v ochagakh pri Shurobskom zemletryaseni i yego povtornykh tolchakh [The mechanism of movements at the focuses during the Shurob earthquake and its aftershocks]: Akad. Nauk Tadzhik. SSR, Inst. Seysmostoykogo Stroitel'stva i Seysmologii Trudy, v. 7, p. 97-102, 1960.

The mechanism of movement at the focuses of the Shurob earthquake of August 21, 1955, 00<sup>h</sup>42<sup>m</sup> Greenwich time is analyzed. The intensity at the epicenter was 6 points and the energy of elastic oscillations is estimated at 10<sup>12</sup> j. Migration of the focuses was in the plane of the fault.— A.J.S.

- 189-81. Houtz, R. E. The 1953 Suva earthquake and tsunami: Seismol. Soc. America Bull., v. 52, no. 1, p. 1-12, 1962.

The epicenter of the Suva earthquake of September 14, 1953 has been re-determined on the basis of landslide intensity, isoseismic analysis, damage criteria, the bathymetry of the epicentral zone, and by other means as being at lat 18.2° S., long 178.3° E., with a probable error of 5 miles. Assuming both a normal and a 60-km depth of focus, P residuals at 15 stations were computed using this new epicenter. A normal depth was decidedly the most likely.

Arrival times of the ensuing tsunami at various points were reconciled to show that the tsunami had an extended source from Suva harbor to Beqa island; it was clearly caused by slumping of marine sediments immediately after the earthquake. Bathymetric changes up to 300 feet vertically were found. At a distance of more than 30 miles from the slumps, submarine cables were disrupted and displaced by as much as 13,000 feet. It is inferred that these effects were caused by turbidity currents traveling down a gradient of about 5 percent for the first 10 miles and nearly flat thereafter.— D.B.V.

- 189-82. Houtz, R. E. Note on minor damage caused by the Suva earthquake of June 1961: Seismol. Soc. America Bull., v. 52, no. 1, p. 13-16, 1962.

A sharp earthquake of intensity 4 to 5 (Modified Mercalli scale) jolted Suva, Fiji, at 10<sup>h</sup>11<sup>m</sup>38<sup>s</sup> local time on June 5, 1961. The shock originated from the epicentral region of the 1953 earthquake (see Geophys. Abs. 189-81); it probably occurred near the surface, for it was not recorded at the seismological stations at Samoa and New Caledonia. An isoseismic chart plotted on the basis of observations throughout Fiji illustrates what is interpreted to be a fault plane striking about N. 30° W. This direction coincides with the N. 29° W. direction deduced by Hodgson (see Geophys. Abs. 168-31) from first-motion data on the 1953 earthquake.

Damage was minor but revealed what could be points of weakness in a more severe earthquake. Brief descriptions are given of a few examples of the type of damage that occurred.— D.B.V.

- 189-83. Rothé, J[ean]-P[ierre]. Tableau de la séismicité du globe pendant les années 1958 et 1959 (Chronique séismologique) [Catalogue of

the seismicity of the globe during the years 1958 and 1959 (seismological chronicle): Rev. Étude Calamités, no. 37, p. 31-69, 1961.

Data on the seismicity of the globe for the years 1958 and 1959 are presented in tabular form. As many seismological stations have been newly established or modernized during the 2-yr period, the number of data received by the International Bureau of Seismology was considerably augmented over that of previous years. The 503 major earthquakes selected are tabulated according to the large orogenic regions of the world, and a brief description is given of the major activity in each region.—V.S.N.

189-84. Lotze, Franz. *Aktuo-geologische Charakteristik des Jahres 1959* [Actuo-geologic characteristics of the year 1959]: Neues Jahrb. Geologie u. Paläontologie Monatsh., no. 12, p. 525-546, 1960.

The losses inflicted on mankind in 1959 as a result of exogenic and endogenic forces are summarized. At the Münster/Westfalen and Strassburg seismic stations, 793 certain and 90 questionable earthquakes were registered. Over the year there occurred an average of 2.17 earthquakes daily, with a maximum of 2.84 in May and August and minimum of 1.32 in December. Epicenters were determined for 474; of these, 94 occurred in Europe and the Mediterranean area, 30 in the Atlantic and Arctic Oceans, 29 on the Asian continent, 25 in India and Indonesia, 242 in the western and northwestern half of the Pacific including the border zone (Alaska to New Zealand), 51 in the southeast half of the Pacific including the coasts of western America, and 3 in the Antilles.

Strong earthquakes ( $M > 6$ ) totalled 106 or 13.4 percent, of which 18 (2.27 percent) had a magnitude of 7 or more and 2 of 8 or more. The strongest ( $8 \frac{1}{4}$ ) was in Kamchatka on May 4, and the next strongest ( $7 \frac{3}{4}$ -8) in the Kermadec Islands on September 14. Focal depths were determined for 92 and were distributed as follows: 17 from 50-90 km, 39 from 100-190 km, 11 from 200-350 km, and 25 from 400-650 km.

No deaths and only minor damage resulted from volcanic activity in 1959. Activity of Etna was intensified on March 24, in mid-April, on October 18, and on December 5; only ash and gases were emitted. Stromboli had a strong eruption on May 19. In Japan, Asama became active on April 15 and again on June 30. Hawaiian volcanism increased in mid-November and continued until the year's end. Volcanic or pseudovolcanic activity was also reported in south Sakhalin, northeast Anatolia, the Atlantic 370 km west of Ireland, and the Caspian Sea.—D.B.V.

189-85. Petrushevskiy, B. A. *Zemletryaseniya i ikh prichiny* [Earthquakes and what causes them]: Priroda, no. 3, p. 15-26, 1961.

Stating that out of 100,000 earthquakes recorded annually only 100 are strong and 1 can be classified as catastrophic, Petrushevskiy discusses types of earthquakes, movement of the crust, the correlation of faults and earthquakes, propagation of seismic shocks from sources, geography of earthquakes, deep earthquakes, tsunami, effects of seismic shocks on the earth's surface, energy and intensity of earthquakes, antiseismic measures, determination of areas of possible earthquakes, the maps of seismic regionalization, and prognosis of the time of earthquakes.—A.J.S.

189-86. Kárník, Vft. *Neue seismische Karten der Tschechoslowakei* [New seismic maps of Czechoslovakia]: Československé Akad. Věd Geofys. Sborník, no. 88, p. 233-252, 1958.

The following seismicity maps are presented: distribution of macroseismic epicenters until 1850, between 1851 and 1956, and between 1751 and 1956; observed maximum intensities until 1956 and between 1851 and 1956; frequency

of observations until 1956; and relative energy between 1851 and 1956. These maps are discussed in the accompanying text.— J.W.C.

- 189-87. Ambraseys, N[icholas] N. On the seismicity of south-west Asia. Data from a XV century Arabic manuscript: Rev. Etude Calamités, no. 37, p. 18-30, 1961.

A translation from Arabic is given of some of the data from a catalog of earthquakes written in the 15th century by Jelal'ed'din As-Soyuti, an Egyptian polygrapher. This note presents only the data from the catalog that are of particular value to the seismologist, primarily a list of earthquakes that occurred in Asia and Africa during the period A.D. 628 to A.D. 1500. In many cases As-Soyuti has treated the seismicity of a whole Muslim year collectively and entered it in his catalogue as one earthquake. Although the data are incomplete, they are believed to be extremely trustworthy and should be of help in appraising the seismicity of many sparsely populated and otherwise undocumented regions.— V.S.N.

- 189-88. Gayskiy, V. N., and Katok, A. P. Nekotoryye voprosy, svyazannyye s izucheniym seymicheskogo rezhima, na primere zemletryaseniya Pamiro-Gindukushskoy zony [Certain problems connected with study of seismic regime as exemplified by the earthquakes of the Pamir-Hindu-Kush zone]: Akad. Nauk Tadzhik. SSR, Inst. Seysmostoykogo Stroitel'stva Seysmologii Trudy, v. 7, p. 27-40, 1960.

The following problems are discussed based on observations of deep focus earthquakes in the Pamir-Hindu-Kush zone during 1956-58: (1) the correlation of the angular coefficient of the graph of recurrence of earthquakes and the seismic activity of the region; (2) the distribution law of the number of earthquakes in time; and (3) the use of the degree of recurrence of earthquakes as a characteristic of the "stability" of the seismic regime in the area.— A.J.S.

- 189-89. Shaginyan, S. A. Rezul'taty instrumental'nogo opredeleniya koeffitsiyenta dinamichnosti  $\beta$  [The results of instrumental determination of dynamic characteristic of coefficient  $\beta$ ]: Akad. Nauk Tadzhik. SSR, Inst. Seysmostoykogo Stroitel'stva i Seysmologii Trudy, v. 7, p. 41-75, 1960.

A study of methods of macroseismic, engineering-geological, and engineering-seismological investigation for solution of problems of seismic microregionization is reported. A network of 23 seismic stations along a profile about 20 km long was established in the Hissara valley, equipped with AIS-2 multipendulum seismometers. Data on seismic accelerations recorded at these stations are given in photographs and tables.— A.J.S.

- 189-90. Nechayev, V. A. Seymicheskoye mikrorayonirovaniye territorii g. Stalinabada na osnove instrumental'no-geologicheskogo metoda [Seismic microregionization of the territory of the city of Stalinabad, based on the instrumental-geological method]: Akad. Nauk Tadzhik. SSR, Inst. Seysmologii Trudy, v. 113, p. 41-67, 1959.

Methods of microregionization and formulas developed in previous investigations are criticized, and a new formula is proposed for local seismic effects on engineering constructions.— A.J.S.

- 189-91. Rezanov, I. A. Tektonika i seymichnost' Turkmeno-Korasanskikh gor [Tectonics and seismicity of the Turkmen-Khorasan Mountains]: Moskva Akad. Nauk SSSR Inst. Fiziki Zemli, 246 p., 1959.

This book describes and discusses the structure of the Turkmen-Khorasan Mountain region, attempting to establish a correlation between seismic phenomena and geologic characteristics. A new variant of the map of seismic regionization of the Turkmen S.S.R. is proposed.— A.J.S.

- 189-92. Petrushevskiy, B. A. Investigations of seismicity of the territory of the Chinese Peoples Republic [in Chinese with Russian abstract]: *Acta. Geophysica Sinica*, v. 8, no. 2, p. 97-104, 1959.

The area under examination [lat 36°-40° N., long 100°-106° E.] consists of several zones, which are geologically heterogeneous and complex. The seismicity of this area is governed by a number of factors. Tectonic movements are not very active, but the seismicity is sometimes high as for example in the Khayyuan' earthquake of 1920.

On a basis of characteristics of the tectonic movements, five large structural complexes can be distinguished in this area: (1) Nanshan and Kukunor Ranges, (2) Tintay-Khayyuan' zone, (3) Alashan massif, (4) Uvey-Shan'dan zone, and (5) Kholan'shan'-Lyuban'shan zone. It is clear that 4 of these 5 zones are closely related to one another. Epicenters are located both within the complexes and on their borders.— Author's abstract, J.W.C.

- 189-93. Ono, Y[oshihiko], Suga, M., and Minami, K. Investigations on the crustal structure and seismic activity in and near Hokkaido (using the data at Sapporo D.M.O.) [in Japanese]: *Quart. Jour. Seismology [Tokyo]*, v. 26, no. 2, p. 39-59, 1961.

Earthquake data from the observatory at Sapporo were used to investigate the crustal structure and seismic activity in and near Hokkaido. The relation between seismic activity and types of seismograms, between the direction of initial motion and the seismic zone, and the crustal structure as deduced from the time distance curves are discussed. The paper is well illustrated with maps and diagrams.— V.S.N.

- 189-94. Nordquist, John M. A special-purpose program for earthquake location with an electronic computer: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 431-437, 1962.

An electronic digital computer program has been developed for determining the source and origin time of a local earthquake by the method of least squares, using the times of arrival of direct and refracted P-waves at stations in the Pasadena network. Output includes the geographic coordinates and depth of the source, the origin time, direct distances from the source to each station, and the difference between observed and computed arrival time of P at each station. Limitations to the applicability of the program are discussed.— Author's abstract

- 189-95. Keylis-Borok, V. I. Plotnost' seymicheskoy energii i uroven' preobladayushey chastoty zemletryaseniya [The density of seismic energy and the level of predominant frequency of earthquakes]: *Akad. Nauk Tadzhik. SSR, Inst. Seysmostoykogo Stroitel'stva i Seysmologii Trudy*, v. 7, p. 32-38, 1960.

Postulating that physical regularities exhibited by an earthquake depend on the properties of the field of stresses and deformations within the focus region of the earthquake, a seismic parameter P is introduced which describes the density of the perturbed elastic energy field, the uniform confining pressure excluded, and analyzes this parameter in an attempt to determine its magnitude and changes during an earthquake. The changes in the energy level of the arriving seismic waves, and their predominant frequencies serve as indicators in determining the value of P (see also *Geophys. Abs.* 173-67).— A.J.S.

- 189-96. Rautian, T. G. Zatkuchaniye seysmicheskikh voln i energiya zemletryaseniya. I. [Decay of seismic waves and the energy of earthquakes. I]: Akad. Nauk Tadzhik. SSR, Inst. Seysmostoykogo Stroitel'stva i Seysmologii Trudy, v. 7, p. 41-86, 1960.

The relationship between the decay of body waves recorded during an earthquake and the total elastic energy liberated at the focus is discussed. The range of 3 to 700 km from the source is investigated. Two types of energy classification were examined: (1) the energy  $E$  of body waves traveling across a reference sphere of  $R=10$  km, and (2) the total energy  $E_0$  emitted by the source ( $r_0=15_m E^{1/2}$ ). The study was based on data of 65 earthquakes recorded during the period from February 1955 to July 1959, presented on 18 pages of the appendix.—A.J.S.

- 189-97. Utsu, T[okuji]. A statistical study on the occurrence of aftershocks: Geophys. Mag. [Tokyo], v. 30, no. 4, p. 521-605, 1961.

The laws governing the occurrence of aftershocks are investigated using data of Japanese shallow earthquakes. It was found that (1) the difference in magnitude between the main shock and the largest aftershock varies from shock to shock but in general is related to the magnitude  $M_0$  of the main shock as given by  $M_0 - M_1 = 4.7 - 0.45M_0$ . The time interval between the main shock and largest aftershock tends to increase with  $M_0$ . (2) The frequency of aftershocks per unit time interval,  $n(t)$ , decreases with increasing time  $t$  as given by the modified Omori formula  $n(t) = A/(t+c)^p$  ( $A$  and  $c$  are constants), and the values for exponent  $p$  for many aftershock sequences average about 1.3. (3) The energy released in aftershocks per unit time interval,  $E(t)$ , seems to decrease more rapidly with time and is represented approximately by  $E(t) = B/(t+d)^q$ ,  $q \neq 2$ ,  $B$  and  $d$  are constants. (4) The size of the area of aftershock occurrence is related to the magnitude of the earthquake as shown by the equation  $\log D = 0.5M_0 - 1.8$ , where  $D$  is the linear dimension of the aftershock area in km. (5) If the residual energy  $E$  contained in the source volume  $V$  (proportional to  $D^3$ ) of the main shock is assumed to be released in aftershocks under the condition  $(dE/E) = -E/V dt$ , the formulas showing the decrease in frequency and energy of aftershocks can be proved using a relationship between  $E(t)$  and  $n(t)$  which is derived from equations connecting the magnitude to energy and frequency of earthquakes  $\log E = \alpha + \beta M$  and  $\log n(M) = a - bM$ . It is also shown that the relation between the exponent  $p$  in the second formula and the coefficient  $b$  in the last is expressed by  $p = 2b/\beta$ .—V.S.N.

- 189-98. Byerly, Perry. Release of energy at the source of an earthquake, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 303-304, 1961.

As an introduction to the symposium on earthquake mechanism, a brief statement is given on the nature of the problem to be solved in determining the force system at the foci and the mechanism responsible for earthquakes.—V.S.N.

- 189-99. Ingram, R. E. Generalized focal mechanism, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 305-308, 1961.

It is shown that a system of forces consisting of three couples without moment introduces a cone of the second degree as the surface separating the compressions and dilatations as recorded at extended distances. This cone is the generalization of the pair of planes associated with a single couple with moment or with two couples without moment. The corresponding surfaces for SH and for SV are also given. The projection of these surfaces on the central plane is examined and some of the geometrical properties noted. In particular, it is seen that the projected S direction passes through a fixed point if two

of the couples are equal. An example of the separation of the compressions and dilatations by a hyperbola is given.— Author's abstract

- 189-100. Knopoff, L[eon]. Analytical calculation of the fault-plane problem, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 309-315, 1961.

Machine calculation of the solution to the fault-plane problem is possible, if an analytical formulation of the problem can be made. An analytical formulation is made in terms of the probability that a station report the correct sign of first motion in the presence of disturbing influences such as background noise. The location of the orthogonal planes depends upon the maximization of a certain probability function. The probability function is simplified if it is assumed that the ground motion noise level is constant at all stations. The maximization is then made with respect to four variables: the three independent angular variables describing the orientation of the two orthogonal planes and the noise. An example of the machine calculation of the maximization is given for the Alaska earthquake of July 10, 1958; the machine solution is compared with the solution obtained by visual means.— Author's abstract

- 189-101. Knopoff, L[eon]. Statistical accuracy of the fault-plane problem, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 317-319, 1961.

The statistics of the probability function used in the analytical calculation of the fault-plane problem is shown, by numerical means, to approximate closely that of a gaussian distribution function. The definitions of error are obtained from gaussian statistics. A numerical example is given for the Alaska earthquake of July 10, 1958. [See also 189-100].— Author's abstract

- 189-102. Balakina, L. M., Shirokova, H. I., and Vvedenskaya, A. V. Study of stresses and ruptures in earthquake foci with the help of dislocation theory, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 321-327, 1961.

The static stresses (forces of internal interaction between particles on opposite sides) acting on an area of future rupture, which rebound at the moment of appearance of the rupture, constitute the stresses acting at the focus. These are determined by the theory of dislocations (Nabarro, 1951) from a force model of a rupture accompanied by slipping. The technique based on the first motion in P, SH, and SV and using the Wulff stereographic projection, is described and applied to earthquakes in three regions. In the Kindu Kush it is shown that the regional pressure acts in a horizontal plane and normal to the strike of the mountain range. The tension acts along the direction of the azimuth. In the northwest Pacific the pressure axes for most foci are also oriented perpendicular to the geologic features. In the Baikal, on the other hand, it is the tension axes which are normal to the geologic features. (See also Geophys. Abs. 180-47.)— V.S.N.

- 189-103. Honda, H[irokichi]. The generation of seismic waves, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 329-334, 1961.

It is assumed that an earthquake is caused by the release of deviatoric [deviating] stresses, and further that the effects of their release will be represented by the radial and transverse impulsive forces acting on the surface of a spherical cavity constructed around the source of the earthquake. The motions of the P- and S-waves at large distances from the source are calculated theoretically in the case when the patterns of the first motions of the waves are quadrantal. Comparisons of the results of the calculations with those of the observations are made for some deep Japanese earthquakes.— Author's abstract

- 189-104. Keylis-Borok, V. I. Some new investigations of earthquake mechanism, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 335-341, 1961.

The investigations summarized in this paper are a continuation of those reported in 1956 and 1959 (see Geophys. Abs. 172-39, 178-68). In the investigation of earthquake mechanism from the spectrums of surface waves, theoretical conclusions predict that in the case where azimuths of surface waves coincide with the fault strike the maximum of the wave spectrums will have longer period than in the case of perpendicular azimuths. This can be used together with body waves or independently for fault-plane determinations. Further, a method is proposed for investigating the selectivity of a system of stations used in fault-plane studies which will also simplify subsequent interpretation. Lastly, calculations are given to demonstrate a simplified method for obtaining a source model by integration of a point source—a double couple—along a fault surface.

It is concluded that waves generated by a plane source of finite dimensions depend essentially upon discontinuous as well as continuous displacements in the source itself. Such a source may be considered as an earthquake source model, if and only if the stresses in it correspond to stresses at the fault plane before and during the earthquake. In the model source, constructed analogously to dislocation theory by integrating double couples, peculiarly distributed shear stresses are obtained that do not correspond to any real source.— V.S.N.

- 189-105. Stauder, William. An application of S waves to focal mechanism studies, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 343-353, 1961.

The material presented in this paper is summarized from previously published articles (see Geophys. Abs. 181-92, 183-107, -138, -139, -140, 186-166) which develop two methods for relating the direction of polarization of S-waves to the mechanism at the focus of an earthquake. Application to three or four earthquakes for which fault-plane solutions from P-waves were previously available shows that in these cases the S-wave data agree with the P-wave solution and conform to a dipole with moment as the model of the focus. In three Kamchatka earthquakes the same methods of analysis indicate a new type of focus represented by a single force.— V.S.N.

- 189-106. Ritsema, A. R. Further focal mechanism studies at De Bilt, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 355-358, 1961.

The three new series of fault-plane solutions determined at de Bilt, Holland, include solutions for 16 Sumatran earthquakes (see Veldkamp, Geophys. Abs. 172-42, 179-79), 48 southeast Asian and west Pacific earthquakes (see Ritsema and Veldkamp, Geophys. Abs. 185-132), and 15 earthquakes at different locations that took place in 1950 (see Geophys. Abs. 184-173). These new solutions are summarized in a table according to the azimuth and plunge of the A, B, and C axes; the fault motion type (normal, reverse, sinistral, and so forth); and reliability of solution. S-wave data, as in the case of former series from southeast Asia, show preference for a single couple at the focus as the cause of the shocks. Most of the fault-plane solutions for earthquakes of other circum-Pacific seismic zones are based only on longitudinal-wave data for which no difference exists between a single and a double force couple at the focus. If earthquakes in these zones are considered to be caused by a double force couple or by an equivalent system of maximal and minimal pressures, there is some evidence that the directions of maximal pressure are non-random. Many more detailed studies are necessary.— V.S.N.

- 189-107. Kukhtikova, T. I. Dislocations in foci of the Tadzhik depression, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 359-364, 1961.

Focal mechanism was determined for 100 earthquakes which occurred in the Tadzhik depression during the period 1955-59. A dipole with moment was indicated as the appropriate mechanism in 98 cases; in the two remaining cases a single force was found. It was shown that the fault planes determined by seismic means agreed very well with surface faulting. It was also shown that a method which depended on studying the sequence of observations at a single station would have had no success in this area.— Author's abstract

- 189-108. Öcal, Nevzat. Determination of the mechanism of some Anatolian earthquakes, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 365-370, 1961.

Using the Byerly method the focal mechanism was determined for three strong Anatolian earthquakes of 1957; results are tabulated. For the first (Fethiye, April 24) movement was vertical on a vertical plane; for the other two (Fethiye, April 25, and Abant, May 26) movement was strike-slip.— V.S.N.

- 189-109. Aki, Keiiti. The use of long-period surface waves in the study of earthquake mechanism, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 371-372, 1961.

A summary of results is presented of studies already published (see Geophys. Abs. 180-55, 181-111, 182-117, 186-201) or in press conducted by Aki on the use of long-period surface waves in the study of earthquake mechanism.— V.S.N.

- 189-110. Brune, James N. Radiation pattern of Rayleigh waves from the southeast Alaska earthquake of July 10, 1958, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 373-383, 1961.

Long-period Rayleigh wave data obtained during the International Geophysical Year are used to measure the initial phases and amplitudes of Rayleigh waves as a function of azimuth for the southeast Alaska earthquake of July 10, 1958. This study indicates that the radiation pattern bears a simple relation to the fault motion, showing four sectors of initial phase and a four-lobed pattern of amplitudes. The symmetry of the radiation pattern is in agreement with the motion on the fault as determined by a fault-plane solution and by field observation of the direction of faulting. The symmetry differs radically from that expected from explosions. It is concluded that this simple technique can be used to study focal mechanism from surface wave data for most of the larger earthquakes when instrumentation is improved and regional variations in phase velocity for shorter periods are known.— Author's abstract

- 189-111. Scheidegger, Adrian E[ugen]. The tectonics of Asia in the light of earthquake fault-plane solutions, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs. v. 24, no. 10, p. 385-387, 1961.

It may be argued that a correlation must exist between the tectonics of a region and the fault-planes of the earthquakes of this region. This correlation exists but it is not possible to determine it readily. It is found that one must consider the nodal direction in these earthquakes, and it is observed that nodal directions are, in general, normal to the direction of tectonic displacement. Consequently, it is possible to determine the direction of tectonic displacement

by a least-squares method. This method has been applied to some Asiatic earthquakes of which numerous observations have been published in the Russian geophysical literature. A remarkable uniformity of tectonic displacement has been found in continental Asia, extending from Sakhalin to the Pamirs and the mountains of Kopet Dagh. This result indicates a large scale uniformity of tectonic forces in the earth's crust.— Author's abstract

- 189-112. Lensen, G. J. Principal horizontal stress directions as an aid to the study of crustal deformation, in A symposium on earthquake mechanism, Helsinki 1960: Dominion Observatory Ottawa Pubs., v. 24, no. 10, p. 389-397, 1961.

The two methods used to determine the principal horizontal stress (PHS—the chief of three stress components in faulting) as previously described by Lensen (see Geophys. Abs. 175-175, 176-53, -54) are reviewed briefly. The PHS directions over a large region show a consistent pattern. Directions are illustrated and discussed for New Zealand; the southwest, northeast, southeast, and northwest Pacific; and for the Pacific as a whole. The fact that consistent regional patterns can be found is a sufficient reason to suggest PHS determinations as an additional aid in the study of crustal deformation.— V.S.N.

- 189-113. Schöffner, Hans-Joachim. Interpretation von Herdmechanismen durch asymmetrische Dislokationen [Interpretation of focal mechanisms by means of asymmetrical dislocations (with English summary)]: Zeitschr. Geophysik, v. 27, no. 4/5, p. 164-174, 1961.

The displacement field resulting from asymmetrical faulting as the initial focal process in an earthquake is investigated mathematically. From the discussion of the nodal lines for P-waves it follows that nonorthogonal solution systems may be interpreted on the basis of an asymmetrical point source. A set of diagrams is given to facilitate such interpretation, and their use is illustrated by a practical example. The asymmetrical solutions obtained by this method can be orthogonalized and tabulated in the usual way.— D.B.V.

- 189-114. Hudson, Donald Ellis]. Some problems in the application of spectrum techniques to strong-motion earthquake analysis: Seismol. Soc. America Bull., v. 52, no. 2, p. 417-430, 1962.

A comparison of analog and digital computation of strong-motion earthquake response spectra is made, and it is shown that the preference as to method depends mainly on availability of computing equipment. The accuracy of analog response spectrum computations is compatible with the limitations of the original ground acceleration data. The accuracy of the customary approximate relationship between the displacement response spectrum and the velocity response spectrum is investigated, and the validity of the simplifications are shown for typical strong-motion earthquake applications. The relationship between the response spectrum and the Fourier spectrum is developed, and a comparison as to suitability for earthquake engineering problems is given.— D.B.V.

- 189-115. Figueroa Albarca, Jesus]. Some consideration about the effect of Mexican earthquakes: World Conf. on Earthquake Eng., 2d, Tokyo and Kyoto 1960, Proc., v. 3, p. 1553-1561, 1960.

The period of the shear waves responsible for maximum destructiveness was measured from the seismograms of four stations located on different geological foundations to study the important role that soil plays in the intensity of an earthquake. Taking into account epicentral distances from the origin to the limit of perceptibility in earthquakes of magnitude greater than or equal to 7, the predominant and most dangerous periods were found to be those between 0.75 and 1.25 sec; of these, a period of 1 sec was the most dangerous. It was

found that the periods become longer and the duration of the phenomenon greater as the epicentral distance increases and as the soil becomes increasingly anelastic. Any increment in depth of focus means greater extension of the shaken block, and in an area of anelastic soil located as far as 500 km from the epicenter of an earthquake of magnitude greater than or equal to 7.5 intensity effects may be compared to those in the epicentral area. Results are tabulated and specific examples are discussed.— V.S.N.

- 189-116. Munk, W[alter Henrich], and Cepeda, H. Concerning a remarkably sharp peak in the sea level spectra at Acapulco [in Spanish and English]: *Geofisica Internac.*, v. 1, no. 3, p. 45-54, 1961.

Tide gauge records at Acapulco and Salina Cruz are analyzed for the tsunami of July 28, 1957, associated with the great Mexican earthquake and for a typical period of meteorologically induced background. At Acapulco the tsunami spectrum and background spectrum both reveal a sharp peak at 2 cycles per hour. This remarkably sharp resonance peak is associated with oscillations of sea level outside the harbor and presumably is related to the dimensions of the continental shelf. The sharpness is due to the precipitous drop-off into the Acapulco Trench.— V.S.N.

- 189-117. Kato, Yoshio; Suzuki, Ziro; Nakamura, Kohei; Takagi, Akio; Emura, Kinya; Ito, Mitsuyoshi; and Ishida, Haruko. The Chile tsunami of 1960 observed along the Sanriku coast of Japan: *Tohoku Univ. Sci. Repts. Geophysics*, ser. 5, v. 13, no. 2, p. 107-125, 1961.

The distribution of the water heights in the Sanriku coastal region, Japan, caused by the Chilean earthquake tsunami of May 1960 is shown in tables and maps. Some of the observed features of the invading waves are described, and the difference between waves produced by near and distant tsunami sources is emphasized.— V. S. N.

- 189-118. Nakamura, Kohei, and Emura, Kinya. Maximum water height at Bay head in case of tsunami invasion: *Tohoku Univ. Sci. Repts.*, ser. 5, v. 13, no. 1, p. 32-42, 1961.

As a typical example of the different ways in which a bay responds to earthquakes of near and far origin, a comparison is made for three bays on the northeast coast of Honshu, Japan, between the water heights produced by the Chile tsunami of 1960 and those produced by the Sanriku tsunami of 1933. In the Chile tsunami the maximum water height occurred at the bay head, whereas in the Sanriku tsunami it occurred at the bay mouth. The 1933 decrease in height toward the bay head could have been a result of damping of the invading waves due to the turbulent motion of the bay water caused mainly by bore-like invasion, and reflection and refraction of waves arising from the irregular shape of the bay. The long period of the waves in 1960 explains the negligibly small effect of eddy viscosity in damping the waves. In general the water height at the bay head is lower or higher than that at the mouth according to whether the seiche period is shorter or longer than the period of the tsunami.— V.S.N.

- 189-119. Rexin, Elmer E., Oliver, Jack [E.], and Prentiss, David. Seismically-induced fluctuations of the water level in the Nunn-Bush well in Milwaukee: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 17-25, 1962.

Expanded time-scale recordings of the water level in a well in Milwaukee, Wis., show many of the familiar seismic phases, including Love waves which in theory have no associated dilatation. Comparison of seismograms from distant earthquakes recorded by the well seismograph at Milwaukee and by conventional inertial instruments at Palisades demonstrates the superior response of the well, relatively, to waves of long period.— Authors' abstract

- 189-120. Merchant, H. C., and Hudson, D[onald] E[llis]. Mode superposition in multi-degree of freedom systems using earthquake response spectrum data: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 405-416, 1962.

Dynamic responses of a series of typical three-degree of freedom structures to strong-motion earthquake excitation were calculated by analog computer techniques and were compared with approximate responses obtained by a superposition of individual modes derived from response spectrum curves. The results indicate that a suitably weighted average of the sum of the absolute values of the individual modes and the square root of the sum of the squares of the modes will give a practical design criterion for the base shear forces in multi-story buildings. For critical designs, this weighted average reduces to the absolute sum of the modes, which is found to be close to the true value for a significantly high proportion of typical earthquake-structure combinations.— Authors' abstract

- 189-121. Nuttli, Otto [W.], and Whitmore, John D. On the determination of the polarization angle of the S wave: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 95-107, 1962.

The minimum epicentral distance for which it is permissible to obtain the value of the polarization angle of the S-wave by measuring the angle between the great circle path at the station and the direction of the horizontal component of the S-wave particle motion obtained from the seismograms can be determined by the fact that at smaller distances the particle motion of the earth's surface due to the incidence of S will be nonlinear ( $S^H$ ) and the horizontal and vertical SV components will be out of phase) while at larger distances it will be linear. An analysis of the S-motion recorded by the Galitzin-Wilip seismographs at Florissant, Colo., indicates that the critical distance is  $42^\circ$ . The periods of these S-waves are of the order of 10 sec.

The analysis also shows that the effective P-wave velocity of teleseismic waves at the earth's free surface is 7.74 km/s, and the effective value of Poisson's ratio and the effective S-wave velocity at the earth's surface are 0.25 and 4.46 km/s, respectively. "Effective values" are those that govern the angle of incidence of the waves at the earth's surface.— D.B.V.

- 189-122. Brune, James N. Attenuation of dispersed wave trains: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 109-112, 1962.

It is shown that groups of seismic waves are attenuated by the factor  $\exp(-\pi X/QUT)$ , where X is the distance, U the group velocity, T the period, and  $Q^{-1}$  is a measure of the damping of free oscillations. Accordingly, observations of Q given by Ewing and Press (see *Geophys. Abs.* 158-137, 159-128) and Sato (see *Geophys. Abs.* 174-61) are revised by the ratio of the phase velocity to the group velocity.— Author's abstract

- 189-123. Lossovskiy, Ye. K. K otsenke tochnosti metoda srednikh skorostey v seysmike prelomlennykh voln [On evaluation of accuracy of the method of mean velocities in the seismics of refracted waves]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 9, p. 1341-1345, 1960.

The method of mean velocities of seismic waves for a covering medium that has a continuous increase in wave velocity with depth is further developed (see *Geophys. Abs.* 181-126). This paper treats the problem of systematic errors due to the difference between the actual curvilinear paths of seismic rays in a medium with density gradient and their assumed linear paths in a hypothetical medium. An improved mathematical process is worked out for determining the depth of an underlying horizontal refracting boundary. An approximate method of differentiation between multiple and transformed refracted waves is discussed.— A.J.S.

- 189-124. Lomnitz, C[inna]. Application of the logarithmic creep law to stress wave attenuation in the solid earth: *Jour. Geophys. Research*, v. 67, no. 1, p. 365-368, 1962.

Available data on the attenuation of stress waves in the earth's interior over a range of frequencies of  $10^{-7}$  to 1 cycle per second show good agreement with theoretical values of  $Q^{-1}$  derived from the logarithmic creep function  $\phi(t)=q \ln(1+at)$ .— Author's abstract

- 189-125. Kozlov, A. V. O nakhozhenii koordinat tochki peresecheniya seismicheskogo lucha s naklonnoy granitsey [On determination of the coordinates of the point of intersection of a seismic ray and an inclined boundary]: *Akad. Nauk Tadzhik SSR Inst. Seysmostoykogo Stroitel'stva i Seysmologii Trudy*, v. 7, p. 103-108, 1960.

The problem of determining the coordinates of the point of intersection of a seismic ray refracted by an inclined layer is discussed, and formulas are derived for the depth and epicentral and hypocentral distances of the point.— A.J.S.

- 189-126. Yoshiyama, Ryoichi. The ratio of the velocity of P and S waves: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 35, no. 4, p. 627-640, 1957.

Study of the  $V_P/V_S$  ratio, directly related to Poisson's ratio, as a method of classifying crustal structures suggests that there is an abrupt increase in  $V_P/V_S$  (from 1.67 to 1.78) at the M-discontinuity, but nothing remarkable at any boundary within the crust; if this is verified, it may throw light on the physical state of the boundary of the crust. More accurate observations, especially of the arrival times of P, are necessary to provide more definite conclusions.— D.B.V.

Takeuchi, H[itoshi], Saito, M[asanori], and Kobayashi, N[oata]. Statical deformations and free oscillations of a model earth. See *Geophys. Abs.* 189-354.

- 189-127. Oliver, Jack [E.]. A summary of observed seismic surface wave dispersion: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 81-86, 1962.

Two sets of curves relating phase and group velocities of Love and Rayleigh waves to periods summarize our present state of knowledge on seismic surface wave dispersion. Periods range from about 1 sec to 1 hr, and velocities from about 1 km/s to about 8 km/s.— Author's abstract

- 189-128. Kuo, John, Brune, James, and Major, Maurice. Rayleigh wave dispersion in the Pacific Ocean for the period range 20 to 140 seconds: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 333-357, 1962.

Rayleigh-wave data obtained from long-period seismographs at Honolulu, Hawaii; Suva, Fiji; and Mount Tsukuba, Japan are analyzed to determine group and phase velocities in the Pacific for the period range 20-140 sec. The group velocity rises from 3.5 km/s at a period of about 20 sec to a maximum of 4.0 km/s at about 40 sec and then decreases to 3.65 km/s at about 140 sec. Phase velocity is nearly constant in the period range 30-75 sec with a value slightly greater than 4.0 km/s. Most of the phase velocity curves indicate a maximum and a minimum at periods of approximately 30 and 50 sec, respectively. At longer periods the phase velocities increase to 4.18 km/s at 120 sec.

Except across the Melanesian-New Zealand region, dispersion curves for Rayleigh wave paths throughout the Pacific basin proper are rather uniform and agree fairly well with theoretical dispersion curves for models with a normal oceanic crust and a low velocity channel. Both phase and group velocities

are comparatively lower for the paths across the Melanesian-New Zealand region, suggesting a thicker crust or lower crustal velocities in this region.— D.B.V.

- 189-129. Jeffreys, Harold. Small corrections in the theory of surface waves: Royal Astron. Soc. Geophys. Jour., v. 6, no. 1, p. 115-117, 1961.

Rayleigh's principle is used to derive expressions for the group velocities of Love and Rayleigh waves without numerical differentiation. It is also used to find expressions, accurate to the first order, for the effects of small changes of the elastic properties on the wave and group velocities. The results do for surface waves what Bullen's transformation (see Geophys. Abs. 185-137) does for body waves.— D.B.V.

- 189-130. Berckhemer, Hans, Müller, Stephan, and Sellevoll, Markvard, A. Die Krustenstruktur in Südwestdeutschland aus Phasen-Geschwindigkeitsmessungen an Rayleigh-Wellen [The crustal structure in southwest Germany from phase velocity measurements on Rayleigh waves (with English summary)]: Zeitschr. Geophysik, v. 27, no. 4/5, p. 151-163, 1961.

The feasibility of determining the phase velocity of surface waves in southwest Germany was investigated by means of a network of stations at Feldberg, Heidelberg, Karlsruhe, Messstetten, Ravensburg, Stuttgart, and Tübingen, nearly all of which are equipped with new short-period three-component seismograph systems having identical amplitude and phase characteristics. The analytic procedures for simple harmonic ground motion and for transient wave trains are described. Numerous Rayleigh wave observations in the 15-45 sec period range are interpreted on the basis of theoretical dispersion curves computed for different multilayered structures. The layer models are derived from seismic refraction and near-earthquake data. Comparison of experimental and theoretical phase velocities suggests that the crust is slightly less than 30 km thick in southwest Germany.— D.B.V.

- 189-131. Arkhangel'skaya, V. M. Issledovaniye korotkoperiodnykh poverkhnostnykh seismicheskikh voln Releya [Investigation of short period surface seismic Rayleigh waves]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1097-1113, 1961.

Short period (5-13 sec) surface Rayleigh waves are investigated. The seismic records of 71 earthquakes are analyzed and tabulated (coordinates of epicenters, depths of foci, times, and intensities). Five groups of waves are differentiated; their group velocities are 4.0, 3.67, 3.57, 3.41, and 3.29 km/s. The dispersion of the first group of  $R_x$  waves, which is assumed to be the first overtone of the Rayleigh wave or  $M_2$  wave, is investigated.— A.J.S.

- 189-132. Koridalin, Ye. A. Nekotoryye kharakteristiki voln tipa  $L_g$  i  $R_g$  i regional'nyye osobennosti ikh rasprostraneniya [Certain characteristics of type  $L_g$  and  $R_g$  waves and regional features of their propagation]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1114-1121, 1961.

General characteristics of the surface seismic waves  $L_i$ ,  $L_{g1}$ ,  $L_{g2}$ , and  $R_g$  are studied from the seismograms of the Moscow and other seismic stations. Mean periods of the waves, their group velocities, and effects of epicentral distances are reported for  $L_g$  and  $R_g$ . The  $L_i$  waves were found to be less stable on seismograms when compared with other waves studied. Possible effects of features of the hypocenter on the formation and characteristics of  $L_g$  and  $R_g$  waves are indicated.— A.J.S.

- 189-133. Arkhangel'skaya, V. M., and Fedorov, S. A. Nekotoryye rezul'taty izucheniya zatukhaniya poverkhnostnykh voln Releya [Some results of study of attenuation of Rayleigh surface waves]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1122-1131, 1961.

The results of studies of attenuation of surface waves and internal friction in the mantle are reported. Rayleigh waves having periods of 22-24 and 320 sec, produced by the earthquake of March 20, 1960 in the region of the Japanese Trough ( $\phi=40^\circ$  N. and  $\lambda=144^\circ$  E.), and by the Chilean earthquake of May 22, 1960 ( $\phi=41^\circ$  S.,  $\lambda=73^\circ$  W.), are analyzed. The coefficients of attenuation  $\gamma$  and of internal friction  $1/Q$  are investigated and compared with the values determined by other writers. A considerable divergence in these values is found, and it appears impossible at this stage to establish any systematic correlation between  $\gamma$  and  $1/Q$ .— A.J.S.

- 189-134. Savarenskiy, Ye. F., Popov, I. I., and Lazareva, A. P. Nablyudeniya dlinnoperiodnykh voln chiliyskogo zemletryaseniya 1960 [Observations of long period waves of Chilean earthquake of 1960: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1132-1140, 1961.

Data on surface long-period Rayleigh waves produced by the Chilean earthquake of May 22, 1960 and recorded at the Simferopol, Moscow, and Pulkovo seismic stations are analyzed. The arrival times, periods, and group velocities of the Rayleigh waves, some of which circled the earth several times, are given in a table. The periods of the waves which traversed distances from 11,000 to 266,000 km were found to range from 160 to 500 sec, and their group velocities between 3.48 and 4.08 km/s. The fundamental period of the earth's spheroidal oscillation, due to a superposition of long surface waves moving in opposite directions, was calculated to be 52 minutes. Dispersion of the waves and their attenuation were determined. The mean absorption coefficient of Rayleigh waves was found to be 0.0022 per degree for the wave periods 240-270 sec, and the internal friction of the mantle is characterized by the value of  $1/Q=800 \times 10^{-5}$ .— A.J.S.

Shechkov, B. N., and Solov'yeva, O. N. On group velocities of Rayleigh waves for a composite continent-ocean path. See Geophys. Abs. 189-349.

Tryggvason, Eysteinn. Crustal structure of the Iceland region from dispersion of surface waves. See Geophys. Abs. 189-342.

- 189-135. Nałecz, Maciej, and Zawicki, Ignacy. A Hall-effect seismograph: Seismol. Soc. America Bull., v. 52, no. 2, p. 439-454, 1962.

The principle of operation and the amplitude and phase frequency characteristics of a new-type seismograph are discussed and compared with those of an electrodynamic seismograph. The properties of this instrument allowing its use also as a tiltmeter are set forth. The action of the new seismograph is based on utilization of the Hall effect in semiconductors. Experimental results obtained with the new device are given.— Authors' abstract

- 189-136. Barr, K. G. The use of a selective amplifier to increase the useful sensitivity of short period electromagnetic seismographs: Seismol. Soc. America Bull., v. 52, no. 2, p. 455-461, 1962.

A frequency selective amplifier has been developed to increase the useful sensitivity of short-period electromagnetic seismographs to near earthquakes. The result has been to reduce the magnitude of the smallest earthquake detectable by about two units, and to reduce the magnitude of the smallest earthquake for which an accurate arrival time can be given by  $1/2$ -1 units.— Author's abstract

- 189-137. Bugajski, H. J., and Willis, D[avid] E. An auxiliary instrument for monitoring seismic signals: *Earthquake Notes*, v. 32, no. 1-2, p. 1-4, 1961.

A visible writing recorder, called a seismic level recorder, which has been designed for use in the field or laboratory to monitor seismic activity is described, and the basic principle of operation is illustrated in a diagram. No gain adjustments are required during operation, the dynamic range covered is approximately 50 db, and the level recorder read out is calibrated directly in seismometer output voltage with full-scale reading of 10 mv peak-to-peak. For large signals a simple attenuator can be used between the seismometer and seismic amplifier. The most useful application of this instrument has been as a monitor in connection with the magnetic tape and photographic recording of such events as quarry blasts, nuclear shots, and earthquakes; it is not used for determining absolute measurements of transient signals. It has also been used to study short-period seismic background noise.— V.S.N.

- 189-138. Jackson, Philip L. Thermal noise in electrodynamic seismometers: *Earthquake Notes*, v. 32, no. 1-2, p. 12-13, 1961.

Byrne (see *Geophys. Abs.* 186-539) has proposed a method for computing apparent earth displacement due to thermal noise in a seismometer in which he considers the special case of damping by means of a shunt resistance over which the output voltage is measured. In this note computations are given for the general case of internal and shunt damping and the special cases resulting. It appears that instrument noise may be minimized by employing vane or viscous damping.— V.S.N.

#### ELASTICITY

- 189-139. Flinn, Edward A. Exact transient solution of some elementary problems of elastic wave propagation: *Jour. Acoust. Soc. Am.*, v. 33, no. 5, p. 623-627, 1961.

Two problems of guided elastic wave propagation are considered: (1) An impulsive point source of shear waves polarized parallel to the boundaries of a free solid plate; and (2) an arbitrary distribution of torsional stress across a normal section of a solid free cylinder. In (1), a solution is obtained in terms of standing waves across the thickness of the plate and another in terms of an infinite summation of delta functions. The two methods of representing the solution are shown to be identical. The harmonic steady state solution far from the source is also obtained and dispersion curves are given. The solution for (2) is a progressive wave consisting of a nondispersive term (the elementary torsional wave) plus a series of higher modes of dispersed waves.— L.P.

- 189-140. Cherry, J. T., Jr. The azimuthal and polar radiation patterns obtained from a horizontal stress applied at the surface of an elastic half space: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 27-36, 1962.

The body waves and surface waves radiating from a horizontal stress applied at the free surface of an elastic half space are obtained. The SV wave suffers a phase shift of  $\pi$  at  $45^\circ$  from the vertical. Also, a surface wave that is SH in character but travels with the Rayleigh velocity is shown to exist. This surface wave attenuates as  $r^{-3/2}$ . For a value of Poisson's ratio of 0.25 or 0.33, the amplitude of the Rayleigh waves from a horizontal source should be smaller than the amplitude of the Rayleigh waves from a vertical source. The ratio of vertical to horizontal amplitude for the Rayleigh waves from the horizontal source is the same as the corresponding ratio for the vertical source for all values of Poisson's ratio.— Author's abstract

- 189-141. Gilbert, Freeman, and Laster, Stanley J. Experimental investigation of PL modes in a single layer: *Seismol. Soc. America Bull.*, v. 52, no. 11, p. 59-66, 1962.

A two-dimensional seismic model has been set up to simulate the problem of elastic wave propagation in a single layer overlying a uniform half space. Both the source and the receiver are mounted on the free surface of the layer. Seismograms are presented as a function of range. In addition to the Rayleigh and shear modes, PL modes are observed. Experimentally determined phase and group velocities compare fairly well with theoretical curves. The decay factor for PL is maximum at the arrival time of P-waves in the half space. There is also a secondary maximum at the arrival time of P-waves in the layer. Although the decay of PL is small, phase equalization of PL does not yield the initial pulse shape because the mode embraces an insufficient frequency band to permit good resolution.— Authors' abstract

- 189-142. Meecham, W. C., and DeNoyer, John. Azimuthal asymmetry of a point source in a cylindrical low velocity medium: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 139-144, 1962.

The geometry of the medium in the vicinity of an otherwise symmetrical source is shown to produce a frequency dependent variation of amplitude with azimuth. The model considered is a cylindrical low velocity and low density fluid medium that is contained in a full space of a higher velocity and density fluid material. A simple harmonic point source is located on the axis of the cylinder. Amplitudes in the higher velocity medium at large distances from the source are found to be functions of the velocity ratio and the density ratio of the two media, the radius of the cylinder, the wavelength, and the angle between the axis of the cylinder and a line connecting the point of observation with the source.— Authors' abstract

- 189-143. Gilbert, Freeman, and Laster, Stanley J. Excitation and propagation of pulses on an interface: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 299-319, 1962.

Exact solutions to Lamb's problem exhibit a pulse that is related to a complex root of the Rayleigh function. The symbol  $\bar{P}$  is used to denote the pulse. For normal values of Poisson's ratio,  $\bar{P}$  arrives at nearly the same time as P, but when Poisson's ratio is near 0.5,  $\bar{P}$  is more distinct and arrives between P and S. The  $\bar{P}$  wave has a prograde orbit and in this respect is the dual to the Rayleigh pulse. The symbol  $\bar{S}$  is defined and used to denote the Rayleigh pulse.

The idea that a pulse can be associated with an extraneous root of the Rayleigh function has been extended to Cagniard's problem, the solid-solid interface problem. In this problem it has long been thought that interface pulses (Stoneley pulses) could exist only for certain values of the elastic parameters and densities. Exact solutions to this problem show that such pulses occur for almost all solid pairs. The symbol  $\bar{S}$  is used to denote these pulses. The  $\bar{P}$  wave also occurs in this problem. As one of the solids becomes a fluid, it seems that its  $\bar{P}$  becomes the fluid-solid Stoneley pulse if the P velocity in the fluid is less than the S velocity in the solid.— D.B.V.

- 189-144. Datta, S. K. Shear waves in a semi-infinite visco-elastic medium due to transient torsional couple applied on the circumference of a circle on the plane boundary: *India Natl. Inst. Sci. Proc.*, v. 27, pt. A, no. 5, p. 482-488, 1961.

The shear waves produced by a torque exponentially decreasing with time and applied to the circumference of a circle on the plane boundary of a semi-infinite isotropic elastic medium are analyzed mathematically. It is assumed that viscous dissipative forces are present in the medium and that the material is of Voigt type. By reducing the radius of the circle to zero the case of a concentrated torque is deduced.— V.S.N.

- 189-145. Pěč, Karel. Theorie der im elastischen Halbraum durch eine fläch-enformige Quelle erregten Wellen (1. Teil) [Theory of the waves excited in the elastic half space by a plane source (Part 1) (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 3, no. 2, p. 135-153, 1959.

The effect of a plane circular source situated on the surface of a completely elastic, isotropic, homogeneous half space on Rayleigh wave propagation is examined. Formulas are derived for the elastic displacements of the static part of the field for the case of tangential and normal forces, and for the Rayleigh wave displacements.

Formulas are also developed for the more rapidly varying components of the Rayleigh wave field at great distances from the source. Comparison of the main parts of Rayleigh waves generated by plane and point sources shows that for Rayleigh waves generated by point sources the two fields are essentially different in the vicinity of a discontinuity. A formula is given for determining the radius of the focal area from observations of Rayleigh wave variations with time at great distances from the source.

The decrease on Rayleigh wave amplitude with distance in the immediate vicinity of the source is also investigated.—D.B.V.

- 189-146. Vavilova, T. I., and Gel'chinskiy, B. Ya. Teoreticheskaya model' vzryva na granitsy razdela [The theoretical model of an explosion at an interface]: Akad. Nauk SSSR, Inst. Fiziki Zemli Trudy, no. 15 (182), p. 102-108, 1960.

The orientation function for the expansion center of an explosion in the neighborhood of an interface is investigated. The first arrival of the longitudinal wave is directed from the source (a compression wave), similar to the case for a uniform medium. Thus, the positive direction (direction from the source) of the first arrival, which is characteristic of underground explosions, remains preserved when the explosion takes place near a plane interface.—A.J.S.

- 189-147. Borodachev, N. M. Obshcheye resheniye dinamicheskoy zadachi dlya vyazko-uprugogo poluprostranstva [A general solution of the dynamic problem for a viscous-elastic halfspace]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 9, p. 1336-1340, 1960.

A generalization of the dynamic problem in interpretation of seismic data on wave propagation in viscous-elastic mediums is developed. Solutions are given for the case of a viscous-elastic halfspace where the material considered follows either Voigt's or Boltzmann's law of stress-deformation.—A.J.S.

- 189-148. Sato, Ryosuke. Short-period elastic surface waves propagated along the surface of a semi-infinite isotropic heterogeneous medium: Japanese Jour. Geophysics, v. 2, no. 4, p. 77-116, 1961.

Elastic waves of SH-type due to a point source in a semi-infinite isotropic heterogeneous medium in which the velocity of propagation of shear waves increases linearly with depth are investigated mathematically. Some short-period surface waves can be interpreted as Lg phases because the group-velocity of these waves is nearly equal to the velocity of shear waves at the free surface; they appear only in a heterogeneous medium, are predominant in the short-period range, and the amplitude becomes smaller with greater depth of the source. Body waves designated SS, sS, SSS, sSS are investigated also, and it is found that the amplitudes of these phases are larger than those of the direct S phase at certain distances. Waves appearing at the point of observation corresponding to the cusps on traveltime curves have amplitudes inversely proportional to the square root of the epicentral distance, while those of body waves appearing at other points are inversely proportional.—V.S.N.

- 189-149. Harkrider, David G., and Anderson, Don L. Computation of surface wave dispersion for multilayered anisotropic media: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 321-332, 1962.

With the program described in this paper it is now possible to compute surface wave dispersion in a solid heterogeneous halfspace containing up to 200 anisotropic layers. Certain discrepancies in surface wave observations, such as disagreement between Love and Rayleigh wave data and other independent evidence, suggest that anisotropy may be important in some seismological problems. In order to study the effect of anisotropy on surface wave dispersion a program was written for an IBM 7090 computer which will compute dispersion curves and displacements for Rayleigh waves in a layered halfspace in which each layer is transversely isotropic. A simple redefinition of parameters makes it possible to use existing programs to compute Love wave dispersion.— Authors' abstract

- 189-150. Dorman, James. Period equation for waves of Rayleigh type on a layered, liquid-solid half space: *Seismol. Soc. America Bull.*, v. 52, no. 2, p. 389-397, 1962.

A convenient formulation of the boundary conditions applicable to elastic wave propagation in a layered, solid half space was obtained by Haskell in terms of matrix algebraic operations. Developing this method further, the analogous problem for liquid layers is solved, and the treatment of liquid-solid interfaces is defined in matrix notation. This leads to a simple expression for the period equation for surface waves of the Rayleigh type on a half space of solid and liquid layers arbitrarily interspersed. This formulation of the period equation appears to yield the most rapid method for numerical computations on surface wave dispersion. It is the basis for computations used in several recent studies of earthquake surface-wave dispersion.— Author's abstract

- 189-151. Keylis-Borok, V. I. Razlichnye spektra poverkhnostnykh voln pri zemletryaseniya i podzemnykh vzryvakh [Differentiation of the spectra of surface waves due to earthquakes and underground explosions]: *Akad. Nauk SSSR, Inst. Fiziki Zemli Trudy*, no. 15 (182), p. 88-101, 1960.

The dependence of the surface wave spectrum in a layered medium on the form of the source is investigated. The distinguishing characteristic of underground explosions is that the predominant period of surface waves is at least 4 times smaller than the period typical for surface waves due to earthquakes that have approximately the same intensity and epicentral distance, provided the paths from the sources are approximately identical.— A.J.S.

- 189-152. Sato, Ryosuke. Love waves propagated across transitional zone: *Japanese Jour. Geophysics*, v. 2, no. 4, p. 117-134, 1961.

The variation of amplitudes and relation between traveltime and group-velocity of Love waves propagated across a transition zone are investigated. The amplitudes of Love waves of long period are little affected by the presence of a transition zone. On the other hand, the amplitudes of Love waves of short period become larger when a transition zone is present; the difference in amplitude becomes larger as the ratio of rigidities between the two media lying on either side of the transition zone becomes larger. In the case of a discontinuity without a transition zone, amplitudes of reflected and transmitted Love waves of long periods show little variation, but when a transition zone exists in which rigidity and velocity of shear waves vary from one side to another, reflected short waves become very small as compared with reflected long waves and transmitted long or short waves. To investigate the relation between traveltimes and group velocities of transmitted Love waves of short period, the mean phase and group velocities in the transition zone are considered.

Using very short waves across the zone, the boundary line between the two different media is found to be approximately at the middle point of the transition zone.— V.S.N.

- 189-153. Rinehart, John S., Fortin, Jean-Pierre, and Burgin, Lorraine. Propagation velocity of longitudinal waves in rocks. Effect of state of stress, stress level of the wave, water content, porosity, temperature, stratification and texture, in Fourth symposium on rock mechanics, 1961, Proc.: Pennsylvania State Univ. Mineral Industries Expt. Sta. Bull., no. 76, p. 119-135, 1961.

Parameters influencing the propagation velocity of longitudinal stress waves in rocks are reviewed. It is concluded that the range of propagation velocity in rocks is narrow, not exceeding 15 percent for rocks with a well defined texture. For rocks of the same rock type but of different origin, the velocity may range over a six fold interval. Propagation velocity generally increases 10-30 percent above the initial value when ambient pressure increases from 1 to 500 bars. At pressures greater than 2,000 bars velocity increases with pressure slowly from 0.3 to 2 percent per 1,000 bars. When uniaxial stress is applied the velocity parallel to the stress is 10 percent higher than the velocity perpendicular to the stress. At atmospheric pressure, the variation of velocity does not depend on the rock type. The variation of the velocity of saturated rocks under varying pressure depends on the differential or framework pressure. Propagation velocity decreases with porosity, and relationships between propagation velocity and porosity given by Biot's theory agree well with experimental results. Generally, an increase in temperature causes a decrease in velocity, only part of which is reversible on cooling. Discrepancies between field and laboratory measurements of velocity for a given rock are discussed, and the critical questions still unanswered by the study are pointed out.— V.S.N.

- 189-154. Iida, Kumizi, and Kumazawa, Mineo. Elastic wave velocity and thermal expansion of volcanic rocks at high temperatures [in Japanese with English abstract]: Volcanol. Soc. Japan Bull., ser. 2, v. 6, no. 2, p. 60-69, 1961; English version in Nagoya Univ. Jour. Earth Sci., v. 9, no. 1, p. 33-35, 1961.

Elastic wave velocity and thermal expansion were measured on four types of volcanic rocks at high temperatures. With rise in temperature an increasing elastic wave velocity was observed in dacite from Showa-shinzan Volcano and in basalt from Mihara Volcano; a decreasing velocity was observed in andesite from Aso Volcano; and in Hakone dacite decreasing velocity was observed up to 150°C, an increasing velocity to 573°C, and step-like decreasing velocity above 573°C.

The great differences observed in thermal expansion curves were found to be related to the crystalline forms of free silica, quartz or cristobalite, in the rocks. The variation of porosity with temperature was determined from the difference between the measured and calculated thermal expansion curves. An increase in wave velocity is generally correlated with a decrease in porosity. A step-like increase in velocity observed in Showa-shinzan dacite with a second heating is related to the inversion of alpha to beta cristobalite.— V.S.N.

- 189-155. Silayeva, O. I., and Shamina, O. G. Pogloshcheniye ul'trazvuka v granitakh [Absorption of ultrasonics in granites]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 9, p. 1354-1359, 1961.

The results of an experimental study of absorption of ultrasonic longitudinal and transverse waves (20-200 kc) in five varieties of granite are described. Of the three existing theories of elastic-wave absorption in solid bodies—the theory of elastic after-effect, the theory of viscous attenuation, and the theory of Coulomb friction—the latter was found to be in agreement with the results of the experiments described.— A.J.S.

- 189-156. Köhsling, Juliusz. Laboratoryjne wyznaczanie modułu sprężystości skał [Laboratory determination of the modulus of elasticity of rocks]: *Przegląd Geol.*, v. 9, no. 9, p. 476-479, 1961.

A method is presented for measuring Young's modulus on the basis of Hook's law in relation to rocks. The apparatus used is available in all soil mechanics laboratories in Poland.—J.W.C.

- 189-157. Wright, J. K., Carpenter, E. W., and Savill, R. A. Some studies of the P waves from underground nuclear explosions: *Jour. Geophys. Research*, v. 67, no. 3, p. 1155-1160, 1962.

The first arrivals ( $P_n$ ) from the Hardtack series of underground nuclear explosions, at distances up to 1,000 km, are analyzed in detail. There is no measurable dispersion in these arrivals. It has been suggested that the observed decay of amplitude with distance may be due to nonlinear processes (see *Geophys. Abs.* 175-85); another possible explanation may be that of a negative velocity gradient in the upper mantle. Energy from the refracted wave traveling along the M-discontinuity would be diffracted downward toward the low-velocity channel and the observed  $P_n$  arrival consequently attenuated more than would be expected on the simple theory of two homogeneous half spaces. Using Gutenberg's data (see *Geophys. Abs.* 180-56) the radius of curvature of a ray traveling along the M-discontinuity is 700 km. Model experiments to test these hypotheses are currently being carried out. This type of theory would be in agreement with Gutenberg's observations (see *Geophys. Abs.* 181-303) that the Q for P-waves can be very high (1,300-2,500) and that longitudinal waves which have traveled repeatedly through the (liquid) outer core show prevalently short periods.—D.B.V.

- 189-158. Werth, Glenn C., Herbst, Roland F., and Springer, Donald L. Amplitudes of seismic arrivals from the M discontinuity: *Jour. Geophys. Research*, v. 67, no. 4, p. 1587-1610, 1962.

Theoretical wave forms for the first cycle and a half are calculated for Romney's recordings of the Blanca, Logan, and Tamalpais underground nuclear explosions at distances of 96 to 714 km (see *Geophys. Abs.* 180-96). Crustal models are constructed from traveltimes. Amplitude calculations based on Zvolinskiy's near-front approximation (see *Geophys. Abs.* 172-56, -57) include head coefficients, geometrical spreading, and corrections for superposed layers. The source function is scaled from measurements made of the Rainier shot. The effects of attenuation and instrument response are included.

By convolving these factors, theoretical displacement amplitudes are calculated in millimicrons for the first half-cycle which agree with the experimental measurements of Logan and Blanca from 300 to 600 km within +4 to -16 percent. A single-layer crust with a Q of about 400 is indicated by the amplitude calculations. The amplitudes of later half-cycles are influenced by the reflection or interaction at the surface of the Rainier mesa. Additional data and calculations indicate that the surface reflection or interaction is nonlinear and has an amplitude about three times that expected on an elastic basis.—D.B.V.

- 189-159. Carder, D[ean] S., and Mickey, W. V. Ground effects from underground explosions: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 67-75, 1962.

For equivalent TNT energy yields of 180 lb to 19.2 kilotons at distances of 0.3 to 3,200 kilofeet, a yield scaling law of  $W^{0.75}$  is indicated. Maximum earth particle displacements satisfy an exponential attenuation function of the form:  $A = CW^{0.75}D^{-n} \times 10^{-kf^{0.8}}$ , where A is maximum earth particle displacement in centimeters, C is a constant, W is yield in tons, D is distance from detector to source in feet, n is a wave propagation constant, k is a constant,

and  $f$  is the visually dominant frequency in cycles per second of the measured pulse on the seismogram.

At 0.3-9.8 kilofeet,  $C=10^{4.57}$ ,  $n=2$ ,  $k=1.75 \times 10^{-6}$ ; at 9.8-525 kilofeet,  $C=10^{0.6}$ ,  $n=1$ ,  $k=1.83 \times 10^{-6}$ ; at 525-3,200 kilofeet,  $C=10^{-2.82}$ ,  $n=0.5$ ,  $k=7.6 \times 10^{-7}$ . The frequency exponent in the 525-3,200 kilofeet range is negligible, as maximum displacements were observed to occur near 1 cycle per second. Stations on desert alluvium recorded displacements 2-4 times greater than indicated by the above scaling functions.

As the higher frequencies are often recorded by geophones or seismometers measuring particle velocities rather than displacements, a scaling function relating to earth particle velocities would be advantageous.—D.B.V.

- 189-160. Willis, D[avid] E., and Wilson, James T. Effects of decoupling on spectra of seismic waves: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 123-131, 1962.

A series of controlled high explosive shots were conducted in a salt mine near Winnfield, La., to investigate seismic decoupling theories. Two recording stations were used at various distances between 1.1 and 14.7 km for a majority of these shots. The results of frequency analysis of the magnetic tape recordings are presented to show the relationship of the frequency spectra as a function of charge size, distance from the source, and coupled vs decoupled shots. The smaller decoupled shots detonated in the large spherical cavities were observed to have somewhat higher predominant frequencies than the equivalent size coupled shots. A change in cavity size produced no significant difference in the shape of the spectra of the large decoupled shots.—D.B.V.

- 189-161. DeNoyer, John, Willis, D[avid] E., and Wilson, James T. Observed asymmetry of amplitudes from a high explosive source: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 133-137, 1962.

Frequency analysis of seismic magnetic tape records from a 500-ton high-explosive source shows a pronounced variation of amplitude with frequency for two different azimuths from the source. This amplitude variation is attributed, at least in part, to diffraction effects produced by the geologic structure in the vicinity of the source. The possibility of generating both SV and SH waves from P-waves within this structure seems very probable.—Authors' abstract

- 189-162. Gupta, Indra N. Resonant oscillations of the overburden excited by seismic waves: *Earthquake Notes*, v. 32, no. 1-2, p. 5-11, 1961.

A study is made of the excitation of resonant oscillations in a single low-velocity layer of varying thickness overlying high velocity bedrock by seismic waves from quarry blasts. It is concluded that there is definite evidence of resonant oscillations of the surface layer in the case of quarry blast records, and the period of the oscillations agrees with the theory. Only transverse waves take part in the excitation, however. Similar results for the case of longitudinal waves only have been obtained by O'Brien (see *Geophys. Abs.* 172-241). Model studies confirm the generation by transverse waves of resonances of forced oscillations of the fundamental as well as higher order modes.—V.S.N.

- 189-163. Rocard, Yves. Sur les inégalités de la propagation seismique des ondes de volume à longue distance [On the inequalities of seismic propagation of body waves at long distance]: *Acad. Sci. [Paris] Comptes Rendus*, v. 254, no. 7, p. 1316-1317, 1962.

Differences in P-wave reception at great distances from nuclear explosions in Nevada as reported by Romney (see *Geophys. Abs.* 180-96) and from the first nuclear blast in the Sahara indicate that propagation is influenced by ge-

ography. In the case of the Nevada blasts, the signal received at 2,500 km was much stronger than that received at 800 km, whereas in the case of the Sahara blast the signals at 2,200-2,800 km were at least 4 times weaker than at 800 km. The inclination and particularly the curvature of the M-discontinuity and, more generally, of every layer capable of producing a seismic refraction is suggested as the reason for the differences.— D.B.V.

Choudhury, Mansur Ahmed. On the longitudinal waves from artificial earthquakes in western Europe. See *Geophys. Abs.* 189-343.

## ELECTRICAL EXPLORATION

189-164. Artamonov, L. V., and Shuval-Sergeyev, N. M. Od dipol'nom induktsionnom profilirovaniy v aeroelektrorazvedke [On dipole induction profiling in airborne electrical prospecting]: *Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3*, p. 109-117, 1961.

The method of airborne electrical prospecting is described in which the horizontal antenna frame is installed in the aircraft, and the reception antenna frame is placed in a special gondola on a line 150 m long towed by the plane. The aircraft has a cruising speed of 300 km per hr. Field tests carried out in 1958 in northwestern Ukraine S.S.R. produced electrical profiles that disclose sections of high electrical conductivity.— A.J.S.

189-165. Shaub, Yu. B. Ob ispol'zovanii izmereniy parametrov ramki generiruyushchego kontura dlya elektrorazvedki na zvukovykh chastotakh [On the utilization of measurements of the parameters of the frame of the generating circuit in electrical prospecting on sonic frequencies]: *Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3*, p. 118-130, 1961.

An open oscillation circuit produced by shunted self-inductance and capacitance in which a nonscreened antenna serves as the self-induction coil is used at sonic frequencies in airborne electrical prospecting. Solutions of direct and indirect problems of electrical prospecting by this method are given for bodies of spherical shape. The theory of the circuit over conducting spherical bodies is discussed, and quality factors are analyzed.— A.J.S.

189-166. Shaub, Yu. B. Apparatura dlya elektrorazvedki metodom izmeneniya rezonansnoy chastoty generiruyushchego kontura [Apparatus for electric prospecting by the method of variation of resonance frequency of the generating circuit]: *Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3*, p. 131-137, 1961.

The method of an open generating circuit (see *Geophys. Abs.* 189-165) for geoelectric prospecting at sonic frequencies is developed further. Frequency measurements by phase parameters are discussed, and apparatus designed for this purpose is described. Schematic diagrams of the apparatus are given.— A.J.S.

189-167. Komarov, V. A. Elementy teorii metoda vyzvannoy polarizatsii [Elements of the theory of induced polarization]: *Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3*, p. 138-171, 1961.

A theoretical discussion is presented of the method of induced polarization based on the results of laboratory and field experiments. A formula expressing Ohm's law in a generalized form was derived evaluating the ratio of induced polarization field intensity observed when the current is switched on to the field intensity when a steady current flows through the circuit. Mathemat-

ical analyses are given for the cases where (1) the induced field is inside a sphere and the current source outside, (2) the induced field and current source are both outside the sphere, (3) the induced field and current source are both inside the sphere, and (4) the induced field is outside the sphere, and the current source is inside.—A.J.S.

- 189-168. Fokin, A. F. Pole tochechnogo istochnika toka i zaryazhennogo provodnika na ploskoy dnevnoy poverkhnosti v sluchaye neodnorodnoy sredy [The field of a point source current and of a charged conductor on the flat surface of the earth for the case of a nonhomogeneous medium]: Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3, p. 172-187, 1961.

An investigation was made of (1) the electric field on the surface of the earth produced by a point source located underground in the presence of a contact of rocks with different resistivities, and (2) the electric field of a conductor in the presence of a contact of two mediums as applied to the charged body method. Theoretical curves of the potential and potential gradient for both fields are plotted.—A.J.S.

- 189-169. Ryss, Yu. S. Osnovnyye osobennosti menyayushchikhsya yestestvennykh elektricheskikh poley v zemle i ikh geologicheskoye znachenie [Main characteristics of variable natural electric fields in the ground and their geologic significance]: Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3, p. 189-217, 1961.

The character of the variation of the natural electric field during a one year period in the northwest part of the Rudnyy Altay is discussed, and the results of the observations are reported. The electric field varies with changes in moisture, structure, and texture of the rocks, and a correlation is noted between field variation and rock type. The variations of potential in such fields may reach 50-100 mv. In some places the observed variations are correlated with hydrothermally altered rocks; therefore, such phenomena may serve as an indirect method in prospecting for sulfide ores.—A.J.S.

- 189-170. Ignat'yeva, T.S. Rekomendatsii po primeneniyu kompleksa s"yemki sredinnykh gradiyentov i mikromagnitnoy s"yemki pri poiskakh redkometal'nykh pegmatitovykh zhil [Recommendations for using a combined survey of average gradients and a micromagnetic survey in prospecting for rare metal pegmatite veins]: Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3, p. 276-284, 1961.

The metallometric, electrical, gravity, radiometric, and magnetic methods of prospecting for rare-metal pegmatite veins are analyzed and found lacking in effectiveness and efficiency. On the basis of experimental laboratory and field work carried out in the search for pegmatite vein deposits in schistose amphybolites, it was found that a combination of the magnetic and electrical methods was effective. The rare-metal pegmatite veins were found to occur where a maximum on the apparent resistivity gradient corresponds to a minimum on the micromagnetic gradient.—A.J.S.

- 189-171. Yokoyama, Hidekichi, and Ibe, Yukimi. Experimental studies for electromagnetic prospecting (pt. 3) [in Japanese with English abstract]: Tohoku Kozan, v. 8, no. 2, p. 52-58, 1961.

Data from model experiments on variation of the secondary magnetic field induced by the two-coil method described in parts 1 and 2 (see Kunori, Geophys. Abs. 183-230, 185-185) are compared with the values calculated from theoretical formulas. The differences between the experimental and theoretical values are due to the size and area of the coils.—V.S.N.

- 189-172. Kellogg, William Crowe. Airborne AFMAG theory, equipment and operation in the western United States: *Mines Mag.*, v. 51, no. 5, p. 15-18, 1961.

The basic theory of the AFMAG system is presented in a schematic rather than a mathematical form, the equipment and data used in aerial surveying are described and illustrated, and some idea of the cost and nature of airborne AFMAG surveys is provided. Emphasis is placed on the equipment and the present method of data presentation and survey operations. The tests described demonstrate that airborne AFMAG is useful and reliable for mineral prospecting in the western United States. The speed with which surveys can be made and the large depth of penetration are advantages that far outweigh the seasonal limitations in its use.— V.S.N.

- 189-173. Ryss, Yu. S., Fokin, A. F., and Shatrov, B. B. Vozmozhnosti elektrorazvedki postoyannym i nizkochastotnym tokom [The possibilities of electrical prospecting by direct and low frequency currents]: *Razvedka i Okhrana Nedr*, no. 1, p. 29-32, 1961.

Following experiments in the Rudnyy Altay with d-c prospecting for deep deposits of ores covered with friable sediments, similar electrical exploration was conducted in the Urals. Low frequency (22 cycles per second) d-c was used over areas containing ores composed of sphalerite, chalcopyrite, galena, and other sulfides of 0.1 to 1 ohm-m electrical resistivity. It was found that the electrical anomalies due to conducting ores are best expressed on the potential gradient curves. The clarity of an anomaly increases as the length of the receiving line increases, the depth of the disturbing deposit decreases, the depth of the current source increases, the distance between the source and the ore body decreases, and the size of the latter increases. For an almost vertical dip of a disturbing body with its upper edge 150-200 m below the surface, the best result was obtained with  $(D/H) > 1$ , where D is distance between the line and the source, and H is the depth of the source.— A.J.S.

- 189-174. Kevorkov, R. A., Sarbash, V. F., and Sluchanko, Z. Ye. Nekotoryye rezul'taty fazovykh izmereniy v metode zaryada na peremennom toke [Some results of phase measurements in the charge method on alternating current]: *Akad. Nauk Kazakh. SSR Vestnik*, no. 7, p. 81-83, 1961.

Phase amplitude measurements of the electric field of a point charge and of a charged ore body made with the charge method using a-c in the frequency range of 75-3,375 cycles per second are discussed. Graphs of phase difference  $\Delta\phi$  drawn for both cases show that the position and extent of a charged ore body can be determined by this method.— A.J.S.

- 189-175. Vedrintsev, G. A. K teorii elektricheskikh zondirovaniy gorizonta'l'no-neodnorodnykh sred [On the theory of electrical sounding of horizontally nonhomogeneous mediums]: *Prikladnaya Geofizika*, no. 26, p. 30-69, 1960.

Disagreements between electric sounding curves obtained by the methods of vertical electric sounding (VES) and bilateral dipole electric sounding (DES) are explained by horizontal stratigraphic nonhomogeneity. The electric field in a horizontally nonhomogeneous medium resting on an insulator or on an absolute conductor is studied. Sharp horizontal discontinuities formed by a vertical contact between two homogeneous and isotropic mediums are analyzed mathematically, and formulas are derived for different arrangements of the axes and the center of the soundings. It was noticed that the right side branches of the graphs, obtained by the VES and DES methods, exhibit maximum divergence under the conditions investigated. Asymptotic formulas for such cases are developed and applied for corrections. Several master charts are designed and given in the text.— A.J.S.

- 189-176. Nazarenko, O. V. O vliyaniy razmerov izmeritel'noy pitayushchey linii na rezul'taty primeneniya dipol'noy osevoy ustanovki [On the effect of the lengths of measuring and input lines on the results of using a dipole axial arrangement]: Azerbaydzhan. Nauchno-Issled. Inst. po Dobyche Nefti Trudy, v. 4, p. 230-243, 1956.

A rule used in vertical electric sounding by dipole arrangements that the observed sounding curve coincides with the theoretical curve when the sizes of the dipoles  $\overline{AB}$  and  $\overline{MN}$ , and the distance  $R$  between their centers satisfy a condition  $(\overline{AB}; \overline{MN}) \leq R/5$ , and when the theoretical curve has been calculated for infinitely small dipoles, is analyzed. Solutions for the effect of the size of the dipoles on the results of an axial arrangement with different values of  $R$  are given. Examples are given for  $\overline{AB} = \overline{MN}$ ,  $\overline{AB} = 0.1R$ ,  $\overline{AB} = 0.2R$ , and when one of the dipoles is infinitely small. A method for a unique geological interpretation of apparent resistivity anomalies obtained from electric profiling and based on the use of systematic changes on apparent resistivity curves in transition from limited to unlimited arrangements is proposed.—A.J.S.

- 189-177. Kaku, Hidezo. Studies on SP phenomena (1) [in Japanese with English abstract]: Butsuri-Tanko, v. 13, no. 4, p. 219-228, 1960; Studies on SP phenomena (2) [in Japanese with English abstract]: Ibid., v. 14, no. 2, p. 55-63, 1961.

In part 1, electrochemical measurements of potential difference and the mechanism of the SP current that results from electrochemical potential, streaming potential, and the like are discussed. The field of SP generation, potential distribution, and inner potential in the case of a sulfide ore body is analyzed. The electrochemical approach has been developed to explain many of the difficulties encountered when using the static potential theory.

In part 2, the study of a sulfide ore body is continued with a discussion of polarization current in an ore body, SP phenomena outside an ore body (near the earth's surface), and streaming potential of porous siliceous rocks. Both papers are well illustrated with diagrams carrying English titles.—V.S.N.

- 189-178. Seya, Kiyoshi. Consideration of spontaneous polarization potential at the Oage pyrite mine, Aomori Prefecture [in Japanese with English abstract]: Butsuri-Tanko, v. 13, no. 4, p. 229-243, 1960.

The linear correlation between self-potential ( $P$ ) and height ( $H$ ) at measurement points in the silicified zone of the Oage mine area is investigated, and the expression  $P = P_D + P_A$  is derived from the relation of  $P-H$ ,  $\Delta P - \Delta H$ , and  $\bar{P} - \bar{H}$  where  $\Delta$  is the operation of normal detection by the running average method (see Geophys. Abs. 182-300),  $\bar{P}$  and  $\bar{H}$  are quantities obtained from the running average of 7 points from  $P$  and  $H$ , respectively,  $P_D$  is the characteristic self-potential in a silicified zone defined by  $P_D = k(H-S)$ , and  $P_A$  is a potential including both noise and anomalous elements. It is reasoned that because of the existence of linear correlation between  $\Delta P$  and  $\Delta H$ , it is possible to detect part of the self-potential produced by an ore deposit. An anomaly map obtained by this method is included.—V.S.N.

- 189-179. Makino, Naofumi. On the potential distribution of spontaneous polarization [in Japanese with English abstract]: Butsuri-Tanko, v. 14, no. 1, p. 9-18, 1961.

The results are summarized of experimental field studies using the self-potential methods at the Ugusu, Hosokura, and Oage mines in Japan. Self-potential distribution was measured on the surface, in mine galleries, and in drill holes. Conclusions agree with Fuchida's proposal (1952) that another type of potential distribution—a static type—is produced by galvanic current. This should help to explain why drilling at a negative center of self-potential often fails to find ore.—V.S.N.

- 189-180. Endo, G., Shibato, K[ihei], and Momose H. Relations between geology, ore deposit, and spontaneous polarization potential [in Japanese with English abstract]: Butsuri-Tanko, v. 14, no. 1, p. 19-30, 1961.

The chief causes of spontaneous polarization - oxidation and reduction of the ore deposit and streaming, contact, and membrane potential - are discussed under three subdivisions: the relation between rocks and spontaneous polarization, between mineralization and spontaneous polarization, and between deterioration and spontaneous polarization. Each subdivision is well illustrated with examples.— V.S.N.

- 189-181. Ohashi, S[hui], Kobayashi, H., Matsuo, H., and Murozumi, M[asayoshi]. On the contributions of surface soil and topography to the SP distribution [in Japanese with English abstract]: Butsuri-Tanko, v. 14, no. 1, p. 31-42, 1961.

In order to evaluate abnormalities in measured values of self-potential caused by surface soil variations and differences in topographic relief (self-potential becomes lower as relief becomes higher) geophysical, geochemical, and geological information should be combined. Moreover, both the resistivity and analytical methods should be used simultaneously with the self-potential method.— V.S.N.

- 189-182. Kojiro, T., Suyama, J[unji], and Hasegawa, K. On the problem of the SP measurement [in Japanese with English abstract]: Butsuri-Tanko, v. 14, no. 1, p. 43-47, 1961.

The reliability of measured natural potential values is discussed in relation to the accuracy of the instrument used, the nature of the ground surface with which the electrode is in contact, and the time variation of the earth potential associated with telluric currents. It is pointed out that the magnitude of the diurnal variation of the earth's electric field is as much as 100 mv per km in some areas.— V.S.N.

- 189-183. Okabe, K[atshuhiko], Sato, K[onosuke], Tsujimura, H., and Momose, H. A part of self potential method at the exploration of ore deposits [in Japanese with English abstract]: Butsuri-Tanko, v. 14, no. 1, p. 48-53, 1961.

The self-potential method has been particularly effective for exploration in Japan for the past 40 yr because of the good responses typical of ore deposits in Tertiary formations, the steepness of the topography and the effect of shallow mineralization on blind ore bodies, and the cheapness of operation. The applicability of the self-potential method to exploration of ore deposits is investigated by the statistical method, and results are described where other geophysical methods are used with the self-potential method.— V.S.N.

- 189-184. Yokoyama, Hidekichi. Experimental studies on the spontaneous polarization method [in Japanese with English abstract]: Tohoku Kozan, v. 8, no. 4, p. 109-111, 1962.

Laboratory experiments to study spontaneous polarization of ore deposits were conducted on vein models using an aluminum plate for the anodic zone and a copper plate for the cathodic zone. It was found that (1) deviation of the negative center occurs when the dip of the ore model is less than 90°; (2) the negative value of the spontaneous polarization increases with an increase in length of the cathodic zone and with an increase in thickness of the vein; and (3) when parallel veins are within a short distance of each other only one negative center is obtained, but when the distance is increased to more than 20 times the thicknesses of the veins, two negative centers appear.— V.S.N.

- 189-185. Dobrovolskiy, V. P. Nekotoryye osobennosti interpretatsii krivyykh VEZ poluchennykh pri issledovanii tolshchi mnogoletnemerzlykh gornykh porod [Certain characteristics of the interpretation of electrical sounding curves obtained during investigation of permafrost thickness]: *Ministerstvo Vyssh. Obrazovaniya SSSR, Nauch. Doklady Vyssh. Shkoly, Geol.-Geog. Nauki*, no. 2, p. 127-133, 1959.

A method is proposed for interpretation of electrical sounding curves in permafrost. The problem is reduced to determination of the point source of the current over a 3-layered conductive semispace with the resistance of the intermediary layer changing linearly with depth. The effect of the anisotropy of the frozen layer as determined by changes in temperature and ice content is taken into account. The formulas used in the calculations are given.—V.S.N.

- 189-186. Rudakov, V. N., and Bogorodskiy, V. V. K voprosu ob izmerenii tolshchiny lednikov elektromagnitnymi metodami [On the problem of measuring glacier thickness by electromagnetic methods]: *Akad. Nauk SSSR Zhur. Tekh. Fiziki*, v. 30, no. 1, p. 82-89, 1960.

Data on the electromagnetic properties of ice and its structure are analyzed to determine the usefulness of electromagnetic methods in measuring glacier thickness. The analysis indicates that ice thickness may be measured electromagnetically with an accuracy of  $\pm 10$  m using time lag signals of not more than  $0.1\mu$  sec duration with intervals of  $40\mu$  sec between signals. It is probably possible to use waves shorter than 1 cm.—V.S.N.

- 189-187. Hesse, Albert. Mesures de resistivités électriques sur une coupe stratigraphique de gisement préhistorique [Electrical resistivity measurements on a stratigraphic section of a prehistoric deposit]: *Acad. Sci. [Paris] Comptes Rendus*, v. 254, no. 3, p. 525-527, 1962.

Electrical resistivity measurements were made on a control section in the Hyene cave in France. The Mousterian level, often difficult to distinguish in a cut, was easily identifiable by a peak in the resistivity profile. Electrical measurements, therefore, can be used to supplement trenching in prospecting of prehistoric sites.—D.B.V.

- 189-188. Swanson, H. E. Model studies of an apparatus for electromagnetic prospecting: *Am. Inst. Mining Metall. Petroleum Engineers Trans.*, v. 220, p. 234-238, 1961.

Scale-model studies of the two methods (in-line and broadside) of operation of the lightweight apparatus for electromagnetic prospecting described by Brubaker (see *Geophys. Abs.* 175-120) have been conducted in the laboratory, and the results are reported. The conductor models include a single sheet conductor at several strike and dip angles and a schistose-type conductor. Data on the effects of the strike length and depth of the conductor are presented also for the broadside method of operation. All of the data show that inclination reverses direction over the top edge of dipping single sheet conductors. Differences between anomalies over conductors dipping between  $90^\circ$  and  $30^\circ$  are subtle, but flat-lying sheets can be readily distinguished from single sheet conductors. Schistose and single sheet conductors are easily distinguished from each other; a procedure is given for determining the direction of schistosity. Depth of penetration ideally is 0.7 of the coil separation.—V.S.N.

- 189-189. Yoshizumi, Eizaburo, and Irie, Tsuneji. Resistance network analyzer of the electrical prospecting [in Japanese with English abstract]: *Butsuri-Tanko*, v. 13, no. 4, p. 207-218, 1960.

Certain simple assumptions often made to solve problems in resistivity distribution in electrical prospecting are inadequate to explain complex resistivity

distributions. A resistance network analyzer capable of high accuracy in the solution of Laplace equations with given boundary conditions is outlined and some examples cited.—V.S.N.

- 189-190. Crosby, James W., III, and Cavin, Richard E. Geochemical and resistivity prospecting methods—A field investigation in Pend Oreille County, Washington: Washington State Inst. Technology Research Rept., no. 61/9-17, 206 p., 1961.

Pend Oreille County in northeast Washington, an area of extensive known lead and zinc deposits, was chosen for testing geochemical methods of prospecting. Field work in the north part of the county demonstrated in a short time that geochemical studies offer virtually unlimited possibilities in the study of large replacement-type ore bodies. Resistivity studies were made in several localized areas to compare the findings with known ore bodies and to check the results obtained from the geochemical sampling. The principles and techniques of both geochemical and resistivity surveying are discussed, and the results from the survey are tabulated.—V.S.N.

- 189-191. Keller, G[eorge] V., and Frischknecht, F[rank] C. Electrical resistivity studies on the Athabasca Glacier, Alberta, Canada: U.S. Natl. Bur. Standards Jour. Research, v. 64D, no. 5, p. 439-448, 1960.

This is the same paper as that published in Internat. Symposium Arctic Geology, 1st, Calgary, Alberta, 1960, Proc., p. 809-832, 1961 (see Geophys. Abs. 187-194).—V.S.N.

- 189-192. Voegtli, K. The Devon Island expedition: Measurement of electrical resistivity of ice: Arctic, v. 14, no. 4, p. 255-256, 1961.

The large difference between the specific resistance of the ice of the Devon Island icecap and of an outlet glacier and that of the underlying bedrock makes it possible to measure accurately the thickness of the icecap or of the glacier by an electrical method. Resistivity measurements made in 1961 indicate that the major part of the glacier rests on compact rock except for one small area underlain by thick sediments. Several small areas of the glacier showed resistivities on the order of 1 megaohm-m higher than that of other areas; this greater conductivity is comparable to that of the ice-masses of the Alps and of the Athabasca Glacier in Alberta. Devon Island ice thus provides an excellent opportunity to study the problem of the large difference in resistance between some arctic ice and that known for glaciers in middle latitudes. Measurements of resistivity of ice on melt-water-fed lakes or filled crevasses show the same low values as those generally found on glaciers and thus eliminate explanations based on pressure or recrystallization. A preliminary study gives some evidence that freshly formed ice-masses have high resistivity; if this is true, resistivity methods will provide an easy method for distinguishing between accumulation and ablation zones. Moreover, a full understanding of conductivity factors in old and new ice could provide information about climatic conditions at the time of formation of ancient ice masses.—V.S.N.

- 189-193. Greenhouse, J. P. The Devon Island Expedition: Measurements of electrical resistivity of ice-formations: Arctic, v. 14, no. 4, p. 259-265, 1961.

A preliminary report is presented giving the details of the geophysical principles involved and the techniques employed in the resistivity survey of the Devon Island icecap and glaciers during the summer of 1961. Ice thickness was determined and careful observations made of the variations in resistivity of arctic land-ice. The survey program and results are outlined. A general summary of the results of these observations is given by Voegtli (see Geophys. Abs. 189-192).—V.S.N.

- 189-194. Borovinskiy, B. A. Elektrorazvedochnyye raboty na morene Maloalmatinskikh lednikov [Electrical exploration of the moraine of the Maloalmatinsky glaciers], in *Glyatsiologicheskkiye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kasakh SSR, p. 113-134, 1961.

Vertical electrical and dipole sounding studies of moraines of the central Tuyuksu glacier in the Zailiysky Alatau show that ground water recharge greatly exceeds discharge during the summer as a result of which the water table may oscillate as much as one or two meters. Catastrophic mudflows occur as a result of tunneling in highly saturated material on steep slopes on the valley side.— H.F.

- 189-195. Borovinskiy, B. A. Application des methodes géophysiques aux investigations du glacier et de la moraine Touyüksou [Application of geophysical methods to investigations of the Tuyuksu glacier and moraine], in *Symposium of Chamonix*, Sept. 1958, *Physics of the movement of the ice*: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 328-335, 1958.

This is virtually the same as the paper published in Russian in *Akad. Nauk Kazakh. SSR Vestnik*, no. 5(158), p. 40-44, 1958 (see *Geophys. Abs.* 176-176).— V.S.N.

- 189-196. Ono, Yoshihiko. Electrical survey by resistivity method for uranium deposits of sedimentary type [in Japanese with English abstract]: *Japan Geol. Survey Bull.*, v. 12, no. 6, p. 459-464, 1961.

A resistivity survey was carried out in the Ombara district near the Ningyo Pass uranium deposits to test the applicability of the method to prospecting for sedimentary-type uranium deposits and to determine the depth of the granite in the district.— V.S.N.

- 189-197. Kobayashi, Hajime. Electrical prospecting at Okuyama mine, Shizuoka Prefecture [in Japanese with English abstract]: *Japan Geol. Survey Bull.*, v. 12, no. 8, p. 623-626, 1961.

Resistivity and self-potential surveys over the known deposits of the Okuyama mine, Shizuoka Prefecture, Japan, demonstrated successfully the applicability of both methods to exploration for gold deposits of the fissure-filling vein type. The resistivity method gave high values over outcrops of known deposits and delineated the boundaries of mineralized zones; the self-potential method produced negative anomalies over mineralized zones.— V.S.N.

- 189-198. Otaki, Takemichi. Investigation of S.P. anomaly at the Matsuo mine field [in Japanese with English abstract]: *Butsuri-Tanko*, v. 14, no. 2, p. 77-81, 1961.

The self-potential anomaly shows an intimate relation to the structure of this massive impregnation iron sulfide ore deposit. The anomaly reflects the boundary of the altered zone and its extension, and the figures made by the peak lines of self-potential contours are similar to the structure lines of the deposit.— V.S.N.

- 189-199. Kunori, Shoichi, and Ishii, Fujio. Studies on the relation between spontaneous polarization potential and mineralization on the adit in the Oizumi Mine, Yamagata Prefecture [in Japanese with English abstract]: *Tohoku Kozan*, v. 8, no. 2, p. 49-51, 1961.

The ore deposits of the Oizumi Mine occur as fissure-filling veins in Miocene tuffaceous rocks and propylite. Results of self-potential measurements in the adit are interpreted and discussed in relation to the exchangeable mag-

nesium ions in the propylite which seem to be a measure of the magnesium-chlorite mineralization. It is concluded that the self-potential values show significant correlation with the increase of exchangeable magnesium ions that was caused by metamorphism before ore deposition and by hydrothermal solutions.— V.S.N.

McGinnis, Lyle D., and Kempton, John P. Integrated seismic, resistivity, and geologic studies of glacial deposits. See *Geophys. Abs.* 189-573.

## ELECTRICAL LOGGING

189-200. Garland, G. D. Natural earth currents and electric logging: Canadian Mining Metall. Bull., v. 55, no. 597, p. 43-45, 1962; also in Canadian Inst. Mining Metallurgy Trans., v. 65, p. 39-41, 1962.

The influence of natural electric currents, induced in the earth by changes in the earth's magnetic field, on the electric logging of boreholes has not always been recognized. Measurements made with fixed electrodes of changes in the vertical potential gradient in a hole near Calmar, Alberta, have indicated the effect of earth currents related to magnetic disturbances. It is found that appreciable errors in self-potential logging could arise during periods of magnetic storms, but the precise pattern of disturbance in any area seems to depend on the local structural conditions. As the amplitude of the natural earth currents increases toward the auroral zone, it is suggested that periods of magnetic disturbance be avoided, if possible, when electric logs are taken in the northern part of the western sedimentary basin [of Canada].— Author's abstract

189-201. Tuman, Vladimir S., and Bollman, Dorothy. Application of computers to the interpretation of well logs: *Jour. Petroleum Technology*, v. 13, no. 4, p. 311-318, 1961.

Computers can be used effectively for interpreting well logs. Types of computers are discussed, and a step-by-step example of how to write a program is given. Five programs that have been prepared are as follows: (1) "Discriminating Program," in IBM 650 language, which discriminates shales from sands and porous mediums and uses gamma-ray or SP curves; (2) " $R_w$  program," using SP data, which is available in IBM 650 and Illiac language; (3) "Computing the porosity from the sonic log," in Illiac language, which is based on the time-average relation; (4) "Computing the formation factor F from any type of porosity," in Illiac language, which is based on standard and Humble formula; and (5) "A cross-correlating program," in Illiac language, which aligns two logs of the same well and removes depth discrepancies.— J.W.C.

189-202. Meyer, V. A. Karotazh skvazhin pri razvedke polimetallicheskikh mestorozhdeniy [Logging of boreholes in prospecting for polymetallic deposits]: Leningrad, Leningrad University, 208 p., 1960.

This monograph treats the subject of borehole logging in geophysical prospecting for polymetallic deposits and consists of two parts. In part 1 borehole logging on a regional basis is discussed. In part 2 the methods and techniques of logging polymetallic deposits are discussed. The electrical resistivity, self-potential, sliding contacts, electrode potentials, galvanic couples, induced polarization, magnetic, radioactivity, radio-wave translucency, and hydrological methods of logging are discussed.— A.J.S.

189-203. Dakhnov, V. N. Sovremennoye sostoyaniye geofizicheskikh metodov opredeleniya kollektorskikh svoystv i neftegazonasyscheniya porod i puti dal'neyshikh issledovaniy [Present status of geophysical methods of determination of reservoir properties and oil-gas saturation of rocks and means for their further investigations]: *Vses. Neftegaz. Nauchno-Issled. Inst. Trudy*, no. 29, p. 6-31, 1960.

The application of geophysical methods to quantitative determination of porosity, permeability, clay content, tortuosity, specific area, salinity of formation water, and the coefficients of oil and gas saturation of the pore space is discussed.— A.J.S.

- 189-204. Pernikov, M. Sh. Metodika opredeleniya pronitsayemosti neftenykh plastov po dannym elektricheskogo karotazha [The method of determination of permeability of oil-bearing strata according to electric logging data]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 29, p. 55-68, 1960.

A method of determination of permeability of sandy-silty strata is proposed; it has been tested on the terrigenous sediments of the Devonian and Carboniferous in the Volga-Ural area. The method is based on the variation in electrical resistivity of oil-bearing strata in the zone of infiltration of drilling mud. Compared with determinations on cores the mean arithmetic error by the method proposed was found to be 11.6 percent.— A.J.S.

- 189-205. Vendel'shteyn, B. Yu. Nekotoryye svedeniya o metodakh opredeleniya parametrov neftegazonosnykh plastov po dannym promyslovo-geofizicheskikh issledovaniy, primenyayemykh za rublezhom [Some information on methods of determination of parameters of oil- and gas-bearing strata according to geophysical logging investigations used abroad]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 29, p. 69-90, 1960.

Methods for resistivity determination of reservoir properties and oil and gas saturation of productive strata used in the United States are surveyed.— A.J.S.

- 189-206. Krinari, A. I. Nekotoryye rezul'taty poiskov ratsional'nykh metodov opredeleniya kollektorskikh parametrov i neftenasyshchenosti porod po elektrometrii skvazhin dlya usloviy Tatarii [Some results of the search for efficient methods of determination of reservoir properties and oil saturation of rocks according to the borehole electrometry under the conditions of Tartaria]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 29, p. 91-102, 1960.

Problems of determination of open porosity by the self-potential method are discussed. No direct and unique correlation was found between electrical and reservoir parameters of the strata; the relationship of electrical resistivity to water saturation of rocks is much affected by their structural features and clay content.— A.J.S.

- 189-207. Dolina, L. P., Ivanchuk, L. F., and Baramzina, V. A. Vnedreniye geofizicheskikh metodov opredeleniya kollektorskikh svoystv plastov dlya podscheta zapasov nefti i analiza razrabotki neftyanykh zalezhey [Introduction of geophysical methods of determination of reservoir properties of strata for calculation of oil reserves and analysis of exploitation of oil pools]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 29, p. 103-112, 1960.

The relationship between the number of specimens used and the accuracy of the average value for porosity of a stratum is analyzed statistically for the Romashkino field. The error is 54 percent with only 1 specimen but drops to 5.2 percent when 12 specimens are averaged. The values of permeability as determined by resistivity are then compared with values determined on cores. There is no agreement when the core values include averages based on small numbers of specimens; agreement is good, however, if only those averages are used that are based on six or more specimens.— J.W.C.

- 189-208. Fel'dman, B. Ye., and Boyarov, A. T. Opredeleniye neftenasyshchennosti i kollektorskikh svoystv porod mestorozhdeniy Kuybyshevskoy oblasti po geofizicheskim materialam [Determination of oil saturation and reservoir properties of rocks of the Kuybyshev area according to geophysical data]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 29, p. 113-124, 1960.

Oil saturation of the productive strata of the Devonian and Carboniferous systems is discussed. The methods of capillary displacement and capillary saturation were used to determine the water saturation of cores. Determination of porosity by the self-potential method requires a determination on at least one core for each horizon.—J.W.C.

- 189-209. Anpilogov, A. P., Korshikov, V. N., and Zudakina, Ye. A. Oprobvaniye metodov opredeleniya kollektorskikh svoystv terrigenykh plastov Tuymazinskogo i Serafimovskogo mestorozhdeniy po promyslovo-geofizicheskim dannym [Testing of methods of determination of reservoir properties of terrigenous strata of the Tuymazy and Serafimovka fields according to geophysical logging data]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 29, p. 125-135, 1960.

The results of determination of oil saturation of strata by their electrical resistivity in the Tuymazy field of the Volga-Ural area are discussed. The coefficient  $Q$  of an increase in resistivity is expressed in terms of coefficients of water saturation,  $K_v$ , and oil saturation,  $K_n$ , in the following analytical formula:  $Q = (0.24/K_v^{1.7}) = [0.24/(1-K_n)^{1.7}]$ . The oil saturation of reservoirs determined by the electrical resistivity method agrees well with geological data. Neutron-gamma logging and microsonde determinations, however, proved to be ineffective.—A.J.S.

- 189-210. Komarov, S. G., Keyvsar, Z. I., Kozina, Z. K., Skoblikova, G. I., and Guzanova, I. G. Opredeleniye poristosti po PS [Determination of porosity by SP]: Prikladnaya Geofizika, no. 25, p. 192-215, 1960.

The assumption that a close correlation exists between self-potential and porosity was examined by field tests in the Volga-Urals oil area. It was found that such an assumption has neither a theoretical nor an experimental basis, and that the self-potential method of porosity determination can be used only for differentiation of layers of high porosity (18 percent or more) from those of low porosity.—A.J.S.

- 189-211. Suyama, Junji. On the interpretation of S. P. log [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 12, no. 8, p. 605-612, 1961.

The theory of interpretation of self-potential logs is reviewed, and several examples of logs obtained in boreholes during investigations for ground water, natural steam, and other resources are cited.—V.S.N.

- 189-212. Marušiak, Ivan, Kalina, Jaroslav, and Vičánek, Jan. The determination of the resistivity of a bed 100 percent saturated with water in shaly sands: Československa Akad. Věd Geofys. Sborník, no. 95, p. 425-437, 1958.

A method is described for determining the resistivity of a stratum in which the pore space is filled completely with formation water. For each bed this value of resistivity is related to the true resistivity, the resistivity of the invaded zone, and the self potential. The method is based on the Tixier formula.—J.W.C.

- 189-213. Perkow (Per'kov), N. A. Über die Methodik bohrlochgeophysikalischer Untersuchungen karbonatischer Speichergesteine [On the methods of geophysical borehole investigations of carbonate reservoirs (with English and Russian summaries)]: *Zeitschr. Angew. Geologie*, v. 6, no. 1, p. 33-35, 1960.

This is a German version of a paper published in "Geologiya Nefti i Gaza" no. 6, p. 45-47, 1959 (see *Geophys. Abs.* 187-204).— D.B.V.

- 189-214. Oilweek. Logging with pipe in hole possible with new tool: *Oilweek*, v. 13, no. 1, p. 38, 1962.

New instrumentation by means of which electric logs can be obtained while the drill pipe is in the hole is announced. The system, known as the DP electric log, is a self-powered and self-recording logging instrument that is pumped down the drill string; no connections are used between the surface and the down-hole instrument package. A cable electrode assembly projects through the bit nozzle into the open hole. As the drill pipe is raised the log is recorded on magnetic tape. The package may be retrieved by sand line or when coming out of the hole for a bit change. Conventional S.P. 16- and 64-in. normal resistivity curves are obtained at the surface by rapid conversion into a visible standard scale paper log.— V.S.N.

- 189-215. Nechay, A. M., and Mel'nikov, D. A. Izucheniye kollektorskikh svoystv plastov po geofizicheskim dannym v rayonakh Severo-Vostochnogo Pred-Kavkaz'ya [Investigation of reservoir properties of strata according to geophysical data in the regions of the northeast cis-Caucasus]: *Vses. Neftegaz. Nauchno-Issled. Inst. Trudy*, no. 29, p. 44-54, 1960.

On the basis of apparent resistivity, self potential, and microsonde logs, porosity was determined for the Maykop and Upper and Lower Cretaceous deposits in the northeast cis-Caucasus. The methods used are described.— A.J.S.

- 189-216. Bedcher, A. Z., Yeremina, A. S., and Stolovitskiy, B. M. Rasprostraneniye verkhnemiotsenovykh kollektorov v Zapadno-Kubanskom progibe po dannym karotazha i ikh gazoneftenosnos' [Distribution of upper Miocene reservoirs in the West Kuban downwarp according to data of electrical logging and their gas-oil productivity]: *Vses. Neftegaz. Nauchno-Issled. Inst., Krasnodar. Filial, Trudy*, no. 6, p. 99-105, 1961.

Electrical resistivity and self potential logs were used for extensive correlation of the upper Miocene deposits of the West Kuban downwarp. Examples of this correlation are illustrated in diagrams.— J.W.C.

- 189-217. Kireyev, V. F. Promyslovo-geofizicheskaya kharakteristika nizhne-apsheeronskikh otlozheniy ploschadi Kalmas v svyazi s ikh neftegazonosnost'yu [Electric log characteristics of the lower Apsheron deposits of the Kalmas area in relation to their oil-gas productivity]: *Vyssh. Ucheb. Zavedeniy Izv., Neft' i Gaz*, no. 7, p. 3-7, 1961.

The electric logs of the lower Apsheron sediments show that these strata contain sand-silt intercalations with thicknesses, areal dimensions, porosities, permeabilities, and probable oil-gas contents adequate for economic development.— J.S.W.

- 189-218. Per'kov, N. A., ed. Al'bom tipovykh geologo-geofizicheskikh razrezov skvazhin neftyanykh rayonov Volgo-Ural'skoy provintsii [Album of type geologic-geophysical sections of boreholes of oil regions of the Volga-Ural province]: Moscow, Gostoptekhizdat, 114 p., 1961.

Type geological-geophysical sections of boreholes in 18 of the principal oil fields of the Volga-Ural district are presented. The diagrams show the lithology and apparent resistivity, self potential, gamma, neutron-gamma, and caliper logs. The location of each borehole is shown on a map.—J.W.C.

- 189-219. Shumenkova, Yu. M., and Shilin, A. K. Opornyye skvazhiny SSSR. Maksimkin-Yarskaya opornaya skvazhina (Tomskaya oblast') [Research drill holes of the U.S.S.R. Maksimkin Yar research drill hole (Tomsk district)]: Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy, no. 166, 130 p., 1961.

The stratigraphy, petrography, chemical composition, paleontology, hydrogeology, and oil productivity of the Maksimkin Yar research drill hole in Siberia are described in detail. The electrical resistivity and self potential logs are reproduced.—J.W.C.

- 189-220. Dryakhlova, Ye. A., and Rozin, A. A. Opornyye skvazhiny SSSR. Pokurskaya opornaya skvazhina (Tyumenskaya oblast') [Research drill holes of the U.S.S.R. Pokur research drill hole (Tyumen district)]: Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy, no. 169, 112 p., 1961.

A detailed description of the stratigraphy, lithology, paleontology, hydrogeology, and oil productivity is given for the Pokur research drill hole in the Tyumen district of Siberia. The log shows electrical resistivity, self potential, grain size, and porosity.—J.W.C.

#### EXPLORATION SUMMARIES AND STATISTICS

- 189-221. Bondarenko, V. M., Demidovich, O. A., and Tarkhov, A. G. Pervyye rezul'taty kompleksnogo primeneniya geofizicheskikh metodov dlya pryamykh poiskov mestorozhdeniy almazov v Yakutskoy ASSR [The first results of coordinated application of geophysical methods for direct prospecting of the diamond deposits in the Yakutsk ASSR]: Vyssh. Ucheb. Zavedeniye Izv., Geologiya i Razvedka, no. 2, p. 118-132, 1961.

The physical properties of the rocks of the Dal'dno-Alakitsk diamond-bearing region in the Yakutsk A.S.S.R. are discussed, and the coordinated geophysical work such as magnetic, gravity, and electrical (d-c and a-c) prospecting carried out over the kimberlite pipes and the traps are described. Profiles made by these methods are illustrated and discussed. It was found that d-c electrical prospecting and gravimetric surveying give positive results in the classification of magnetic anomalies indicative of diamond bearing kimberlite pipes. Micromagnetic surveying is suggested for prospecting for placer diamond deposits.—A.J.S.

- 189-222. Mel'kanovitskiy, I. M. Glubinnoye geologicheskoye stroeniye territorii Pritashkentskogo rayona, Kyzyl-Kumov i sopredel'nykh rayonov po dannym geofizicheskikh issledovaniy [Crustal structure of the territory of the Peri-Tashkent region, Kyzyl-Kum, and adjacent regions according to geophysical data]: Sovetskaya Geologiya, no. 2, p. 17-28, 1962.

The area between the Aral Sea and Tashkent is 70 percent covered with barchan sands, and its geology is little known except on the edges. The results of extensive geophysical surveys in this region are reported here; electrical, seismic, gravity, and magnetic studies were made. The M-discontinuity was determined at several points; it slopes from a depth of 35 km just east of the Aral Sea to 47 km in the Mogol-Tau Mountains on the eastern periphery.—J.W.C.

- 189-223. Dzhafarov, Kh. D. Nekotoryye novyye dannyye o geologicheskoy stroynii Agdzhabedy-Zhdanovskogo rayona Kirovabadskoy neftenosnoy oblasti [Some new data on the geology of the Agdzhabedy-Zhdanovsk region of the Kirovabad oil-bearing area]: Vyssh. Ucheb. Zavedeniye, *Izv., Neft' i Gaz.*, no. 11, p. 15-18, 1960.

The geology of the Tertiary and Mesozoic deposits of the Agdzhabedy-Zhdanovsk area based on seismic, electrical, gravimetric, and magnetic exploration is discussed.—A.J.S.

- 189-224. Kailasam, L. N. Seismic exploration in the Karaikal-Nagore area of the Cauvery basin, Madras State: *Current Sci. (India)*, v. 30, no. 5, p. 168-171, 1961.

Gravity and magnetic surveys of the coastal sedimentary belt of Madras State, India, were begun in 1954 to determine the thickness, stratigraphy, and structure of the marine sediments and to assess their petroleum possibilities, and if possible to locate additional lignite deposits (see *Geophys. Abs.* 176-139). An east-west seismic reflection profile from the crystalline outcrops west of Vriddhachalam to Porto Novo on the coast shows a sedimentary thickness of the order of 9,000 feet at the coast.

The gravity and magnetic surveys were then extended southward across the Coleroon and Cauvery Rivers to cover most of the Cauvery basin. The Bouguer map of the eastern Cauvery basin shows a prominent high in the Karaikal-Nagore region, corroborated by a magnetic high. A reflection traverse along the coast confirms the presence of an important structure (the "Karaikal structure") and indicates a sedimentary thickness of the order of 9,000-10,000 feet. Another prominent Bouguer anomaly in the Mannargudi-Pattukkottai area is worthy of seismic investigation.—D.B.V.

- 189-225. Odani, Yoshitaka, and Baba, Kenzo. Geophysical explorations at Magome and Mizuhiki mines, Fukushima Prefecture—Investigation of the applicability of magnetic method for lead and zinc deposits of contact type [in Japanese with English abstract]: *Japan Geol. Survey Bull.*, v. 12, no. 8, p. 613-621, 1961.

Electrical, magnetic, and radioactivity surveys were carried out over the contact galena, sphalerite, and pyrrhotite mineralization of the Magome and Mizuhiki mines, Fukushima Prefecture, Japan. Both electrical and magnetic anomalies were observed along the line of outcrop of the deposits. Radioactivity, surveyed by scintillometer in mine adits, was found to be lowest in the vicinity of the ore bodies and highest over granitic rock. It is concluded that the magnetic method is useful in exploration of lead-zinc deposits when they are associated with magnetic minerals.—V.S.N.

#### GENERAL

- 189-226. Nedyalkov, I. P. V''rkhu obratnata zadacha na potentsiala za n tela [On the inverse problem of potential for n bodies]: *B''lgarska Akad. Nauk Inst. Geofiz. Izv.*, v. 1, p. 69-76, 1960.

The following theorem is proved: If a total potential  $U=U_1+U_2+\dots+U_n$  of  $n$  separate bodies is given, a unique determination of the potentials  $U_1, U_2, \dots, U_n$  is possible under certain conditions by using the method of quadratures only, and without data on the shapes of the bodies. The feasibility of application of this theorem to a unique and accurate separation of gravity, magnetic, and geoelectric anomalies is discussed.—A.J.S.

189-227. Tereshko, D. L. Vychisleniye potentsial'nogo polya na razlichnykh urovnyakh po raspredeleniyu ego na poverkhnosti zemli, zadannomu v vide karty isoliniy [Calculation of the potential field at different levels according to its distribution on the earth's surface, as given on a map of isolines]: Azerbaydzhan, Nauchno-Issled. Inst. po Dobyche Nefti. Trudy, v. 4, p. 199-211, 1956.

Dirichlet's external problem of the space distribution of a potential field is discussed. Special master charts are constructed for an extension of the field into an upper half-space.—A.J.S.

189-228. Ogil'vi, A. A. Geofizicheskiye metody issledovaniy [Geophysical methods of investigation]: Moscow, Izdatel'stvo Moskov. Univ., 411 p., 1962.

This is an introductory textbook on geophysical exploration. The six chapters are devoted to the gravity, magnetic, seismic, electrical, and radioactivity methods and to use of geophysical methods in hydrogeology and engineering geology.—J.W.C.

189-229. Teskey, Maurice F. Use of high speed computers in geophysics: Oil in Canada, v. 14, no. 21, p. 23-25, 1962.

Abstracts are given of seven technical papers on the use of high speed computers in geophysics presented at a symposium sponsored by The Canadian Society of Exploration Geophysicists and The Calgary Computing and Data Processing Society at Calgary, March 12, 1962. The papers abstracted are: Hodsen, B. S., Introduction in working of computers; Stoian, D., General Application of computers to geophysics; Cameron, J. B., Removal of regional from seismic contour maps; Cartwright, J., Velocity profiling; Herbert, E. V., Well velocity surveys; Moyse, R. K., Synthetic seismograms; and Rimmer, W. G., Magnetic and gravity second derivative maps.—V.S.N.

189-230. Harwood, T. A., and Lotz, J. R. The McGill ice research project, 1955-60: Polar Rec., v. 11, no. 70, p. 13-23, 1962.

The ice research program carried out in the Department of Physics of McGill University, Canada, is reviewed. The program has been limited to the study of the physical properties of ice frozen from melts containing trace quantities of organic and inorganic materials and of the physical properties of sea ice. The project is divided into four sections: (1) instrumentation—the design, building, and testing of instruments for determination of the physical properties of sea ice and for other ice studies such as an airborne method of determining thickness of sea ice; (2) laboratory and cold-room research to study crystal orientation and single crystal freezing, additives and de-icing compounds, physical and chemical properties of sea-ice cores, and freezing of water drops; (3) field studies in the Canadian Arctic and the Gulf of St. Lawrence; and (4) other research largely related to consultation on problems of defense.—V.S.N.

- 189-231. Bulmasov, A. P. Oblast' i usloviya primeneniya geofizicheskikh metodov razvedki v rayonakh mnogoletney merzloty [The area and conditions governing the use of geophysical survey methods in permafrost regions, in *Materialy po podzemnym vodam Vostochnoy Sibiri*: Irkutsk, Akad. Nauk SSSR Vostochno-Sibirskiy Filial, p. 157-163, 1957.

The effects of permafrost on seismic, electrical, gravimetric, and magnetic soundings and the applicability of the methods in subsurface exploration of permafrost areas are discussed. Seismic methods detect only the existence of permafrost, but when combined with electrical methods results are improved. Electrical methods are not suitable for determining horizontal boundaries. The self-potential method may be suitable for prospecting for ore in permafrost. The applicability of gravimetric methods has been studied very little, but observations of permafrost density and gravity anomalies in Yakutia suggest a relation between the two. Magnetic methods in permafrost do not differ from those in thawed ground.—V.S.N.

- 189-232. McDonald, H. R., and Wantland, Dart. Geophysical procedures in ground water study: *American Soc. Civil Engineers Trans.*, v. 126, pt. 3, paper no. 3137, p. 122-135, 1961.

The principles of application of seismic, electrical, magnetic, and gravimetric methods to ground water investigations are discussed briefly, and their use illustrated by a description of seismic reflection and gravity surveys in the Weber Basin project on the east shore of Great Salt Lake, and of resistivity surveys in the vicinity of Huron, South Dakota. A field trial of the application of electrical logging to detection of leakage in irrigation canals is described and illustrated. In this method four electrodes are placed in a line at measured distances on the bottom of the water-filled canal. Wire lines lead to a current source and recording equipment in an instrument truck. The record is made as the truck moves along the bank dragging the electrodes behind it; seepage locations may be identified if they are markedly different in resistivity from adjacent sections.—V.S.N.

- 189-233. Ramage, C. S. The Hawaii Institute of Geophysics: *Am. Geophys. Union Trans.*, v. 43, no. 1, p. 14-19, 1962.

The Hawaii Institute of Geophysics was established at the University of Hawaii in 1961, and the building of its two main units—a research center on the Manoa campus on Oahu and an observatory on top of Mt. Haleakala on Maui—should be completed early in 1963. A variety of geophysical activities closely linked but not limited to the Pacific environment are being or will be undertaken, including basic and applied research on tsunamis, seismology, volcanism, meteorology, and shoreline processes.—D.B.V.

- 189-234. Shapley, A. H. *International Geophysical Calendar for 1962*: *Science*, v. 134, no. 3494, p. 1982-1984, 1961.

The calendar issued by a committee of the International Council of Scientific Unions to aid coordination of certain types of geophysical observations and analyses in 1962 is presented, together with a brief explanation and examples of how it may be used in planning geophysical programs (see also *Geophys. Abs.* 184-322).—D.B.V.

- 189-235. Montandon, Frédéric. Les grandes catastrophes causées par les forces de la nature pendant les années 1958, 1959 et 1960 [The great catastrophes caused by the forces of nature during the years 1958, 1959, and 1960]: *Rev. Étude Calamités*, no. 37, p. 70-85, 1961.

Major natural disasters for the years 1958 through 1960 are: in 1958, drought and famine in Brazil; in 1959, tropical cyclones in Madagascar and Japan and floods in Argentina and India; and in 1960, the three disastrous earthquakes of Agadir, Lar, and Chile, plus the gigantic tsunami produced by the Chilean earthquakes, a tropical cyclone in the Antilles and the United States, a flood in Europe, and a famine in China. The disasters are described briefly.—V.S.N.

- 189-236. Newton, R., and Round, G. F. The diffusion of helium through sedimentary rocks: *Geochim. et Cosmochim. Acta*, v. 22, no. 2/4, p. 106-132, 1961.

Little work has been done on the mode of migration of helium within the earth to the atmosphere. In this paper the effect of diffusion control on the migration of helium in sediments has been evaluated by the construction of a series of mathematical models representing a wide range of practical situations, from the case of a single infinite uniform layer to that of  $n$  different finite uniform layers. The problem has been reduced to one-dimensional diffusion with the Precambrian basement as the helium source, and the diffusion equation has been solved for this system with different boundary conditions.

The models developed here can be applied in regions, including orogenic and other regions of tectonic activity, for which the lateral extent of sediments is 3 or 4 times their total thickness and for which there is no extensive variation in lithology.—D.B.V.

GEODESY

- 188-237. Whipple, F[red] L. Perturbation in the eccentricity of 1958 $\beta_2$  [Harvard College Observatory Announcement Card 1420]: *Internat. Geophys. Year Annals*, v. 12, pt. 1, p. 198, 1960.

A perturbation in the eccentricity of the orbit of satellite 1958 $\beta_2$  has been reported by O'Keefe and others (see *Geophys. Abs.* 176-159, 186-389) that appears to correspond to the third degree zonal harmonic of terrestrial gravity. The coefficient of this harmonic is calculated to be  $A_{3,0} = 3.0 \times 10^{+29}$  (in meter-second units), which corresponds to 5.6 mgal in gravity at the surface of the earth.—D.B.V.

- 189-238. Bjerhammar, Arne. On the gravity field of the earth: *Acad. Sci. Fennicae Annales*, Ser. A, III, no. 61, p. 43-53, 1961.

For an arbitrary figure of the earth there seems to be no series expansion that would give a direct explicit solution. Molodenskiy has attempted to solve the problem by means of an implicit integral equation based on gravity anomalies, but as the integral equation is singular the method can be used only if the anomalies are free from spherical harmonics of the first order. All gravity data must be adjusted before being entered in the equation. Any solution is affected when new gravity values are added to the original ones. To overcome these difficulties, Bjerhammar (1959) has used an explicit solution which does not include any gravity data; this solution can be solved for all parts of the world as soon as the approximate geometrical shape of the earth is known.

In this paper it is verified that the integral equation is singular as well as inconsistent. The inconsistency is eliminated for a spherical surface by omitting the first spherical harmonic of the right member. For a nonspherical surface, remaining inconsistency has to be eliminated by the aid of the trans-normal inverse or similar methods. Equations are given to be used for surfaces which are approximately spherical; these expressions can also be used as approximate values for a rigorous calculation of a nonspherical surface.—D.B.V.

- 189-239. Heiskanen, W. A. Ten years as professor in geodesy in America: *Acad. Sci. Fennicae Annales*, Ser. A, III, no. 61, p. 55-62, 1961.

The first full department devoted to academic education in geodetic science in America was established at Ohio State University in 1950 in response to a need felt since World War I for highly trained geodesists. The personnel and work of this Institute of Geodesy, Photogrammetry, and Cartography are described here.—D.B.V.

### GEOTECTONICS

- 189-240. Caputo, Michele. Tables for the deformation of an earth model by surface mass distributions: *Jour. Geophys. Research*, v. 67, no. 4, p. 1611-1616. 1962.

The surface displacements of a spherical earth model, consisting of a homogeneous elastic shell enclosing a fluid core, are given for the case where the deforming forces arise from a mass distribution of constant thickness over a single spherical surface segment of arbitrary size. A simple method is also given for computing the displacements whose deforming forces arise from any surface mass distribution. Such loads are associated with geologic structures, ice and snow caps, changing atmospheric pressure, and ocean tides. Values of surface displacement are listed for various radii of the segment and for elastic parameters corresponding to a simplification of Bullen's earth model. The density and thickness of the mass over the segments have been chosen to give a mean pressure of  $10^6$  d per  $\text{cm}^2$  over the surface, but displacements for other densities and thicknesses can easily be obtained from the tables. The tables can also be used for other values of the elastic parameters in core and mantle, if Poisson's ratio in the mantle is kept at 0.23. (See also *Geophys. Abs.* 185-569.)—D.B.V.

- 189-241. Subbotin, S. I., and Naumchyk, G. L. Z pryvodu statti P. Ya. Halushko "Pro mozhlyvosti vyvchennya prychyn vertykal'nykh rukhiv zemnoyi kory za anomal'yamy syly tyazhinnya" [Concerning the paper of P. Ya. Galushko "On the possibility of determining the cause of vertical movements of the earth's crust from gravity anomalies" (in Ukrainian)]: *Akad. Nauk Ukrain. RSR Heol. Zhur.*, v. 21, no. 1, p. 84-86, 1961.

Halushko [Galushko], P. Ya. Shche raz pro mozhlyvist' vyvchennya prychyn vertykal'nykh rukhiv zemnoyi kory za anomal'yamy syly tyazhinnya [Once more concerning the possibility of determining the cause of vertical movements of the earth's crust from gravity anomalies (in Ukrainian)]: *ibid.*, no. 5, p. 105-108, 1961.

Subbotin and Naumchyk agree that crustal structure has an effect on gravity anomalies. There is no question that the mantle, especially its upper part, is the scene of complex processes whose external manifestation is vertical crustal movements and tectonic movements in general. As these processes cause redistribution of mass they naturally are reflected in the distribution of the earth's gravitational field. No justification can be found, however, for elevating conclusions reached on the basis of examination of individual structural correlations to the rank of general laws. Galushko answers specific criticisms by Subbotin and Naumchyk. It is not true that he denied the possibility of subcrustal currents as a cause of vertical movements and proposed no other process or mechanism, as they charge. His discussion was not concerned with promoting his own theory that volume changes at depth cause vertical movements, but with the possibility of determining the cause of such movements from gravity anomalies. [See also *Geophys. Abs.* 187-250.]—D.B.V.

- 189-242. Stovas, M. V. Znachennya nerivnomirnosti obertannya Zemli v utvorenni planetarnykh glybnykh rozlomiv v zemnyi korі [Importance of irregularities in the earth's rotation in the formation of planetary deep fractures in the earth's crust (in Ukrainian with Russian summary)]: *Akad. Nauk Ukrain. RSR Heol. Zhur.*, v. 21, p. 13-24, 1961.

At any point on a spherical crustal layer, a change of polar compression produces a strain ellipsoid and also a change of volumetric compression. This obviously produces not only broad latitudinal-meridional fractures and folding but also disjunctive diagonal stresses, giving the crust its block-structure character. The regularities exhibited in the major surface features of the earth cannot be explained by the hypotheses of gravitational differentiation, radioactive heating, and others; they have prompted several Russian tectonophysicists to seek a crustal mechanism in irregularities of rotation. The majority of investigators recognize that deep fractures, and also deep and superficial folding, are the result of planetary compression and expansion stresses that have operated throughout earth history.— D.B.V.

- 189-243. McMath, Vernon E. Rapid sedimentation and phase transition at the M discontinuity: *Geol. Soc. America Bull.*, v. 73, no. 2, p. 253-256, 1962.

MacDonald and Ness (see *Geophys. Abs.* 182-358) and Noble (see *Geophys. Abs.* 184-348) either state or imply that if phase transition is assumed for M, isostasy invoked, and sedimentation considered essentially instantaneous, the possible thickness of sediments is independent of the depth of the initial basin of sedimentation. Their treatments involve the assumption that the relative position of M is independent of the P-T conditions in the crust, which is incompatible with the assumption that M is a phase boundary. Therefore, it is not established that the thickness of sediments is independent of the depth of the initial basin.— Author's abstract

- 189-244. Noble, Donald C. Stabilization of crustal subsidence in geosynclinal terranes by phase transition at M—a reply: *Geol. Soc. America Bull.*, v. 73, o. 2, p. 257-260, 1962.

Noble states that in his paper (see *Geophys. Abs.* 184-348) criticized by McMath (see *Geophys. Abs.* 189-243) a cause and effect relationship between sedimentation and isotherm depression was not discussed, the amount of isotherm depression was not necessarily considered solely as a function of the material deposited at the earth's surface, and it was not stated or implied that the deposition of the same thickness of less dense material would cause greater rise of M than would the deposition of more dense material. McMath considers only passive geothermal depression, whereas the required depression of isotherms may also be produced by a decrease in heat flow from the mantle.

A more general treatment of the geosynclinal model discussed in Noble's original paper leads to the conclusion that it is extremely unlikely that marked basin deepening could occur in an isostatically balanced geosyncline activated by a phase transition mechanism, unless a decrease in heat flow from the upper mantle occurred at the same time. It follows logically from the model that areas of rapid sedimentation should in general be located where heat flow from the mantle is abnormally low during the period of sedimentation.— D.B.V.

- 189-245. Popov, V. V. O temperaturnykh deformatsiyakh zemnoy poverkhnosti [On temperature deformations of the earth's surface]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 7, p. 913-921, 1960.

Tilt and deformation of the surface of the earth due to variation in insolation during diurnal rotation and annual revolution are studied. It is considered that observed tilt and deformation are caused mainly by a nonuniform heating of the surface, characterized by a parameter  $l$ . Although the diurnal temperature variation penetrates approximately 1.5 m below the surface, the tilt and deformation caused by such a variation can penetrate up to 1 km; the magnitude attenuates with depth and depends on the magnitude of the nonhomogeneity factor  $l$ . Because of the nonhomogeneity factor  $l$ , the tilt and deformation at two adjacent locations may differ significantly both in amplitude and phase.— A.J.S.

- 189-246. Bonchkovskiy, V. F. Nekotoryye obobshcheniya rezul'tatov nablyudeniy naklonov zemnoy poverkhnosti [Certain generalizations of results of observations of tilts of the earth's surface]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 7 (174), 62 p., 1959.

This is a monograph on tilting of the earth's surface developed on the basis of earlier papers by Bonchkovskiy and others. Various systems of tiltmeters are described and discussed. Thermal tilting, daily and annual variations, variations with atmospheric pressure, and secular tilts are analyzed. The correlation between earthquakes and volcanism is studied. An example of application of tiltmetering is given where the front of burning coal in underground gasification is followed.—A.J.S.

- 189-247. Weertman, J[ohannes]. Mechanism for continental drift: Jour. Geophys. Research, v. 67, no. 3, p. 1133-1139, 1962.

The analysis of the gravitational spreading of floating ice shelves and continents has been extended to include the deformation of ocean basins. It is found that if a slight difference exists in the density of rock under two different oceans, and if this difference persists to depths of the order of 1,000 km or more, stresses under the oceans may be great enough to cause one of these oceans to spread out and the other to contract. As a result of this process the center of any continent lying between the oceans will be shifted. The mechanism can be shown to be equivalent to a Vening Meinesz thermal convection cell.—Author's abstract

- 189-248. Runcorn, S. K[leigh]. Towards a theory of continental drift: Nature, v. 193, no. 4813, p. 311-314, 1962.

Opponents of continental drift have argued that it is difficult to believe that if continental drift took place it occurred so late in geologic time, and that no tenable dynamic explanation has yet been proposed. The probability of convection currents in the mantle is demonstrated by means of calculations based on the following assumptions: that the mantle acts as a liquid, that the 20° discontinuity in seismic velocity-depth curves is due to a phase change and can be disregarded, and that the earth is spherically symmetrical. It is reasonable to suppose that the growth of the core as envisaged by Urey (1952) could in the comparatively recent life of the earth have caused a fundamental redistribution of the convection currents in the mantle, resulting in the dispersal of the continents.—D.B.V.

- 189-249. Plumstead, Edna P. Ancient plants and drifting continents: South African Jour. Sci., v. 57, no. 7, p. 173-181, 1961.

The closely similar and even identical plant histories of the southern continents, including Antarctica, can only be explained by continental drift. Paleomagnetic evidence offers strong support.—D.B.V.

- 189-250. Khain, V. Ye. Osnovnyye etapy razvitiya zemnoy kory (v predelakh sovremennykh materikov) [Main stages of development of the crust (in the areas of the present continents)]: Moskov. Obshch. Ispytateley Prirody Byull. Otdel Geol., v. 37, no. 1, p. 8-24, 1962.

The main stages in the development of the crust within the area of the present continents are traced on a basis of absolute age determinations and structural analysis. The first stage was the Katarchean and Early Archean at 3,500-2,200 m.y. These rocks contain no indication of the existence of platforms. The second stage was the Late Archean at 2,200-1,800 m.y. The main feature of this stage was the formation of the first platforms, the best manifestation of which is in South Africa. The third stage was the Early Proterozoic at 1,800-1,200 m.y. At this time the main features of the modern structural plan

of the earth had developed; the older platforms and shields were defined and the principal geosynclinal belts had formed. The fourth stage was the Late Proterozoic at 1,200-600 m.y., and the fifth was the Paleozoic, Mesozoic, and Cenozoic at 600-0 m.y.—J.W.C.

- 189-251. Wilson, J. T[uzo]. Geophysics and continental growth [in Chinese]: *Acta Geophys. Sinica*, v. 8, no. 1, p. 15-30, 1959.

This is virtually the same paper as that published in English in *Am. Scientist*, v. 47, no. 1, p. 1-24, 1959 (see *Geophys. Abs.* 176-162).—V.S.N.

- 189-252. Shneiderov, Anatol J. The plutono- and tectonophysical processes in an expanding earth: *Boll. Geofisica Teor. ed Appl.*, v. 3, no. 11, p. 215-240, 1961.

The dynamic processes in the interior of the earth and their observed manifestations in the crust are discussed from the standpoint of radial field (*Geophys. Abs.* 118-7517, 123-8240). The tectonism of the earth is due to radial expansion and tangential distension, and radial contraction and tangential constriction, alternating to produce periods of pulsation of the entire earth. A hypothesis of cataclysmic formation of continents, oceans, seas, and other features of the earth's surface from the primordial parent continent and parent ocean is proposed, and the development of epicontinental seas, peninsulas, islands, bays, and straits is formulated on the basis of a residual expansion of the earth of a few hundredth of centimeter per century.—A.J.S.

- 189-253. Woodruff, Ray, and Goering, Marjory. Do the mountains of earth come from the moon?: *Saturday Rev.*, v. 45, no. 9, p. 43-46, 1962.

It is proposed that as the solid rocks of the crust bulge outward under the tension produced by the passage of the moon, holes open between and within the rock-forming crystals allowing ions to diffuse into the holes. As the crest of the tide passes, the crust goes from a state of tension to one of compression and the ions that shifted are trapped in their new locations resulting in an infinitesimal thinning and broadening of the crust. This process is repeated for the underside of the earth's crust as it bends in the opposite direction in response to the moon's pull. With each passage of the moon the process of expansion and thinning of the crust is continued. The thrust of expansion accentuates arcs of weakness in the planet's spherical shell, and the crust wrinkles, folds, and slips, causing earthquakes and freeing energy through volcanoes. In the course of millions of years the wrinkles and folds grow sufficiently pronounced to be called mountains. The theory also helps to explain the segregation of granitic materials of the earth into continental masses by a process similar to that proposed by Griggs (see *Geophys. Abs.* 96-4855) but with the substitution of lunar tidal flexing for deep thermal convection as the motivating force. [See also *Geophys. Abs.* 154-14757].—V.S.N.

- 189-254. Saxov, Svend [E.]. The vertical movement of Eastern Greenland (Angmagssalik) [with Danish summary]: *Dansk Geol. Foren. Medd.*, v. 14, no. 4, p. 413-416, 1961.

Repeat-measurements of the old bench-marks at Gustav Holms near Angmagssalik indicate an annual uplift of 7 mm during the period 1950 to 1957 thus confirming that an uplift of Greenland has taken place for the last 15 to 20 yr. [See also *Geophys. Abs.* 177-181].—Author's abstract

- 189-255. Kazanchan, P. P. Materialy k izucheniyu sezonnykh dvizheniy zemnoy kory metodom geodezicheskikh izmereniy vusloviyakh Armyanskoy SSR [Data for the study of seasonal movements of the crust under the conditions of the Armenian SSR]; *Akad. Nauk Armyan. SSR Izv. Ser. Geol. i Geog. Nauk*, v. 13, no. 3-4, p. 101-110, 1960.

A high accuracy leveling survey made in the Leninkan mountainous region in 1928, 1954-55, and 1957-58 is reported. The region rose uniformly from 1928 to 1955, but the differences in altitude after earthquakes were not uniform.—A.J.S.

- 189-256. Kumar, P. Geotectonic movements and their influence on the hydrography of Indo-Gangetic Plains: World Conf. on Earthquake Eng., 2d, Tokyo and Kyoto 1960, Proc., v. 3, p. 1655-1668, 1960.

It is proposed that the cause of catastrophic floods of exceptional discharge and magnitude that occur only a few times in a century in the area of Indo-Gangetic Plains is related to geotectonic movements. A discussion of how the geotectonic movements have developed and their ultimate effect on hydrography is presented based on recent information from geological, geophysical, geotectonic, aeromagnetic, and seismological investigations. It is concluded that the geotectonic movements which were originally responsible for the formation of the Indo-Gangetic Plains as well as for their present great instability are due to two horizontal compressive forces acting perpendicular to each other in a north-south and east-west direction and resulting in the formation of zones of concentric shear along the axis of the asymmetrical syncline of the Gangetic trough. Earthquakes originate from rupture of the strata caused by tensional forces at the outer arc of the Gangetic synclinorium. As a result of the movements great amounts of secular changes in ground level are continuously taking place. Changes in the main drainage lines and recurrence of flood cycles are attributed to the secular differential changes in the hydrostatic gradients of the rivers within the Indo-Gangetic trough. The hydrography of the plains has been profoundly affected since post-Siwalik times.—V.S.N.

- 189-257. Iijima, Azuma, and Kagami, Hideo. Cainozoic tectonic development of the continental slope, northeast of Japan [in Japanese with English abstract]: Geol. Soc. Japan Jour., v. 67, no. 793, p. 561-577, 1961.

The continental slope off the Sanriku coast of Honshu, Japan, has an upper broad gentle slope that deepens from 200 to 2,200 m over a distance of 130 km. A remarkable level occurs between 2,000 and 2,200 m whose outer edge probably represents the late Pliocene shore line. At some point during late Pliocene to early Pleistocene time, subsidence began along with deepening of the Japan trench. The average rate of subsidence now is approximately 22 mm per yr at the outer edge of the upper continental slope and two to three times more in the trench.—V.S.N.

#### GLACIERS

- 189-258. Crary, A. P., Field, W. O., and Meier, M[ark] F. The United States glaciological researches during the International Geophysical Year: Jour. Glaciology, v. 4, no. 31, p. 5-24, 1962.

The glaciological program of the United States for the International Geophysical Year is reviewed in two parts: Antarctica and northern latitudes. The objectives of the program are outlined and the results of each investigation are briefly summarized. The following are discussed: for Antarctica, over-snow and airlifted traverses, station glaciology, deep drilling, oxygen isotopes, Ross Ice Shelf deformation and strain rate, radiation and micrometeorological studies, and glacial geology; the northern latitudes; glacier studies in Alaska, the United States south of Alaska, the Polar Basin, and Greenland. A general discussion of changes in the earth's ice cover is included. A bibliography of 69 items is given.—V.S.N.

- 189-259. Scheidegger, A[drian] E[ugen]. Nival effects, in Theoretical geomorphology: Berlin, Springer-Verlag, chap. 7, p. 256-286, 1961.

A brief review of the theories of ice ages is followed by a detailed discussion of the two modes of glacial flow—internal motion and sliding. A variant of Nye's theories (1952, 1955) based on the plasticity theory is discussed as the most suitable to explain the longitudinal flow of glaciers. Although this theory assumes as a limiting condition that the velocity of the glacier vanishes at the bed, it may be expected that some sliding will always take place. The two effects—pressure melting and stress concentrations—that can contribute appreciably to sliding are discussed. The dynamics of glacier snouts and crevasses, and the geomorphological effects of longitudinal glacier motion are treated briefly. Three-dimensional movement of ice is discussed using the linear equation proposed by Matschinski (1958) that develops a differential equation of ice flow from purely logistic considerations. Three-dimensional problems of ice caps, piedmont and cirque glaciers, and crevasses are cited. Finally, various geomorphological and other nival effects are described.—V.S.N.

189-260. Weertman, Johannes. Equilibrium profile of ice caps: U.S. Army Cold Regions Research and Eng. Lab. Research Rept., no. 84, 12 p., 1961.

Nye's law for the sliding of ice over bedrock is generalized to include the effect of the presence of a longitudinal stress. A profile of an icecap or glacier is calculated with two equations—one applicable to the central region of an icecap and the other (Nye's) elsewhere. The complete profile of an icecap is obtained by joining the two profiles. Two sample calculations are given to show that for a large icecap Nye's theory is valid, but for a small icecap (on the order of 30 km in width) the modification to include longitudinal stress is necessary.

A simple extension of the analysis of the icecap profile allows for the effect of isostatic sinking of the bedrock surface under a large icecap.—V.S.N.

189-261. Goldthwait, R. P. Study of ice cliff in Nunatarssuaq, Greenland: U.S. Army Snow, Ice, and Permafrost Research Estab., (SIPRE) Tech. Rept. 39, 108 p., 1960.

The form and activity of an ice cliff 500 m long and up to 40 m high on the east margin of North Ice Cap near its junction with the main Greenland Ice Cap were studied during the summers of 1955 and 1956 to learn in detail how the glacier moves and how the calving of ice masses and ablation during the melt season counteract this motion to produce a balanced ice cliff. The following are discussed: regimen including climatology, ablation, and discharge of melt water; motion of the ice cliff surface, the glacier surface and the base of the glacier; structure including physical properties, foliation and fracture, crystal distortion, and englacial strain; and history.—V.S.N.

189-262. Gow, A. J. Drill-hole measurements and snow studies at Byrd Station, Antarctica: U.S. Army Snow, Ice, and Permafrost Research Estab., Tech. Rept. 78, 12 p., 1961.

A hole was drilled to 1,013 feet in the Antarctic Ice Cap at Byrd Station in 1957-58 to recover cores for glaciological investigation and to provide a deep hole for studying temperature profiles and flow properties of ice in the surface layers of a high polar glacier. The hole was instrumented in December 1958 for temperature, inclination, and rate of closure readings. Measurements were repeated in January 1960 and 1961. Temperatures below 200 feet appeared to have stabilized by January 1961. Surface mean annual temperature is approximately  $-28.2^{\circ}\text{C}$ , it decreases to  $-28.4^{\circ}\text{C}$  at 400 feet, and below 400 feet decreases almost linearly at a rate of  $0.01^{\circ}\text{C}$  per 100 feet. The accelerating rate of closure observed in the data for 1960 and 1961 is attributed to a process of continuous recrystallization in ice under high stress. Inclinations are insignificant in the three-year period. Core studies show that since 1893 snow has been accumulating at an average rate of 14.4 cm water per yr at Byrd Station. (See also Geophys. Abs. 187-278.)—V.S.N.

- 189-263. Jacobs, J. A. Geophysical investigations on the Salmon Glacier, British Columbia, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 43-55, 1958.

This is a more detailed version of the paper published in the Canadian Mining Jour., v. 78, no. 4, p. 136-138, 1957 (see Geophys. Abs. 173-189).— V.S.N.

- 189-264. White, Sidney E. Preliminary studies of motion of an ice cliff, Nunatarssuaq, Northwest Greenland 1955, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 64-71, 1958.

A survey by a Wild T-2 theodolite of the positions of 40 markers in the south-facing cliff of North Ice Cap at the north tip of Nunatarssuaq, northwest Greenland, from July 4 to August 19, 1955 identified differential ice motion throughout the cliff. An average daily motion of 13.1 mm existed throughout, with 12.8 mm at the cliff top and 7.1 mm near the cliff base. Although the upper clean ice moved faster than the lower dirty brown ice, differential motion at the contact between these zones is not great. The glacier moved faster in early July than in August. A distinct turbulence within the ice exists. [See also Goldthwait, Geophys. Abs. 189-261.]— Author's abstract

- 189-265. Ward, W. H. Surface markers for ice movement surveys, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 105-110, 1958.

An account is given of the development and design of ice augers and surface markers used in movement studies of temperate ice carried out by the Cambridge Austerdalsbre Expeditions in 1956 and 1957.— Author's abstract

- 189-266. Lliboutry, L[ouis]. La dynamique de la mer de glace et la vague de 1891-95 d'après les mesures de Joseph Vallot [The dynamics of the glacier and the wave of 1891-95 according to the measurements of Joseph Vallot], in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 125-138, 1958.

From study of the observations made by Vallot in 1891-95, the movement of a wave a few meters high and 3 km long that appeared to descend the glacier at 800 m per yr, six times more quickly than the ice, is explained. In the first part (Echelets-Montenvers) the glacier slid on its bed, but in the second part (Montenvers-Mauvais Pas) it was at the limit of sliding. The speed of deformation in the second part determined the speed of sliding in the first part. Calculation of friction on the bed by an improved formula gives 1.8 bar for the second part where friction was static and 1.0 bars for the first part where friction was dynamic. This difference explains the spasmodic movement of glaciers.

In 1891-93, the dynamic friction diminished by 1 or 2 percent, while the speed of sliding was augmented by 28 percent. At the same time, however, as a result of the general deformation of the glacier, particularly at the bend before Echelets, the longitudinal tension was augmented less and the overload of ice was thus balanced.— V.S.N.

- 189-267. Nye, J. F. A theory of wave formation in glaciers, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 139-154, 1958.

A theory of the formation of surface undulations ("wave ogives") at the foot of an icefall is presented. The simple case where the forward velocity of the ice depends only on the distance down the glacier and on time is treated ana-

lytically, and it is found that this case gives waves without the necessity of pressure. All elements are stretched out as they pass through the icefall, owing to high local velocity, and thus present greater surface area. Therefore, in summer more ice is lost by ablation in the icefall than in regions of lower velocity, and waves are produced by a combination of plastic deformation and ablation. The positions and amplitudes of waves observed on Austerdalsbre are predicted correctly by a numerical calculation based on observed summer velocity and ablation. (See also *Geophys. Abs.* 177-182, -183.)—V.S.N.

- 189-268. Oulianoff, Nicolas. *Mouvement des glaciers (Plasticité de la glace, Tectonique du fond rocheux)* [Movement of the glaciers (Plasticity of the ice, structure of the rock basement)], in *Symposium of Chamonix*, Sept. 1958, *Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub.*, no. 47, p. 155-161, 1958.

Two of the factors—plasticity of ice and structure of the bedrock—important to the movement of glaciers are discussed. It is pointed out that results of laboratory studies of the plasticity of ice are not directly applicable to the mechanism of a glacier. Two examples are discussed to illustrate this: the origin of the basin of Märjelen Lake on the left bank of Aletsch Glacier, and the source of transport for the Mont Blanc granite found on the moraine on the right bank of Entremont Valley. The glaciers of the Mont Blanc massif are discussed to illustrate the influence of lithology and tectonic history on ice movement.—V.S.N.

- 189-269. Weertman, J[ohannes]. *Traveling waves on glaciers*, in *Symposium of Chamonix*, Sept. 1958, *Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub.*, no. 47, p. 162-168, 1958.

An analysis is made of traveling waves on glaciers. Wave solutions are obtained by slightly perturbing steady-state solutions of the equations of Nye's theory of glacier motion. It is found that glacier waves should travel at a speed three to eight times the surface velocity.—Author's abstract

- 189-270. Meier, Mark F. *Vertical profiles of velocity and the flow law of glacier ice*, in *Symposium of Chamonix*, Sept. 1958, *Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub.*, no. 47, p. 169-170, 1958.

Measurements of vertical profiles of velocity in glaciers extend knowledge of the flow law of ice. Discrepancies between results observed in borehole experiments and in laboratory and certain tunnel closing experiments probably reflect differences in thermodynamic and physical environments rather than poor knowledge of stress and strain rate fields. For a complete understanding of the flow law of ice, direct measurements of vertical profiles of velocity are essential. The distribution of velocity at depth must be predicted with assurance in order to understand thickness, velocity, surface profiles, wave-like behavior, and similar characteristics of glaciers.—V.S.N.

- 189-271. Nakaya, Ukichiro. *Visco-elastic properties of snow and ice in Greenland Ice Cap*, in *Symposium of Chamonix*, Sept. 1958, *Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub.*, no. 47, p. 199-212, 1958.

Ice samples from the Greenland Ice Cap taken in the tunnel at Tuto, from cores drilled in the icecap, and from snow near the surface were examined by the sonic method using a newly designed visco-elastic meter of portable type. Young's modulus was calculated from the resonance frequency, and the loss factor was measured by the damping method. The coefficient of viscosity was calculated by using the Maxwell model. The icecap was found to fall into three density regions—that of pure ice, intermediate snow and ice, and soft snow near

the surface. In the first region, Young's modulus decreases very rapidly when density deviates slightly from that of pure ice; in the second region, the relation between density and Young's modulus is expressed by a straight line; and in the third region, Young's modulus decreases in exponential form. The logarithm of the coefficient of viscosity decreases linearly with decrease in density until the latter reaches 0.55; below density 0.50 another linear relationship is observed with a steeper slope. Young's modulus and viscosity are shown from these results to exhibit similar behavior as functions of density. A study was also made of the activation energy, which was found to be much larger for old icecap ice than for ordinary ice.— V.S.N.

- 189-272. Steinemann, Samuel. Thermodynamics and mechanics of ice at the melting point [with German abstract], in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 254-265, 1958.

Study of phase equilibrium within polycrystalline ice shows that melting due to strain-work has definite locations with no direct effect upon ice strength. Diffusion-like deformation mechanisms and recovery behave in a normal fashion at ordinary melting points. Qualitatively, temperate ice behaves exactly the same as cold ice; quantitatively, the behavior of "dry" temperate ice should be determined by suitable extrapolation of measurements at subzero temperatures that takes into account the variable influence of all superposing intracrystalline and intercrystalline deformation mechanisms.— V.S.N.

- 189-273. Vialov [Vyalov], S. S. Regularities of glacial shields movement and the theory of plastic viscous flow, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 266-275, 1958.

On the basis of experimental research and field observations made during the 2d Antarctic expedition of the U.S.S.R. and from the experimental data of others, a theory of glacial shield movement (and of glaciers in general) is developed. According to this theory glacial flow starts with the development of even the smallest strain, in which the flow is not ideally viscous but "anomalously" viscous. As soon as a certain conventional limit is exceeded, plastic deformations arise accompanied by block sliding. The relationship between strain and speed of ice flow is a power and not a linear relationship, and as soon as the strain has reached the above critical value (breaking displacement strain  $\tau_0$ ) the curve of the relationship shows a breaking point. Thus, the deformation process in ice can be divided into two stages: one of slow flow approaching Newton's flow, and a second in which the power index suddenly increases greatly and in which even a small increase of strain provokes a sharp increase of flow speed, thus regulating the thickness of the shield and ensuring its dynamic equilibrium. The dynamic equilibrium of a glacial shield is examined in detail, and it is demonstrated that the above theory shows the interrelation between the value and character of the distribution of accumulation, the outline of the shield's surface and bed, the distribution of strains along the bed and the flow speed of glacial thickness, and at the same time takes into account temperature field effects in the shield. Application is made to the Antarctic Shield.— V.S.N.

- 189-274. Agostinelli, Cataldo. Sul movimento di un ghiacciaio. Nuove ipotesi per la determinazione del profilo di una sezione retta [On the movement of a glacier. New hypothesis on the determination of the profile of a right angle section [with French abstract], in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 276-286, 1958.

The movement of a glacier is treated after the manner of Somigliana (1921), but with different limiting hypotheses, as that of a thick and incompressible viscous fluid in a cylindrical canal. Assuming that the tangential forces at the contact between the ice and the canal wall are determined by Coulomb's law of dynamic sliding with the coefficient of sliding in general variable with depth, a differential equation is established for the profile of the normal section of a glacier by applying the principle of minimum resistance and reducing the determination of the velocity at each point of that section to a Neuman problem. With this equation, the thickness of the glacier may be determined from data measured on the free surface as well as the form of the profile and the coefficient of sliding between the ice and the side of the bed at different depths. In the specific case where the speed of the surface varies according to a parabolic law, the profile determined for the glacier section is the symmetrical arc of a parabola. In this same case, the isotachys are homofocals of the ellipses, and the velocity of the ice along the side of the bed increases with depth while the coefficient of sliding decreases.— V.S.N.

- 189-275. Bogoslovski [Bogoslovskiy], V. N. The temperature conditions (regime) and movement of the Antarctic glacial shield, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub. no. 47, p. 287-305, 1958.

Preliminary results of ice temperature measurements in boreholes and of seismic determinations of ice thickness in Antarctica are reported. The upper layers of ice are characterized by temperature reduction with depth, the rate of decline decreasing with distance from the coast. The best correspondence between values calculated with a hydraulic integrator and observational data for the temperature field of the ice was found by assuming that the ice moves throughout its thickness, except for the lowermost layers, at rates up to 25 m per year, the rate rising as the coast is approached. A complete analytical solution of the problem is obtained that takes into account the heat release as a result of the possible parabolic distribution of horizontal velocities along the cross-section of the ice, the linear temperature variations at the surface, and heat transfer due to snow compaction. Velocities obtained from thermal calculations are smaller than those obtained from the mass balance.— V.S.N.

- 189-276. Hansen, B. L., and Landauer, J[oseph] K. Some results of ice cap drill hole measurements, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 313-317, 1958.

Temperature measurements were made in a hole drilled to a depth of 1346 feet in the Greenland Ice Cap after its completion in the summer of 1957. In the summer of 1958 the inclination, diameter, and temperature were measured at various depths for closure and temperature gradient studies. Instruments and methods are discussed, and results are illustrated in tables and graphs. Closure is analyzed on the basis of Nye's flow law.— V.S.N.

- 189-277. Rigsby, George P. Fabrics of glacier and laboratory deformed ice, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 351-358, 1958.

Crystal fabric studies made in the ablation zone of three widely separated temperate glaciers and two polar glaciers are summarized, and the relationship of the crystal fabric to the mechanics of orientation and solid flow of the glacier is discussed. (See also Geophys. Abs. 175-182, 182-275).— V.S.N.

- 189-278. Sharp, Robert P., and Epstein, Samuel. Oxygen-isotope ratios and glacier movement, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 359-369, 1958.

This paper was reprinted in California Inst. Tech., Div. Geol. Sci. Contr., no. 875, p. 359-369, 1959 (see Geophys. Abs. 179-281).— V.S.N.

- 189-279. Vilesov, Ye. N., and Shabanov, P. F. Iz opyta bureniya na vysokogornyykh lednikakh [Drilling experiments on high-mountain glaciers], in *Glyatsiologicheskiye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kazakh SSR, p. 31-35, 1961.

Ice-drilling techniques and statistical results of borings in the Tuyuksuysky group of glaciers, Zailiysky Alatau, are discussed.— H.F.

- 189-280. Barvenko, H. Ya. Poverkhnostnoye dvizheniye l'da na lednike Tsentral'nom Tuyuksuyskom [Surface motion of the ice in the Central Tuyuksuysky glacier], in *Glyatsiologicheskiye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kazakh SSR, p. 37-42, 1961.

Statistics of ice movement in the Central Tuyuksuysky glacier, Zailiysky Alatau, during 1956-59 show velocities from 0.1 to 5 cm per day.— H.F.

- 189-281. Makarevich, K. G., and Tokmagambetov, G. A. Nekotoryye dannyye o formirovani l'da na Maloalmatinskikh lednikakh [Some data on ice formation on the Maloalmatinsky glaciers (with English summary)], in *Glyatsiologicheskiye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kazakh SSR, p. 60-69, 1961.

Statistics on ice accumulation and crystal structure of the ice in the cirque of the Central Tuyuksuysky glacier in the Zailiysky Alatau for 1956-59 are reported. Firn forms during the first year and changes to ice during the following year. Three discernible types of ice are formed.— H.F.

- 189-282. Tokmagambetov, G. A. Mekhanicheskiye svoystva l'da firna Maloalmatinskikh lednikov [Mechanical properties of ice and firn in the Maloalmatinsky glaciers (with English summary)], in *Glyatsiologicheskiye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kazakh SSR, p. 70-83, 1961.

Viscosity and instant cohesion of the ice in several profiles of the Central Tuyuksuysky glacier in the Zailiysky Alatau are reported in detail as a function of position and temperature. Viscosity ranges from about 6 to about  $18 \times 10^{12}$  poises and cohesion from about 1 to about 10 kg per cc; the latter is highest in the ablation zones and lowest in the accumulation zones.— H.F.

- 189-283. Tokmagambetov, G. A. Teploprovodnost' snega, firna i l'da na Maloalmatinskikh lednikakh [Thermal conductivity of snow, firn, and ice on the Maloalmatinsky glaciers (with English summary)], in *Glyatsiologicheskiye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kazakh SSR, p. 84-94, 1961.

The thermal conductivity of the superficial layers of the Central Tuyuksuysky glacier in the Zailiysky Alatau is directly proportional to density. Cores from depths to about 350 m show irregular variation of these parameters with depth, the thermal conductivity ranging from 3.7 to 4.3 cal/cm-degree-sec and the density from 0.88 to 0.91.— H.F.

- 189-284. Pal'gov, N. N. Moshchnost' lednikov Kazakhstana i otsenka metodov yeye opredeleniya [Thickness of the Kazakhstan glaciers and evaluation of the methods for its determination (with English summary)], in *Glyatsiologicheskiye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kazakh SSR, p. 136-149, 1961.

Ice thickness is estimated in 19 glaciers by a method of material balances and verified by electrical and seismic prospecting.—H.F.

- 189-285. Cherkasov, P. A., and Zenkova, V. A. Istoriya issledovaniya so-vremennogo i drevnego oledeneniya khrebt Dzhungarskiy Alatau [History of the studies of present and ancient glaciation of the Dzhungarskiy Alatau Range], in Glyatsiologicheskkiye Issledovaniya v Period MGG, no. 1: Alma-Āta, Akad. Nauk Kazakh SSR, p. 170-182, 1961.

The history of the study of glaciation in the Dzhungarskiy Alatau is reviewed. Glacial motion, heat balance, and ablation were primary objects of this study.—H.F.

Borovinskiy, B. A. Electrical exploration of the moraine of the Maloalmatin-skiy glaciers. See Geophys. Abs. 189-194.

## GRAVITY

- 189-286. Cook, A[lan] H[ugh]. The comparison of the earth's gravitational potential derived from satellite observations with gravity obser-vations on the surface: Royal Astron. Soc. Geophys. Jour., v. 5, no. 1, p. 29-33, 1961.

Instead of regarding gravity as a function of height above sea level and an-gular co-ordinates, it may be regarded as a function of geopotential and an-gular co-ordinates. Since the operations of spirit levelling give differences of geopotential directly, observed values of gravity on the surface of the earth are obtained as functions of geopotential, while gravity as a function of geopo-tential may be calculated from the expression for the potential derived from satellite observations. Comparing these two functions, we obtain differences between observed and calculated gravity at the same values of geopotential, the most direct possible comparison between the two sets of observational da-ta.— Author's summary

- 189-287. Stephenson, G. The gravitational instability of an infinite homoge-neous rotating viscous medium in the presence of a magnetic field: Royal Astron. Soc. Monthly Notices, v. 122, no. 5, p. 455-459, 1961.

It is shown that the Jeans criterion for the gravitational instability of an in-finite homogeneous medium is unaffected by the combined action of a Coriolis force, a magnetic field, and a viscous force. The necessary and sufficient con-ditions for stability are also discussed.— Author's summary

- 189-288. Tsuboi, Chuji. Upward continuation of gravitational potential and force for a spherical earth [in Japanese with English abstract]: Tokyo Univ. Geophys. Inst. Geophys. Notes, v. 14, no. 1, contrib. no. 1, 7 p., 1961.

Expressions for the gravitational potential and force at a point (not neces-sarily on the earth's axis) at any higher elevation of a spherical earth have been obtained in a simple summation series form in terms of zonal averages of surface gravity anomalies taken around the axis passing through the point. The numerical values to be multiplied by zonal averages of gravity anomalies in order to obtain the potential and force are given in tables. If the elevation is zero, the potential values agree with those of Lambert's  $\phi$  function.—V.S.N.

Subbotin, S. I., and Naumchik, G. L. Concerning the paper of P. Ya. Galushko "On the possibility of determining the cause of vertical movements of the earth's crust from gravity anomalies."

Halushko [Galushko], P. Ya. Once more concerning the possibility of determining the cause of vertical movements of the earth's crust from gravity anomalies. See *Geophys. Abs.* 189-241.

189-289. Arnold, Kurt. Die Methoden der Freiluftreduktion und der isostatischen Reduktion in ihren gegenseitigen Beziehungen [The methods of free-air reduction and of isostatic reduction in their reciprocal relations (with English summary)]: *Gerlands Beitr. Geophysik*, v. 70, no. 3, p. 131-136, 1961.

A new derivation is given for isostatic reduction for geodetic purposes, and a rigorous mathematical relationship is derived between the methods of free-air reduction and isostatic reduction. This relationship is similar to the approximate form that has been known for a long time; however, the isostatic deflections of the vertical and undulations refer to the earth's physical surface rather than to sea level, which is particularly important in the case of deflections of the vertical.—D.B.V.

189-290. Nedelkov, I. P., and Burnev, P. H. Determination of gravitational fields in depth: *Geophys. Prosp.*, v. 10, no. 1, p. 1-18, 1962.

A method is developed to calculate the gravitational field within spheres or circles surrounding a disturbing body. The computations involved can be very moderate if the Kelvin transformation is carried out by means of Fourier analysers.—D.B.V.

189-291. Thyssen-Bornemisza, Stephen, and Stackler, W. F. Micro-gravimetric measurements over a known geologic structure: *Alberta Soc. Petroleum Geologists Jour.*, v. 10, no. 2, p. 57-61, 1962.

Two different gravitational effects observed by micro-gravitational surveys over the Turner Valley structure of Alberta are discussed as an example of the application of this type of survey to near-surface geological problems. It is possible with modern gravimeters to carry out a micro-gravitational survey with an accuracy of 0.01 mgal or better. With this accuracy, quick and easy solutions of problems concerning glacial drift coverings, groundwater research, volcanic craters, and the like are possible.—V.S.N.

189-292. Danes, Z. F[rankenberger]. Structure calculation from gravity data and density logs: *Soc. Mining Engineers Trans.*, v. 223, March, p. 23-29, 1962.

A combination of gravity data and density logs is presented that makes it possible to determine structural relief. Under a wide class of geologic conditions, the solution is unique or limited to a single parametric system of solutions. The theory is developed mathematically, and solutions given for structures that are constant with depth and with an even tilt. Limitations of the method are discussed, and a test interpretation is given. The method also yields a new way to construct derivative maps, continue the field up or down, subtract regional anomalies, and perform smoothing.—V.S.N.

189-293. Kononkov, V. F. Opredeleniye glubiny zaleganiya tsentra tyazhesti anomal'nykh mass po dannym gravirazvedki [Determination of depth of occurrence of the center of gravity of anomalous masses according to data of gravity surveying]: *Novosti Neftyanoy i Gazovoy Tekhniki, Geologiya*, no. 2, p. 32-36, 1961.

A method is proposed for determining the depth to the center of gravity of a disturbing body using the results of measurements with a gravimeter on a dense net and anomaly determinations of the horizontal component of gravity. A mathematical analysis is given. Depth determinations according to this

method are compared with depths based on drilling and other geophysical methods, and the agreement is found to be satisfactory. — J.W.C.

- 189-294. Sagitov, M. U. Raschet vtoroy vertikal'noy proizvodnoy ot anomalii sily tyazhesti i ispolzovaniye yeye dlya opredeleniya anomal'nykh mass [Calculation of the second vertical derivative of gravity anomaly, and its application to determination of anomalistic masses]: *Prikladnaya Geofizika*, no. 27, p. 143-157, 1960.

The problem of determination of the second vertical derivative  $W_{ZZZ}$  of gravity is treated mathematically, and simple methods of solution are suggested. The values of  $W_{ZZZ}$  determined provide more detailed and accurate data for the interpretation of disturbing bodies. — A.J.S.

- 189-295. Raspopov, O. N. Vychisleniye vertikal'nogo gradienta sily tyazhesti po izvestnomy raspredeleniyu anomalii sily tyazhesti na poverkhnosti lyuboy formy [Calculation of the vertical gravity gradient from the known distribution of the gravity anomaly on a surface of arbitrary shape]: *Leningrad. Univ. Uchenyye Zapiski, Voprosy Geofiziki*, no. 278, p. 248-251, 1959.

A formula is derived for calculating the vertical gradient of gravity from the known distribution of the anomalies  $\Delta g$  on the surface of an arbitrary form. The formula is developed from the gravity potential outside the surface for which the surface density  $\mu(S)$  is known and is expressed in terms of the observed gravity anomaly on the surface. — A.J.S.

- 189-296. Raspopov, O. M. Metodika ucheta vliyaniya topograficheskikh mass na velichinu vertikal'nogo gradiyenta sily tyazhesti [Method of calculating the effect of topographic masses on the value of the vertical gradient of gravity]: *Leningrad. Univ. Uchenyye Zapiski, Voprosy Geofiziki*, no. 278, p. 252-262, 1959.

Methods are discussed for processing data on vertical gradients of gravity that take into account the effect of topographic masses. Formulas are derived for the effects of ground irregularities near the instrument, neighboring reliefs, and remote topographic masses, and master charts for expediting these calculations are suggested. — A.J.S.

- 189-297. Managadze, G. D. K voprosu opredeleniya poverkhnosti razdela plotnostey [Problem of determination of a density interface]: *Akad. Nauk Gruzin. SSR Soobshch.*, v. 22, no. 4, p. 407-412, 1959.

In interpretation of gravity data, formulas are usually employed in which the density difference  $\sigma$  between the two strata that cause the anomaly is considered constant. A more realistic analysis of the anomaly may be obtained, if the above constancy does not exist, by assuming a linear change in  $\sigma$ , according to  $\sigma = \sigma_0 - m\xi$ , where  $\xi$  is the depth, and  $m$  is a constant vertical gradient of the density difference. A mathematical analysis is carried out and formulas are derived that make it possible to determine the interface  $u=f(xy)$  of the densities when the above assumption is made. — A.J.S.

- 189-298. Kulikov, V. I. K voprosu geologicheskoy interpretatsii gravitatsionnykh anomalii [On the problem of geological interpretation of gravity anomalies]: *Azerbaydzhan. Nauchno-Issled. Inst. po Dobyche Nefti Trudy*, v. 4, p. 173-185, 1956.

A stratigraphic terminology for use in interpretation of gravity anomalies is proposed, and anomalies are classified into four orders: Regional anomalies of the first order, due largely to gabbro-basaltic rock of the intermediate stratum but including the covering rock; second order anomalies due to uplifts

and depressions in the sedimentary stratum and in regions of igneous rocks; and anomalies of the third and fourth order due to the topography of the upper part of the crust (up to 4-5 km).—A.J.S.

Blinstrupas, S. I., and Gedvilayte, N. M. Problem of modeling magnetic and gravity fields (1). See *Geophys. Abs.* 189-462.

189-299. Hamilton, Angus C. Evaluation of the Dominion Observatory bronze pendulum apparatus: *Royal Astron. Soc., Geophys. Jour.*, v. 6, no. 1, p. 9-28, 1961.

Analysis of all the observations on the pendulum pier in Ottawa, Canada, over a three-year period shows that there is a long-term trend in the periods of the bronze pendulums; there is a gradual increase of some  $4 \times 10^{-7}$  sec followed by a decrease of about the same amount, which is believed to be due partly to a change in operating temperature and partly to creep of the bronze metal. It is found that the standard deviation for a gravity difference may be as low as 0.15 mgal or as high as 0.58 mgal depending on the method of computation; this shows that the internal consistency is much better than the consistency between sets of observations.

The temperature control system is discussed, and the record of thermistor resistances for one pendulum pair is presented to show that there is a negligible correlation between temperature and residual errors and only partial correlation with the long term drift of the pendulum periods. Other possible sources of error are discussed, and it is concluded that shocks of undetermined origin affect the pendulums each time they are removed from the thermistor case.—D.B.V.

189-300. Beck, A[lan] E., and Valliant, H. D. On minimum pendulums: *Geophysics*, v. 27, no. 2, p. 274, 1962.

An error in two recent textbooks concerning the suspension of the Gulf pendulums is pointed out. It is shown that for pendulums of this type, built wholly of a single isotropic material, the proportional error in the period, and hence in  $g$ , due to thermal expansion is independent of the geometry of the pendulum and of the position of the axis of rotation.—D.B.V.

189-301. Suda, Yoshiro. On the calibration of the North American gravimeter AGI-108 and AGI-157 [in Japanese with English abstract]: *Japan Geol. Survey Bull.*, v. 12, no. 7, p. 541-545, 1961.

A series of observations carried out near Kashiwa City, Chiba Prefecture, Japan, to calibrate the North American gravimeter AGI-108 and AGI-157 are reported. Comparison of results with those obtained with a Geographical Institute pendulum apparatus shows a scale value of  $0.0923 \pm 0.00003$  mgal per scale division for the AGI-108 and of  $0.1205 \pm 0.00005$  mgal per scale division for the AGI-157.—V.S.N.

189-302. Inoue, Eiji. A new GSI pendulum apparatus: *Japan Geog. Survey Inst. Bull.*, v. 6, pt. 4, p. 167-200, 1961.

The main case and the optical system of an improved model of the GSI (Geographical Survey Institute) gravity pendulum apparatus for use in Japan and the Antarctic by the Geographical Survey Institute are described in detail and illustrated. The design is based on the following principles: the Vening Meinesz' three-pendulum arrangement with fused silica in the main part and high speed steel in the knife edge, a minimum type pendulum, a swinging plate composed of agate with optical flat, a photo-electric recording method in direct comparison with the time standard, a crystal clock as the time standard adjusted by time signals, temperature controlled within  $0.1^\circ\text{C}$  in fluctuation at the selected temperatures and corrected by reading the temperature, and pressure maintained at about 0.1 mm mercury during measurements.—V.S.N.

- 189-303. Service Hydrographique de la Marine and Compagnie Générale de Géophysique. Tidal gravity corrections for 1962: *Geophys. Prosp.*, v. 9, supp. no. 1, 53 p., 1961.

Three tables give, at hourly intervals, the corrections which must be added to observed gravity values in order to eliminate the disturbing effect of the sun and moon. The factor 1.2 introduced by the elasticity of the earth has been incorporated in these values. The corrections are given in units of a hundredth of a mgal to the nearest half unit.—D.B.V.

- 189-304. Inoue, Eiji, and Seto, Takao. Pendulum determinations of the gravity difference between Tokyo and Melbourne: *Japan Geog. Survey Inst. Bull.*, v. 6, pt. 4, p. 201-211, 1961.

A gravity connection was made between stations at the Geographical Survey Institute, Tokyo, Japan, and at the Geophysical Laboratory of the Bureau of Mineral Resources at Footscray near Melbourne, Australia, during the period from February to May 1959. The difference between the two stations was found to be  $201.1 \pm 0.2$  mgals. The gravity value of 979.9791 gals at Melbourne is based on a value of 979.7770 gals at Tokyo.—V.S.N.

- 189-305. Wiid, B. L. Gravity observations at Marion Island, Tristan da Cunha and Gough Island: *Royal Soc. South Africa Trans.*, v. 36, pt. 3, p. 119-128, 1961.

Gravity values at two stations on Tristan da Cunha and one each on Marion and Gough Islands were determined with a Worden geodetic-type gravimeter relative to the international gravity base at Mowbray, Cape Town. Two methods for extending the range of the gravimeter by operating it in a tilted position are described; these methods were necessary to determine the gravity value at Marion. The values are given in a table.—V.S.N.

- 189-306. Pohly, Richard A. Gravity work may aid search for Trenton fracture zones: *World Oil*, v. 154, no. 1, p. 85-88, 1962.

Gravity surveying may be useful in locating dolomitized Trenton fracture zones in the Michigan basin. Problems of changing density within glacial drift and deeply eroded bedrock surfaces are difficulties in some areas; however, they can be largely eliminated by detailed studies. The typical gravity anomaly associated with Michigan basin pinnacle reefs is a nearly circular maximum having an intensity range of 0.1 to 0.5 mgal. Some reefs exhibit no gravity anomaly and could produce a negative anomaly where porosity is sufficiently high. The gravity method cannot map porous fracture zones in the Trenton as such but can map basement faults, with which present Trenton production is associated.—J.W.C.

- 189-307. Tanner, J. G., and Uffen, R. J. Gravity anomalies in the Gaspé Peninsula, Quebec: *Dominion Observatory Ottawa Pub.*, v. 21, no. 5, p. 221-260, 1960.

Bouguer anomalies are presented for 600 gravity stations established in the Gaspé Peninsula and isostatic anomalies computed for about 50 of these stations. The most outstanding feature of the gravity anomaly map is the positive gravity anomaly over the Shickshock Mountains. Calculations of the stress differences from isostatic anomalies show that the earth's crust may be sufficiently strong to support the mountain chain without any isostatic compensation. However, analysis of the Bouguer anomalies suggests that the main structure associated with the Shickshock Mountains may be a horst, in which case the mass excess could give rise to subsequent movement in the fault zone. The regional Bouguer anomaly trends can be explained by a rotational fault zone which has disturbed the hypothetical "intermediate layer."—Author's abstract

- 189-308. Innes, M. J. S. Gravity and isostasy in northern Ontario and Manitoba: Dominion Observatory Ottawa Pub., v. 21, no. 6, p. 265-338, 1960.

Regional gravimeter surveys in northern Canada were first initiated in 1947 by the Dominion Observatory using aircraft transportation. The results of measurements for 1,220 stations established in northern Ontario and Manitoba to the end of 1950 are given in the form of Bouguer and Hayford isostatic anomaly maps and in tables of principal facts. The values of gravity are referred to networks of sub-bases established in successive years. These have been adjusted to the primary base network of Canada.

The principal variations in the Bouguer anomalies are examined in the light of the surface geology and larger crustal structures. It is shown that surface densities provide the major control. Two negative anomaly belts may be related to deeply eroded granitic roots of former Precambrian mountains. A major positive anomaly belt which separates the Superior and Churchill geological provinces may mark a major crustal dislocation due to basic material from deep within the crust and mantle. A northeast trending anomaly belt toward James Bay may indicate a major tensional feature of the crust developed during the formation of Hudson Bay. Statistical analysis of isostatic anomalies suggests trends which may be related to crustal depression during Pleistocene glaciation.— Author's abstract

- 189-309. Bott, M[artin] H[arold] P[hillips]. A gravity survey off the coast of north-east England: Yorkshire Geol. Soc. Proc., v. 33, pt. 1, no. 1, p. 1-20, 1961.

The results of a gravity survey, using an underwater gravimeter, off the Durham coast of northeast England are reported. The Bouguer anomalies indicate the pattern of the Lower Carboniferous sediments associated with the seaward extensions of the Ninety Fathom and Butterknowle faults.— V.S.N.

- 189-310. Rechenmann, Julien. Carte d'anomalies isostatiques de la Côte-d'Ivoire et des régions de Bamako et de Bobo-Dioulasso [Map of isostatic anomalies of the Ivory Coast and of the Bamako and Bobo-Dioulasso areas]: Acad. Sci. [Paris] Comptes Rendus, v. 254, no. 7, p. 1318-1320, 1962.

The anomalies shown on the gravimetric map (isostatic reduction, Airy,  $T=30$  km) covering the Ivory Coast and the Bamako and Bobo-Dioulasso areas to the north are for the most part directly related to surface geology. Most of the area is underlain by Precambrian formations which disappear under the Paleozoic plateaus of Bobo-Dioulasso. The map thus can be considered to be typical of the granitic and metamorphic Precambrian basement of West Africa when it is in equilibrium, far from major faults, and should prove useful in interpreting gravity maps of other areas where regional anomalies related to sedimentary basins, large faults, or later intrusions are superposed on the basement effect.— D.B.V.

- 189-311. Blot, Claude, Crenn, Yvonne, and Rechenmann, Julien. Elements apportés par la gravimétrie à la connaissance de la tectonique profonde du Sénégal [Elements contributed by gravimetry to the knowledge of the deep structure of Senegal]: Acad. Sci. [Paris] Comptes Rendus, v. 254, no. 6, p. 1131-1133, 1962.

A positive gravity anomaly shown on the gravimetric map of Senegal and southern Mauritania (isostatic reduction, Airy,  $T=30$  km) between Goudiry on the south and Akjoujt on the north elucidates the geology of the area. It is considered to be due to a fault that affects the entire crust. To the west of this anomaly gravity values are normal, and to the east they indicate a mass deficit of  $6.5 \times 10^{13}$  tons; the anomaly itself is due to a mass excess of  $9 \times 10^{13}$  tons, which could be caused by a basic intrusion, a thickening of the basaltic layer, or 11 km of formations having the density of the Akjoujt series.— D.B.V.

- 189-312. Vecchia, Orlando. Gravimetric exploration for natural steam in Tuscany: *Quaderni di Geofisica Applicata*, v. 21, p. 18-27, 1960 (1961).

The Larderello geothermal field is not a local feature but rather part of a regional geothermal zone that extends at least 70 km parallel to the trend of the Apennines. The existence of this natural steam region is related to deep regional structures, and the positions of steam escape are determined by regional fractures. Gravity surveys were made to determine the pre-Neogene basement structure in an area of about 1,200 sq km. Station points were fairly distributed at 0.81 per sq km in the valleys and 0.87 per sq km on the hills. A Bouguer map, which accompanies the article, was compiled by calculating the attraction exerted at each station by all the surrounding masses, near or distant, each with its own density. Such an elaborate procedure is necessary in mountainous areas. In favorable cases, near-surface faults are distinguishable on the gravity maps.—J.W.C.

- 189-313. Berger, I. Studien zur geophysikalische Prospektion im Gebiet von Freiberg-Brand (Sächsisches Erzgebirge) [Studies on geophysical prospecting in the Freiberg-Brand region (Saxon Erzgebirge)]: *Geophysik u. Geologie*, no. 1, p. 35-47, [1959].

The granite responsible for the mineralization of the Freiberg-Brand mining district of Germany was sought by gravimetric methods. The Bouguer map with its strong regional gradient was useless for interpretation; therefore, residual anomalies, local gradients, and second derivatives were calculated. The resulting anomaly corresponds best to a body lying about 1,000-2,000 m below the surface. A gravity minimum west of Freiberg that is unrelated to surface geology suggests an updoming of granite there, but magnetic measurements show that there is no accompanying change in susceptibility.—D.B.V.

- 189-314. Smithson, S. B. A regional gravity study over the Permian Baerum cauldron of the Oslo region: *Norsk Geol. Tidsskr.*, v. 41, no. 2-4, p. 211-221, 1961.

Thirty-five stations were added to a preexisting gravity net over the Baerum cauldron, and the Bouguer anomalies were computed. A positive anomaly lies over the south side of the cauldron. Removal of the effect of a 1,000-m-thick basalt mass downfaulted into the cauldron leaves a 10-mgal negative anomaly over the cauldron. This corresponds to a theoretical vertical cylinder of nordmarkite 10 km in diameter and 6 km deep with its top 3 km below the surface. A small negative anomaly associated with contact-metamorphosed sandstones outside the cauldron is ascribed to a subjacent intrusive. A large negative anomaly exists over the Tryvasshögda nordmarkite pluton.—D.B.V.

- 189-315. Moiseyenko, F. S. O geologicheskoy prirode gravitatsionnykh anomalii Ulutau, Betpak-Daly i Yerementau (Vostochnyy Kazakhstan) [Geologic nature of the gravity anomalies of Ulutau, Betpak-Daly, and Yerementau (eastern Kazakhstan)]: *Leningrad. Univ. Vestnik*, no. 6, Ser. Geol. i Geog., no. 1, p. 67-73, 1960.

The large gravity anomalies in the Ulutau-Betpak and Yerementau-Chingiz Hercynian tectonic zones are due to inhomogeneities in the upper part of the crust. Negative anomalies correspond to anticlinoriums, and positive anomalies to synclinoriums. The mass defect in the anticlinoriums is explained by the low density of pre-Upper Proterozoic rocks and granites that are disposed in the cores of these structures.—J.W.C.

- Zhogolev, L. P., and Mironov, V. S. Large-scale gravi-magnetometric work carried out during geologic mapping in the Rudnyy Altay. See *Geophys. Abs.* 189-474.

- 189-316. Chujo, Junsuke. Gravitational survey of Kumamoto district in Kyushu [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 12, no. 5, p. 343-365, 1961.

A total of 403 stations were occupied in a gravity survey of the Kumamoto district of Kyushu in 1960. Data for each station are given in a table and results are illustrated in isogal maps. High anomalies were found over Mount Kinpo and Mount Tokura and over Amakusa-Kami Island; the latter is related to the Median line. Low anomalies were found over the Kumamoto plain and between the first two high anomalies. The running means for the district were applied to find minor structures.— V.S.N.

- 189-317. Matsuda, Takeo, Tateishi, Tetsuo, and Suda, Yoshiro. Gravity survey at the southern part of Jōban coal field [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 12, no. 5, p. 391-396, 1961.

A gravity survey of the southern part of the Jōban coalfield shows that the distribution of gravity is closely related to undulations of the surface of the basement. Results are illustrated by an isogal map.— V.S.N.

- 189-318. Mumme, I. A. Geophysical investigation of the Blinman Dome: Roy. Soc. South Australia Trans., v. 85, p. 7-11, 1961.

The results of gravity and magnetic surveys of the dome structure at Blinman, about 35 miles east of Lake Torrens in South Australia, are discussed and compared with results of geological surveys. Both the geophysical and geological surveys suggest that the dome is a diapir structure. The small gravity "low" over the structure indicates that the rock formations beneath the center of the structure are less dense than those of the surrounding area. Surface density measurements are in agreement with the gravity results. No significant magnetic variations were observed.— V.S.N.

- 189-319. International Geophysical Year Bulletin (No. 45). Ocean tide measurements from Antarctic ice shelves using gravity techniques: Am. Geophys. Union Trans., v. 42, no. 1, p. 136-139, 1961.

This is a condensed version of a report by Thiel and others published under the title "Gravimetric determination of ocean tide, Weddell and Ross Seas, Antarctica" in the Jour. Geophys. Research, v. 65, no. 2, p. 629-636, 1960 (see Geophys. Abs. 181-293).— D.B.V.

- Ushakov, S. A., and Lazarev, G. E. Some conclusions from seismic and gravimetric data for the profile from Little America to Byrd Station. See Geophys. Abs. 189-584.

#### HEAT AND HEAT FLOW

- 189-320. Stewart, R. W., Carrier, G. F., Robinson, A. R., and Stommel, H[enry]. Heat flux from the ocean bed produced by dissipation of the tides: Deep-Sea Research, v. 8, nos. 3/4, p. 275-279, 1961.

It is suggested that the energy of tides is dissipated in the sediments of the ocean floor and thus contributes to the observed heat flux from the sediments. Calculations are given for possible mechanisms capable of dissipating the energy of the tides within the sediment. The most effective means found is the viscous seepage of interstitial water vertically as it is compressed by tidal pressure on the sediments. It is concluded, however, that only a fraction of the energy of tides is dissipated in bottom sediments by this means, and that the generation of heat by the various mechanisms of this type can contribute only a small amount to the observed flux of heat up through the sediments.— V.S.N.

- 189-321. Drummond, J. E., and McNabb, A. On the analysis of surface temperature surveys: *New Zealand Jour. Geology and Geophysics*, v. 5, no. 1, p. 3-17, 1962.

A theoretical investigation of the problem of obtaining information about underground heat sources from maps of surface temperatures and temperature gradients shows that the source distribution is not uniquely defined by this surface information and that methods for numerically extrapolating temperature maps are troubled by instability. Two methods are suggested for overcoming these difficulties, one a numerical method using Poisson's equation and the other a method of models similar to methods used in interpreting gravity surveys. Both methods are dependent on preconceived ideas about the temperature underground.—D.B.V.

- 189-322. Rostomyan, P. M., and Ramazanzade, M. G. Ob odnoy prichine nekotorykh izmeneniy geotermicheskoy stupeni v neftyanykh mestorozhdeniyakh [One cause of certain variations in the geothermal step in oil fields]: *Vyssh. Ucheb. Zavedeniy, Izv. Neft' i Gaz.*, no. 10, p. 21-25, 1960.

The problem of determining the geothermal gradient in oilfields, taking into account the heat produced by aging of the oil, is analyzed and discussed. The energy produced by this aging process causes a decrease in the geothermal gradient within an oilfield.—A.J.S.

- 189-323. Saull, V[incent] A., Clark, T. H., Doig, R[onald] P., and Butler, R. B. Terrestrial heat flow in the St. Lawrence Lowland of Quebec: *Canadian Mining Metall. Bull.*, v. 55, no. 598, p. 92-95, 1962; also in *Canadian Inst. Mining Metallurgy Trans.*, v. 65, p. 63-66, 1962.

Terrestrial heat flow has been determined for four boreholes in the Montreal area. The mean value of the results (uncorrected for glacial effects) is  $0.79 \pm 0.053 \times 10^{-6}$  cal per  $\text{cm}^2$  per sec (95 percent confidence limits).

Thermal gradients were determined using a thermistor probe and d-c bridge, and also by a new method using a probe-contained phase-shift oscillator, the output frequency of the oscillator being a function of probe temperature. Thermal conductivity determinations were made on core from the boreholes, using a divided bar apparatus.—Authors' abstract

- 189-324. Gerard, Robert, Langseth, Marcus, G., Jr., and Ewing, Maurice. Thermal gradient measurements in the water and bottom sediment of the western Atlantic: *Jour. Geophys. Research*, v. 67, no. 2, p. 785-803, 1962.

A new instrument for obtaining thermal gradient measurements in ocean bottom sediments, called a thermograd, is described. The thermograd is attached to a piston coring device, and it measures temperatures simultaneously at three or more depths in the sediment while obtaining a core for later thermal conductivity measurement. Thermistor needle probes are used to achieve thermal equilibrium with the sediment in about 1 min after penetration. The sensors are calibrated in place at each station by recording temperature in the deep ocean waters. Fourteen thermal gradient measurements were obtained in the western Atlantic Ocean sediments, with an average probe penetration of 10 m. The average heat flow computed for 11 basin measurements is  $1.42 \mu$  cal per  $\text{cm}^2$  per sec; a measurement in the mid-Atlantic ridge indicates a heat flow of  $3.37 \mu$  cal per  $\text{cm}^2$  per sec, and one in the Puerto Rico trench is  $1.17 \mu$  cal per  $\text{cm}^2$  per sec.—D.B.V.

- 189-325. Sultanov, B. I. Nekotoryye prichiny geotermicheskoy anomalii Apsheronskoy neftenosnoy oblasti [Some causes of geothermal anomalies in the Apsheron oil region]: *Vyssh. Ucheb. Zavedeniy Izv., Neft' i Gaz*, no. 7, p. 9-15, 1961.

Numerous factors influence heat distribution in the Apsheron oilfields. Temperatures generally are higher over anticlines and lower over synclines, but the magnitude of temperature and gradient varies from place to place depending on the geologic setting. Composition, Eh, and pH, as well as water circulation and thermal conductivity can be correlated with geothermal anomalies. Release of heat by aging of oil, activity of mud volcanoes, and absorption by adiabatic expansion of rising gases modify the normal heat flow from within the earth.— J.S.W.

- 189-326. Uyeda, S[eiya], Horai, K[i-iti], Yasui, M., and Akamatsu, H. Heat-flow measurements over the Japan trench: *Jour. Geophys. Research*, v. 67, no. 3, p. 1186-1188, 1962.

Terrestrial heat flow was measured at three localities along the 38° N. parallel across the Japan Trench by the Japanese deep-sea expedition of 1961. The apparatus used is described briefly. A thermogradmeter was used for measuring the thermal gradient, and the thermal conductivity of sediments recovered with a core sampler at the time of the gradient measurements was measured in the laboratory. The heat flow values obtained were 0.273, 1.14, and 2.05  $\mu$  cal per  $\text{cm}^2$  per sec from east to west. The lowest heat flow does not occur at the bottom of the trench but some 100 miles to the west on the inner side of the arc; this seems to be in contrast to Von Herzen's result obtained in the southeast Pacific (see *Geophys. Abs.* 177-229). The low value at this station, however, harmonizes quite well with the distribution of heat flow in the Japanese islands as determined by Uyeda and Horai (in press). The average heat flow is low (less than 1.0  $\mu$  cal per  $\text{cm}^2$  per sec) on the Pacific Ocean side of the Japanese islands and high (more than 2.0  $\mu$  cal per  $\text{cm}^2$  per sec) on the Japan Sea side except where the extension of the Mariana-Bonin Arc meets the main Japan Arc.— D.B.V.

- 189-327. Hulston, J. R., and McCabe, W. J. Mass spectrometer measurements in the thermal areas of New Zealand. Pt. 1, Carbon dioxide and residual gas analyses: *Geochim. et Cosmochim. Acta*, v. 26, p. 383-397, 1962.

Mass spectrometer measurements have been made on carbon dioxide and residual gases in some thirty geothermal bores, fumaroles and pools in New Zealand. With one exception, the  $\text{Ar}^{40}/\text{Ar}^{36}$  ratios in the discharges show the argon to be of atmospheric origin. Consideration of argon to water ratios appears to confirm the hypothesis that loss of gas occurs underground in some areas. The argon to nitrogen ratios, which were lower than the 2.7/100 value expected from heated ground water, suggest an alternative source of nitrogen. The excess nitrogen appears to be related to the total hydrogen content by a square law. The underground temperatures calculated assuming chemical equilibrium between carbon dioxide and methane are given in some cases and are in reasonable agreement with bore measurements.— Authors' abstract

- 189-328. Hulston, J. R., and McCabe, W. J. Mass spectrometer measurements in the thermal areas of New Zealand. Pt. 2, Carbon isotopic ratios: *Geochim. et Cosmochim. Acta*, v. 26, p. 399-410, 1962.

The variations of the C-13/C-12 ratio of gas and water samples from pools, boreholes, and fumaroles of North Island of New Zealand have been studied. In general, the isotopic composition is in the range  $\delta\text{C}^{13}=0$  to  $-7\text{‰}$  w.r.t. the PDB Belemnite Standard.

Calculations of isotopic equilibrium temperatures from the  $\delta\text{C}^{-13}$  values of methane and carbon dioxide have been made and indicate temperatures of 350°C and 440°C on Big Donald Mound, White Island; approximately 250°C from boreholes in the Wairakei area; and 280°C from Champagne Pool at Waiotapu. These later results are in good agreement with measured borehole temperatures at depth.

It appears from the measurements made in this work that the carbon in geothermal gases in New Zealand comes from a common origin which has a  $\delta^{13}\text{C}$  value close to that of carbonate rocks and also similar to that found by Craig for  $\text{CO}_2$  from the Yellowstone thermal area.— P.C.I.

- 189-329. Byron, L. G. Wild steam well controlled by directional drilling: *World Oil*, v. 154, no. 5, p. 154-156, 1962.

Directional drilling was used to kill a wild steam well at Wairakei, North Island, New Zealand, where geothermal power is being developed. Due to unusually high pressure problems existing in the borehole at about 500 feet, the first well blew out and blanketed the area for weeks with steam. An offset well was spudded in at a distance of 200 feet from the blowing well. By directional drilling, the wild well was intersected at 1,500 feet depth and killed.— J.W.C.

- 189-330. Doig, Ronald [P.], Saull, V[incent] A., and Butler, R. A. A new borehole thermometer: *Jour. Geophys. Research*, v. 66, no. 12, p. 4263-4264, 1961.

A borehole thermometer consisting of a temperature-sensitive oscillator contained in a sealed brass probe has been designed and tested. With this device, frequency measurements are made at the surface, giving the temperature at depth. Temperature measurements are virtually independent of the type or condition of the supporting cable. The precision of the temperature measurements is better than  $0.05^\circ\text{C}$ . Temperatures were successfully measured with the instrument to depths greater than 2,000 feet.— Authors' abstract

- 189-331. Kaganov, M. A., and Rozenshtok, Yu. L. Ob izmerenii teplovykh pojokov s pomoshch'yu teplomerov [On the measurement of thermal fluxes with the aid of heat meters]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 8, p. 1174-1178, 1961.

Heat flow meters are used for measurement of heat flow in the active layers of soil, snow, and ice. These meters are basically batteries of differential thermocouples in a sheet of thermally nonconducting material, placed in the medium to be investigated for measuring changes in temperature. Reliable measurements can be obtained if the ratio of the diameter of the plate to its thickness is not less than 10 and if the ratio of the conductivity of the plate material to that of the medium is between 0.6 and 3.0.— J.W.C.

- 189-332. Hayakawa, Masami. Study of the thermal state in the upper part of the earth's crust: *India Natl. Inst. Sci. Proc.*, v. 27, pt. A, no. 5, p. 416-440, 1961.

Studies made during the past 10 yr on sources of geothermal energy in Japan are summarized. The first part of the paper discusses the geothermal source, its scale, life, and depth; the second part deals with the transportation of heat associated with steam, and secondarily with conduction and convection if it is through a reservoir or fissured formation; and the last part describes the methods of geophysical prospecting employed in exploration. (See also *Geophys. Abs.* 180-235).— V.S.N.

- 189-333. Nakamura, Hisayoshi; Yanagihara, Chikataka; and Takagi, Shinichiro. The third drilling for geothermal investigations in the Onikobe basin, Miyagi Prefecture [in Japanese with English abstract]: *Japan Geol. Survey Bull.*, v. 12, no. 7, p. 499-502, 1961.

A well drilled on the bank of the Fukiage River as a part of the geothermal investigations in the Onikobe basin, Miyagi Prefecture, Japan, to a depth of 192.5 m has a bottom temperature of more than  $100^\circ\text{C}$  and a steeper thermal gradient than found in a previous well. The chemical composition of the ther-

mal water resembles that of the natural thermal springs in the neighborhood. Apparently the thermal waters in this area fill the fissures and cracks of fracture zones which are crossed by the valleys of the Miya and Fukiagi Rivers.—V.S.N.

Vecchia, Orlando. Gravimetric exploration for natural steam in Tuscany. See Geophys. Abs. 189-312.

- 189-334. Pomîrleanu, Vasile V. Cercetări geotermometrice asupra zăcămintului metalifer din bazinul văii Nistrului, reg. Baia Mare [Geothermometric investigations on the metalliferous deposit in the Nistru basin, Baia Mare region (with Russian and French summaries)]: Jassy Univ. Analele Ştiinţ., Sec., 2, v. 7, no. 1, p. 129-134, 1961.

Geothermometric investigations on liquid inclusions in quartz show that in the hydrothermal deposits of the Nistru valley in the Baia Mare region of Rumania the temperature of formation of the quartz increases with depth of the deposit. In the upper horizon (+V) the temperature frequency maximum varies from 200°C to 205°C, and in the lower horizon (-II) from 275°C to 280°C. The geothermal gradient of the mineralizing solutions is calculated as having been 6°C per 100 m and its reciprocal, the geothermal step, as 16 m per 1°C. The deposit is intermediate between epithermal and mesothermal.—D.B.V.

- 189-335. Savul, M., and Pomîrleanu, V[asile V.] Cercetări paleogeotermometrice asupra zăcămintelor de sulfuri complexe localizate în şiturile cristaline din Carpaţii Orientali din R.P.R. I. Mineralizările de la Leşul Ursului [Paleogeothermometric investigations on complex sulfide deposits localized in crystalline schists in the Eastern Carpathians in the Rumanian Peoples Republic. 1. Mineralizations of the Leşul Ursului (with Russian and French summaries)]: Jassy Univ. Analele Ştiinţ., Sec. 2, v. 7, no. 1, p. 149-154, 1961.

The frequency maximums of temperature of crystallization of quartz in the complex sulfide ores of the Fundul-Moldovei-Leşul Ursului type in the eastern Carpathians of Rumania and in the enclosing schists were measured and found to be 155°C-170°C for the ores in the sericite and chlorite schists and 115°C-120°C for the ores in graphitic schists. Lens quartz with weak chalcopyrite mineralization in the chlorite schists indicate a temperature of 170°C-175°C. It is suggested that the ore is of sedimentary origin, with submarine basic eruptions as the source of the copper.—D.B.V.

#### INTERNAL CONSTITUTION OF THE EARTH

- 189-336. Rezanov, I. A. O stroyenii zemnoy kory platformennykh oblastey [Crustal structure in platform areas]: Moskov. Obshch. Ispytately Prirody Byull. Otdel Geol., v. 37, no. 1, p. 25-42, 1962.

Analyzing the most recent data of deep seismic sounding and of laboratory measurements of velocity of elastic waves in rocks under high pressure, it is concluded that the entire crust down to the M-discontinuity is composed of metamorphic rocks. Seismic interfaces within the crust are interpreted as structural surfaces (unconformities) separating structural stages of different ages. The older platforms, in contrast to the younger, are characterized by rocks of greater density, which possibly have a more basic composition.—J.W.C.

- 189-337. Demenitskaya, R. M. Osnovnyye cherty stroyeniya kory Zemli po geofizicheskim dannym [Basic features of the structure of the earth's crust according to geophysical data]: Leningrad, Gostoptekhizdat, 223 p., 1961.

The structure of the crust is analysed systematically, and a method of investigation using interrelated geological and geophysical data is developed. The monograph is divided into five chapters: (1) The crust and crystalline shell of the earth; (2) methods of investigation of the structure of the crystalline shell of the earth; (3) the main features of the structure of the crust and crystalline shell of the continental parts of the earth; (4) the main features of the structure of the crust and its crystalline shell of the oceanic areas of the earth; and (5) the planetary structures of the crystalline shell of the earth. Maps show the interrelation between granitic, basaltic, and "hyperbasaltic" (peridotite, ultra-basalt) complexes up to 80 km deep. The irregular character of the earth's evolution both in time and space is discussed, and its development from the Paleozoic to the Quaternary is described for some continental areas. A 22 page table gives seismic depth determinations of the M-discontinuity for 301 geographical positions. (See also *Geophys. Abs.* 185-369.)—A.J.S.

189-338. Russell, R. D. The evolution of the earth's crust— isotopic evidence: *Canadian Geophys. Bull.*, v. 14, p. 171-181, 1961.

A review of the data on radiogenic and stable isotope tracers suggests that the growth of continents has proceeded throughout geological time. The data on Ar-40 can be interpreted either by continuous, uniform growth of the continents or by formation of the continents during a relatively short time near the beginning of the earth's history. Compston (1960) appears to have demonstrated the existence of a secular variation in stable carbon isotopes in the direction expected for growth of the continents. Data on the radiogenic tracer system Rb-87/Sr-87 suggest that strontium is being continuously added to the crust. Studies of the radiogenic tracer system suggest that galena ores coming from the mantle can be distinguished from ores originating in the crust. This suggests that some lead as well as strontium is added to the crust throughout geologic time.—B.R.D.

189-339. Shor, George G., Jr. Seismic refraction studies off the coast of Alaska: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 37-57, 1962.

Seismic refraction profiles in the Gulf of Alaska and Bering Sea in 1956 and 1957 provide data for some tentative conclusions about sea-floor structure. The Alaskan Abyssal Plain is a sedimentary wedge overlying normal deep-sea floor. Deep-ocean crustal structure continues to a point close to the foot of the continental slope; the possible presence of a "buried trench" at the foot of the slope needs to be checked. The eastern part of the Aleutian Trench has a greater filling of sediment than do other Pacific trenches. The shelf areas near Kodiak and Unimak have thick layers of sediments over a crust having velocities of 6.2-6.4 km/s, suggesting granitic material. Near Dixon Entrance the sediment is thinner and of extremely variable thickness. Oceanic crust is at shallow depth in Dixon Entrance and northeast of Kodiak. The Aleutian Basin differs from normal oceanic structure in having thicker sediments, a thicker second layer, and possibly lower-than-normal mantle velocity. The Aleutian Ridge seems to be a volcanic mass resting on crustal material of normal oceanic velocity but greater-than-normal thickness.—D.B.V.

189-340. Oborina, S. F. K voprosu o stroenii zemnoy kory v Arktike [On the problem of crustal structure in the Arctic]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 6, p. 818-821, 1961.

From seismograph records of 18 earthquakes that occurred in Alaska during the period of 1929-58, the dispersion of Love waves on the traverses Alaska-Pulkovo, and of Rayleigh waves on the traverses Alaska-Pulkovo and Franz Joseph Land-Pulkovo was reconstructed. From the group velocities of Love (24-58 sec) and Rayleigh (20-44 sec) surface waves, the thickness of the crust in the Arctic was found to be 9-10 km in the ocean and 30-40 km along the continental traverses.—A.J.S.

- 189-341. Lomnitz, C[inna]. On Andean structure: Jour. Geophys. Research v. 67, no. 1, p. 351-363, 1962.

The crustal structure of the Andes is discussed on the basis of physiography, seismicity, gravity anomalies, and geologic evolution of Chile. Four tectonic provinces may be defined on the basis of seismic correlation coefficients. Only the fourth province was activated in the 1960 Chilean earthquake. Crustal thickness may be correlated with mean elevations of the Andes, but abnormal thicknesses are found under the northern region (about 70 km under the Puna block where Chile, Bolivia, and Argentina meet). Longitudinal gravity profiles are given, and a Bouguer anomaly map of central Chile is provided. Refraction studies indicate a complex crustal structure in northern Chile. A transcontinental gravity profile of the earth's crust is presented which includes the offshore section between Valparaiso and Juan Fernandez Islands, a trans-Andean profile at about the same latitude, and parts of the continental shelf off the Argentine coast.—D.B.V.

- 189-342. Tryggvason, Eysteinn. Crustal structure of the Iceland region from dispersion of surface waves: Seismol. Soc. America Bull., v. 52, no. 2, p. 359-388, 1962.

Surface waves on Icelandic records of earthquakes originating in the Mid-Atlantic seismic belt between lat 52° and 70°N, are chiefly in the period range 3-10 sec and are first mode Love- and Rayleigh-waves. The surface wave dispersion can be explained by a three-layered crustal structure as follows: a surface layer having an S-wave velocity of about 2.7 km/s covers the whole region studied; a second layer having an S-wave velocity of about 3.6 km/s covers Iceland and extends several hundred kilometers off the coast; and a third layer having an S-wave velocity of about 4.3 km/s and P-wave velocity of about 7.4 km/s underlies the entire region. The surface layer appears to be about 4 km thick on the Mid-Atlantic Ridge south of Iceland and in western Iceland, 3 km in central Iceland, and 7 km northwest of Iceland. The second layer is of similar thickness, whereas the third layer is thicker. Surface wave dispersion does not indicate any layer of higher velocity. This 7.4-km/s layer is considered to belong to the mantle, although its velocity is significantly lower than usually found in the upper mantle.—D.B.V.

- 189-343. Choudhury, Mansur Ahmed. Sur les ondes longitudinales de séismes artificiels en Europe occidentale [On the longitudinal waves from artificial earthquakes in western Europe]: Acad. Sci. [Paris] Comptes Rendus, v. 253, no. 14, p. 1473-1475, 1961.

Observations of two artificial earthquakes (a mine collapse on January 16, 1959, and an explosion off the coast of Belgium on September 9, 1959) more than 700 km from the station indicate a  $P_n$  velocity close to 8.1 km/s and a slight southward rise of the M-discontinuity. In addition, three waves traveling through the crust with velocities of 5.9, 5.7, and 5.3 km/s were distinguished; these probably travel, respectively, in the granitic layer ( $P_g$ ), the Permian, and a near-surface sedimentary layer.—D.B.V.

Berckhemer, Hans, Müller, Stephan, and Sellevoll, Markvard A. The crustal structure in southwest Germany from phase velocity measurements on Rayleigh waves. See Geophys. Abs. 189-130.

- 189-344. Arkhangel'skaya, V. M. Dispersiya poverkhnostnykh voln i stroyeniye zemnoy kory [Dispersion of surface waves and structure of the crust]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 9, p. 1360-1391, 1961.

The results of crustal studies made during the last ten years in the basins of the Pacific, Atlantic, Indian, and Arctic Oceans and over continents are summarized. The following four points are emphasized: (1) the region of study of the propagation route of surface waves, location of epicenters, the

recording stations, and their instrumentation; (2) data on the observed group and phase velocities, and periods of recorded surface waves; (3) data on the theoretical models of the crust of the earth used in the comparison with observations; and (4) the results of the interpretation. These results indicate a relatively uniform structure of the crust within the limits of the oceanic and continental basins.—A.J.S.

- 189-345. Chakravorty, K. C., and Ghosh, D. P. Seismological study of the crustal layers in Indian region from the data of near earthquakes: World Conf. in Earthquake Eng., 2d, Tokyo and Kyoto 1960, Proc., v. 3, p. 1633-1642, 1960.

Time-distance curves are drawn for 19 earthquakes of shallow focal depth recorded at Indian stations, and from these the focal depths, velocities of the waves characteristic of individual layers, and the thickness of each layer are calculated. Results are tabulated. The values for velocity and thickness are believed to be accurate for a distance of 1,000 km around each epicenter. It is observed that the focal depth of almost all the earthquakes studied are below 20 km and lie either at the bottom of the granitic layer or at the top of the basaltic layer. The thickness of the granitic layer is 13 to 14 km north of lat 30° N. and increases southward to 20 km. The thickness of the basaltic layer is 17 to 19 km in the southern part of the central Himalayan region and 22 to 27 km in Assam Kutch, Arakan, and the remainder of the Himalayan region. The values of the total thickness for the two layers give an uneven picture of the depth to the M-discontinuity of between 35 and 42 km with the maximum occurring in the eastern Himalayan region. The question of why the Himalayan region shows a shallower depth for the M-discontinuity than does the Alpine region remains to be examined critically. A wide variation in the velocities of different types of seismic waves throughout India is not unusual when compared with similar irregularities throughout other parts of Asia.—V.S.N.

- 189-346. Gal'perin, Ye. I., Goryachev, A. V., and Zverev, S. M. Issledovaniye zemnoy kory v oblasti perekhoda ot aziatskogo kontinenta k tikhomu okeanu [Crustal structure researches in the transition region from the Asiatic Continent to the Pacific]: Moscow, Akad. Nauk SSSR, 28 p., 1958; translation, U.S. Joint Pubs. Research Service, JPRS 540-D, 25 p., 1959.

Preliminary results are given from a geologic-geophysical study of the structure of the crust in the transitional zone from the Asiatic Continent to the Pacific Ocean in the region of the Kurile-Kamchatka Arc. Seismic, gravimetric, and magnetic methods of investigation were used, and geological field work was conducted over a broad area. Both explosion and natural earthquake data were used; the former were recorded both on land and at sea. Seismic observations at sea are supplemented by acoustic and hydrologic studies. An aeromagnetic survey was undertaken for the entire region, and gravity measurements were made along several profiles. General results show that the crust under the islands is of continental type. Under the Sea of Okhotsk the total crustal thickness is about 20 km, increasing to 30-40 km near the islands. Approximately 300 km seaward from the Kurile Islands the crust is definitely oceanic with a thickness of 12-17 km including the water layer.—V.S.N.

- 189-347. Suzuki, Ziro, and Ishida, Haruko. On the surface waves of Kamchatka earthquakes: Tohoku Univ. Sci. Repts., ser. 5, v. 12, no. 3, p. 252-260, 1961.

Surface waves of Kamchatka earthquakes propagating in the boundary area between continent and ocean were studied from observations made at Sendai, Japan, to obtain information on crustal structure. Only the waves in the boundary area were used in order to avoid the dispersion effects caused by a sloping discontinuity. The dispersion curves show that the crustal layer from Kamchatka to Japan is continental in nature but with a thickness of only 20 km. In

many cases waves having a Love-type orbit and a lower group velocity than that of the fundamental Love waves are observed;  $L_g$  waves are not found in every case. A study of surface waves from a Formosa earthquake, observed as a check on the Kamchatka results, indicates that the region from Formosa to Japan is also continental and of slightly greater crustal thickness.—V.S.N.

- 189-348. Suzuki, Ziro, and Ishida, Haruko. On the surface waves of Aleutian, Alaska and Philippine earthquakes: *Tohoku Univ. Sci. Repts.*, ser. 5, Geophysics, v. 13, no. 1, p. 43-51, 1961.

The dispersion of surface waves of earthquakes with larger epicentral distances is studied as a continuation of the previous studies on Kamchatka and Formosa earthquake waves (see *Geophys. Abs.* 189-347). Records from five earthquakes were used—2 in the Aleutian region, 1 in Alaska, and 2 in the Philippine Islands. Analysis of surface waves from the Philippines indicates a continental crustal structure similar to that found from Formosa to Sendai, Japan. Dispersion curves of Aleutian earthquakes, in striking contrast to those of Kamchatka, show oceanic crustal features although there is a slight difference from curves of perfect oceanic structure. These results show that all of the regions concerned are in the transition area between continent and ocean basin.

The  $L_3$  waves with Love-type orbit and lower velocity than that of fundamental Love waves may be an Airy phase of higher mode Love waves. As in the previous study,  $L_g$  waves are not observed in every case, even when the path is continental.—V.S.N.

- 189-349. Shechkov, B. N., and Solov'yeva, O. N. O gruppyvykh skorostyakh releyevskikh voln dlya smeshannogo puti kontinentocean [On group velocities of Rayleigh waves for a composite continent-ocean path]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 8, p. 1171-1173, 1961.

Seismograms of 19 earthquakes in the south and southwest parts of the Pacific obtained at the Moscow, Tiksi, South-Sakhalinsk, and Klyuchi seismic stations are analyzed, and characteristics of propagation of Rayleigh waves along paths traversing the composite oceanic-continental crust are studied. Comparing wave paths of different earthquakes, it was found that the thickness of the crust in the western part of the Pacific is thicker than in its central part.—A.J.S.

- Kuo, John, Brune, James, and Major, Maurice. Rayleigh wave dispersion in the Pacific Ocean for the period range 20 to 140 seconds. See *Geophys. Abs.* 189-128.

- 189-350. Thompson, A. A., and Evison, F. F. Thickness of the earth's crust in New Zealand: *New Zealand Jour. Geology and Geophysics*, v. 5, no. 1, p. 29-45, 1962.

Study of dispersive earthquake waves shows that over much of New Zealand the crust has a typical continental thickness of 30-40 km, in accordance with the evidence of earthquake body waves and of gravity.—Authors' abstract

- 189-351. Adams, R. D. Thickness of the earth's crust beneath the Campbell Plateau: *New Zealand Jour. Geology and Geophysics*, v. 5, no. 1, p. 74-85, 1962.

The method of surface-wave dispersion has been used to find the thickness of the earth's crust beneath the submerged region to the southeast of New Zealand known as the Campbell Plateau. By use of records from eight earthquakes an average value of about 20 km was found. This is intermediate between the values usually found for oceanic and continental regions.—Author's abstract

- 189-352. Afanassiev [Afanas'yev], G. D. L'interprétation pétrographique des données géophysiques sur la structure de l'écorce terrestre [The petrographic interpretation of geophysical data on the structure of the earth's crust]: Soc. Géol. France Bull., ser. 7, v. 2, no. 6, p. 801-820, 1960 (1961).

This is a French version of the paper previously published in Akad. Nauk SSSR Izv. Ser. Geol., no. 7, p. 3-31, 1960 (see Geophys. Abs. 182-345).—D.B.V.

- 189-353. Bullard, E. C., and Griggs, D[avid] T. The nature of the Mohorovičić discontinuity: Royal Astron. Soc. Geophys. Jour., v. 6, no. 1, p. 118-123, 1961.

Three objections are offered to the theory that the M-discontinuity is a change in crystal structure rather than a change in chemical composition: (1) the stability relations are such that the continental and oceanic discontinuities cannot both have the heavier material below them; (2) the small variation of the depth of the discontinuity with heat flow cannot be accounted for; and (3) the transition should not be sharp in a rock which is not composed of a single well defined chemical substance. It seems likely that the M-discontinuity represents a change in chemical composition.—D.B.V.

- 189-354. Takeuchi, H[itoshi], Saito, M[asanori], and Kobayashi, N[aota]. Static deformations and free oscillations of a model earth: Jour. Geophys. Research, v. 67, no. 3, p. 1141-1154, 1962.

The Gutenberg model of the earth mantle and a homogeneous core have been used in a study of static deformations of the earth by tidal attractions and under surface loads of spherical harmonic  $n$  types. Displacement and potential distributions within the earth are shown for eleven  $n$  values less than 16, and the values of Love's numbers  $k$ ,  $h$ , and  $l$  and the similar  $k'$  and  $h'$  in the load problem are calculated for these  $n$  values. Free oscillations of the earth model have also been studied. Displacement and potential distributions for the above  $n$  values are drawn. The effect of self-gravitation on the oscillation periods is about 1 percent for  $n=6$ , and it would be smaller for larger  $n$ . The upper limit of the rigidity of the core which is compatible with the observations of the free oscillations is shown to be  $10^{10}$  d/cm<sup>2</sup>. The radial displacement distributions within the mantle and the core are shown for various rigidity values of the core.—Authors' abstract

- 189-355. Cagniard, Louis. Expansion du Noyau, contraction de l'Écorce et cycles orogéniques [Expansion of the core, contraction of the crust, and orogenic cycles]: Acad. Sci. [Paris] Comptes Rendus, v. 253, no. 19, p. 2096-2098, 1961.

The mechanism of orogenesis in Cagniard's unified theory of the earth's internal constitution (in which the core is expanding at the expense of the mantle) is analyzed, using symbolic calculus. A thin skin of unit mass encircling the core passes suddenly from "mantle facies" to denser "core facies." The resulting contraction at the base of the mantle disrupts equilibrium and substitutes a new system of elastic tensions, producing a "vault effect" analogous to that involved when a miner digs a tunnel or a mason builds an arch. Ionic diffusion and secular readjustments ensue; it is shown that in the long run it is the crust alone that suffers the effects of the decompression that was produced at the core some tens of millions of years earlier.

It is shown that radioactive decay in the earth, which is continuous and regular, tends to concentrate the vault effect in the crust. Eventually the crust yields, and an orogenic crisis occurs. The whole crust is affected, but not all at once; the orogeny spreads in slow waves, some areas being affected tens of millions of years sooner or later than others. Local resistance of material and other more complex factors also enter in. The mantle is no more affected

by the orogeny than are the ocean depths by violent tempests at the surface. A new cycle would commence after about 150 million years.

A crustal shortening of about 50 km seems adequate to account for Alpine folding. As the core-mantle density discontinuity can hardly be far from 3.75, the radius of the core would increase by 129 m per million years, or at least 20 km per cycle.—D.B.V.

- 189-356. Yukutake, Takesi. The influence of the magnetic field on spectra of seismic core waves: Tokyo Univ. Earthquake Research Inst. Bull., v. 35, no. 4, p. 641-657, 1957.

The effect of the magnetic field on seismic waves propagated in the electrically conductive core was studied mathematically for different values of magnetic field intensity and electrical conductivity. The results indicate that seismic waves are not affected by the magnetic field until the field intensity exceeds  $10^6$  gauss or the electrical conductivity is smaller than  $10^{-8}$  emu. A spectral analysis of an actual seismogram shows no change owing to propagation through the core, the possible limits of the magnetic field intensity (H) and electrical conductivity ( $\sigma$ ) in the core must be  $H < 10^7$  gauss and  $\sigma > 10^{-8}$  emu.—D.B.V.

#### ISOTOPE GEOLOGY

- 189-357. Oeschger, Hans, Renaud, André, and Schumacher, Ernst. Essai de datation par le Tritium des couches de névé du Jungfraufirn et détermination de l'accumulation annuelle [Attempt at dating by tritium of the snow layers of the Jungfraufirn and determination of the annual accumulation]: Soc. Vaudoise des Sci. Nat. Bull., v. 68, pt. 1, no. 306, p. 49-56, 1962.

After discussing the processes commonly used for direct measurement of the annual accumulation on alpine glaciers, the authors explain the principles of the physical analysis based on the determination of the age of snow layers according to the amount of radioactive tritium. A first attempt was made in 1957 on the Jungfraufirn (Switzerland) in order to study the technological aspects of this new method in view of its systematic application to the Greenland Icecap (E.G.I.G. 1957-60). The mean rate of the annual accumulation for the Jungfraufirn (rate of 134 cm  $\pm$  10 cm) is then discussed.—Authors' English abstract

- 189-358. Lorius, Claude. Concentration en deutérium des couches de névé dans l'Antarctique [Concentration of deuterium in layers of névé in the Antarctic]: Annales Géophysique, v. 17, no. 4, p. 378-387, 1961.

Analyses of 130 samples of snow and firn, collected during the Victoria Land Traverse in 1959-60, show that the relationship which exists between the temperature of formation and the deuterium content may be used to distinguish seasonal firn layers. The relation between the mean annual temperature at different stations and the deuterium content and its application to glaciological and meteorological problems are discussed.—V.S.N.

- 189-359. Buttlar, H. von, Stahl, W., and Wiik, B. Tritiummessungen an Regenwasser ohne Isotopenanreicherung [Tritium measurements on rainwater without isotope enrichment]: Zeitschr. Naturforschung, v. 17a, no. 1, p. 91-92, 1962.

A method is described for measuring tritium concentrations in rainwater without isotope enrichment with a statistical error of about 10 percent. A large counting tube is used, and counting time is 10 hr.—D.B.V.

- 189-360. Chow, Tsaihua J., and Patterson, C[laire] C. The occurrence and significance of lead isotopes in pelagic sediments: Geochim. et Cosmochim. Acta, v. 26, p. 263-308, 1962.

The isotopic composition of lead in pelagic sediments is analyzed to obtain an estimate of the isotopic composition of lead in the upper crust. The lead analyzed was deposited during approximately the last million years. The amount of dissolved lead in the oceans has been determined previously to be  $10^4$  times the amount removed in one year, and the periods of water turnover are short and surface currents are rapid within a period of  $10^4$  yr. Despite these conditions that favor homogenization, marine leads of distinctly different isotopic compositions are deposited at various locations. The differences are correlated with certain continental and ocean physiographic features. The study shows that the earth's surface is enriched in uranium relative to lead. The average age of this high U-Pb ratio for that part of North America that drains into the Pacific Ocean is estimated to be 600 m.y., and that part that drains into the Atlantic Ocean is 1,400 m.y. The major conclusion is that leads of "normal" isotopic composition may evolve within the continental crust and that departures may be due to ageing in the high U-Pb environment for various periods of time.—B.R.D.

- 189-361. Richards, J. R. Isotopic composition of Australian leads. 2. Experimental procedures and interlaboratory comparisons: *Jour. Geophys. Research*, v. 67, no. 2, p. 869-884, 1962.

This paper is concerned principally with the instrumental techniques developed for the isotopic analysis of lead minerals by gas-source mass spectrometry of tetramethyl lead. Close attention is given to the conditions required for the achievement of good precision and accuracy of measurement, and some interlaboratory comparisons are shown suggesting that this has been achieved. Finally, a few preliminary conclusions of geological interest are drawn from some results of measurements on Australian leads.—Author's abstract

- 189-362. Slawson, William F., and Austin, Carl F. A lead isotope study defines a geological structure: *Econ. Geol.*, v. 57, no. 1, p. 21-29, 1962.

The isotopic constitutions of lead in galenas from west-central New Mexico appear to be related to the location of the samples. "Modern" leads from a belt bounded on either side by "anomalous" leads. The "modern" lead belt extends for more than 130 miles and lies essentially along a line defined by the towns of Alamogordo and Socorro, New Mex. Geologists have postulated a regional lineament to lie under the belt defined by the "modern" lead samples. This structure is known variously as the Zuni, Zuni-Sacramento, or New Mexico-Utah lineament in the literature. It is proposed that lead isotopes can show a rational geological control and thus should be among the interpretative tools of tectonophysicists and geologists.—Authors' abstract

- 189-363. Boyer, P. D., Graves, D. J., Suelter, C. H., and Dempsey, M. E. Simple procedure for conversion of oxygen of orthophosphate or water to carbon dioxide for oxygen-18 determinations: *Anal. Chemistry*, v. 33, p. 1906-1909, 1961.

A method is described for determining the O-18 content of  $H_2O$  or  $KH_2PO_4$  based on heating the samples with guanidine hydrochloride. A means of releasing  $CO_2$  and trapping  $NH_3$  from heated samples, a vacuum train, gas-collecting, and mass spectrometer facilities are described. The procedure is reportedly accurate and simple.—J.C.A.

- Sharp, Robert P., and Epstein, Samuel. Oxygen-isotope ratios and glacier movement. See *Geophys. Abs.* 189-278.

- 189-364. Shields, W. R., Garner, E. L., and Dibeler, V[ernon] H. Absolute isotopic abundance of terrestrial silver: *U.S. Nat. Bur. Standards Jour. Research*, v. 66A, no. 1, p. 1-3, 1962.

Isotopic abundance ratios are reported for a commercial silver nitrate, 13 samples of native silver, and 11 silver minerals of various compositions and from widely distributed deposits. The Ag-107/Ag-109 ratio obtained from pooling the data is 1.07597 with a 95 percent confidence limit of  $\pm 0.00055$  for the effect of random errors and a total uncertainty of  $\pm 0.00135$  when an allowance for the possible effects of known sources of systematic error is included.—S.S.G.

189-365. Urbach, W., Ackermann, W., Ewald, H., and Ludwig, R. Das Isotopenverhältnis  $^{87}\text{Sr}/^{86}\text{Sr}$  von Strontium-Proben aus Kalkgesteinen [The Sr-87/Sr-86 isotope ratio of strontium samples from calcareous rocks]: Zeitschr. Naturforschung, v. 17a, no. 3, p. 273-275, 1962.

Earlier work (see Geophys. Abs. 167-34) on the isotopic abundance ratio of Sr-87/Sr-86 has been continued; 11 samples of strontium from calcareous rocks of different geologic occurrence and age, 1 from recent shellfish, and 1 from sea water have been measured with improved accuracy. Results are tabulated. The fact that the Schwinger marble from Bavaria and several other samples now give values close to the value for modern sea water, though in earlier measurements they have been as much as 3-4 percent lower, suggests that the previous measurements were faulty.—D.B.V.

189-366. Ebert, A. A., Jr. Use of a getter-ion type pump with a mass spectrometer: Appl. Spectroscopy, v. 15, no. 5, p. 152, 154-155, 1961.

Two years of testing a getter-ion pump on an analytical mass spectrometer have shown the pump to be completely satisfactory. Advantages of the pump are: (1) elimination of a cold trap, cooling water, and mechanical forepump, (2) saving of the cost and inconvenience of liquid nitrogen, and (3) less downtime on the mass spectrometer.—J.C.A.

189-367. Hoering, T. C., and Abelson, P. H. Carbon isotope effects in aerobic metabolism of microorganisms: Carnegie Inst. Washington Year Book 60, p. 199-200, 1960-61; reprinted in Carnegie Inst. Washington Geophys. Lab. Ann. Rept. of Director for 1960-61, 1961.

*Chlorella pyrenoidosa* cells were put in a glucose medium, placed in the dark, and aerated with  $\text{CO}_2$ -free air. *Escherichia coli* was grown aerobically in a 1 liter glucose-containing culture placed in a sealed 5 liter bottle. The carbon-isotope ratios of most of the amino acids from the cells were found not to differ greatly from those of the remainder of the molecules, which in turn have about the same ratio as the input glucose. The striking feature is the low C-13/C-12 ratio of lipides.—B.R.D.

189-368. Hoering, T. C., and Bufalini, M. The isotope effect in the low-temperature adsorption of gases: Carnegie Inst. Washington Year Book 60, p. 205-207, 1960-61; reprinted in Carnegie Inst. Washington Geophys. Lab. Ann. Rept. of Director for 1960-61, 1961.

The isotope effect on the low-temperature adsorption of gases was determined for  $\text{N}_2$ , Ne, Ar,  $\text{O}_2$ , and  $\text{CH}_4$  adsorbed on a variety of materials. Little temperature effect was noted on the fractionation factor between 74°K and 193°K. The heavy isotope concentrates on the adsorbent. The fractionation factor in the adsorption of  $\text{N}_2$  was not a function of pressure up to the vapor pressure of liquid nitrogen. A comparison of the isotope fractionations in the adsorption of nitrogen on different adsorbates shows that they fall into two classes; those with lower heat of adsorption (charcoal, silica gel, and alumina) and those with a higher heat of adsorption (chromia and iron).—B.R.D.

Russell, R. D. Isotopic studies and geochronology; VIII. See Geophys. Abs. 189-14.

Hulston, J. R., and McCabe, W. J. Mass spectrometer measurements in the thermal areas of New Zealand. Pt. 1, Carbon dioxide and residual gas analyses. See *Geophys. Abs.* 189-327.

Hulston, J. R., and McCabe, W. J. Mass spectrometer measurements in the thermal areas of New Zealand. Pt. 2, Carbon isotopic ratios. See *Geophys. Abs.* 189-328.

## MAGNETIC FIELD OF THE EARTH

189-369. Sugiura, Masahisa. Evidence of low frequency hydromagnetic waves in the exosphere: *Jour. Geophys. Research*, v. 66, no. 12, p. 4087-4095, 1961.

Damped waves of a period of several minutes with amplitude up to several hundred gammas are found in the geomagnetic field in the auroral zones. These damped waves occur simultaneously in magnetically conjugate regions in the northern and southern hemispheres. The waves are very nearly elliptically polarized in the plane approximately perpendicular to the magnetic field. Hence the damped waves are interpreted as low-frequency hydromagnetic waves generated in the exosphere at an altitude of several earth radii and transmitted to the earth along the lines of magnetic force in the longitudinal mode of propagation. The number of occurrences of these damped waves has a distinct local time variation that appears to vary with season. [See also *Geophys. Abs.* 187-429.] — Author's abstract

189-370. Heirtzler, James R. The longest electromagnetic waves: *Sci. American*, v. 206, no. 3, p. 128-137, 1962.

Investigations of electromagnetic waves have indicated that those with periods of 1 to 100 or more sec originate mostly, if not entirely, above the earth's surface. These waves may be divided into 4 types on the basis of period. The fourth type (D) which extends to waves with periods of several hundred seconds and wavelengths of more than 1,000 million kilometers has been detected only recently by instruments monitoring the earth's magnetic field. Despite their dimensions these waves are classified as micropulsations because of their small amplitude. Often a Type D wave train consists of no more than a single cycle or pulse, but occasionally long trains have been detected. Theoretically the effect of the thin crust of the earth on these waves should be negligible, and because the structure of the mantle is thought to be quite uniform the secondary magnetic field generated by these long waves should be the same wherever it strikes. However, magnetometers separated by as little as 200 miles have tuned to the same incoming wave and produced significantly different records of intensity, vector, and period. In Japan, investigators are checking to determine if the junction of the oceanic crust with the continental crust produces this anomaly. When the origin of these waves is understood they may tell a great deal about the electrodynamic interaction of the earth and the sun and provide a new way to look into the earth's interior. — V.S.N.

189-371. Hoerlin, Herman. Artificial aurora and upper atmospheric shock produced by Teak: *Univ. Calif., Los Alamos Sci. Lab. Rept.*, LAMS-2536, 18 p., 1961.

From analysis of the artificial aurora and features of upper atmospheric shock produced by shot Teak exploded at 252,000 feet above Johnston Island, it is evident that various geo-astrophysical phenomena can be simulated and explored by the release of known amounts of nuclear energy in space. A qualitatively good correlation between the brightness-time history of the aurora and the decay of fission products and a pronounced slowing down of the upper shock caused by work against the geomagnetic field were observed. The surprisingly high magnitude of the observed brightness of the shock front at plus 500 km is probably the result of interaction of the front with the compressed geomagnetic field. — V.S.N.

- 189-372. Mauersberger, Peter; Lucke, Otto; Lauterbach, Robert; and Frölich, Friedrich. *Geomagnetismus und Aeronomie, Band 3. Über das aus dem Erdinneren stammende Magnetfeld* [Geomagnetism and aeronomy, v. 3. Concerning the magnetic field originating in the interior of the earth]: Berlin, VEB Deutscher Verlag der Wissenschaft, 632 p., 1959.

Geomagnetism is treated in a detailed, comprehensive manner. The chapter headings of this book are as follows: results of observations of the principal field and secular variations, mathematical description and statistical investigation of the principal field and of secular variations, analysis of changes in the earth's principal magnetic field derived from potential developments, physical state of material in the interior of the earth and the origin of the principal geomagnetic field, and geomagnetic research methods in the service of geology.—J.W.C.

- 189-373. Allredge, Leroy R., and Van Voorhis, Gerald [D.]. Source of the great Arctic magnetic anomaly: *Jour. Geophys. Research*, v. 67, no. 4, p. 1573-1578, 1962.

The unique pattern made by magnetic component contours and magnetic meridians in the Arctic region is explained in terms of magnetic sources at the core-mantle interface. The position and amplitude of 8 radial dipoles used to approximate the nondipole field, were adjusted so that their field, together with the field of a centered dipole, reproduced all of the general features of the great Arctic anomaly. The radial dipoles are good approximations to current loops at the core-mantle interface. Since electric currents in the core are generally accepted as the source of large regional anomalies in the earth's magnetic field, it is concluded that the great Arctic anomaly is due to this type of source rather than to Hope's geological explanation (see *Geophys. Abs.* 177-378).—D.B.V.

- 189-374. Keyser, A. R., Rice, J. A., and Schearer, L. D. A metastable helium magnetometer for observing small geomagnetic fluctuations: *Jour. Geophys. Research*, v. 66, no. 12, p. 4163-4169, 1961.

A metastable helium magnetometer using the principle of optical pumping has been constructed. The operating principles of the device are discussed together with some of the design considerations. The application of the magnetometer to the direct recording of variations in the magnitude of the earth's magnetic field in the milligamma range is presented. Records of the commencement and ending of a magnetic storm are shown.—Authors' abstract

- 189-375. Rotshteyn, A. Ya. *Absolyutnyy yaderno-rezonansnyy tsifrovoy geomagnitometr* [Absolute nuclear-resonance digital magnetometer]: *Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3*, p. 218-227, 1961.

The absolute digital nuclear resonance magnetometer, AYATsM-5-VITR is described. Block and schematic diagrams are given, and the pickup of the magnetometer, its amplifier, multiplier of repetition of impulses, counter, recording digital device, methods of control, and accuracy are discussed. Field tests indicate a necessity for increasing the signal frequency 24 times. Two such high-speed nuclear-resonance digital magnetometers have been used for studies of short-period geomagnetic field variations.—A.J.S.

- 189-376. Pogrebnykov, M. M., Rotshteyn, A. Ya., and Tsirel', V. S. *Voprosy izucheniya i ucheta variatsiy pri ispol'zovanii yaderno-rezonansnoy apparatury* [Problems of study and calculation of variations in connection with using nuclear-resonance apparatus]: *Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3*, p. 258-267, 1961.

An investigation of the intensity of the magnetic field of the earth was made in the Caspian Sea using a portable nuclear resonance magnetometer type AYPM-4-VITR. The effects of temporal variations of the natural magnetic field on the observed T values were measured. It was found that this magnetometer is suitable for investigation of microvariations of the modulus of the total vector of geomagnetic field, and that such variations may affect the accuracy of magnetic surveys. A suggestion is made for constructing nuclear resonance magnetometers which automatically take into account variations in the field.— A.J.S.

- 189-377. U.S. Coast and Geodetic Survey. Magnetograms and hourly values, Honolulu, T. H., 1958: U.S. Coast and Geodetic Survey Magnetic Observatory, Honolulu, MHV-Ho58, 146 p., 1961.

The records of the Honolulu Magnetic Observatory for 1958 are presented in the form of quarter-size reproductions of magnetograms and tables of hourly mean values of each of the magnetic elements - declination (D), horizontal intensity (H), and vertical intensity (Z).— V.S.N.

- 189-378. U.S. Coast and Geodetic Survey. Magnetograms and hourly values, San Juan, P. R., 1958: U.S. Coast and Geodetic Survey Magnetic Observatory, San Juan, P. R., MHV-SJ58, 98 p., 1961.

The records of the San Juan Magnetic Observatory for 1958 are presented in the form of quarter-size reproductions of the magnetograms and tables of hourly mean values of each of the magnetic elements - declination (D), horizontal intensity (H), and vertical intensity (Z).— V.S.N.

- 189-379. Voelker, Hans. Zur Breitenabhängigkeit der Perioden erdmagnetischen Pulsationen [On the dependence of the period of geomagnetic pulsations on latitude]: *Naturwissenschaften*, v. 49, no. 1, p. 8-9, 1962.

Since the beginning of June 1961, simultaneous three-component (H, D, and Z) records of geomagnetic pulsations have been obtained at the Wingst-Niederelbe, Göttingen, and Fürstenfeldbruck observatories in Germany, using the same types of instruments. A preliminary comparison of the records of June 1961 shows that the pt's in the H and D components are similar even in details, and no differences in period could be established. On the other hand the pc, sinusoidal morning pulsations are very different at the three stations, especially in the H component; at Wingst (geomag lat 54.6° N.) the predominant period is 36 sec, at Göttingen (geomag lat 52.3° N.) it is 31 sec, and at Fürstenfeldbruck (lat 48.9° N.) it is 25 sec. The same phenomenon was observed in individual effects in the forenoon and early afternoon. After 4 p.m. (MEZ) no difference in period was observed.— D.B.V.

- 189-380. Geographical Survey Institute. Magnetic survey of Japan, 1951-57: *Japan Geog. Survey Inst. Bull.*, v. 7, pt. 1, 85 p., 1961.

Results of the 1951-57 first-order magnetic survey of Japan are tabulated for the 91 stations occupied. Calculated values of magnetic elements reduced to 1960.0 and sea level are given in a table, and isogonic and isoclinic lines for 1960.0 and lines of equal horizontal intensity for 1960.0 are shown on maps that also give the locations of the stations.— V.S.N.

- 189-381. Ionosphere Research Committee. Catalogue of disturbances in ionosphere, geomagnetic field, field intensity of radio wave, cosmic ray, solar phenomena and other related phenomena, no. 21: Rept. Ionosphere [and Space] Research Japan, v. 11, no. 2, p. 67-98, 1957.

Observational data of remarkable disturbances that occurred from January 21-24, 1957 are given for the following elements: ionosphere, geomagnetic

field, field intensity of radio wave, cosmic-ray, and solar phenomena, and related phenomena such as the three-hour range of earth-current potential. The data represent a compilation of simultaneous observations at 16 observatories in Japan and include some data obtained by the Japanese Antarctic Research Expedition. This catalogue is a continuing feature in this report series; each issue covers a new period of important disturbances.— V.S.N.

- 189-382. Ionosphere Research Committee. Catalogue of disturbances in ionosphere, geomagnetic field, field intensity of radio wave, cosmic ray, solar phenomena and other related phenomena, no. 23: Rept. Ionosphere [and Space] Research Japan, v. 11, no. 4, p. 251-276, 1957.

Observational data of unusual disturbances for the period March 26-30, 1957 are reported.— V.S.N.

- 189-383. Ionosphere Research Committee. Catalogue of disturbances in ionosphere, geomagnetic field, field intensity of radio wave, cosmic ray, solar phenomena and other related phenomena, no. 25: Rept. Ionosphere [and Space] Research Japan, v. 12, no. 1, p. 101-145, 1958.

Observational data of unusual disturbances are given for the period September 11-15, 1957.— V.S.N.

- 189-384. Ionosphere Research Committee. Catalogue of disturbances in ionosphere, geomagnetic field, field intensity of radio wave, cosmic ray, solar phenomena and other related phenomena, no. 30: Rept. Ionosphere [and Space] Research Japan, v. 12, no. 4, p. 525-548, 1958.

Observational data of unusual disturbances are given for the period July 7-10, 1958.— V.S.N.

- 189-385. Nagata, T[akesi], Oguti, T[akasi], and Momose, K[an-Ichi]. Preliminary report of geomagnetic observations at Prince Harald Coast, Antarctica: Rept. Ionosphere [and Space] Research Japan, v. 11, no. 2, p. 41-49, 1957.

The results of geomagnetic observations at Prince Harald Coast during the first Japanese Antarctic Research Expedition (1956/57) are discussed briefly. Tables summarize the results of absolute measurements and give hourly mean values of the magnetic elements, D, H, and Z for the month of February 1957. The geomagnetic total intensity was found to be about 10 percent less than the value charted in Vestine's world-wide map. Correlation between the geomagnetic and ionospheric phenomena and some characteristics of geomagnetic pulsations are discussed and illustrated.— V.S.N.

- 189-386. Barta, G[yörgy]. Connections between the secular variations of the earth's magnetic field and other phenomena: New York Acad. Sci. Annals, v. 95, art. 1, p. 351-367, 1961.

Barta's observations previously published in several different papers (see Geophys. Abs. 179-197, 181-349, 182-307) that the observed periodic fluctuation of 40-50 yr in the secular variation of the earth's magnetic field and in the rotational speed of the earth's axis may indicate a mass displacement of the same period in the core of the earth are summarized.— V.S.N.

- 189-387. Lucke, Otto. Zur plasmatheoretischen Darstellung des erdmagnetischen Variationsfeldes [On the plasma-theory representation of the geomagnetic variation field (with English summary)]: Gerlands Beitr. Geophysik, v. 70, no. 5, p. 266-293, 1961.

Two problems concerning the plasma theory of geomagnetic variations are considered, the dynamo theory of geomagnetic tides and the theory of drift currents within the magnetosphere. Using the equations of Lucas and Schluter for the plasma in the ionosphere, the tensor of conductivity is calculated and compared to that obtained by Baker and Martyn by a different method. For the Hall conductivity there are differences that cannot be neglected. The vertical distribution of the current density is calculated.

The regional motions of the plasma in the magnetosphere in the directions perpendicular and parallel to the magnetic lines of force are studied. Their equations of motion are derived, taking into account the collective interactions. The result is compared to that for the approximations for one particle. Other questions, for example the propagation of hydromagnetic waves and the determination of the outer limits of the atmosphere, are also discussed.—D.B.V.

189-388. Gouin, Pierre. Reversal of the magnetic daily variation at Addis Ababa: *Nature*, v. 193, no. 4821, p. 1145-1146, 1962.

The magnetic station at Addis Ababa, Ethiopia, is near the magnetic zero-dip equator and directly under the influence of these equatorial electrojet currents (geog. lat N. 09°02'; geomag. lat N. 05°2; mag. lat S. 0°5). During the first week of January 1962 there was a drastic change in the characteristics of the daily variation ( $\Delta H$ ,  $\Delta Z$ , and  $\Delta D$ ). At local noon on January 3 and 5 the H curves, on quiet days normally smooth with a maximum between 1130 and 1230 local time, were completely reversed; on January 6 the curve was of equatorial type with a strong electrojet amplification during the first part of the day, but the curve for the second part of the day belonged to a completely different latitude. The Z curves of January 3 and 6 are clearly of southern type with a single maximum around noon, but those of January 7 and 8 show three maximums and two minimums, characteristic of quiet days around winter solstice. The D curves were highly distorted on January 3, 5, and 6.

This phenomenon might be caused by a shift in latitude of the ionospheric currents responsible for the Sq+L daily variation or of the electrojet itself, or it might be an extraordinarily amplified L-effect. The magnetic records for the same period during the following lunation support the latter explanation.—D.B.V.

189-389. Rastogi, R. G. The effect of geomagnetic activity on the F<sub>2</sub> region over central Africa: *Jour. Geophys. Research*, v. 67, no. 4, p. 1367-1374, 1962.

The variations of  $f_0F_2$  at stations in central Africa, where the geomagnetic and magnetic equators are greatly separated from each other, are described. Differences in these variations lead to the conclusion that the  $f_0F_2$  variations at low and medium latitudes are determined by the magnetic and not by the geomagnetic latitude of the station.—D.B.V.

189-390. Bartels, J[ulius]. Geomagnetic activity in the International Geophysical Year discussed against the background of previous years: *Internat. Geophys. Year Annals*, v. 11, p. 48-58, 1961.

Comparison of geomagnetic activity during the International Geophysical Year with previous years on the basis of the 3-hr range planetary geomagnetic indexes ( $K_p$ ) shows that the International Geophysical Year was very disturbed but not as intensely as might have been expected from the extremely high sunspot numbers. Some years (1941, 1946, and 1951-52) were more disturbed than the International Geophysical Year. The highly disturbed month of September 1957 surpassed all months since 1937; the curiously quiet month of November 1958 was reminiscent of sunspot minimum conditions. Distinct 27-day recurrence tendencies appeared in the International Geophysical Year rather unexpectedly at the peak of the sunspot cycle.—D.B.V.

- 189-391. Afanasieva [Afanas'yeva], V. I. Preliminary results of investigation of magnetic storms for the first half of the IGY: *Internat. Geophys. Year Annals*, v. 11, p. 58-60, 1961.

In the period June 1957-March 1958, 9 great and very great magnetic storms occurred; 13 great and very great storms occurred during all of 1957, the year of maximum activity of the current solar cycle. Close examination of the records leads to the conclusion that type of commencement is not one of the main physical features of a magnetic storm, and storms with sudden commencement do not constitute a special class. Storms and disturbances are classified into two groups depending on the character of Di (with and without a short-period part of the Di spectrum) and on the geoactive regions relative to the earth's projection on the sun; these classes are associated with different conditions of interaction between the geomagnetic field and the corpuscular streams. The intensity of a storm depends on that of the active process on the sun. Very great magnetic storms in years of high magnetic activity are caused by very active regions far outside the earth's projection on the sun.—D.B.V.

- 189-392. DeWitt, R. N. The occurrence of aurora in geomagnetically conjugate areas: *Jour. Geophys. Research*, v. 67, no. 4, p. 1347-1352, 1962.

The simultaneous occurrence of auroras in geomagnetically conjugate areas is reported; correlation of variations of luminosity is high and similarities of form and motion are striking.—D.B.V.

- 189-393. Wescott, Eugene [M.]. Magnetic activity during periods of auroras at geomagnetically conjugate points: *Jour. Geophys. Research*, v. 67, no. 4, p. 1353-1355, 1962.

The correlation of the variations of H and D at the conjugate stations Kotzebue, Alaska, and Macquarie Island during two days in March 1958 when conjugate auroras were observed, and also during other times studied, is found to be very good. This evidence supports the theory that ionospheric events in the northern and southern hemispheres are closely linked by the magnetic field lines, at least during certain periods.—D.B.V.

- 189-394. Nikolsky, A. P. On the problems connected with comparing magnetic disturbances of the Arctic and the Antarctic: *Internat. Geophys. Year Annals*, v. 11, p. 43-46, 1961.

One of the main problems in comparing magnetic records obtained in the Arctic and Antarctic is the choice of stations to be compared. Proximity to the geographic poles is not a feasible criterion because the features of magnetic disturbance depend mainly on geomagnetic latitude; yet stations chosen on the grounds of comparable geomagnetic latitude may also prove unsatisfactory due to longitudinal effects. The isochrons of morning maximums of magnetic disturbances in the Arctic represent a system of spirals originating at the pole of uniform magnetization and developing clockwise; it seems expedient to apply this law in choosing comparable stations. Maps of the Arctic and Antarctic are given to facilitate the choice. Magnetograms from Mirnyy, for instance, should be compared with those of stations on the north and west coasts of Iceland or eastern Greenland.—D.B.V.

- 189-395. Alexandrov, V. A., Pudovkin, M. I., and Yanovsky, V. M. The field of magnetic disturbances in the Arctic and Antarctic: *Internat. Geophys. Year Annals*, v. 11, p. 60-61, 1961.

Geomagnetic observations at 6 or 7 stations in northwest Siberia, spaced 150-200 km apart and operated from March to September in the years 1953-57, showed that each station not only had its own variations corresponding to a given magnetic disturbance, but also had its own field distribution; this indi-

cates that the source of the disturbances is distinctly limited and mobile. The epicenters of these disturbances were localized between the meridians of Tixie Bay and Mapikar, and frequently were south of the Arctic circle. The principal direction of the maximum gradient of field intensity of the disturbances was meridional at almost any time of day, showing that the ionospheric current lines are mainly latitudinal. Usually the isolines of the H component include epicenters of the Z component of both signs, the H component being a maximum on the zero isoline of the Z component; this confirms the latitudinal character of the current lines.

Comparison of magnetic and ionospheric disturbances observed at Mirnyy in May-August 1957 showed that magnetic disturbances in the Antarctic are caused by the sporadic E-layer of a screen type. It is reasonable to assume that the source of magnetic disturbances in the Arctic is also in the E-layer.—D.B.V.

189-396. Kotadia, K. M., and Ramanathan, K. R. Magnetic and ionospheric disturbances in low latitudes: *Internat. Geophys. Year Annals*, v. 11, p. 68-82, 1961.

Studies on meridional profiles of  $f_oF_2$  and  $h_pF_2$  in the eastern zone in different seasons of 1954 and 1957, and at different times of the day, are summarized. The effect of magnetic disturbances was to reduce the  $f_oF_2$  subequatorial anomaly. Statistical study of  $f_oF_2$  for magnetically disturbed days shows that the increase of daytime  $f_oF_2$ , which occurs near the equator, changes to a decrease at about geomag lat  $7^\circ N.$ , or mag dip  $20^\circ N.$  This is also the latitude at which the phase reversal of lunar variation of  $f_oF_2$  occurs. SD variations of  $f_oF_2$  at Ahmedabad, India, derived from records of days of Sc-type magnetic storms and from other magnetically disturbed days, were compared with results obtained at other places; Dst variations were also studied.

The occurrence of spread-F at Ahmedabad was found to decrease as magnetic activity increased, opposite to what happened at Slough; the changeover occurs somewhere near mag dip  $45^\circ N.$ , or geomag lat  $25^\circ N.$ —D.B.V.

189-397. Bol'shakova, O. V., and Zybin, K. Yu. On the frequency of occurrence and amplitude spectrum of the geomagnetic field pulsations (according to IGY and IGC data): *Annales Géophysique*, v. 17, no. 4, p. 345-350, 1961.

The patterns of short-period pulsations of the geomagnetic field reported here confirm and define more accurately those properties reported earlier (1960) as a result of interpretation of observations performed with induction fluxmetric installations during the International Geophysical Year and the International Geophysical Cooperation. Continuous pulsations with periods from 20 sec to 4 min, divided into groups of 10 sec periods and of 1 min periods, were analyzed. It is concluded that as the latitude of the observational site becomes lower, the pulsations of shorter periods become more stable; the amplitudes of continuous S.P.P. have a maximum at noon, local time, independent of the period of pulsation; and the frequency of occurrence of continuous S.P.P. is independent of their amplitudes.—V.S.N.

189-398. Bol'shakova, O. V., Zybin, K. Yu., and Mal'tseva, N. F. Nekotoryye zakonomernosti v povedenii vertikal'noy sostavlyayushchey KPK geomagnitnogo polya ustoychivogo rezhima (Pc) [Certain regularities in the behavior of the vertical component of short-period pulsations KPK of a geomagnetic field of continuous character (Pc)]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 6, p. 818-827, 1960.

Regularities in the behavior of the vertical component of short-period pulsations (KPK) of the earth's magnetic field observed at the Lovozero, Borok, and Petropavlovsk-Kamchatskiy geophysical stations in the U.S.S.R. during the period from August 1957 to January 1958 are described. The frequency spectrum of the KPK field, the diurnal distribution of KPK, their maximum amplitudes and the KPK behavior related to the geographical distribution of observation points are discussed.—A.J.S.

- 189-399. Scarf, F. L. Micropulsations and hydromagnetic waves in the exosphere: *Jour. Geophys. Research*, v. 67, no. 5, p. 1751-1761, 1962.

New data on micropulsations from instruments designed to record high-frequency magnetic fluctuations show that oscillations with an extremely sharp cutoff ranging between 1.5 and 3 cycles per second exist for hours during periods of minimum ionosphere electron density; it is suggested that this cutoff is a property of the primary hydromagnetic wave. No model without a loss mechanism can reproduce the cutoff, because the ordinary and extraordinary circularly polarized waves are strongly coupled. Thermal damping is investigated by means of the collisionless Boltzmann equation; it is found that this effect may explain the observed cutoff if the proton temperature near 5 earth radii ( $R_e$ ) is of the order of  $10^5$  K, with a density  $N \approx 10^2 - 10^3 \text{ cm}^{-3}$ . It is suggested that above  $5 R_e$  the exosphere is not in thermal equilibrium; therefore, long-range damping cannot occur.—D.B.V.

- 189-400. Mrazek, J. A relation between the frequency of the sporadic E-layer and the geomagnetic activity: *Internat. Geophys. Year Annals*, v. 11, p. 68, 1961.

Statistical analysis of all observations from 1947 to 1957 of the maximum frequencies of the sporadic E-layer from the Lindau ionospheric station in Bavaria, using the method of overlapping periods, shows a relationship between sporadic E-layer activity and geomagnetic activity. For days when the highest frequency was less than 3 megacycles per sec, geomagnetic activity was less than for other days of the period, and for days when the highest frequency was more than 2.5-3.5 megacycles per sec, geomagnetic activity was greater.—D.B.V.

- 189-401. Gettemy, John W. Magnetic daily variation at Koror: *Jour. Geophys. Research*, v. 67, no. 5, p. 1885-1888, 1962.

A method of exhibiting the magnetic daily variations using contours on running means, which can show seasonal changes in daily variation more precisely, is applied to the variations recorded at Koror in the Palau Islands, situated almost exactly on the magnetic dip equator. The contour charts give new evidence of a seasonal shift in the ionospheric currents and show that throughout the International Geophysical Year period the equatorial electrojet was located to the north of Koror. This indicates that the electrojet does not form a barrier between the north and south current systems.—D.B.V.

- 189-402. Smith, Edward J. A comparison of Explorer VI and Explorer X magnetometer data: *Jour. Geophys. Research*, v. 67, no. 5, p. 2045-2049, 1962.

Comparison of magnetometer data obtained by Explorer VI and Explorer X confirms the Explorer VI result that a large-scale deformation of the geomagnetic field is present even on quiet days. There appear to be two possible explanations for this deformation: Either a ring-current is present, caused by particles trapped in the geomagnetic field (see *Geophys. Abs.* 180-257, 185-431), or dipole field lines are transported by the streaming solar plasma around the earth to form a magnetic tail in the antisolar direction (see *Geophys. Abs.* 179-294, 186-491). It is possible that both effects are present simultaneously.—D.B.V.

- 189-403. Duffus, H. J., Shand, J. A., and Wright, Charles S. Short-range spatial coherence of geomagnetic micropulsations: *Canadian Jour. Physics*, v. 40, no. 2, p. 218-225, 1962.

An experiment designed to measure the coherence of natural geomagnetic signals 10 km apart is described. A qualitative measurement was performed

on a section of 1 cycle per second signal (of unusual occurrence) and a quantitative measurement on a section of normal daytime record. The coherence tends to be high for moderate signal levels.— Authors' abstract

- 189-404. Saito, Takao. Oscillation of geomagnetic field with the progress of pt-type pulsation: Tohoku Univ. Sci. Repts., Geophysics, ser. 5, v. 13, no. 2, p. 53-61, 1961.

Rapid-run magnetograms recorded at 20 observatories in both the northern and southern hemispheres were used in this study. From the magnetograms 62 typical pt pulsations that occurred during the International Geophysical Year and that were studied on a world-wide basis were selected for analysis. The following phenomena, probably caused by hydromagnetic wave propagation along the magnetic lines of force, were observed: (1) Simultaneously with the onset of a pt, disturbing hodographs at every station in the northern (southern) hemisphere converge toward (diverge from) a point on the northern (southern) auroral zone near the local midnight meridian and then oscillate radially centering around the point; (2) oscillations are generally synchronous over the middle and low latitudes but tend to delay gradually in both polar regions; (3) with the occurrence of pt pulsations a bay or baylike phenomenon is detected without exception somewhere near the auroral zone although the magnitude of the two is not always proportional; and (4) when pt's are accompanied by a sharp negative bay in the auroral zone, the centers of convergence are crowded about the region in the auroral zone near the local midnight meridian, but when accompanied by a positive or weak bay they are distributed in a scattered fashion around the region.— V.S.N.

- 189-405. Lebeau, André. Sur une propriété de l'activité magnétique nocturne à la station Dumont d'Urville (Terre Adélie) [On a property of the nighttime magnetic activity at the Dumont d'Urville station (Adélie Land)]: Acad. Sci. [Paris] Comptes Rendus, v. 253, no. 9, p. 1094-1096, 1961.

At Dumont d'Urville station in Antarctica the perturbation vector of the horizontal geomagnetic field during nighttime bays is oriented in a direction opposite to the direction of the sun seen from the center of the auroral zone. This direction coincides with that of the circumzenithal auroral arcs observed by Weill. There appears to be no direct correlation between the two phenomena.— Author's abstract, D.B.V.

- 189-406. Brown, R. R., and Campbell, W[allace] H. An auroral-zone electron precipitation event and its relationship to a magnetic bay: Jour. Geophys. Research, v. 67, no. 4, p. 1357-1366, 1962.

The relationship of an auroral-zone electron precipitation event to a magnetic bay has been examined using simultaneous observations of X-ray intensity at balloon altitudes, ionospheric absorption of cosmic radio noise, geomagnetic micropulsations in the 5-30 sec period range, and variations in the geomagnetic elements H, D, and Z. These observations show that an intense electron bombardment of the upper atmosphere was in progress prior to the bay and suggest that the current system of the bay was "triggered" by the sudden intensification and expansion of the electron precipitation. The motion of the current system of the westward electrojet and the electrons precipitating on the atmosphere was toward the north, indicating that processes well out of the lines of force through the auroral zone, rather than local field conditions, were responsible for the movement.— Authors' abstract

- 189-407. Crews, A., and Futterman, J. Geomagnetic micropulsations due to the motion of ocean waves: Jour. Geophys. Research, v. 67, no. 1, p. 299-306, 1962.

When sea waves move in the magnetic field of the earth, electric currents are generated in the water volume. These currents give rise to a small mag-

netic field which perturbs the earth's field. For plane trochoidal waves, this perturbing field decays exponentially with altitude and lies in a vertical plane which is oriented in the direction of wave propagation. The magnitude of the perturbing field also depends upon the magnitude and dip angle of the earth's field, and upon the height, wavelength, and propagation direction of the sea waves. For north-south waves, sea state 5, and an altitude of 100 feet, the perturbation is of the order of 0.1 gamma.— Authors' abstract

- 189-408. Obayashi, Tatsuzo. Propagation of solar corpuscles and interplanetary magnetic fields: *Jour. Geophys. Research*, v. 67, no. 5, p. 1717-1729, 1962.

A model of interplanetary magnetic fields formed by the outward blast of solar plasma clouds can account for various characteristics of solar particles observed on the earth. All available information on solar-geophysical data for the period July 1957-December 1960 has been examined. It is shown that a plasma cloud ejected from the sun forms an expanding magnetic bulge that is linked with the sun and can trap or sweep out solar cosmic rays, depending on the relative positions of the injected particles and of the cloud in space. The results also confirm some inequality of the time variations of solar cosmic-ray flux with respect to the heliographic position of the source flares. This is explained by the westward convex nature of magnetic field lines due to the rotation of the sun. The average speed and the lifetime of magnetic plasma clouds are estimated from the characteristics of delay times between solar flares and geomagnetic storms. (See also *Geophys. Abs.* 188-413.)—D.B.V.

- 189-409. Wilson, Charles R. Sudden commencement hydromagnetic waves and the enhanced solar wind direction: *Jour. Geophys. Research*, v. 67, no. 5, p. 2054-2056, 1962.

Wilson and Sugiura (see *Geophys. Abs.* 188-409) have shown that sudden commencements of geomagnetic storms in high latitudes are the effect of elliptically polarized transverse hydromagnetic waves with two zones of opposite polarization. From analysis of 77 SC's (for 1957-60) at Sitka and College, Alaska, the azimuth of the meridian plane of symmetry separating the two polarization zones has been determined to be 25° west of the sun-earth line. The fact that this plane is inclined to the west is thought to indicate that the solar plasma stream, which generates the SC hydromagnetic waves upon collision with the earth's magnetic field, propagates parallel to the extended solar magnetic field.—D.B.V.

- 189-410. Cole, K. D. On solar wind generation of polar geomagnetic disturbance: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 1, p. 103-114, 1961.

Solar wind generation of polar geomagnetic storms is examined on a model suggested by Piddington (see *Geophys. Abs.* 185-434). His theory is criticized and inferences are drawn which may be tested against observation. However, the solar wind theory is not at variance with the concept of hydromagnetic wave emission by the sun. Comparison with the concept of atmospheric dynamo generation of magnetic disturbance suggests that a combination of the two processes may be necessary to explain the total phenomenon.—D.B.V.

- 189-411. Sinno, Kenji. Method of magnetic storm forecasting from the activities of flares accompanied by solar radio noise outbursts: *Rept. Ionosphere [and Space] Research Japan*, v. 11, no. 4, p. 195-204, 1957.

A statistical study is made of the relationship between magnetic storms and solar flares that are accompanied by 200 Mc radio noise outbursts for purposes of forecasting magnetic storms. The statistical method is discussed according to occurrence probability and the longitudinal effect. It is found that as the

flares and radio outburst are of increasing importance the probability of occurrence of a magnetic storm within 3 days becomes higher. A forecast of magnetic storms from the relationship between various grades of flares and outbursts is made for the Special World Interval of the International Geophysical Year, and results are compared with test warnings by the World Warning Agency during the period from May 9 to December 31, 1956. Results are tabulated and illustrated in graphs.— V.S.N.

189-412. Hirono, Motokazu. On the magnetic clouds responsible for variations of cosmic-ray and geomagnetic field: Rept. Ionosphere [and Space] Research Japan, v. 11, no. 4, p. 205-228, 1957.

The dissipation of the solar magnetic field would occur within 12 years if Morrison's (1956) theory of the ejection of a vast magnetic cloud is accepted. There is no known mechanism to replenish this field. It is suggested that the intermittent ejection from the sun of magnetic clouds of much smaller dimension and magnetic energy is more plausible. These magnetic clouds are considerably slowed down by interplanetary gas. If the number density integrated near the sun in the direction of ejection is about  $10^{20}/\text{cm}^2$  column, the cloud ceases to advance at about 1.5 A.U. from the sun and brings about a field-free cavity behind it, thus possibly forming the outer trapping magnetic field advocated by Sekido and Murakami (1955). The slowed magnetic cloud may be captured readily by the earth's gravitational or magnetic field to produce a geocentric magnetic cloud (Parker 1956). If the interplanetary gas temperature is of the order of  $10^5\text{K}$ , the nonmagnetized stream is not slowed down and some of it may reach the earth ahead of the magnetized parts to give rise to the initial phase of a magnetic storm.— V.S.N.

189-413. Watanabe, Tomiya. Geomagnetic bays and storm sudden commencements in high latitudes: Tohoku Univ. Sci. Repts. Geophysics, ser. 5, v. 13, no. 2, p. 62-79, 1961.

Protons coming from the sun to impinge on the auroral region and electrons secondarily precipitated from the outer Van Allen belt triggered by protons of solar origin build up the electric field, which in the ionosphere produces electric currents responsible for the geomagnetic bay. The mechanism of storm sudden commencements in high latitudes is shown to be essentially the same as that of bay disturbances.— Author's abstract

189-414. Saemundsson, T. Statistics of geomagnetic storms and solar activity: Royal Astron. Soc. Monthly Notices, v. 123, no. 4, p. 299-316, 1962.

The geomagnetic effect of Ca-flocculi and large sunspots has been investigated statistically for the period 1919-54 using the method of superposed epochs. Magnetic storms show a definite relation to the central meridian passage of active regions on the sun, the correlation persisting throughout the solar cycle without noticeable change of character. The type of correlation is markedly different for recurrent and sporadic storms; this lends support to the hypothesis that there are two kinds of solar corpuscular emission, prolonged emission from M-regions which are largely independent of active areas and transient emission from active areas. The hypothesis that recurrent storms are caused by particle streams from active areas is shown to be untenable.— D.B.V.

189-415. Nikolsky, A. P. On the distribution of periods of activity of magnetic disturbances over the 24 hours of the day: Internat. Geophys. Year Annals, v. 11, p. 46-47, 1961.

A statistical analysis of the distribution of magnetic storms during the day was made for 140 days characterized by such storms. Three diurnal intervals stand out clearly as the times when magnetic disturbances are most likely to

occur and when their intensity is greatest: 2000, 0200, and 0600 hrs local time. These agree satisfactorily with Störmer's theory of magnetic storms.— D.B.V.

- 189-416. Troitskaya, V. A. The microstructure of the magnetic storms in respect of pulsations for the first eight months of the IGY: *Internat. Geophys. Year Annals*, v. 11, p. 62-68, 1961.

The microstructure of the 5 main magnetic storms in 1957 (September 2-3, 4, 13, and 29) and 2 weaker storms (August 29 and November 6-7) was analyzed, using ultra-rapid 24-hr records of earth currents. With respect to pulsations (1-30 sec periods) the microstructure was found to be different for different storms. The storms studied can be divided into those composed mainly of characteristic short period (2-6 sec) oscillations and those consisting mainly of continuous pc-type pulsations with periods of 10-15 sec or more. In most, the SC consisted of two to four more or less intensive oscillations with periods of 8-14 sec. At the end of the disturbed period there occurred characteristic short-period oscillations of the beating type with periods of 1-4 sec; these appear to be worldwide. These characteristic periods with respect to pulsations could be discerned at all the earthcurrent stations of the U.S.S.R.'s network, including stations in the Arctic, Antarctic, middle latitudes, and Far East.— D.B.V.

- 189-417. *International Geophysical Year Bulletin No. 57. Solar-terrestrial activity during the second half of 1961: Am. Geophys. Union Trans.*, v. 43, no. 1, p. 136-138, 1962.

During the period July 1-December 31, 1961, solar observatories throughout the world reported 14 major solar flares, and 15 geomagnetic storms were recorded by the World Warning Agency, 5 of which were classified as severe. July 1961 was marked by the greatest solar activity since November 1960, with 11 of the major solar flares and 3 of the severe magnetic storms. The major solar flares, geomagnetic disturbances, Worldwide Geophysical Alerts, and Special World Intervals are listed.— D.B.V.

- 189-418. Axford, W. I., and Reid, G. C. Polar-cap absorption and the magnetic storm of February 11, 1958: *Jour. Geophys. Research*, v. 67, no. 4, p. 1692-1696, 1962.

The variation of the energetic particle flux behind the shock wave, based directly on the model proposed by Gold (1955), is described; it provides a plausible explanation of the rapid decrease of the absorption following the SC of a magnetic storm. It is suggested that the increase in absorption prior to the SC is caused by acceleration of the solar particles in the region ahead of the shock wave. The probability of this effect being seen on the earth depends fairly critically on the location of the earth in the preexisting interplanetary field; this may explain the comparative rarity of the pre-SC increase. The occurrence of a very pronounced main phase in a geomagnetic storm may be an indication that the earth has entered the solar bubble.— D.B.V.

- 189-419. Sinno, Kenji. On the great solar flare which started at 21h09m, February 9th, 1958, as the likely source of geomagnetic storm, February 11th: *Rept. Ionosphere [and Space] Research Japan*, v. 12, no. 1, p. 6-9, 1958.

Selection of the solar flare responsible for the geomagnetic storm of February 11, 1958 is based on the statistical method of estimation of occurrence probability of magnetic storms from solar flares and radio emission previously reported (see *Geophys. Abs.* 189-411). An estimate is made from a study of the equi-probability lines of magnetic storm occurrence for 3 days after observation of the flare, from the importance of the flare and the total energy

excess of radio outburst observed on 200 Mc, and from the positional effect of the flare. Data of the solar flare at 21<sup>h</sup>09<sup>m</sup>, February 9, 1958 is tabulated and compared with other great storm generating flares.— V.S.N.

189-420. Kokouchi, Yukio. Severe magnetic storms recorded at Kakioka: Rept. Ionosphere [and Space] Research Japan, v. 12, no. 1, p. 42-43, 1958.

An unusual variation occurred in the initial phase of the magnetic storm on February 11, 1958. The magnitude of horizontal intensity of the sudden commencement was  $62\gamma$ ; this was followed by an immediate decrease reaching a maximum of  $141\gamma$  at 21 minutes after commencement. The storm variation is compared with variations of 12 other severe magnetic storms that have occurred since 1924. Fukushima (1951) has interpreted a similar variation as a result of the development of an intense SD-field or bay disturbance immediately following the sudden commencement, and it is believed that this is applicable to the storm of February 11, 1958.— V.S.N.

#### MAGNETIC PROPERTIES AND PALEOMAGNETISM

189-421. Patton, Bob J., and Fitch, John L. Anhyseretic remanent magnetization in small steady fields: Jour. Geophys. Research, v. 67, no. 1, p. 307-311, 1962.

Although known for a long time, the phenomenon called anhyseretic remanent magnetization, ARM, has received relatively little attention. Proper application of alternating field demagnetization techniques to rock magnetism problems required a knowledge of ARM. Over a wide range of low values of the steady field  $H_{dc}$ , the ARM intensity is a linear function of  $H_{dc}$  when the maximum alternating field intensity  $H_{ac}$  is constant. The coercive force of the ARM is a function of  $H_{ac}$  only, for small values of  $H_{dc}$ . Partial anhyseretic remanent magnetization, PARM, is analogous to partial thermoremanent magnetization, PTRM. It is shown that PARM's are additive in the same manner as PTRM's. These properties of ARM are useful in determining the magnetic nature of a material and in predicting its behavior on exposure to a magnetic field.— D.B.V.

189-422. Dickson, G. O. Thermoremanent magnetization of igneous rocks: Jour. Geophys. Research, v. 67, no. 2, p. 912-915, 1962.

A study has been made of the thermal demagnetization of natural and laboratory-induced moments of basalts and dolerites, and a quantitative study of thermoremanent magnetization (TRM) has been carried out on the same materials. In this note the TRM results are compared with available theories of acquisition of TRM. It is concluded that the TRM of all the rocks examined is in good agreement with Stacey's multidomain theory (see Geophys. Abs. 177-287), and that there is no evidence of single domain inclusions of the type proposed by Verhoogen (see Geophys. Abs. 180-267).— D.B.V.

189-423. Stacey, F. D. Theory of the magnetic properties of igneous rocks in alternating fields: Philos. Mag., v. 6, no. 70, p. 1241-1260, 1961.

Each magnetic grain in a rock contains ferromagnetic domains with a range of sizes, the small ones being magnetically harder and responding less readily to demagnetizing fields than the larger ones. By exposing a grain which has a thermoremanent magnetic moment to an alternating field, domains larger than a critical size are demagnetized leaving the smaller domains unaffected. Domain size distributions are calculated for spherical and cubical grains and used to derive characteristic curves of the fraction of an initial thermoremanent magnetization which remains after demagnetization in a progressively increasing field. Coercive force, saturation remanence, and anhyseretic magnetization are also calculated from the domain size distributions. Irregularities of

grain shape are shown to lead to a pseudo-single domain behavior which is responsible both for very hard components of thermoremanent moments and for the fact that small, randomly directed moments may be found to remain after rocks have been demagnetized in the highest fields.— Author's abstract

- 189-424. Kawai, Naoto. Subsolidus phase relation in titanomagnetite and its significance in rock-magnetism: Internat. Geol. Cong., 20th, Mexico 1956, [Trabajos], Sec. 11-A, p. 103-120, 1959.

The subsolidus relation in the magnetite-ulvöspinel solid solution was investigated by introducing thermomagnetic measurements into solid state analysis. It was found that magnetite with any Ti content is stable above 600°C, whereas below that temperature unmixing occurs. The mode of exsolution depends not only on temperature but also on time. It is concluded that in many rocks, titanomagnetites with intermediate Ti-contents are thermoremanently magnetized at the time of their formation. On cooling, the original magnetite breaks down into Ti-rich and Ti-poor magnetites and the original thermoremanent magnetization disappears. However, if the composition of the exsolved phase is on the full line part of the solvus curve, a thermoremanent magnetization may still be acquired, which decreases in time unless renewed by further exsolution. On the other hand if the composition is on the broken line part of the solvus curve, the magnetization acquired is isothermal remanent and increases with time. Reversal of magnetization frequently occurs during and after the phase renewals.

On further cooling and after cooling, newly generated exsolution phases acquire isothermal remanent magnetization in such manner that the phases are magnetized in order of increasing Curie point. Phase splitting into a pair of titanomagnetites, one with a Curie point at about 50°C and the other at 540°C, is the lowest energy state of exsolution at ordinary temperature; a titanomagnetite with any other Curie point is merely transitional or metastable at that temperature.— D.B.V.

- 189-425. Petrova, G. N., and Trukhin, V. I. Samoproizvol'noye izmeneniye  $H_C$  chastykh tsiklov namagnichivaniya pri okhlazhdenii ferromagnetikov [Spontaneous variation in  $H_C$  of rapid cycles of magnetization of cooled ferromagnetics]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 892-897, 1961.

An investigation of variations in the values of  $H_C$  and  $I_R$  of highly and medium coercive magnetites and weakly coercive nickel effected by a drop in temperature is described. The investigation was aimed at determining whether or not the spontaneous relaxational (viscous) destruction of  $I_R$  during geologic times is accompanied by a change in  $H_C$ . It was found that a change in  $I_R$  due to temperature change only is accompanied by a corresponding change in  $H_C$ . The change in  $H_C$  can be separated into two parts: one proportional to change in  $I_R$ , and the other independent of  $I_R$  decreasing with drop in temperature. An increase in  $H_C$  for a given range of temperatures is always greater than the corresponding increase of  $I_R$ , and a decrease in  $H_C$  (when observed) is less intensive than the corresponding decrease in  $I_R$ . The spontaneous increase in  $I_R$  and  $H_C$ , and the part of  $H_C$  independent of  $I_R$  was found to be a function of the coercive force of the material.— A.J.S.

- 189-426. Brodskaya, S. Yu., and Grabovskiy, M. A. Izucheniye prosessov namagnichivaniya odnokomponentnykh i dvukhkomponentnykh ferromagnitnykh sistem [Study of magnetization processes of single-component and double-component ferromagnetic systems]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1158-1170. 1961.

The processes of magnetization of single-component system of different concentration of ferromagnetic components of different susceptibilities are discussed. General expressions are derived for the mean values of suscepti-

bility and magnetization for systems containing two ferromagnetic components magnetized in closed and open circuits. There is good agreement between experimental and calculated data.— Authors' abstract, A.J.S.

- 189-427. Neumann, W. Irreguläre geomagnetische Anomalien und ihre Bedeutung [Irregular geomagnetic anomalies and their explanation]: Geophysik u. Geologie, no. 2, p. 3-63, 1960.

Occasionally in geomagnetic measurements anomalies are found that cannot be explained by induction in the earth's field. These irregular anomalies are the expression of a spontaneous magnetization of the disturbing geologic body that deviates from the direction of the present earth's field. By means of several practical examples, all possible causes that can lead to irregular spontaneous magnetization of iron ores and igneous rocks are discussed. The investigations show that this particular magnetic property of a geologic body depends above all on its geologic history. In the opinion of the author the reciprocal action between adjacent ferromagnetic bodies is of greatest significance in the formation of irregular magnetization.

In the last section of this paper it is shown how the appearance of an irregular vertical magnetic gradient can be used to clarify the nature of the magnetic disturbance of a geologic body.— Author's summary, D.B.V.

- 189-428. King, R. F., and Rees, A. I. The measurement of the anisotropy of magnetic susceptibility of rocks by the torque method: Jour. Geophys. Research, v. 67, no. 4, p. 1565-1572, 1962.

Two variations on Granar's magnetometer (see Geophys. Abs. 176-270) are described, designed respectively for maximum sensitivity (minimum detectable susceptibility difference  $10^{-10}$  emu/cm<sup>3</sup>) at fields of 20 oersteds or less and for maximum convenience of operation at intermediate fields of 10-80 oersteds. An assessment is made of the importance of the various sources of error in measurement with the second instrument, and these experimental errors are compared with the natural scatter of principal axes of susceptibility of rock specimens.— D.B.V.

- 189-429. Bewersdorff, Axel. Der Einfluss der Entmischung auf remanente Magnetisierung von Titanomagnetiten [The effect of exsolution on remanent magnetization of titanomagnetites (with English summary)]: Zeitschr. Geophysik, v. 27, no. 4/5, p. 215-256, 1961.

Investigation of exsolution in titanomagnetites shows that the composition of unstable titanomagnetite alters continuously when heated above 200°C. The increase in Curie point temperature that is related to this exsolution is determined as a function of temperature and duration of heating. If exsolution takes place in a magnetic field, it is found that a strong and stable remanence will develop. The character of this remanence and its dependence on conditions during its formation are investigated in detail.— D.B.V.

- 189-430. Iwata, Takao. Concentration dependence of the magnetically induced directional order in face-centered cubic non-ideal solid solutions: Tohoku Univ. Research Inst. Sci. Repts., ser. A, v. 13, no. 6, p. 356-373, 1961.

The effect of short-range order or of clustering of like atoms on magnetically induced directional order is calculated by the quasi-chemical method using quadruplets approximation for the entire concentration range of face centered cubic binary solid solution systems. The results of the numerical calculation of the induced anisotropy are compared with available experimental data for Ni-Fe and Ni-Co alloys.— V.S.N.

- 189-431. Yamamoto, Mikio, and Miyasawa, Ryofu. Ferromagnetic behavior and its dependence on the crystal orientation and on the method of demagnetization in single crystals and a polycrystal of 0.5 percent aluminium iron: Tohoku Univ. Research Inst. Sci. Repts., ser. A, v. 13, no. 6, p. 374-401, 1961.

The magnetization curve, ballistic demagnetizing factor, domain distribution, magnetocrystalline anisotropy constants, saturation magnetic field, residual magnetization, coercive force, and initial magnetic susceptibility, and their dependence on crystal orientation have been studied at ordinary temperatures. The ballistic method was used with single crystals and a polycrystal of iron containing 0.53 percent Al in a thermally demagnetized state and in an a-c demagnetized state.— V.S.N.

- 189-432. Nedyalkov, I. P. V''rkhu namagnitovaneto na tela s malka magnitna pronitsayemost [On magnetization of bodies of weak magnetic permeability]: B''lgarska Akad. Nauk Inst. Geofiz. Izv., v. 1, p. 77-90, 1960.

An integral equation is worked out that describes magnetization of homogeneous bodies by a homogeneous magnetizing field. A parameter of the integral equation, a certain constant  $\zeta$ , was found to be proportional to the difference between magnetic permeability of the body and that of the surrounding medium. Since  $\zeta$  for bodies of a weak permeability surrounded by a nonferromagnetic medium is very small, all terms containing  $\zeta$  in the developed Neumann's series can be disregarded, and the first term of the series considered a solution of the equation. It is shown that this solution of the integral equation indicates that the magnetization field of weakly permeable bodies is identical with the field of a homogeneously magnetized body of the same form.— A.J.S.

- 189-433. Vlasov, A. Ya., Kovalenko, G. V., and Tropin, Yu. D. Vliyanie uplotneniya iskusstvenno osazhdennykh osadkov na ostatochnuyu namagnichennost' [The effect of compaction of artificially deposited sediments on remanent magnetization]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1179-1182, 1961.

A laboratory experiment was made based on the assumption that the process of formation of sedimentary rocks and of the remanent magnetic field in them consists of slow deposition of mud particles, some containing magnetic material which under the effect of the earth's magnetic field is oriented in the direction of the field during the time of the deposition. The total vector  $I_n$  of natural magnetization of the deposit is subsequently fixed during the process of dehydration. Sediment was precipitated under magnetic fields of different intensities, then dried and cut into samples of 35×35×35 mm. Their remanent magnetization was measured repeatedly under different pressures. It was established that the inclination of the  $I_n$  vector is decreased systematically with increasing vertical compression of samples of 8-micron particles. The decrement  $-\Delta J$  reached 6° after the sample was compressed by 400 kg/cm<sup>2</sup>, 8° for 820 kg/cm<sup>2</sup>, 9° for 1,666 kg/cm<sup>2</sup>, and 10° for 3,268 kg/cm<sup>2</sup>. This decrease of inclination under increasing vertical compression seems to reconcile the difference in the Paleozoic pole coordinates determined according to American and Eurasian data.— A.J.S.

- 189-434. Patton, Bob J., and Fitch, John L. Design of a room-size magnetic shield: Jour. Geophys. Research, v. 67, no. 3, p. 1117-1121, 1962.

Several areas of geophysical research require a large space having a controlled, low-level magnetic field. A walk-in magnetic shield has been constructed which provides a field of less than 5  $\gamma$  with typical gradients of 2  $\gamma$  per ft. This condition can be maintained for long periods with little attention. Concepts and formulas were developed which permit efficient shield design. The

formulas are given and the design and performance of the shield are discussed. Heretofore, shields which could produce low-level fields over large volumes were thought to be unattainable or prohibitively expensive. It is now practical to design very large shields. The cost is generally much less for field reduction by this method than for coil systems.— Authors' abstract

- 189-435. Barinov, Ye. A., and Zhogolev, L. P. Pribor dlya izmereniya ostatochnogo namagnicheniya obraztsov gornyykh porod [A device for measuring remanent magnetization of specimens of rocks]: Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3, p. 268-275, 1961.

The design is given of an apparatus for measuring values of remanent magnetization of the order  $3\text{-}5 \times 10^{-6}$  CGSM. The threshold of sensitivity of the apparatus is  $2 \times 10^{-6}$  CGSM for  $x_0 = 10$  cm, sample volume is  $150 \text{ cm}^3$ , and multiplying factor is 0.15 gamma. The relative error in multiple measurements of remanent magnetization was found to be 1-2 percent for a constant orientation of the sample with reference to the measuring apparatus.— A.J.S.

- 189-436. Cook, John C., and Carts, Stanley L., Jr. Magnetic effects and properties of typical topsoils: Jour. Geophys. Research, v. 67, no. 2, p. 815-828, 1962.

Basic data on some magnetic characteristics of the upper 25 cm of soil were collected at 250 sites throughout the United States and Panama, chosen so as to include soil types representative of most of the principle Great Soil Groups occurring throughout the world (and where possible, in a natural state, undisturbed by man). Ten-meter-long microprofiles of a semivertical component of the geomagnetic field were recorded very close to the surface, with a resolution of 5 cm laterally and  $1\gamma$  in field strength. Samples of the soil and admixed pebbles were analyzed separately for susceptibility, composition, texture, color, and remanent magnetization.

Susceptibilities vary from less than  $10^{-6}$  gauss/oersted for most light-colored, well-sorted sands to about  $10^{-3}$  gauss/oersted for certain dark silts, sands, or loams derived from igneous rocks. Most forest, plains, and desert soils have susceptibilities between  $10^{-6}$  and  $3 \times 10^{-5}$  gauss/oersted, due almost entirely to magnetite grains with a minor contribution from limonitic or maghemitic stains. The natural irregularities (noise patterns) in the geomagnetic field above the soil vary in amplitude more or less according to soil susceptibility from less than  $1\gamma$  to about  $1,000\gamma$ ; the noise patterns, fixed in space and time, consist chiefly of smooth humps 15 to 60 cm broad, and correlate to some degree with microtopography and with individual magnetized stones such as basaltic pebbles in coarse glacial or mountain soils.— D.B.V.

- 189-437. Refai, Eglal. Magnetic anomalies and magnetization of basalts in the area around Kemnath (Oberpfalz): Zeitschr. Geophysik, v. 27, no. 4/5, p. 175-187, 1961.

Measurements of vertical magnetic anomalies and of the natural magnetization (both remanent and induced) were made on 13 basalt bodies in the Kemnath area in Oberpfalz (Upper Palatinate), Bavaria. The basalt pipes were found to be positively magnetized whereas bodies of less well defined shape were negative. The pipes contain olivine nodules and carry 3.3 percent titanomagnetite having an average grain size of  $9\mu$ ; in the negatively magnetized bodies the olivine occurs only as phenocrysts in a fine to glassy groundmass, and the titanomagnetite content is 5.3 percent with an average grain size of  $6\mu$ .— D.B.V.

- 189-438. Kopayev, V. V., and Martynova, T. A. O magnitnoy vospriimchivosti zhelezistykh kvartzitov Starooskol'skogo zhelezorudnogo rayona KMA [On the magnetic susceptibility of ferruginous quartzites of the Sary Oskol iron ore region of the KMA]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 7, p. 988-997, 1960.

An attempt is made to clarify the relation of the values of magnetic susceptibility of ferruginous quartzites to various geologic factors of the Kursk magnetic anomaly in the Sary Oskol region. A total of 1,762 samples were used in the investigation. Variation curves of magnetic susceptibility of the ferruginous quartzites for different localities of the region and of magnetic susceptibility as a function of the percentage of magnetite in the samples are given.—A.J.S.

- 189-439. Zavoytskiy, V. N., and Krutikhovskaya, Z. A. Obostatochnoy namagnichennosti zhelezistykh kvartzitov v yuzhnom zamykanii krivo-rozhskogo sinklinoriya [On remanent magnetization of ferruginous quartzites at the southern closure of the Krivoy Rog synclorium]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1150-1157, 1961.

Investigations of the remanent magnetization of oriented samples taken from open pits in Precambrian iron ore formations near Krivoy Rog in the Ukraine S.S.R. show that: (1) The structures studied were magnetized by a field whose orientation was similar in direction to the present magnetic field of the earth; (2) the magnetization of the rocks took place after their basic metamorphism; and (3) the orientation of magnetization depends mainly on the internal structure of the strata.—A.J.S.

- 189-440. Chiguryayeva, A. A., and Ismail-Zade, T. A. Palinologicheskiiye dannyye dlya apsheronskikh otlozheniy rayona Ali-Bayramly i ikh svyaz' s parametrom magnitnoy stabil'nosti [Palinological data for the Apsheron deposits of the Ali-Bayramly region, and their correlation with the magnetic stability parameter]: Akad. Nauk Azerbaydzh. SSR Doklady, v. 16, no. 2, p. 137-142, 1960.

Correlation between the magnetic stability and the content of spores and pollen in the sediments of the Apsheron group is discussed. In four boreholes in the Ali-Bayramly region the curves of microspore content agree in general with the curves of magnetic stability.—A.J.S.

- 189-441. Ismail-Zade, T. A., and Dzhabarova, Kh. S. Svyaz' razrushayushchego polya s dannymi sporovo-pyl'tsevoyo analiza dlya maykopskikh i sarmatskikh otlozheniy Talysha [Relation between the destructive field and data of spore-pollen analysis on Maykop and Sarmat deposits of Talysh]: Akad. Nauk Azerbaydzh. SSR Doklady, v. 16, no. 11, p. 1079-1081, 1960.

The relation between the destructive magnetic field intensity  $H_C$  and the amount of spores and pollen found in more than 300 cores taken in the Baku area and the Apsheron Peninsula is discussed.  $H_C$  is the demagnetizing field of an intensity higher than that of the coercive intensity of a rock with natural remanent magnetization. Samples requiring a higher value for  $H_C$  for permanent demagnetization contain more spores and pollen than do samples requiring lower  $H_C$ .—A.J.S.

- 189-442. Metallova, V. V., Ryazanova, V. N., and Rzhesskaya, I. V. K voprosu ob obratnoy polyarnosti titanomagnetitov [On the problem of reversed polarity of titanomagnetites]: Leningrad, Univ. Uchenyye Zapiski, Voprosy Geofiziki, no. 278, p. 230-234, 1959.

Thermomagnetic analyses of 42 rock samples from the Sokrat (Kazakh S.S.R.) titanomagnetite deposits which contain from 11.2 to 22 percent  $TiO_2$ , are reported. Direct polarization with regard to the present geomagnetic field is exhibited by 18 of the 42 samples, and reversed polarity by 24. Rectangular prisms of 6x6x70 mm were investigated on an astatic thermomagnetometer, and the behavior of the natural remanent magnetization,  $J_n$ , was studied in the range of temperature from ambient to 700°C. From the curves of  $J_n$  vs. temperature it was concluded that the reversed polarization of the titanomagnetite

samples is a result of an interaction of several different ferromagnetic phases present in the rock, and having different Curie points and stabilities. It was found that the direct magnetization phase has the hematite Curie point whenever a reversal of  $J_n$  occurred during the thermomagnetic analysis.—A.J.S.

- 189-443. Rao, B. S. R., and Bhimasankaram, V. L. S. Studies on magnetic properties in relation to magnetic prospecting of Kodur manganese belt, pt. 3. Correlation of the field results with the laboratory studies: India Natl. Inst. Sci. Proc., v. 27, pt. A, no. 3, p. 207-215, 1961.

Results of magnetic surveys and laboratory investigations reported in parts 1 and 2 of this paper (see Geophys. Abs. 182-405) showed that all manganese samples collected in the Kodur manganese belt were ferromagnetic in character and that the ferromagnetism may be due to a single mineral. In this paper the results of studies to determine the nature of the ferromagnetic mineral and to correlate the normative values of the mineral with the measured susceptibility values, and the magnetic properties of the manganese ore are discussed in relation to magnetic prospecting of the ores.

The magnetic character of the manganese ore of the Kodur belt is due to the presence of one or more of the minerals jacobsonite, manganomagnetite, and (or) vredenburghite which differ from each other only in the amounts of Fe or Mn in molecular combination. The susceptibility of the manganese samples thus depends not on the individual amounts of Mn and Fe but on the amount of Mn and Fe present in molecular and isomorphous combination. Accordingly these minerals may be responsible for the high magnetic anomalies over some of the ore deposits. However, the scope of the magnetometer as a unique instrument in manganese prospecting is limited; the ores are not always magnetic (specifically those high in psilomelane and pyrolusite) and the magnetic highs are not always associated with manganese ores but may reflect underlying granitic bedrock.—V.S.N.

- 189-444. Kawai, Naoto, and Kang, Yong-ho. Magnetic minerals in black and red beds in Japan: Kyoto Univ. Coll. Sci. Mem., ser. B, v. 28, no. 2, p. 285-303, 1961.

Investigation of the strong and stable paleomagnetism of some black shales and red sandstones in Japan has led to a study of the ferromagnetic minerals responsible for the remanence. Thermomagnetic and X-ray analyses and microscopic observations show that pyrrhotite is responsible for most of the natural remanent magnetism of the black shale, but  $\alpha$ -hematite, magnetite, and pyrrhotite are coexistent in the red sandstones. As  $\alpha$ -hematite possesses parasitic ferromagnetism with intensity about  $10^4$  times less than that of  $\text{Fe}_3\text{O}_4$  and  $\text{FeS}_{1+x}$ , the coexistence of even very small amounts of these ferromagnetic minerals in red beds is significant in their remanent magnetism. The direct formation of iron sulfides in sea water associated with marine volcanic activity and an indirect formation by biochemical procedures are discussed.—V.S.N.

- 189-445. Hilten, D. van. Presentation of paleomagnetic data, polar wandering, and continental drift: Am. Jour. Sci., v. 260, no. 6, p. 401-426, 1962.

A method is proposed for presenting paleomagnetic data by means of isoclines on paleomagnetic maps. These maps offer a more detailed picture of ancient magnetic fields than is given by a single virtual pole position. The isoclines of these maps restore the original connection between the continental forms and their ancient magnetic—and geographic—latitude. This is of importance particularly when we want to investigate the mutual relative positions of different continents or tectonic units of the past; from the maps we can easily see where continental coasts were opposite one another, and what rotations and translations have occurred since. Paleomagnetic data make the assump-

tion of continental drift and polar wandering necessary; the data do not appear to be in conflict with the major hypotheses on continental drift, which are based on geological, morphological, and climatological grounds. A tentative reconstruction is made of the distribution of continents since the Permian. It allows us to distinguish between polar wandering and continental drift.— Author's abstract

189-446. Doell, Richard R., and Cox, Allan. Paleomagnetism, in *Advances in Geophysics*: New York, Academic Press, v. 8, p. 221-313, 1961.

In this review of the comparatively recent field of paleomagnetism emphasis is given to discussion of the axial, nontransient dipole component of the geomagnetic field during the past half-million years, the decrease in intensity of the main dipole for several thousand years, and the reversals in polarity that the field has undergone, as well as to a discussion of the ways in which rocks become magnetized. Other topics include interpretations of paleomagnetic results in terms of the theories of polar wandering, continental drift, and an expanding earth. Paleomagnetic data currently available are tabulated and keyed to a reference list of 208 items. (See also *Geophys. Abs.* 182-406).—V.S.N.

189-447. Van Houten, Franklyn B. Ferric oxides in red beds as paleomagnetic data: *Jour. Sed. Petrology*, v. 31, no. 2, p. 296-300, 1961.

Of the genetically different ferric oxide minerals in red beds, only those inherited grains or weathering products that were oriented during sedimentation and those alteration products magnetized essentially at the time of deposition yield valid information about a geomagnetic pole position dated by the deposit. Analysis of 29 red deposits ranging in age from Precambrian to Recent reveals that in most specimens older than middle Tertiary at least 80 percent of the black grains are specular hematite. Ilmenite and magnetite predominate in rocks of Tertiary to Recent age and this along with the fact that grains of specularite and martite are not abundant in source rocks or in analyzed laterites suggests that the hematite grains in many red beds may be post-depositional alteration products derived from inherited ilmenite and magnetite. If conversion to hematite occurred long after burial the remanent magnetization in the black grains may not be a measure of the earth's magnetic field at the time of deposition.

The magnetization of many red rocks apparently resides in the ferric oxide pigment, and current information and opinions fail to provide a unifying explanation for its origin and nature. Most of the red pigment probably is inherited hematitic clay, but some apparently has been redistributed in colloidal and possibly chemical form after deposition or may have been altered diagenetically.—V.S.N.

189-448. Graham, K. W. T. The remagnetization of a surface outcrop by lightning currents: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 1, p. 85-102, 1961.

Scattered directions of magnetization are commonly found in samples taken from surface outcrops in South Africa. An investigation of the directions of magnetization in samples from one outcrop of a Pilansberg dike combined with laboratory measurements of the remanent magnetization produced by d-c fields and spark discharges showed that the pattern of magnetization in the outcrop was due to two horizontal electrical currents, one of 5,000 amps and the other of 50,000 amps. These currents are almost certainly associated with lightning discharges.

The effect of a-c demagnetization in removing this magnetization is discussed. It is concluded that the only completely satisfactory way of avoiding the effects of lightning in paleomagnetic work is to use only samples collected from depths of more than about 50 feet. However, systematic sampling over even a fairly small area cannot yield consistent but "wrong" directions of mag-

netization resulting from lightning discharges. If scattering is found, a-c washing may prove useful, particularly if the specimens have come from moderate depths (3-6 feet). — D.B.V.

- 189-449. Frölich, Friedrich, Stiller, Heinz, and Wagner, Friedrich Christian. Erfahrungen mit Laborverfahren für Gesteinsuntersuchungen [Experiences with laboratory methods of rock investigations (with English summary)]: Zeitschr. Geophysik, v. 27, no. 3, p. 136-148, 1961.

To evaluate rock samples for paleomagnetic research, not only must the coercive force of the constituents, particularly of the Ti fraction, be known, but also fabric arrangement, grain size, and crack filling also must be determined. The various petrophysical laboratory methods used for this purpose are discussed. — D.B.V.

- 189-450. Hibberd, F. H. An analysis of the positions of the earth's magnetic pole in the geological past: Royal Astron. Soc. Geophys. Jour., v. 6, no. 2, p. 221-244, 1962.

An analysis has been made of 129 determinations from all continents of the positions, inferred from paleomagnetic observations, of the magnetic pole in the geological past. The pole positions for each geological age fall into two well-defined groups concentrated along opposite longitudes. Secondary magnetization produces characteristic displacements of the latitudes of the inferred poles. Examination of the data shows the positions of most of the inferred poles which exhibit a single polarity are consistent with the hypothesis that secondary magnetization is present in some of the paleomagnetic specimens. It appears that the paleomagnetic observations could be accounted for by a combination of a slow northward and westward spiral movement of the actual pole together with secondary magnetization. — Author's summary

- 189-451. Irving, E. Palaeomagnetic directions and pole positions, part 4. Pole numbers 4/1 to 4/34: Royal Astron. Soc. Geophys. Jour., v. 6, no. 2, p. 263-267, 1962.

Results of 34 paleomagnetic measurements published since the last tabulation (see Geophys. Abs. 187-475) are compiled. — D.B.V.

- 189-452. Larochelle, A[ndré]. Palaeomagnetism of the Monteregian Hills, southeastern Quebec: Canada Geol. Survey, Dept. of Mines and Tech. Surveys, Bull., no. 79, 44 p., 1962.

Remanent magnetization measurements were carried out for a suite of oriented specimens collected from the igneous cores of most of the Monteregian Hills, a series of seven plugs of basic rocks intruding Paleozoic sediments eastward from Montreal, Quebec. The direction of the remanent magnetic moment in the rocks was found to be slightly different from that of the present earth's field or diametrically opposite to it. The cause of the stable reverse polarization was investigated with polished sections and Curie point determinations, and it is concluded that the reverse polarity of parts of the igneous bodies is related to reversals of the former geomagnetic dipole field. A comparison of the geomagnetic pole positions with those derived from well-dated sedimentary and volcanic rocks collected elsewhere in North America suggests that the basic rocks of the Monteregian Hills were intruded during post-Triassic time; in fact, the position is closest to the Cretaceous pole. Two independent K/Ar age determinations agree with that from the paleomagnetic data in indicating a Cretaceous or Jurassic age for the intrusions (see also Geophys. Abs. 187-478). — V.S.N.

- 189-453. Creer, K. M. A statistical enquiry into the partial remagnetization of folded Old Red Sandstone rocks: *Jour. Geophys. Research*, v. 67, no. 5, p. 1899-1906, 1962.

The directions of natural remanent magnetization of Old Red Sandstone rocks from five sites in south Wales where the strata are steeply inclined to the horizontal are significantly different from the average direction of magnetization of Old Red Sandstone rocks from flat-lying sites. The hypothesis that the observed directions of magnetization are resultants of a primary component acquired in the Devonian and a secondary component acquired after folding, either in the Permian or Triassic, is shown to be tenable. A statistical technique, which utilizes the normal to the best-fitting plane through the observed and the supposed primary and secondary mean directions, is described. Ovals of confidence surrounding these normals are also calculated. Partial remagnetization of these rocks is shown to be slightly more probable in the Triassic than in the Permian at four out of five sites considered.— Author's abstract

- 189-454. Everitt, C. W. F. The magnetic properties of three Carboniferous sills: *Philos. Mag.*, v. 6, no. 65, p. 689-699, 1961.

Paleomagnetic measurements on borehole specimens from three dolerite sills in the Carboniferous system of Great Britain yielded magnetic directions that were closely grouped for one sill but widely scattered in the other two, showing that contrary to the experience of previous workers, specimens from underground do not always yield satisfactory paleomagnetic results.

The intensities of magnetization were very low at the margin of each sill. Detailed study on one instance suggests that this phenomenon is due to the fact that at the margins the iron occurs mainly in the form of a nonmagnetic carbonate produced when the sill was intruded into limestone. Some wider implications of the work are discussed.— D.B.V.

- 189-455. Hilten, Dick van. Geology and Permian paleomagnetism of the Val-di-Non area, W. Dolomites, N. Italy: *Geologica Ultraiectina*, no. 5, 95 p., 1960.

The stratigraphy and tectonic history of the Val-di-Non area in the western part of the Dolomite Alps where these are separated from the central Alps by the Judicaria fault are discussed. It is concluded that the structural evolution of the Val-di-Non area is in complete agreement with van Bemmelen's concept (see *Geophys. Abs.* 183-329, 186-368) that the Tertiary orogenic phase in the eastern Alps can be better explained by gravitational tectonics than by tangential pressure.

A paleomagnetic investigation of the Lower Permian volcanic series in the vicinity of Bolzano fixed the Early Permian pole at lat 51.4° N., long 118.6° W. in contrast to the location given by Dietzel in 1960 (see *Geophys. Abs.* 185-461) at lat 45° N., long 146° W. The position as found in this study deviates considerably from the position of Permian poles derived from other European sampling sites. Available data suggest that this deviation is not due to a temporary variation (secular) of the magnetic field during the effusion of the quartz porphyries investigated, but is probably a result of some alpine geotectonic process.— V.S.N.

- 189-456. Rodionov, V. P., and Sidorova, E. P. Rezult'aty paleomagnitnykh issledovaniy v yuzhnoy chasti Sibirskoy platformy i smezhnykh rayonakh [Results of paleomagnetic investigations in the south part of the Siberian platform and adjacent regions]: *Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy*, no. 186, p. 354-364, 1961.

The paleomagnetism of the Cambrian, Ordovician, and Silurian rocks of the south part of the Russian platform was investigated. Three thousand oriented

cubic specimens (5 cm on an edge) were taken from outcrops; 1,800 of these were of sedimentary rocks and 1,200 were igneous. Two predominant directions of  $I_n$  were determined. These are approximately  $180^\circ$  from one another and do not change with changing dip of the rocks. A reference paleomagnetic section was synthesized; it consists of four zones of normally magnetized rocks which alternate with four zones of reversed magnetism. The contacts between the paleomagnetic zones do not correspond to stratigraphic boundaries; in fact, they cut the latter.—J.W.C.

- 189-457. Komissarova, R. A., and Slautsitays, I. P. O vozraste Ashinskoy svity po paleomagnitnym dannym [On the age of the Ashin formation according to paleomagnetic data]: Vses. Neft. Nauchno-Issled. Geol. -Razved. Inst. Trudy, no. 186, p. 365-369, 1961.

The Ashin formation of the Ural Mountains is a thick terrigenous unit that consists of sandstones, siltstones, and conglomerates. Ages ranging from the Cambrian to Early Devonian have been assigned to this formation. On a basis of measurements of the vector of remnant magnetization  $I_n$  on 110 specimens the pole position was determined at lat  $20^\circ$  N., long  $151^\circ$  E. Such a position indicates a Late Ordovician age for these rocks.—J.W.C.

- 189-458. Kawai, N[aoto], Ito, H., and Kume, S[hoichi]. Deformation of the Japanese Islands as inferred from rock magnetism: Royal Astron. Soc. Geophys. Jour., v. 6, no. 1, p. 124-130, 1961.

Results are presented of paleomagnetic measurements on 28 sets of rocks collected from various parts of Japan. The directions for pre-Tertiary rocks from southwest Japan differ systematically from those from northeast Japan. It is suggested that the difference is due to deformation in late Mesozoic or early Tertiary time. Because of this deformation, the pre-Tertiary geomagnetic pole for Japan cannot be inferred accurately.—D.B.V.

- 189-459. Norris, D. K., and Black, R. F. Palaeomagnetism and differential rotation in the Lewis thrust plate: Alberta Soc. Petroleum Geologists Jour., v. 10, no. 1, p. 13-21, 1962.

This is virtually the same paper as that published in Nature, v. 192, no. 4806, p. 933-935, 1961 (see Geophys. Abs. 188-434).—V.S.N.

## MAGNETIC SURVEYS

- 189-460. Lauterbach, R[obert]. Bemerkungen zum gegenwärtigen Stand der mikromagnetischen Erkundungsmethode [Remarks on the present state of the micromagnetic investigation method]: Geophysik u. Geologie, no. 1, p. 73-82, [1959].

Although extensive work has provided an empirical picture of the sometimes startling correspondence between structure of superficial geologic layers and micromagnetic anomalies, certain fundamental problems remain to be solved: Is the variation in susceptibility that causes the anomalies peculiar to young sediments, or does remanent magnetization play a part? Are the anomalies the expression of individual structures or the sum total of a multitude of individually weak effects? What is the effect of the weathered layer of higher susceptibility (see Geophys. Abs. 165-271) on micromagnetic anomalies? These can be answered only by extensive field investigations, together with petrographic laboratory studies, supplemented by theoretical investigations. Current work along these lines is discussed.—D.B.V.

- 189-461. Conrad, W. Störkörperberechnung in Bereich der Micromagnetik [Calculation of disturbing bodies in the field of micromagnetics]: Geophysik u. Geologie, no. 1, p. 83-88, [1959].

A summation formula is derived for calculation of the magnetic anomalies of a vein system. It shows that even a vein system of relatively low susceptibility can be detected by micromagnetic measurements. The effect of LeBorgne's weathered surface layer of higher susceptibility (see Geophys. Abs. 165-271) is calculated.—D.B.V.

- 189-462. Blinstrupas, S. I., and Gedvilayte, N. M. K voprosu modelirovaniya magnitnykh i gravitatsionnykh poley (I) [Problem of modeling magnetic and gravity fields (I)]: Lietuvos TSR Mokslų Akad. Darbai, Ser. B, no. 4(27), p. 73-85, 1961.

The possibility is demonstrated for using a M-2 field magnetometer for measuring the vertical component of an anomalous magnetic field above models of a single pole and of an inclined filament of poles. As a result of the measurements, curves of change in the value of  $Z_a$  depending on the position of the model on a profile were compared with theoretical curves for corresponding cases. The data presented in the figures and tables show a very satisfactory correspondence between the graphs of experimental and theoretical curves of  $Z_a$ .—Authors' abstract, J.W.C.

- 189-463. Ignat'yeva, T. S., and Il'yushchenko, N. P. Opyt izucheniya form redkometal'nogo zameshcheniya v pegmatitovykh zhilakh s primeneniym metoda mikromagnitnoy s'emki povyshennoy tochnosti [An experiment in the study of forms of rare metal replacement in pegmatite veins by using the method of high accuracy micromagnetic survey]: Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3, p. 285-293, 1961.

Detailed study of the mineralogy of the pegmatites in three deposits has demonstrated that metasomatic replacement bears a close relationship to the microfractures. The character of the magnetic field above these pegmatites is dependent on the amount and character of distribution of such minerals as muscovite, garnet, tourmaline, and ore minerals in the body. These minerals form largely by metasomatic replacement and are deposited in zones of weakness within the pegmatite body. Consequently, the orientation of the isolines of  $\Delta Z$  will depend on the type of microfracturing within the pegmatite and on the related metasomatic mineralization. Therefore, micromagnetic surveying can be used in the search for such deposits.—J.W.C.

Ignat'yeva, T. S. Recommendations for using a combined survey of average gradients and a micromagnetic survey in prospecting for rare metal pegmatite veins. See Geophys. Abs. 189-170.

- 189-464. Ward, Stanley H., and Ruddock, Kenneth A. A field experiment with a rubidium-vapor magnetometer: Jour. Geophys. Research, v. 67, no. 5, p. 1889-1898, 1962.

A field experiment in the vicinity of a small deposit of massive magnetite has served to illustrate the nature of the results obtainable with a rubidium-vapor magnetometer in a natural micropulsation field superimposed upon a natural nonuniform unidirectional magnetic field. The ultimate purpose of this type of experiment is to explore the feasibility of using this instrument to measure the ratio of induced to remanent magnetism for a buried natural ferromagnet. The results indicate that (1) magnetic "amplification" of micropulsations occurs in the vicinity of ferromagnetic masses, (2) a change in the direction of either the unidirectional earth's main field or the micropulsation field leads to a change in the component of the micropulsation field recorded, (3) stability of the magnetometer platform must be constant to within 0.01 mm, and (4) the signal-to-noise ratio of the magnetometer tends to degenerate. This last effect can be minimized by appropriate orientation of the detection heads, but it is a phenomenon which occurs only under the rare condition of an outcropping massive magnetic body.—Authors' abstract

- 189-465. Rotshteyn, A. Ya. O razreshayushchey sposobnosti yadernorezonansnogo aeromagnetometra [On the resolution power of a nuclear resonance airborne magnetometer]: Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3, p. 228-240, 1961.

By analyzing errors (or distortions) arising in the components of airborne nuclear resonance magnetometers during their operation, the maximum errors are evaluated in the radio channel and in the frequency analyzer. On a basis of the maximum values of these errors, magnetometer parameters are selected to produce a resolving power that satisfies requirements of airborne geological mapping.— A.J.S.

- 189-466. Tsirel', V.S. Primeneniye yadernogo peshekhodnogo magnetometra dlya s'yemki na more [Use of a nuclear portable magnetometer for surveys at sea]: Vses. Nauchno-Issled. Inst. Metod. i Tekhn. Razvedki Trudy, Sbornik 3, p. 241-257, 1961.

Experimental measurements with the portable absolute nuclear magnetometer AYAPM-4 in the Caspian Sea are reported. Error in the modulus of the total vector,  $T$ , did not exceed  $\pm 2$  gammas for individual measurement of 2-seconds duration with an interval between measurements of 10 seconds. The total weight of the magnetometer and batteries is 8.5 kg. The measuring technique is explained, values of the magnetic field over the traverses are given, and suggestions for improving the accuracy of the survey are made. The accuracy obtained with the AYAPM-4 magnetometer was higher than that obtained with the AN/ASQ magnetometer in the Gulf of Mexico in 1954 (see Geophys. Abs. 165-287).— A.J.S.

- 189-467. Raff, Arthur D. Further magnetic measurements along the Murray Fault: Jour. Geophys. Research, v. 67, no. 1, p. 417-418, 1962.

The results of additional measurements during the summer of 1961 on three long magnetic profiles parallel to the Murray Fault provide a picture of strike-slip movement that is more complex than was anticipated. Whereas lateral displacement in the Mendocino and Pioneer Faults is nearly uniform over all the surveyed length, and the strike slip appears to terminate abruptly at the continental slope, the slip along the Murray Fault is of different magnitude in two distinct sections that are separated by a large disturbed zone, and the evidence for the fault dies out less abruptly as it approaches the continental slope.

This disturbed zone is worthy of more detailed study, as it appears to be an area of random anomalies within the large area of orderly lineation found off the west coast of North America. It bears on the question of crustal material apparently gained or lost between the two zones of cross match, for in terms of east-west miles of oceanic crust, the disturbed zone is 300 miles wider on the south side of the fault than on the north side. If this is truly an area of dilation and more recently formed crust, some topographic evidence should be found; bathymetric and physiographic charts do show moderate evidence that this is an area of slight rise and dilation.— D.B.V.

- 189-468. Gregory, A[lan] F., Bower, Margaret E., and Morley, L. W. Geological interpretation of aeromagnetic profiles from the Canadian Arctic Archipelago, in Geology of the Arctic, v. 1: Internat. Symposium on Arctic Geology, 1st, Calgary, Alberta, 1960, Proc., p. 427-437, 1961.

Regional interpretation of the geophysical data from 9,000 line miles of widely-spaced aeromagnetic profiles flown over the Canadian Arctic Archipelago in 1955 substantiates the field geology and provides additional details. The Boothia arch appears to be an imperfectly developed horst extending at depth as far north as the southeast corner of Bathurst Island. Related basement up-

lifts may underlie the southern portion of the Cornwallis fold belt. Several lower Paleozoic basins may occupy graben or fault block structures; maximum depths to basement in the basins are more than 10,000 feet. A west trending regional fault in Lancaster Sound parallels the south coast of Devon Island and may offset the north end of Boothia arch. Magnetic data from the Sverdrup basin indicate igneous dike activity and extensive folding only in the eastern half, although sheets of basic rock may be present in the western half; a structural complex similar to the Parry Islands and Central Ellesmere fold belts may bound the basin on the northwest. Variform magnetic expressions result from sills in the strata which are upturned by intrusion of gypsum domes.—V.S.N.

- 189-469. Graulich, J. M. Présentation et interprétation de la carte magnétique de la partie méridionale du massif de Grand-Halleux [Presentation and interpretation of the magnetic map of the Grand Halleux massif]: Soc. Géol. Belgique Bull., v. 84, no. 9-10, p. 581-584, 1961.

These remarks accompanied the presentation to the Geological Society of Belgium of the 1/6,000-scale magnetic map (vertical component) of the southern part of the Grand Halleux massif in Belgium, which is composed of Devillian rocks. Beds of magnetite-bearing phyllite were easily followed under the eluvial cover. The course of the anomalies shows that the Devillian overlies Revinian conformably in this massif. Also, the Hourt quartzites are shown to be a local lenticular facies near the top of the Devillian, rather than a basal facies brought to the surface by a hypothetical "Hourt dome".—D.B.V.

- 189-470. Kopf, Manfred. Studien zur Methodik der geologischen Auswertung geomagnetischer Untersuchungsergebnisse, dargelegt am Beispiel des Elbtalschiefergebirges [Studies on methods of geologic interpretation of geomagnetic results, illustrated by the example of Elbe Valley Schiefergebirge]: Geophysik u. Geologie, no. 1, p. 48-59, [1959].

Rough susceptibility measurements and petrographic investigations usually suffice to correlate magnetic anomalies with rock types in the Elbe Valley Schiefergebirge. Each of the various local anomalies is referred to one or more of the different igneous rocks of the area.—D.B.V.

- 189-471. Fröhlich, Lothar. Über geomagnetische und petromagnetische Untersuchungen im Bereich der Frankenwälder Querzone als Beitrag der geophysikalischen Regionalstörungen [On geomagnetic and petromagnetic investigations in the region of the Frankenwald transverse zone as a contribution to the regional geophysical anomalies]: Geophysik u. Geologie, no. 1, p. 60-72, [1959].

Geomagnetic and petrographic investigations were made in the Frankenwald transverse zone as part of a regional survey of the East Thuringian Schiefergebirge in East Germany. Rocks were tested for magnetism in outcrop, using a field balance, and then studied petrographically. Amygdaloidal diabase, paleopicrite, kersantite, and granite were found to be sufficiently magnetic, at least in part, to cause local anomalies.

The vertical magnetic survey results were then interpreted in the light of this petrographic information and of gravity survey data. In the southern part of the area the local anomalies are attributed to surface or near-surface effects. In the northern and central parts local anomalies that seem to be related in part to differentiation phenomena in the diabase and in part to granite projections from the depths can be distinguished against the regional background. The Variscan structural trends of the area are not reflected in either the magnetic or the gravity anomalies; rather, both types of anomaly are related to igneous rocks emplaced along Hercynian tectonic lines.—D.B.V.

- 189-472. Lauterbach, R[obert]. Geomagnetische Gefügeforschung in der Nordöstlichen Heide Mecklenburgs [Geomagnetic fabric investigation in the Northeast Heath of Mecklenburg]: Geophysik u. Geologie, no. 1, p. 89-96, [1959].

It has been variously suggested that the sandy plain known as the Northeast Heath of Mecklenburg, Germany, was deposited by rivers, in a dammed lake, or as outwash. Micromagnetic measurements reveal a northeast trend that supports the first view.—D.B.V.

- 189-473. Franz, P. Erdmagnetische und petrographische Untersuchung im südwestlichen Teil des Schwarzburger Sattels und im Südwestthüringisch-Fränkischen Triasland als Beitrag zur Deutung regionaler magnetischer Anomalien [Geomagnetic and petrographic investigation in the southwest part of the Schwarzburg Saddle and in the southwest Thüringian-Franconian Triassic area, as a contribution to the interpretation of regional magnetic anomalies]: Geophysik u. Geologie, no. 2, p. 64-75, 1960.

The intersection of Hercynian and Erzgebirgian structural trends is clearly brought out by the pattern of magnetic anomalies in the southwestern part of the Schwarzburg Saddle of eastern Thüringia and the surrounding Triassic area. Anomalies over the Rogliende are due to volcanic flows or near-surface intrusives, whereas over the Precambrian and Paleozoic (except for the anomalies near Waffenrod) they are presumed to be due to intrusive rocks. Possible causes of the magnetic and gravity anomalies near Eisfeld are suggested; a conclusive explanation can be expected only on the basis of drilling data.—D.B.V.

- 189-474. Zhogolev, L. P., and Mironov, V. S. Krupnomasshtabnyye gravimagnitorazvedochnyye raboty pri geologicheskoy kartirovaniy na Rudnom Altaye [Large-scale gravi-magnetometric work carried out during geologic mapping in the Rudnyy Altay]: Leningrad. Univ. Uchenyye Zapiski, no. 278, Voprosy Geofiziki, p. 66-82, 1959.

The results of gravity and magnetic investigations carried out over the Irtysh River sections of the Rudnyy Altay region are discussed. The survey was designed to provide preliminary data for preparing geologic maps at scales of 1:10,000 and 1:2,000. A method of high frequency magnetic surveying was developed that gives an accuracy of 2-3  $\gamma$  for scales of 1:10,000 and larger and for the middle latitudes where no large variations of the magnetic field occur.—A.J.S.

- 189-475. Kang, Yong-ho. On the anomalies of the geomagnetic field due to Mt. Kabuto, Hyogo Prefecture, Japan: Kyoto Univ. Coll. Sci. Mem., ser. B, v. 28, no. 2, p. 131-146, 1961.

Interpretation of measurements made with Schmidt type magnetometers of vertical and horizontal components of the geomagnetic field over and around the Mount Kabuto andesitic tholoide in northern Nishinomiya City, Hyogo Prefecture, Japan, is discussed. The positive and negative values of the magnetic anomalies due to the volcano for both vertical and horizontal components are  $\pm 900\gamma$ , and the direction of magnetization is approximately that of the present geomagnetic field. The direction, declination, inclination, intensity, and susceptibility of the rocks are discussed, and thermomagnetic and X-ray analyses suggest that titanomagnetites with various Curie points contribute to the ferromagnetism of the Kabuto andesite. For purposes of an approximate calculation of the observed results, a spherical model with an eroded top is assumed.—V.S.N.

- 189-476. MacDowall, J. A local survey of the earth's magnetic field in the vicinity of Royal Society Base, Halley Bay: *Polar Rec.*, v. 10, no. 64, p. 90-92, 1960.

The problems encountered in establishing geomagnetic observatories on the floating ice shelf at Halley Bay, Antarctica are outlined, and work conducted at the base is reviewed. A comparison made between local magnetic surveys made in 1956 and 1958 suggests that the ice front features are the result of the geological structure below the ice shelf; this supports a previous hypothesis that considerable sections of the seaward boundary of the ice shelf may be grounded on shoals. If contours of the magnetic anomaly are related to the geologic structure below the ice shelf, measurement of the movement of the ice may be possible by repeating the magnetic survey after a time lapse.— V.S.N.

- Mumme, I. A. Geophysical investigation of the Blinman Dome. See *Geophys. Abs.* 189-318.

#### MICROSEISMS

- 189-477. Frantti, G[ordon] E., Willis, D[avid] E., and Wilson, James T. The spectrum of seismic noise: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 113-121, 1962.

The seismic noise spectrum in the frequency range 0.5-31.5 cycles per second is presented graphically for a number of sites over a wide geographical range. Except for a small anomalous effect near 2 or 3 cycles per second, the ground particle motion curves are observed to decrease smoothly with increasing frequency at a rate approximately proportional to the second power of frequency. The curves steepen at frequencies below 1 cycle per second.— Authors' abstract

- 189-478. Haubrich, R[ichard] A., and Iyer, H. M. A digital seismograph system for measuring earth noise: *Seismol. Soc. America Bull.*, v. 52, no. 1, p. 87-93, 1962.

A digitally recording seismograph station has been installed to record and study earth noise in the frequency range of 0.01 to 1 cycles per second. The system is capable of recording four channels of information plus time on paper tape at sample rates of up to three times per second with a dynamic range of 90 db. Preliminary analyses of the digital records show that the spectral peak between 0.1 and 0.2 cycles per second exhibits properties consistent with Rayleigh waves arriving from the southwest mixed with isotropic noise.— Authors' abstract

- 189-479. Bernard, P[ierre]. Variation annuelle de l'agitation microseismique à Honolulu [Annual variation in microseismic agitation at Honolulu]: *Annales Géophysique*, v. 17, no. 4, p. 410, 1961.

A study of the statistical record of microseisms as recorded in Honolulu by the U.S. Coast and Geodetic Survey shows an annual variation in the microseismic amplitude that is observed at no other stations; the augmentation of September to November is much more rapid than the diminution of January to June. This dissymmetry is explained as a result of the superposition of the effects of atmospheric depressions of the polar front upon those of the cyclones of the south Pacific. Hawaii is well placed to receive oceanic swells from all directions.— V.S.N.

- 189-480. Rykunov, L. N., and Mishin, S. V. Nekotoryye osobennosti rasprostraneniya mikroseysem po kontinental'nym putyam [Certain features of propagation of microseisms along continental paths]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 6, p. 810-817, 1961.

The effect of surface topography and of the structure of the upper part of the crust on intensity of microseisms is discussed. The microseismic storm caused by the cyclone which passed along the northwest coast of Norway on February 1-3, 1958 is studied on models representing the actual relief along the traverse. It was found that microseisms are sensitive to local features of the surface relief and of the upper part of the crust. In passing through sectors of complex relief and structure the intensities of the Rayleigh components decrease due to absorption and dispersion. Data were obtained that indicate that the transverse Love components of the microseisms appear as a result of partial transformation of initial Rayleigh waves in passing across such terrains.— A.J.S.

## RADIOACTIVITY

189-481. Watt, D. E., and Glover, R. N. A search for radioactivity among naturally occurring isobars pairs: *Philos. Mag.*, v. 7, no. 73, p. 105-114, 1962.

Low-background techniques have been used to search for radioactivity among the naturally occurring isobars pairs Cd-113-In-113, In-115-Sn-115, Sb-123-Te-123, and Re-187-Os-187. No activity was observed from Cd-113 which is found to have a minimum half life of  $1.3 \times 10^{15}$  yr for emission of  $\beta$ -rays with energy  $>1.2$  Kev. A new value of  $480 \pm 30$  Kev has been obtained for the beta-disintegration energy of In-115 and the half life measured to be  $5.1 \pm 0.4 \times 10^{14}$  yr. The unstable member of the Sb-Te-123 pair is shown to be Te-123 which decays by K electron capture with a half life of  $1.24 \pm 0.10 \times 10^{13}$  yr. The decay of Re-187 is established by observation of the beta spectrum with maximum energy  $1.2 \pm 0.10$  Kev. The half life is estimated to be of the order of  $3 \times 10^{10}$  yr.— Authors' abstract

189-482. McNair, A., and Wilson, H. W. The half-life of rubidium-87: *Philos. Mag.*, v. 6, no. 64, p. 563-572, 1961.

A  $4\pi$  proportional counter system capable of examining thin sources of extended area has been used to determine the half life of Rb-87, which was found to be  $(5.25 \pm 0.10) \times 10^{10}$  yr. Corrections for absorption of electrons and for scattering in the source supporting foil are discussed.— Authors' abstract

189-483. Graeffe, G., and Nurmia, M. The use of thick sources of alpha spectrometry: *Acad. Sci. Fennicae Annales*, ser. A-6, no. 77, 14 p., 1961.

Expressions for the differential and integral spectra of infinitely thick alpha sources are derived. Measurements on thick sources of U, Sm, Pt, and W are described. The following results are obtained: Sm-147:  $2.23 \pm 0.05$  Mev,  $T_{1/2} = 1.13 \cdot 10^{11}$  yr; Pt-190:  $3.16 \pm 0.05$  Mev,  $T_{1/2} = 6.8 \cdot 10^{11}$  yr; natural W: no activity with  $T_{1/2} \cdot (\text{abundance}) < 10^{15}$  yr · percent. The accuracy of the  $T_{1/2}$  values is mainly limited by the available stopping cross-section values. It is estimated that with present methods the limit of detection is  $10^{16}$  yr · percent.— Authors' abstract

189-484. Taagepera, R., and Nurmia, M. On the relations between half-life and energy release in alpha decay: *Acad. Sci. Fennicae Annales*, ser. A-6, no. 78, 16 p., 1961.

By introducing approximations to the Bethe equation, the following expression for the logarithm of the half life of an alpha-active nuclide is obtained:  $\log T = C_1 X - C_2$ , where  $X = Z_d E^{-1/2} - Z_d^2/3$ ,  $Z_d$  being the atomic number of the daughter and E the alpha-particle energy. By choosing  $C_1 = 1.61$ ,  $C_2 = 28.9$ , a good fit for most alpha emitters is obtained. It is surprising that the formula also predicts half lives of the right order of magnitude for such alpha emitters as He<sup>5</sup> and Li<sup>5</sup>. The effects of closed shells, spin change, and odd nucleons are investigated, and some examples of the application of the formula are discussed.— Authors' abstract

- 189-485. Kauranen, Pentti. Alpha branching in the decay of  $Pb^{210}$  and  $Bi^{210}$ ; a new mercury isotope  $Hg^{206}$ : Acad. Sci Fennicae Annales, Ser. A-6, no. 96, 30 p., 1962.

A small alpha-branching in  $Pb$ -210 (RaD) has been established by ion chamber measurements with purified  $Pb$ -210 samples. The ratio is  $(1.7 \pm 0.3) \times 10^{-8}$  and the alpha-particle energy is  $3.72 \pm 0.02$  Mev. The alpha branching-ratio of  $Bi$ -210 has been re-determined to be  $(1.32 \pm 0.10) \times 10^{-6}$ . The alpha-decay daughter of  $Pb$ -210, a new mercury isotope  $Hg$ -206, has been isolated and its beta activity studied. A half life value of  $8.5 \pm 0.1$  min and a beta-decay energy of 1.29 Mev have been obtained for  $Hg$ -206. — V.S.N.

- 189-486. Roubault, M[arcel], and Coppens, R[éné]. Influence de l'alteration sur la répartition des éléments radioactifs dans les roches [Effect of alteration on the distribution of the radioactive elements in rocks]: Soc. Savantes Cong., Dijon 1959, Sec. Sci., Comptes Rendus, p. 287-295, 1960.

The effect of alteration on the distribution of radioactivity in rocks was investigated by examination of samples taken at different depths in a boring down to fresh rock in the Mortagne granite batholith in Vendée, France. In two samples, one fresh and the other slightly altered, significant differences were observed. In the fresh rock the inclusions accounted for 75 percent of the radioactivity, in the altered rock only 29 percent; on the other hand, leaching of the powdered rock yielded 27 percent of the total uranium in the fresh sample and 68 percent of the total uranium in the altered sample. It is concluded that alteration of the essential constituents of a rock is attended by parallel alteration of certain radioactive crystals (only zircon is virtually unalterable), with corresponding diffusion of the radioactivity. — D.B.V.

- 189-487. Morais, Marília Xavier de. Radioatividade do sienito nefelínico da pedreira do Quiculungo (Golongo Alto, Angola) [Radioactivity of the nepheline syenite of the Quiculungo quarry (Upper Golongo, Angola) (with English summary)]: Coimbra Univ. Mus. Mineralog. Geol. Mem. e Notícias, no. 51, p. 49-55, 1961.

The radioactivity of two samples of nepheline syenite, one coarse-grained and the other very coarse-grained, from the Quiculungo quarry in Angola has been determined by means of alpha-tracks on nuclear emulsion plates and found to be lower than the average for granites. Individual crystals (ilmenite, zircon, malacon, and apatite) from the coarser-grained sample are more radioactive on the average than crystals from the other, but the total radioactivity of the former rock is lower because the radioactive grains are more widely scattered. — D.B.V.

- 189-488. Nishimura, Susumu. Variation in radioactivity across igneous contacts (the third reports): Kyoto Univ. Coll. Sci. Mem., ser. B, v. 28, no. 2, p. 255-264, 1961.

Fifty-three new profiles of distribution of radioactivity across igneous contacts have been made, and several of the more typical ones are reproduced in this report. Measurements of radioactivity of samples collected continuously along a line perpendicular to the line of igneous contact show the same variations as found in previous sampling (see Geophys. Abs. 172-208, 178-324). A study to determine whether or not the peak observed in the curves of radioactivity distribution may be caused by a predominating type of radioactive element was made by comparing an alpha-activity curve with a beta-activity curve of the same samples along a traverse. Results were indefinite because of the weak beta activity (presumably a lack of instrumental sensitivity) except that a peak observed in the beta-ray curve close to the contact and apparently corresponding to the peak in the alpha-ray curve is suggestive of concentration of Th, U, and K-40 as well as Rb-87. — V.S.N.

- 189-489. Nishimura, Susumu. Variations in radioactivity and chemical elements across igneous contacts: Kyoto Univ. Coll. Sci. Mem., ser. B, v. 28, no. 2, p. 265-284, 1961.

Large variations in chemical composition and alpha-activity are found along traverses normal to the contact of granitic material with various rock types. Studies of these variations by analysis of closely spaced samples using semi-quantitative spectrographic methods and by measurement of beta-activity are described. Results indicate that major and minor rock components are mobile when moderate temperature- and concentration-gradients are present. Migration of materials is believed to take place late during the cooling history by diffusion along mineral boundaries. Generally smooth and continuous variations in alpha-activity are found across contacts between intrusives and wall rocks of different original compositions that have been held at high temperatures. Highly irregular variations are found where the intrusive and wall rock are compositionally different and a steep thermal gradient existed. No remarkable variations in beta-activity distribution have been found in either case, however. (See also Geophys. Abs. 172-208, 178-324, 189-488.)— V.S.N.

- 189-490. Tokarev, A. N., and Shcherbakov, A. V. Radiohydrogeology: U.S. Atomic Energy Comm. Office Tech. Services, AEC-tr-4100, 346 p., 1960. Translation of Radiogidrologiya: Moscow, Gosgeoltekhizdat, 1956.

"Radiohydrogeology" is a first attempt to analyze the conditions for formation of radioactive waters, their role in the formation of radioactive mineral deposits, and the procedures for their investigation. Part 1, Fundamentals of radiohydrogeology, includes three chapters: (1) conditions for enrichment of natural waters with radioactive elements, (2) types of natural radioactive waters and their formation, and (3) hydrogeological conditions for formation and destruction of uranium deposits. Part 2, procedures for radiohydrogeological investigations, includes six chapters: (1) general, (2) organizing and conducting radiohydrogeological investigations, (3) procedural instructions concerning interpretation of radiohydrogeological data, (4) methods of determining the radioactivity of water and gas, (5) methods of computing the resources of radioactive waters, and (6) processing of data. A bibliography of 118 items is included. Examples of illustrating data graphically are shown in 9 addenda.— V.S.N.

- 189-491. Servant, J., and Tanaevsky, O[lga]. Mesures de la radioactivité naturelle dans la région Parisienne [Measurement of natural radioactivity in the Paris region]: Annales Géophysique, v. 17, no. 4, p. 405-409, 1961.

The methods of measuring natural radon emanation on or at various levels above the ground are described, and the results of measurements at Quai Branly and the Eifel Tower in Paris are discussed and illustrated in tables and graphs. Measurements at the ground were begun in 1955 and have continued without interruption to the present time. Comparison between the monthly mean of radon for 1955 and 1960 at Paris and at Saclay shows that it was weak from 1955 through 1958 but became more elevated in 1959 and 1960. Results demonstrate that radon accumulation above the ground is favored by intense fog, stable air, and temperature inversion due to radiation or subsidence. The accumulation is of the same order on plateaus as in valleys.— V.S.N.

- 189-492. De Santis, L. Prime misura di radioattività naturale dell'aria a Bari [First measurements of natural radioactivity of air at Bari]: Boll. Geofisica Teor. ed Appl., v. 3, no. 9, p. 3-18, 1961.

Background information is given on the normal concentration of radon and thoron in the atmosphere and on the techniques used in determination of the concentration of these elements in the air filtered by the International Geophysical Year station at Bari, Italy during the period from May 3 to August 4, 1960. The highest concentrations of Rn (894.00  $\mu\mu$  Curie per m) and of Tn (53.1  $\mu\mu$  Curie per m) were recorded on May 15, and the lowest concentrations of Rn (2.1  $\mu\mu$  Curie per m) on June 18, and Tn (1.3  $\mu\mu$  Curie per m) on May 6.—A.J.S.

#### RADIOACTIVITY SURVEYING AND LOGGING

- 189-493. Yermakov, V. I., Laubenbakh, A. I., Ovanesov, M. G., Romanov, Yu. A., and Skosyreva, L. N. Rezul'taty issledovaniy yestestvennogo gamma-polya v neftenosnykh rayonakh metodami vozduшной i nazemnoy radiometricheskoy s"yemki [Results of investigation of the natural gamma field in oil-bearing regions by the methods of airborne and land radiometric survey], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 264-278, 1959.*

Changes in intensity of gamma radiation over oil pools and correlation of these changes with structural elements were studied by the methods of land and airborne radioactivity surveys complemented by geologic-lithological observations and laboratory analyses. The intensity of gamma radiation above oil pools is as much as 20-30 percent lower than that above the surrounding area. The conclusion was reached that variations in gamma radiation due to the presence of oil can be determined with the aid of highly sensitive scintillation spectrum discriminators.—A.J.S.

- 189-494. Grumbkov, A. P. Opyt razdel'noy registratsii avtomobil'nym radiometrom toriyevoy i radiyevoy sostavlyayushchikh gamma-izlucheniya pri poiskakh nefi [An experiment in separation of thorium and radium components of gamma radiation by an automobile radiometer in prospecting for oil], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 300-305, 1959.*

An hypothesis is proposed to explain the drop in intensity of gamma radiation over petroleum deposits. It is suggested that the gamma radiation anomaly associated with oil is due to radium (Ra-228) activity only, because Th-232 has little chemical mobility and its decay products have a low half life. An automobile gamma-spectrometer was designed to test the hypothesis in the field. Spectroscopic measurements of gamma radiation carried out with the apparatus (AGR-SS) in oilfields of the Bashkir A.S.S.R. and Turkmen S.S.R. indicate that there is a correlation between oil pools and the intensity of the radium-uranium component of the gamma radiation.—A.J.S.

- 189-495. Alekseyev, F. A., Grumbkov, A. P., and Gottikh, R. P. Radiometriya i radiogeokhimiya pri pryamykh poiskakh nefi i gaza [Radiometry and radiogeochemistry in direct search of oil and gas], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 225-278, 1960.*

Several investigations on the applicability of radiometric and radiochemical methods to exploration for oil pools conducted in the U.S.S.R. and elsewhere are discussed.—V.G.G.

- 189-496. Grumbkov, A. P., Matveyev, V. V., Semenov, G. S., and Sokolov, A. D. Radiometr-analizator "Avtogras" i yego primeneniye dlya radiometricheskikh poiskov nefi i gaza [Radiometer-analyzer "Avtogras" and its application to radioactive prospecting for oil and gas], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 279-289, 1959.*

A new radiometer "Avtogras" designed for spectroscopic discrimination of intensity of gamma radiation produced by the uranium-radium-thorium family

and by the radioactive isotope of potassium is described. The apparatus is used for obtaining data for a system of four independent equations derived from the four component equation  $J_{\text{tot}} = J_U + J_{\text{Ra}} + J_{\text{K40}} + J_{\text{Th}}$ ; it consists of a two-core threshold gamma spectrometer installed on an automobile type GAZ-69. In this transportable form the radiometer "Avtogras" was tested in the Kum Dag and Okarem oil-bearing areas in southwestern Turkmen S.S.R.—A.J.S.

189-497. Matveyev, V. V., and Sokolov, A. D. Stintillyatsionnyy zhidkostnoy radiometr-analizator "Aviagras" [Scintillation liquid radiometer-analyzer "Aviagras"], in *Yadernaya Geofizika: Moscow, Gostoptekhzdat*, p. 290-299, 1959.

This is a variation of the "Avtogras" radiometer discussed in another paper (see *Geophys. Abs.* 189-496). The "Aviagras" radiometer is a 20 liter liquid scintillation counter, the signals of which enter a two-channel threshold amplitude impulse analyzer designed specially for airborne radiometry.—A.J.S.

189-498. Petrov, G. I., Kutenkov, M. V., Tenenbaum, I. M., and Yevseyeva, L. S. *Metody geologo-geofizicheskogo obsluzhivaniya uranovykh rudnikov* [Methods of geological-geophysical development of uranium mines]: Moscow, Atomizdat, 216 p., 1961.

Field procedures and instruments used in radioactivity surveying and well logging in the U.S.S.R. are described as part of this general treatment of the development of uranium deposits.—J.W.C.

189-499. Schmidt, Robert G. *Aeroradioactivity survey and areal geology of the Savannah River Plant area, South Carolina and Georgia: U.S. Atomic Energy Comm., Civil Effects Study CEX-58.4.2*, 41 p., 1962.

In a survey of 10,000 sq mi near Augusta, Ga., continuous radioactivity profiles were obtained with scintillation counting equipment at approximately 500 feet above the ground on parallel northwest-southeast flight lines spaced 1 mile apart. A map of radioactivity units prepared from the profiles is included (see also *Geophys. Abs.* 187-540). The gamma-radiation data indicate a wide range in the levels of natural radioactivity, and the levels are found to be closely related to the types of underlying rock.

About 2,000 sq mi of the Piedmont province, which is largely mantled by a thick residual soil, is included in the area. Several rock units may be mapped by their characteristic radioactivity irrespective of this residual mantle. The Coastal Plain province with Cretaceous to Quaternary sedimentary units comprises the remainder of the area surveyed. The radioactivity of the Upper Cretaceous and Eocene rocks ranges from moderate to high whereas that of the younger beds is generally low.—V.S.N.

189-500. Lorenz, Philip J., Rodenberg, Orville C., Shadle, Larry G., Antes, Alan C., and Hess, William D. *Background radioactivity in the Decorah fault region: Iowa Acad. Sci. Proc.*, v. 68, p. 397-403, 1961.

A known fault site at Decorah, Iowa, was surveyed for indicative variations in surface radioactivity. Significant increases in gamma ray intensity were found at several locations; at one point the radiation level was 70 percent higher than background. Measurements repeated one year later verified this pattern. A map of radiation contours plotted over an extensive area of Decorah with other supporting evidence indicates a possible fault strike of approximately N. 55° W. There is no reason to expect that all faults will display a high gamma radiation profile. However, if such an increase is generally characteristic of faults in a specific region, a welcome addition to methods of geophysical exploration may be developed.—V.S.N.

- 189-501. Argentière, R[ômulo]. Notas sobre a companhia radiométrica na região centro-sul da Bahia [Notes on the radioactivity survey in the south central part of Bahia]: Engenharia, Mineração e Metalurgia, v. 30, no. 178, p. 203-206, 1959.

The results of recent radioactivity prospecting in south central Bahia, Brazil, are reported. Radioactivity anomalies are associated with fluorite, manganese, and lead and iron mineralization, and also with thermal waters. About one percent of the area of Brazil has been covered during a 20-year period. Many interesting things have been found, but no deposits of uranium, the principal object of the surveys.—D.B.V.

- 189-502. Löser, Günter. Radioaktive Bodenluftmessungen als Beitrag zur Klärung tektonischer Probleme am Südwestrand des Thüringer Waldes [Radioactive soil air measurements as a contribution to clarification of structural problems on the southwest border of the Thüringer Wald]: Geophysik u. Geologie, no. 1, p. 97-103, [1959].

Measurements of soil air radioactivity aid in mapping faults under the soil cover along the southwest border of the Thüringer Wald in Germany. The traces of the Floher, Klinger, Stahlberg, and Hessleser faults were clearly evinced by increases in radon concentration in the overlying soil air. No systematic relationships could be established between depth, throw, dip, and country rock of the faults on the one hand and height and shape of the radioactivity anomalies on the other. The results are reproducible. In wooded areas or areas of thick, moist overburden the measurements were of limited value, however.—D.B.V.

- 189-503. Dmitriyev, M. K., Flaks, Ya. Sh., and Golovin, A. P. Opyt primeneniya radiometricheskikh issledovaniy dlya pryamykh poiskov neftyanykh mestorozhdeniy v Bashkirii [Experience in the application of radiometric investigations for the direct prospecting for oil deposits in the Bashkir ASSR], in Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 206-219, 1960.

Aerial and ground radiometric surveys have covered more than 25,000 sq km in the Bashkir A.S.S.R. Oil pools are marked by a decrease in gamma-ray activity. The relative decreases in intensity are usually equal to 20-25 percent of the surrounding areas and show zonal persistence. Sharp intensity changes of the gamma-ray fields are not typical of oil pools but are due to surface factors.—V.G.G.

- 189-504. Voskoboinikov, G. M., Utkin, V. I., and Burdin, Yu. B. Spektral'nyye metody opredeleniya prirody anomalii selektivnogo karotazha [Spectral methods of determination of the nature of selective logging anomalies]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1141-1149, 1961.

When proper equipment is used the K-absorption band of heavy elements is clearly observed in gamma radiation scattered by ore deposits in boreholes. Therefore, the characteristic scattering spectrum associated with the K-absorption edge of heavy metals provides a basis for developing a practical logging method. The method was tested on lead-zinc deposits. Since small amounts of zinc cannot be detected by this method, the deposits must be regarded as containing only lead. Close agreement is found between the indications of lead mineralization from the log and the occurrence of galena determined by coring.—J.W.C.

- 189-505. Fel'dman, I. I. K metodike kolichestvennogo opredeleniya sodержaniya bora i margantsa neytronnymi metodami v plastakh gornykh porod [On the method of the quantitative determination of boron and manganese contents in rock strata], in Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 181-205, 1960.

Neutron methods have been used in exploration for boron deposits since 1954. The neutron-gamma method is the basic tool and is satisfactory under ordinary geological conditions. The thermal neutron method is more sensitive to the presence of boron; however, its wide application is not practical because of the lack of standardized equipment. The epithermal neutron method has the least capability for differentiating boron deposits. The neutron-gamma method combined with the study of thin sections has been used successfully.

Radiometric methods have been used in exploration for manganese deposits since 1954. The neutron, neutron-neutron, neutron-gamma, and induced radioactivity methods have been employed.— V.G.G.

- 189-506. Guberman, Sh. A. Ispol'zovaniye printsipov podobiya pri reshenii zadach radiometrii skvazhin [Application of similarity principles to solution of borehole radiometry problems]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1183-1188, 1961.

The application of similarity principles to solution of problems of particle and radiation transfer on the basis of a known kinetic equation is discussed. The results obtained are applied for solution of problems of neutron and  $\gamma$ -quanta distribution in rocks penetrated by a borehole. The problems of neutron and  $\gamma$ -quanta distribution in a homogeneous medium, in a layer penetrated by a borehole, and in a layered medium are treated.— A.J.S.

- 189-507. Alekseyev, F. A., and Denisik, S. Ts. Radioaktivnyye metody kontrolya za razrabotkoy neftyanykh mestorozhdeniy [Radioactivity methods of control of exploitation of oilfields]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 29, p. 32-43, 1960.

Radioactive methods of borehole investigation are discussed. Problems of distinguishing oil- and water-bearing strata in cased holes, tracing water movements in the stratum, application of isotopes for distinguishing absorbing strata, and control of technical conditions in boreholes by radioactive methods are discussed.— A.J.S.

- 189-508. Zakharchenko, V. F. Nekotoryye voprosy teorii neytronnogo karotazha s primeneniym impul'snogo generatora neytronov [Certain problems of neutron logging theory using an impulse generator of neutrons]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 847-854, 1961.

The nonstationary problem of transfer of retarded neutrons is discussed from the point of view of the time characteristic of the process of neutron propagation from an impulse source. A system of differential equations is obtained by the Fermi-Greiling-Hertze approximation, which being solved by the inverse Laplace transformation yields the function of the initial density of retardation,  $q_0$ , leading to the energy-time distribution of fast neutrons from an isotropic, monochromatic point source. A concept of narrow and wide impulses of neutrons is introduced based on the above investigation. The duration of the narrow impulses is many times shorter than the time of retardation, whereas an impulse with a duration comparable to the duration of retardation is considered to be a wide impulse. The applicability of the time distribution theory to neutron logging practice is discussed.— A.J.S.

- 189-509. Burov, B. M., Darvoyd, G. N., Denisik, F. Ts., Odinokov, V. P., and Shcherbinskiy, V. G. Ispol'zovaniye neytron-neytronnogo metoda (NNM) po nadteplym neytronam dlya otsenki poristosti peschanykh i karbonatnykh kollektorov [Utilization of the neutron-neutron method (NNM), according to the epithermal neutrons for evaluation of porosity of sand and carbonate reservoirs], in Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 121-133, 1959.

The possibility of determining porosity by the method of epithermal neutrons is discussed. Laboratory modeling and borehole data indicate that: (1) There is a nearly exponential relationship between epithermal neutron density and porosity in uncased boreholes; (2) the differential readings in an uncased borehole are higher than in a cased one; and (3) in a dry uncased borehole the recorded reading of epithermal neutron density increases with an increase in porosity.— A.J.S.

- 189-510. Alekseyev, F. A., Denisik, S. A., Miller, V. V., and Odinkov, V. P. *Primeneniye metoda spektrometrii gamma-izlucheniya dlya issledovaniya skvazhin* [Application of the method of gamma-radiation spectroscopy in borehole investigations], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 134-145, 1959.*

The possibilities of application of gamma-radiation spectrometry in studies of rock composition in boreholes, and determination of oil- and water-bearing layers and the contact zone between them are discussed. Natural gamma-radiation data are presented, the procedure and apparatus of spectroscopic determination of gamma-radiation due to an induced radioactivity are discussed, and spectrometry of gamma-radiation of radiative capture is studied. It is found that the intensities of the spectral lines of radium, thorium, and potassium, and therefore their content in the rock, can be determined by this method.— A.J.S.

- 189-511. Guberman, Sh. A. *O spektroskopii gamma-izlucheniya yestestvennykh i iskustvennykh radioaktivnykh izotopov v usloviyakh skvazhiny* [On the spectroscopy of gamma radiation of natural and artificial radioactive isotopes under borehole conditions], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 146-153, 1959.*

The problem of differentiation of water- and oil-saturated strata by gamma spectrometry is investigated with a LS-2 scintillation counter. The energy spectrum in the range from 100 Kev to 1.7-1.8 Mev was studied by taking the integral curves of spectral distribution of natural gamma radiation in cased water-filled boreholes drilled in water- and oil-bearing sandstone, shales, and limestones. It was found that the soft radiation up to 0.3 Mev only should be recorded in order to have a satisfactory differentiation of the spectrum. The energy range should be increased to 1.3 Mev when the induced activity method is used for recording the Na-24 radiation.— A.J.S.

- 189-512. Odinkov, V. P., Denisik, S. A., and Shimelevich, Yu. S. *Opredele niye polozheniya vodo-neftyanogo kontakta po dannym neytronogo gamma-metoda so stsintillyatsionnym schetchikom (NGM-LS) i neytron-neytronogo metoda po teplovyim neytronam (NNM-T)* [Determination of the location of the water-oil contact from data of the neutron-gamma method and scintillation counter (NGM-LS) and of the neutron-neutron method according to thermal neutrons (NNM-T)], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 154-169, 1959.*

The physical basis of the neutron-neutron and neutron-gamma methods are described from the point of view of their application to tracing water-oil contacts in reservoir rocks. Laboratory experiments by the neutron-gamma method are described, and the effects of steel casing and concrete in the borehole on the intensity of gamma-radiation are discussed. Modeling experiments and field tests for observing the differences in emission intensity of thermal neutrons from water- and oil-bearing layers by the neutron-neutron method of thermal neutrons are described.— A.J.S.

189-513. Gulin, Y. A. Vliyaniye usloviy izmereniy pri otsenke poristosti poro po dannym neytronnogo gamma-metoda [Effect of conditions of measurement on evaluation of rock porosity from the data of gamma logging], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 201-221, 1959.

Porosity determination by gamma logging is discussed. The total porosity of rocks is generally not proportional to water content; such a relationship does not exist, for example, in gas-bearing strata, in sandy strata containing highly saline water, and in clay and gypsum containing layers with chemically bound water. The existing methods of porosity evaluation according to the neutron-gamma method graphs, such as one and two marker horizon methods, the method of two sounding electrodes, and the method of the tangent of the dip angle are described.—A.J.S.

189-514. Tslav, L. Z. K voprosu ob opredelenii polozheniya vodo-neftyanogo contacta v karbonatnykh otlozheniyakh v usloviyakh obszhennykh skvazhin [The problem of locating a water-oil contact in carbonate sediments in cased boreholes], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 228-237, 1959.

The problem of determining the water-oil contact in cased boreholes by the neutron method and the neutron-gamma method is discussed. Experiments with models of carbonate layers and field tests in four boreholes in limestone are described. It was found that the method of chlorine activation is the most promising in determination of water-oil contacts by radiometric methods.—A.J.S.

189-515. Yerozolimskiy, B. G., and Shkol'nikov, A. S. Metod razdeleniya vodo i nefte nasyshennykh plastov, osnovanny na primenenii impulsnogo neytronnogo istochnika [Method of separation of water and oil saturated layers based on application of an impulse neutron source], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 337-345, 1959.

An impulse source of neutrons and a neutron impulse meter are discussed. The impulse method is analyzed, and experimental curves of thermal neutron density as a function of time are obtained from the models of oil- and water-bearing sandstone layers.—A.J.S.

189-516. Alekseyev, F. A., Yerozolimskiy, B. G., Bespalov, D. F., Bondarenko, L. N., Voytsik, L. P., Popov, N. V., Khaustov, A. I., Romanovskiy, V. F., Shimelevich, Yu. S., Shkolnikov, A. S., and Yudin, L. I. O rezul'tatakh primeneniya neytronnykh impul'snykh metodov i apparatury dlya issledovaniya razreza skvazhin [On the results of application of neutron pulse methods and instrumentation for investigation of sections of wells], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 3-20, 1960.

The utilization of a neutron tube as a neutron generator has given a strong impetus to designing for the neutron pulse method. The neutron tube contains two spirals made of titanium, one of which is saturated with deuterium. The tube is connected to a relatively high voltage generator, two transformers, and a condenser, and the flow of neutrons is recorded by eight counters. Neutron condenser generators have been used in correlating well sections in the Bashkir A.S.S.R. at depths ranging from 1,600 to 1,800 m. It was found that the flow of neutrons was  $2 \times 10^6$  neutrons per second with the duration impulse equal to  $40 \mu$  sec at approximately 450 cycles per second. It was also found that the flow of neutron depends more on tube pressures and less on high voltages.

Pulse neutron-neutron logging has been under consideration since 1958, and it was shown that under certain conditions water-oil contacts can be identified satisfactorily.—V.G.G.

- 189-517. Guberman, Sh. A. O vozmozhnosti kompleksnoy interpretatsii dannykh neytron-neytronnogo i neytronnogo gamma-metodov issledovaniya skvazhin [On the possibility of an integrated interpretation of the data of neutron-neutron and neutron-gamma methods for investigation of boreholes], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 86-93, 1960.

The use of integrated interpretation of the neutron-neutron, neutron-gamma, and gamma methods in logging cased boreholes is investigated. Basic data for interpretation of both neutron-neutron and neutron-gamma methods are given, and then the selection of units of measurement and depth of probing, and evaluation of chlorine content, porosity, and oil saturation are discussed. It is concluded that (1) integrated interpretation of data of the neutron-gamma and neutron-neutron methods permits evaluation of the chlorine and hydrogen content of a stratum; (2) by using the same data, the percent of bound water can be evaluated; and (3) the magnitude of chlorine content in a stratum can be utilized for the evaluation of oil saturation in the same stratum.— V.G.G.

- 189-518. Kukharenko, N. K. Rol' apparaturnykh i skvazhinnykh faktorov pri opredelenii poristosti plastov po dannym neytronnogo gamma-karotazha skvazhin [Role of instrumental and borehole factors in the determination of stratum porosities according to data of neutron-gamma logging of boreholes], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 94-104, 1960.

Data obtained using two channel radioactivity logging apparatus do not yield reliable porosities. It is believed, however, that improvements will lead to broader use of the neutron-gamma method. A careful evaluation of the influence of mud cake and of salinity of drilling muds on neutron-gamma logs is necessary.— V.G.G.

- 189-519. Larionov, V. V. Opredeleniye poristosti porod po dannym neytronnogo gamma-metoda [Determination of rock porosities from neutron-gamma logging data], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 105-116, 1960.

The low effectiveness of neutron logging for determination of reservoir porosities is due chiefly to the simplified approach in interpretation of the data. Reliable interpretation calls for a detailed evaluation of numerous factors such as the absorption and scattering characteristics of rocks, their mineralogical characteristics, and the salinity of the formation fluids. — V.G.G.

- 189-520. Tal'yanskiy, I. I., Bilen'kiy, B. F., and Dragan, Ya. P. K teorii neytronnogo karotazha [To the theory of neutron logging]: *Prikladnaya Geofizika*, no. 25, p. 223-233, 1960.

The spatial distribution of thermal neutrons from a point source located on the axis of a liquid-filled borehole logged by the neutron-neutron method is treated mathematically.— A.J.S.

- 189-521. Alekseyev, F. A., Odinkov, V. P., and Shimelevich, Yu. S. Aktivatsionnyy analiz gornyykh porod v usloviyakh skvazhiny i yego ispol'zovaniye dlya opredeleniya mestopolozheniya neftenosnykh i vodonosnykh plastov [Activation analysis of rocks under borehole conditions, and its application to locating oil-bearing and water-bearing strata], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 65-99, 1959.

The method of induced radioactivity or activation analysis is described, and its results discussed as applied to determination of oil and water horizons intersected by a borehole. Positive results were obtained with moderate salinity of the water (less than 100 g of NaCl per l) and under conditions of nonhomo-

geneous strata where the neutron method failed to produce satisfactory results. It was found that under favorable conditions Na, Al, Cl, Mg, Ca, and Mn can be determined.— A.J.S.

- 189-522. Aksel'rod, S. M. Otivka vodo-neftyanogo kontakta metodom navedennoy aktivnosti natriya v usloviyakh neftnyanykh mestorozhdeniy Azerbaydzhana [Water-oil contact determination by the method of induced sodium activation under the conditions of the oil fields of Azerbaijan], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 100-102, 1959.

The application of the induced activity method under the conditions of the low salinity formation waters in the Azerbaijan S.S.R. is discussed. Applying sodium activation the water-oil contacts in a number of boreholes were determined more satisfactorily than was possible by the neutron gamma method.— A.J.S.

- 189-523. Rezmanov, R. A. Vozmozhnosti metoda navedennoy aktivnosti dlya kolichesvennoy otsenki neftenasyschennosti i drugikh kharakteristik plastov [Potentiality of the method of induced activity for quantitative evaluation of oil saturation and other parameters of a stratum], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 103-109, 1959.

The application of the induced activity method to study of the chemical and mineral composition of rocks and to quantitative determination of oil saturation in cased boreholes is discussed. Oil saturation is determined on a basis of Na-26, which is formed by action of neutrons on Na-23, an isotope which is in low concentration in oil. The induced activity method gives better results in ore boreholes. The contents of Mn, V, Al, Cu, Au, Ag, and other metals were determined accurately. For example, a content of 0.1 percent V and 0.01 percent In were determined.— A.J.S.

- 189-524. Blankova, T. N. Effektivnost' metodov navedennoy aktivnosti natriya i khloro pri raschlenenii peschanikov devona po vodoneftenasyschennosti [Effectiveness of the methods of induced activity of sodium and chlorine in differentiating Devonian sandstones according to water and oil saturation], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 110-120, 1959.

A variant of the induced activity method using sodium and chlorine (see Geophys. Abs. 189-523) and more accurate criteria for water and oil contents in sandstone reservoirs are discussed.— A.J.S.

- 189-525. Blankov, Ye. B. Vydeleniye izlucheniya otdel'nykh elementov pri issledovanii neftnyanykh skvazhin metodom navedennoy aktivnosti natriya i khloro [Distinguishing the radiation of individual elements in logging oil wells by the method of induced activity of sodium and chlorine], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat* p. 170-186, 1959.

The method of induced activity of sodium and chlorine in boreholes drilled in water- and oil-bearing sandstones is analyzed. Nomograms for distinguishing count rates from integral 2- and 3-component curves are constructed, statistical error in discriminated component curves is determined, and the threshold activity of chlorine is calculated.— A.J.S.

- 189-526. Leypunskaya, D. I., and Gauer, Z. Ye. Oneytronnom aktivatsionnom analize gornyykh porod [On neutron activation analysis of rocks], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat*, p. 238-251, 1959.

The property of selectivity of slow neutron activation analysis is used in analyzing ore-bearing rocks for Ag, Rh, Al, V, Cu, Co, I, Cl, Br, Th, In, Mn, Dy, Eu, Sm, Si, and other elements in samples and boreholes, thereby bypassing chemical analysis. Examples of determination of V, In, and Co in ores, Mn in ores and soils, and Al and Si in rocks are given and discussed.— A.J.S.

- 189-527. Zolotov, A. V. Effektivnyye secheniya khloro dlya medlennykh neytronov [Effective cross sections of chlorine for slow neutrons], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p. 332-336, 1959.

As chlorine is an anomalous absorber of thermal neutrons and their density and that of secondary gamma radiation depend on the neutron parameters of the rock such as slowing-down length  $L_S$ , thermal diffusion length  $L_D$ , and the mean lifetime  $\tau$ , determination of the water-oil contact and of saturation of rocks with water, oil, and gas depends on the content of chlorine and the above mentioned rock parameters. The effective absorption cross sections of chlorine for slow neutrons are studied, and the theoretical and experimental curves are compared. Data for the total cross section, absorption cross section, resonant scattering cross section, and potential scattering of chlorine are given.— A.J.S.

- 189-528. Dvorkin, I. L., and Rezvanov, P. A. K ispol'zovaniyu stsintilatsionnykh schetchikov dlya scheta medlennykh neytronov v neftyanykh skvazhinakh [On the application of scintillation counters for counting slow neutrons in oil wells], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p. 187-194, 1959.

Characteristic features of proportional and scintillation counters are compared, and their efficiency is evaluated by laboratory and field experiments. It was found that: (1) The efficiency of scintillation pick-ups is considerably greater than that of proportional counters, (2) the same design of a scintillation counter can be used in all radiometric methods of recognizing oil- and water-bearing rock reservoirs, and (3) the scintillation apparatus has no feedback effect and is sturdy in construction.— A.J.S.

- 189-529. Filippov, Ye. M. Nekotoryye voprosy metokiki i teorii gamma-gamma-metoda [Some problems of the technique and theory of the gamma-gamma method], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p. 306-331, 1959.

Application of the gamma-gamma method in prospecting for coal, ores, and oil and gas is discussed. The effect of the thickness of the lead screen, thickness of the medium, borehole diameter, and the mud cake on the intensity of diffused gamma radiation is analyzed. Deep radial penetration devices for measuring diffused gamma radiation in boreholes are discussed.— A.J.S.

- 189-530. Bupalov, D. F., and Khaustov, A. I. Istochnik vysokogo napryazheniya 100 kv dlya skvazhinnogo generatora neytronov [High voltage source of 100 kv for a borehole neutron generator], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p. 346-350, 1959.

A high voltage (100 kv) source for feeding the accelerator tube of a borehole neutron generator is proposed. The generator is also described and a schematic diagram given. It is designed as an externally excited resonance power amplifier.— A.J.S.

- 189-531. Voytsik, L. P., and Yerozolimskiy, B. G. Laboratoriy generator neytronov [A laboratory neutron generator], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p. 356-369, 1959.

A generator of neutrons for laboratory use is described. The generator operates on pulse and continuous rates using a single acceleration of ions and direct current. A diagram of the apparatus is given and the work principle is described. The high voltage source and rectifier are discussed. The observed output is of the order of  $2 \times 10^6$ – $3 \times 10^7$  neutrons per second. The generator is considered capable of  $10^{10}$  neutrons per second, in which case appropriate shielding should be provided.— A.J.S.

- 189-532. Chelok'yan, R. S. Razrabotka odnokanal'nogo skvazhinnogo pribora RK dlya ovsluzhivaniya skvazhin s temperaturoy do 250°C [Development of one-channel borehole radioactivity logging apparatus for operation in boreholes with temperatures up to 250°C], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p. 117-123, 1960.

Standard radioactivity logging devices are efficient in surveying drill holes at temperatures not exceeding 170°C. Introduction of a new high voltage generator, miniaturized stabilizers and condensers of constant capacity, and other relatively small improvements make the standard logging devices suitable for surveying drill holes at temperatures up to 250°C. A few well logs and a diagram of the high voltage generator are given.— V.G.G.

- 189-533. Chelok'yan, R. S. Skvazhinnyy pribor dlya odnovremennoy registratsii diagramm RK i muftovykh soyedineniy kolonny [Drill hole apparatus for simultaneous registration of radioactivity logs and joints in the casing], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p. 124-125, 1960.

An apparatus for simultaneous registration of radioactivity and joints in the casing is described; it consists of a radioactivity logging system and a differential magnetic system. Precise depth can be obtained using this system. The apparatus proved successful during two years of field tests.— V.G.G.

- 189-534. Zelenskaya, M. L. Ispol'zovaniye plastmass dlya prigotovleniya radioaktivnykh suspenziy [The utilization of plastics for preparation of radioactive suspensions], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p.220-224, 1960.

The radioactive isotopes Co-60, Fe-59, Zn-65, and Zr-95 have been used in salt solutions in well logging. It is believed, however, that the suspension method is superior because neither the drill-hole walls nor the containers absorb the isotope particles. The isotope particles should be sufficiently small to create a stable suspension. The best plastics to be used for the suspensions are polystyrene and polyethylene.— V.G.G.

- 189-535. Yerozolimskiy, B. G., Bondarenko, L. N., Voytsik, L. R., Shimelevich, Yu. S., and Yudin, L. I. Malogabaritnaya otpayannaya neytronnaya trubka [Small size sealed-off neutron tube], in *Yadernaya Geofizika*: Moscow, Gostoptekhizdat, p. 351-355, 1960.

A small-gage sealed-off ion accelerator tube is described. The design is analogous to that used in the method of maintaining working gas pressure in hydrogen thyratrons.— A.J.S.

- 189-536. Ismet, A. R., Mamedova, R. A., and Shakhmaliyev, R. N. O gamma-anomaliyakh, vyyavlennykh v neftyanykh skvazhinakh Apsheron [Concerning gamma-anomalies occurring in oil wells of Apsheron]: Vyssh. Ucheb. Zavedeniye Izv., Neft' i Gaz, no. 7, p. 23-27, 1961.

Gamma ray anomalies occur frequently in upper and occasionally in lower parts of the productive horizons of the Apsheron Peninsula in the Azerbaijan S.S.R. The anomalies lie in a belt near the edge of producing areas, are gen-

erally located near the oil-water contact in the well, but cannot be correlated from well to well. Neither natural rock radioactivity nor radioactivity of connate waters appear to be adequate causes. Precipitation of radioactive salts on walls of the wells caused by diffusion of connate waters into the drilling fluids may account for these anomalies.— J.S.W.

- 189-537. Aksel'rod, S. M., and Putkazadze, L. A. *Primeneniye radioaktivnykh metodov issledovaniya skvazhin v neftyanoy promyshlennosti Azerbaydzhanskoy SSR* [Application of radioactive methods for investigation of drill holes in the oil industry of the Azerbaijan SSR] in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 21-36, 1960.*

The gamma logging, neutron-gamma logging and neutron-neutron logging methods have been applied on a relatively large scale in the Azerbaijan S.S.R. for determination of porosity, saturation, and oil-water and gas-water contacts. Utilization of induced sodium activity for determination of oil-water contacts in oil reservoirs has been tried both in oilfields and laboratories. Short-lived radioactive isotopes of Al, Cl, Na, and Mn have also been used for determination of oil-water contacts.— V.G.G.

- 189-538. Meshcheryakov, I [Yu.] A. *Primeneniye radiometricheskikh metodov issledovaniya skvazhin v rayonakh Kuybyshevskogo Povolzh'ya* [Application of radiometric methods for the investigations of drill holes in the Kuybyshev area on the Volga], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 37-44, 1960.*

Radioactive methods have been applied in the Kuybyshev area since 1952 and at the present time are widely utilized for stratigraphic and lithological studies in well logging, for location of water-oil contacts, and in certain problems pertaining to well casings. In addition to the standard radiometric methods, the radioactive isotope methods are applied successfully for evaluation of changes in water saturation. In general, the following conclusions can be made: Oil-water contacts can be located in 75 out of 100 cases with the use of standard type neutron-gamma logging, and location of oil-water contacts can be carried on concurrently with the temperature observations.— V.G.G.

- 189-539. Shapiro, D. A. *Primeneniye radioaktivnykh metodov issledovaniya skvazhin v Tatarskoy A.S.S.R.* [Application of the radioactive methods for investigation of drill holes in the Tatar ASSR], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 45-56, 1960.*

In the Tatar A.S.S.R. the standard neutron-gamma and gamma logging methods are used for detailed studies of lithological characteristics, the neutron-gamma logging method based on the induced activity is used for distinguishing oil-bearing and water-bearing strata in cased wells, the gamma logging method for concurrent search for radioactive ore deposits, and the isotope methods for evaluation of problems met in actual well drilling. It was found that successful application of radioactive methods depends on careful control of conditions in the boreholes. Several radioactive well logs are illustrated.— V.G.G.

- 189-540. Shnurman, G. A. *Opyt primeneniya metodov radiometrii na neftnykh ploshchadyakh vostochnogo Predkavkaz'ya* [Experience in the application of radiometric methods in the oil areas of the east cis-Caucasus], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 57-69, 1960.*

Radioactive logging has been utilized in the east cis-Caucasus since 1950. Gamma logging, neutro-gamma logging, and the radioactive isotope method are used chiefly. In general, three different types of geological sections are found in this area; these respond differently to the radioactive methods. Numerous graphs and radiometric well logs are given.— V.G.G.

- 189-541. Tslav, L. Z., and Stenin, P. A. Sostoyaniye i perspektivy razvitiya neytronnykh metodov issledovaniya skvazhin v Orenburgskoy oblasti [Present status and the possibilities of development of neutron methods for the investigation of drill holes in the Orenburg district], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 70-75, 1960.*

Carbonate sediments predominate in the geologic section of the Orenburg district, and these contain the principal oil reservoirs. The neutron methods have proved the most satisfactory for study of well sections here. Model studies using neutron-gamma logging have shown that the difference in intensity of secondary gamma radiation and of thermal neutrons for oil-bearing and water-bearing rocks ranges from 30 to 40 percent less in carbonate rocks than in terrigenous. Oil- and water-bearing models of cased wells exhibit differences in magnitude of induced activities of sodium and manganese by amounts ranging from 60 to 80 percent.— V.G.G.

- 189-542. Bayembitov, F. G. Metodika interpretatsii diagram radioaktivnogo karotazha v usloviyakh rifogennykh massivov [Method of interpretation of diagrams of radioactive logging in reefs], in *Yadernaya Geofizika: Moscow, Gostoptekhizdat, p. 76-85, 1960.*

The neutron-gamma logging method was used in 1954 in the cis-Ural down-warp for the evaluation of porosity of reef limestones. The results were not satisfactory; however, it is believed that the method can be improved. The influence of mud cake and of zone of penetration of saline drilling fluids on the intensity of secondary gamma radiation is under study.— V.G.G.

Per'kov, N. A., ed. Album of type geologic-geophysical sections of boreholes of oil regions of the Volga-Ural province. See *Geophys. Abs. 189-218.*

## SEISMIC EXPLORATION

- 189-543. Musgrave, Albert W. Wave-front charts and three dimensional migrations: *Geophysics, v. 26, no. 6, p. 738-753, 1961.*

A computer is required to calculate the complex wave-front charts which are needed in many areas. On a medium size computer wave-front charts can be constructed using up to 40 layers. Each layer can be a constant velocity or can start with any velocity and have an increase in velocity with vertical time. These wave-front charts may be automatically plotted for use in migration in a vertical plane. At the same time that the wave-front chart is being obtained, a list may be made which shows the depth and offset for each reflection time and stepout value. This migration list may be used to migrate values from time maps in three dimensions. Before migrating, these time maps should have contours of all time values even though overlapping occurs as on buried foci of sharp synclines. Thus, it is a simple matter to make a migrated depth map from any time map regardless of the crookedness and discontinuity of the profiles or the lack of cross-line control.— Author's abstract

- 189-544. Emura, Kinya. Elastic waves generated by a directional source (1): *Tohoku Univ. Sci. Repts. Geophysics, ser. 5, v. 13, no. 2, p. 87-106, 1961.*

Generation of transient elastic waves due to a surface linear force acting at an inclination is investigated theoretically. The spatial distribution of relative amplitudes of the dilatational and distortional waves, and the effect of inclination of the force on the particle motion of the surface are elucidated for all possible values of Poisson's ratio. The results are related to the practical problem of improvement in the signal-to-noise ratio in seismic exploration. It is concluded that an increase in inclination of the force results in an increase

of the angle of emergence, for which the amplitude of the P-wave has a maximum value, and also results in a decrease in the maximum amplitude; the amplitude of the P-wave passes through zero at the angle of emergence, and phase inversion takes place for emergence beyond this angle; the pattern of amplitude variation for S-waves is sensitive to variation of the inclination of force as well as to that of Poisson's ratio; the ratio of the amplitudes of P- to S-waves for any of the force systems increases with increasing Poisson's ratio; and the inclination of the force increases with  $\sigma$ . About  $20^\circ$  is required for  $\sigma=0.25$ , and particle motion for Rayleigh waves at the surface is elliptical retrograde regardless of the values of inclination or of Poisson's ratio.—V.S.N.

- 189-545. Petkow [Petkov], I. N. Über eine analytische Methode zur Bestimmung der Schichtgeschwindigkeiten seismischer Wellen [On an analytical method of determining the layer velocities of seismic waves]: *Geophysik u. Geologie*, no. 1, p. 12-14, [1959].

When the more accurate borehole measurements are not possible, layer velocities must be determined from traveltime curves based on reflection and refraction observations. An analytical method of determining layer velocities from traveltime curves of refracted waves in the case of flat-lying parallel layers having constant velocities is presented.—D.B.V.

- 189-546. D'Hoeraene, J. Déconvolution de traces réelles [Deconvolution of real traces]: *Geophys. Prosp.*, v. 10, no. 1, p. 68-83, 1962.

The techniques of deconvolution (the reduction of filtering effects caused by the apparatus and the ground), previously developed and tested on synthetic seismograms (see *Geophys. Abs.* 183-549), are applied to field records or playbacks. Three examples show that deconvolution increases resolving power and thus emphasizes the resemblances as well as the differences between traces. It is shown that the comparison between deconvoluted traces and an impulsive synthetic seismogram is more significant than one between a field record and a filtered synthetic seismogram. Finally, a section of deconvoluted traces shows that it is possible to increase resolution significantly using one and the same inverse filter for a group of field records obtained with the same filter setting, even in locations where subsurface conditions are somewhat variable.—D.B.V.

- 189-547. Trorey, A[lan] W. The information content of a Rieber sonogram: *Geophysics*, v. 26, no. 6, p. 761-764, 1961.

Shortly after F. Rieber originally proposed the seismic data processing method of controlled directional sensitivity (CDS), whose end-product is a "sonogram," considerable criticism and discussion of the method appeared in geophysical literature. Certain of the criticism apparently had to do with the belief that CDS did not faithfully preserve all the information contained in the original field recording. This paper shows by a simple argument based on Fourier Transforms that CDS causes no such loss of information.—Author's abstract

- 189-548. Kulikov, V. I. K voprosu geologicheskoy interpretatsii seymorazvedochnykh materialov [On the problem of geological interpretation of seismic prospecting data]: *Azerbaydzhan Nauchno-Issled. Inst. po Dobyche Nefti Trudy*, v. 4, p. 186-198, 1956.

Methods of reduction of seismic profiles normal to the dip of the strata to geologic vertical profiles and *vice versa* are discussed. Graphical and analytical methods are presented, probable errors and their causes evaluated, and a master chart for reduction of isonormals to isoverticals needed for preparing the structural maps is given.—A.J.S.

- 189-549. Junger, Arne. Signal, noise and seismic records: Canadian Oil and Gas Industries, v. 15, no. 5, p. 84-86, 1962.

The purpose of this discussion is to show that it is possible to express the quality of a seismic record numerically and to set up a mathematical relationship between the signal to noise ratio and the appearance or visual quality of the record. Field practice confirms the intuitive observation that when the signal to noise ratio is very low, a moderate improvement will still leave a low signal to noise ratio and no visual improvement; if the ratio is high then addition of a small amount of noise which decreases the signal to noise ratio will not materially decrease the visual quality. Thus a measurable visual quantity is needed to plot against the signal to noise ratio. It is shown that the phase shift between various traces is the quantity most readily measured and treated mathematically. A theoretical calculation is made and plotted against an experimental calculation by Dyk (see Geophys. Abs. 145-12835).— V.S.N.

- 189-550. Knudsen, William C. Elimination of secondary pressure pulses in offshore exploration: Geophysics, v. 26, no. 4, p. 425-436, 1961.

The behavior of a gas bubble generated by detonating an explosive below the surface of the ocean and located centrally in a perforated sphere, perforated pipe, and solid-walled pipe has been studied by means of a scale model. The motion of the bubble was recorded using a high speed camera, and the pressure variations were recorded using a small pressure detector. The behavior of the gas bubble when surrounded by a perforated sphere has also been analyzed numerically. The model results showed that significant reduction in secondary pressure pulse amplitude was effected by all three devices, but the perforated sphere was the most effective. That enclosing the gas bubble in a perforated sphere would effectively eliminate the secondary pressure pulses was also verified by the numerical solution of the motion. Design criteria for a perforated sphere are presented.— Author's abstract

- 189-551. McGuinness, William T., Beckmann, Walter C., and Officer, Charles B. The application of various geophysical techniques to specialized engineering projects: Geophysics, v. 27, no. 2, p. 221-236, 1962.

Sonic and seismic methods applied to marine and land civil engineering projects and several unique techniques applied to specialized problems encountered in engineering are described. The geophysical techniques discussed include sparker and gas exploder surveys for marine site investigations, measurements of ground motion for quiet instrument facilities, undersea cable environmental studies, and in situ determination of pile lengths.— Authors' abstract

- 189-552. Oksa, Donald R. Resolution and curved path computation of steep dip using an electronic computer: Geophysics, v. 26, no. 6, p. 800-805, 1961.

A program for a basic IBM 650 electronic computer is discussed that resolves and computes four-way seismic dip control. The velocity parameters are a separate entry to the program in order that prospect re-evaluation, because of new velocity data, can be easily accomplished. Ample identification of specific reflection data is permitted. Although written specifically for curved path velocity assumptions, modification for different types of velocity functions would be a comparatively simple task.— Author's abstract

- 189-553. Dürschner, Horst. Über den Reflexionscharakter und die Laufzeitkurven nach Geschwindigkeitslogs [On the character of reflections and the traveltime curves according to velocity logs (with English summary)]: Zeitschr. Geophysik, v. 27, no. 4/5, p. 188-206, 1961.

Examples are given to illustrate the possibilities of variation in the construction of synthetic seismograms, and then some applications are discussed. Synthetic seismograms are particularly useful in interpreting the character of reflections in the case of transgressing horizons. Another application is the calibration of velocity logs by comparing synthetic and field seismograms; this permits construction of an accurate traveltime curve.—D.B.V.

- 189-554. Olszak, G. Einige Untersuchungen über die Wirkung von Gruppenschüssen in der Reflexionsseismik [Some investigations on the action of group shooting in seismic reflection surveying]: *Geophysik u. Geologie*, no. 1, p. 15-26, [1959].

The principles and methods of group shooting are explained. Results of empirical studies on the effect of variation of the number and depth of shot-holes under different geological conditions are reported. It is concluded that group shooting is effective in many cases, including some otherwise seismically difficult areas, but that in some instances it is not satisfactory.—D.B.V.

- 189-555. Hesche, Werner. Untersuchungen über Mehrfachreflexionen in der Seismik [Investigations on multiple reflections in seismic surveying]: *Geophysik u. Geologie*, no. 1, p. 27-34, [1959].

Multiple reflections can be expected when dense horizons are present, when the weathered layer is thin (ground water table near surface), and when energy absorption is small in the layers traversed. Comparisons of traveltimes and moveout times of primary and echo reflections often suffice to distinguish multiple reflections; if not, velocity analysis is the surest way of detecting them.—D.B.V.

- 189-556. Opitz, Dietrich. Geometrische Auswertung der durchschnittlichen Geschwindigkeiten bei reflexionsseismischen Messungen mit "expanding spread" [Geometric evaluation of average velocities in seismic reflection measurements with "expanding spread"]: *Geophysik u. Geologie*, no. 2, p. 78-83, 1960.

The calculations, relationships, and derivations given by Bortfeld on the "expanding spread" method (see *Geophys. Abs.* 172-230) are investigated further. From the control conditions that are obtained, a geometric solution is developed, based on an evaluation scheme given here for central and counter-shots in  $t^2-x^2$  coordinates.—D.B.V.

- 189-557. Teupser, Christian, and Olszak, Gerd. Ein Beitrag zur Technik und Anwendung der Hammerschlagseismik [A contribution to the technique and application of hammer-blow seismic surveying]: *Geophysik u. Geologie*, no. 2, p. 84-88, 1960.

Improvements in apparatus for hammer-blow surveying, developed at the Institute for Soil Dynamics and Earthquake Research of the German Academy of Sciences, are described briefly. The results of test measurements in the vicinity of Otterwisch, where a graywacke ridge with Erzgebirgian trend emerges from the Pleistocene cover, are presented. In addition to its many possible engineering applications, the technique offers valuable support for geologic investigations to depths of about 20 m.—D.B.V.

- 189-558. Śliwiński, Zygmunt, and Soja, Zbigniew. Praktyczna metoda konstrukcji sejsmicznych przekrojów refleksyjnych [Practical method of construction of seismic reflection profiles (with English and Russian summaries)]: *Przegląd Geol.*, v. 9, no. 9, p. 484-490, 1961.

A method that is sufficiently simple and exact for practical application is presented for constructing seismic sections. The method is based on use of

approximate  $t_0$  lines and is worked out here in three different modifications for different dips and for vertical and horizontal velocity variations. Plotting technique and auxiliary nomographs for every modification are described, and comparisons are given for structure models, single reflections, and  $(h, \alpha)$  polar coordinates.—J.W.C.

189-559. Honsho, Shizumitsu; Nagumo, Shozaburo; Kamata, Seikichi; and Hirasawa, Kiyoshi. On delay shooting [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 12, no. 9, p. 667-676, 1961.

The results of field experiments with delay shooting (progressive detonation) techniques for seismic exploration are described and discussed. It was found that it is not possible to make the delay time long enough to reduce surface waves but that the signal to noise ratio can be improved considerably over that of single shots. In these experiments, delay shooting in a shallow hole with considerable overdelay time was the most efficient method to improve N-S ratios.—V.S.N.

189-560. Steinhart, John S., and Meyer, Robert P. Minimum statistical uncertainty of the seismic refraction profile: Geophysics, v. 26, no. 5, p. 574-587, 1961.

Interpretation of refraction results resolves in finding a model that fits the data as closely as possible. In many cases several plausible models may be postulated. Criteria are then required to evaluate the uncertainty of these models and especially to determine if the data are sufficiently good to distinguish among the models. By expanding the depth function in a Taylor series, a straightforward evaluation of statistical uncertainty may be made. The problems of obtaining estimates of uncertainty for the parameters are discussed, and the method is outlined for estimating uncertainty of the depths. This estimate of the statistical uncertainty is shown to be a minimum in the sense that it may be said that the uncertainty is at least as large as the estimate. Finally, the applicability of least squares procedures to refraction work is discussed, and it is shown that the method of least squares is preferred for the purpose of the minimum estimate.—Authors' abstract

189-561. Stam, J. C. Modern developments in shallow seismic refraction techniques: Geophysics, v. 27, no. 2, p. 198-212, 1962.

A brief review is given of the development of seismic refraction equipment applicable to engineering problems. Specific aspects of the one-channel and the multi-channel equipments are compared and their relative usefulness discussed. Examples of some seismic surveys are presented.—Author's abstract

189-562. Linehan, D., Murphy, S. J., and Murphy, V. J. Engineering seismology applications in metropolitan areas: Geophysics, v. 27, no. 2, p. 213-220, 1962.

Seismic refraction investigations in two "noisy" areas differing in geologic environment and field conditions indicate the reliability of such a technique for foundation engineering problems. Shothole conditions and generating media are of great importance. Dense media, clay, and materials within the water-table are most favorable; fill debris is the least suitable. Seismic noise in the city, usually transient in character, is not an insurmountable problem; a patient instrument operator is a key to success. Several shot locations along an individual spread and a geophone spacing not to exceed 50 feet are standard field procedure for achieving a maximum amount of data.—Author's abstract

189-563. Walker, Terry. Fracture zones vary acoustic signal amplitudes: World Oil, v. 154, no. 6, p. 135, 137, 142, 1962.

An acoustical logging method is described that utilizes measurement of peak-to-peak amplitude rather than first arrival data. This amplitude is related to a great extent to interface reflection; the more fracturing present, the lower the signal amplitude. Higher porosity also reduces the signal amplitude. Field tests have demonstrated that the method is practical in locating fracture zones.— J.W.C.

- 189-564. Costello, J. T., and Wilson, W. T. The many advantages of the sonic log: Canadian Oil and Gas Industries, v. 15, no. 1, p. 32-35, 1962.

The superiority of the sonic log in comparison with other logging techniques in detecting porosity is demonstrated by a discussion of these devices in relation to the effect of borehole fluid, bed thickness, borehole size, invasion, lithology, porosity range, accuracy of calibration, and repeatability. The new interpretation methods made feasible because of the sonic log's independence of most of the variables encountered in the borehole are discussed. Moreover, the sonic log can give information that aids in seismic mapping and structural and correlation studies. The recent addition of the caliper log to the sonic log has further extended the use of the tool.— V.S.N.

- 189-565. Swain, R. J. Recent techniques for determination of "in-situ" elastic properties and measurement of motion amplification in layered media: Geophysics, v. 27, no. 2, p. 237-241, 1962.

Determination of the elastic properties of earth materials by laboratory means is subject to sizable errors. These errors may be serious in spite of the large safety factors normally used in engineering design, particularly if the structure must withstand severe dynamic loads. Means of obtaining elastic constants "in-situ" are described. Further, the phenomenon of displacement multiplication between the underlying competent rock and overlying alluvium or fill is reviewed and the first instrumentation system designed specifically to measure this relationship for engineering purposes is described.— Author's abstract

- 189-566. Tarczy-Hornoch, Antal. Zur Ortung seismischer Herde in Bergbaugebieten [On the localization of seismic focuses in mining districts (with English summary)]: Gerlands Beitr. Geophysik, v. 70, no. 3, p. 137-151, 1961.

An elementary method is suggested for rapid computation of the focus of a rockburst from arrival times. Three linear equations with 4 unknowns are obtained. One of these unknowns can be eliminated by choosing the 4 stations at equal elevation, and further simplification can be obtained by taking the origin of the coordinate system as station 1 and the x-axis as going through station 2. The simplest case is when stations 1, 2, and 3 lie on the x-axis and 4 on the y-axis. This discussion does not treat all the questions connected with the proposed method, and the effect of elastic anisotropy, in particular, should be investigated more closely; it does, however, bring the solution closer to practical application.— D.B.V.

- 189-567. Zhukov, V. S. Primeneniye elektronno-akusticheskikh i radiometricheskikh metodov dlya izucheniya svoystv morskogo l'da [Use of electronic-acoustical and radiometric methods in the study of sea-ice properties]: Problemy Arktiki i Antarktiki, no. 2, p. 83-93, 1960.

The principles, equipment, and effectiveness of sonic and radioactive methods for studying the physical and mechanical properties of sea ice in place are discussed. An acoustical AM microsecond meter consisting essentially of a vibrator for generating elastic waves in the ice, a sound receiver, a nonlinear

amplifier, and an oscillograph, and a radioactive device consisting of a Duralumin sheet with CO in a lead vessel at one end facing an MS-4 gas counter were used. The sonic soundings evaluate the elastic and nonelastic characteristics of ice, whereas the use of radioisotopes determines the inertial characteristics of the medium traversed by the elastic waves. If both methods are used simultaneously the deformation and strength of sea ice are obtained.—V.S.N.

- 189-568. Warrick, R[ichard] E., Hoover, D[onald] B., Jackson, W[ayne] H., Pakiser, L[ouis] C., and Roller, J[ohn] C. The specification and testing of a seismic-refraction system for crustal studies: *Geophysics*, v. 26, no. 6, p. 820-824, 1961.

A new seismic-refraction system built for the U.S. Geological Survey for crustal studies has been tested in the laboratory and shown to meet strict performance specifications for broad frequency response, low noise, high gain, and high dynamic range. The inherent advantages of magnetic recording, with selective filtering on playback, were demonstrated in field tests by the recovery of weak events that otherwise would be obscured by high seismic noise.—Authors' abstract

- 189-569. Hefer, Fred W. The use of photo-resistive cells as lossier elements in a transistorized seismic amplifier: *Geophysics*, v. 26, no. 5, p. 550-559, 1961.

The usual advantages of transistorized amplifiers—lowered power consumption, lighter weight, improved compactness, and increased reliability—are often cited. A fifth consideration is improved performance. One of the elements previously limiting amplifier performance is the AGC lossier device. A photo-resistive device can approach the five idealized requirements quite closely. The amplifier described uses four cells of photo-resistive material mounted in a common configuration. The four cells are illuminated from a common miniature lamp. Voltage for the lamp is derived from AGC control circuits. Resistance of the cells, and hence loss across them, depends on the level of illumination. Temperature compensation is achieved for the entire amplifier by use of a "fifth" stage with current derived from its being fed back to the other four primary amplifying stages. Amplifier performance and stability are illustrated by graphs of pertinent data.—Author's abstract

- 189-570. Gurevich, V. F. Pribor dlya kontrolya i ispytaniya seysmicheskoy apparatury [A device for control and testing of seismic apparatus]: *Azerbaydzhan. Nauchno-Issled. Inst. po Dobyche Nefti Trudy*, v. 4, p. 217-222, 1956.

A brief description is given of a testing apparatus for seismic recorders. The apparatus, known as ISA-1-55, uses two methods of measurements: the resonance method and the method of Lissajous figures. Seismic stations can be tested in the field, both on land and at sea, without usual laboratory accessories. The natural frequencies of the seismographs, the galvanometers, the phase identity, and the amplifiers can be checked rapidly. A schematic diagram of the apparatus is given.—A.J.S.

- 189-571. Shan'gin, N. V. Ustanovka dlya modelirovaniya seysmicheskikh protsessov [An arrangement for modeling seismic processes]: *Leningrad. Univ. Uchenyye Zapiski, Voprosy Geofiziki*, no. 278, p. 235-238, 1959.

An ultrasonic seismoscope for modeling seismic processes on the similitude principle is described, and experiments imitating seismic profiling and seismic logging are discussed. A schematic diagram of the apparatus is given.—A.J.S.

- 189-572. Shan'gin, N. V. Seismostantsiya dlya inzhenerno-geologicheskikh izyskaniy [Seismic station for engineering-geological investigations]: Leningrad. Univ. Uchenyye Zapiski, Voprosy Geofiziki, no. 278, p. 239-247, 1959.

The design and performance of a 20-channel seismic station used in engineering geological explorations is described, and the construction of the geophones, amplifiers, oscillograph, power supply, and control board is discussed. In a field test the depth to granite-gneiss bedrock was determined to be 19.5 m, and the depth found by drilling was 18.45 m.—A.J.S.

- 189-573. McGinnis, Lyle D., and Kempton, John P. Integrated seismic, resistivity, and geologic studies of glacial deposits: Illinois Geol. Survey Circ., no. 323, 23 p., 1961.

The employment of seismic, resistivity, and geologic methods for the study of glacial deposits in three areas in north Illinois has resulted in increased reliability of identification of materials and determination of thickness of units by eliminating some of the problems encountered in a single method. Resistivity values give information on low-velocity sand and gravel as well as on high-velocity drift materials, whereas seismic refraction methods give more reliable bedrock data.

A low-velocity surficial layer 3-17 feet thick is indicated in all three areas; some correlation between it and the weathered zone is noted. Where the drift is 10-20 feet thick and the bedrock surface uneven, bedrock depth and velocity cannot be determined accurately, and where resistivities in drift and bedrock were similar, the resistivity method fails to determine depth. Comparative data from each area are illustrated.—V.S.N.

Hersey, J. B. Findings made during the June 1961 cruise of Chain to the Puerto Rico Trench and Caryn sea mount. See Geophys. Abs. 189-610.

Shor, George G., Jr. Seismic refraction studies off the coast of Alaska. See Geophys. Abs. 189-339.

- 189-574. Macpherson, J. D. Seismic refraction measurements of the bottom structure off the north shore of Prince Edward Island: Seismol. Soc. America Bull., v. 52, no. 2, p. 399-404, 1962.

During September and November of 1960 two sets of unreversed seismic refraction profiles were made at two locations off the north shore of Prince Edward Island in the Gulf of St. Lawrence. The depths and velocities of the four sedimentary layers detected at both locations were identical within the limits of experimental error. From top to bottom the layers are as follows: 907±140 feet having a velocity of 9,860±300 fps; 1,750±190 feet, velocity 11,800±250 fps; 2,750±750 feet, velocity 14,020±100 fps; and below this, a layer with a velocity of 16,680±200 fps.—D.B.V.

- 189-575. Hobson, George D. Seismic exploration in the Canadian Arctic islands: Geophysics, v. 27, no. 2, p. 253-273, 1962.

Seismic reflection and refraction techniques were used during May-August 1960 in the first stages of reconnaissance in connection with the Polar Continental Shelf research project in the Canadian Arctic. Certain new techniques were developed. The crew operated from motor toboggans, but in the future will use helicopters. Adverse weather conditions are a hindrance at various times of the year.

It was found that the sea ice presents no great noise problem to standard recording techniques, that the gain in energy level by using air shots was insufficient to justify using that method, and that both reflection and refraction techniques are satisfactory. Results of the 1960 program are illustrated in a cross section.—D.B.V.

- 189-576. Roethlisberger, Hans. The applicability of seismic refraction soundings in permafrost near Thule, Greenland: U.S. Army Cold Regions Research and Eng. Lab. Tech. Rept. 81, 19 p., 1961.

This is virtually the same as the paper published in Internat. Symposium on Arctic geology, 1st, Calgary, 1960, Proc., p. 970-980, 1961 (see Geophys. Abs. 187-581).— V.S.N.

- Hunkins, Kenneth. Seismic studies of the Arctic Ocean floor. See Geophys. Abs. 189-611.

- 189-577. Clarke, A. M., Chambers, R. E., Allonby, R. H., and McGraw, D. A marine geophysical survey of the undersea coalfields of Northumberland, Cumberland, and Durham: Mining Engineer, no. 15, p. 197-212, 1961; Inst. Mining Engineers Trans. 1961-62, v. 121, Paper no. 3897, 1961.

Details are given of a marine seismo-acoustic reflection (Sparker) survey over the undersea Northumberland, Durham, and Cumberland coal fields. Seam contour maps of middle and north Northumberland and the north extremity of County Durham, and a map of the undersea Cumberland coal field showing drift thicknesses and positions of newly discovered relatively deep channels together with general dips and some inferred fault positions are included. The technique and special problems of interpretation of the data, together with the mining implications for the pits concerned in these areas, are discussed also. The paper is complementary to an earlier one. (See Maries, Geophys. Abs. 185-545.)— V.S.N.

- 189-578. Carron, Jean-Paul, and Nozières, Philippe. Discontinuité du bruit du fond séismique sur les failles bordières de la Limagne [Discontinuity of seismic background noise on the border faults of the Limagne]: Acad. Sci. [Paris] Comptes Rendus, v. 252, no. 7, p. 1048-1050, 1961.

The amplitude of seismic background noise determined by highly sensitive seismographs decreases abruptly in passing from the sedimentary basin of the Limagne, France, to the granitic basement, with a slight increase directly over the border faults. The amplitude of background noise is of the same order on the granite as in other basement regions studied; however, if the amplitude of background noise in the basin is proportional to the thickness of the sediments it is two or three times stronger here for the same thickness than in the Paris basin. Several possible explanations are offered; at present no one possibility can be favored or eliminated.— D.B.V.

- 189-579. Hjelme, Jørgen. Seismiske eksperimenter ved Rømø [Seismic experiments near Rømø (with English summary)]: Dansk Geol. Foren. Medd., v. 14, no. 4, p. 406-412, 1961.

In the summer of 1959 a seismic refraction profile was measured in south Jutland using as the source a series of explosions detonated in the tidal flats between the island of Rømø and the west coast of Jutland. The seismograph was moved along the profile, and each shot was recorded at only one site. The instrumentation is described and illustrated, and results are summarized in a table and figure. Comparison of results with other investigations shows that the soundings give an approximate picture of the geological structure. Three main layers are indicated: a 0.33-1.9 km/s (Quaternary or Tertiary) layer, a 1.78-2.33 km/s (chalk, limestone, loess, sandstone) layer, and a 6.03 km/s [granite(?)] layer.— V.S.N.

- 189-580. Tvaltvadze, G[uri] K. Novyye dannyye o seismologicheskoy stroynii Mukhransko-Tirifonskoy doliny [New data on the seismologic structure of Mukhrani-Tirifoni valley]: Akad. Nauk Gruzin. SSR Soobshch., v. 21, no. 6, p. 659-666, 1958.

Seismic studies of the structure and physical properties of the rocks in the Mukhrani-Tirifoni valley in the Caucasus are reported. The crystalline basement here occurs at depths of 2.5-4.0 km.—A.J.S.

- 189-581. Abdullayev, R. A. O tektonike glubokikh gorizontov Lokbatana i Khudat-Khachmasskogo uchastka prikaspiyskogo rayona po dannym seysmologii [Tectonics of the deep horizons of Lokbatan and the Khudat-Khachmas area of the cis-Caspian region from seismic prospecting data]: Vyssh. Ucheb. Zavedeniy Izv., Neft' i Gaz. no. 10, p. 9-12, 1960.

The structure of the south flank of the Lokbatan fold and of the Khudat-Khachmas area of the cis-Caspian is discussed on the basis of seismic exploration to depths of 4.5 and 9 km, respectively.—A.J.S.

- 189-582. Berzon, I. S., Pak, V. A., and Yakovlev, V. N. Seysmicheskoye zondirovaniye lednika Fedchenko [Seismic sounding of the Fedchenko Glacier], in Glyatsiologicheskaya ekspeditsiya na lednik Fedchenko: Tashkent, Akad. Nauk Uzbek. SSR, p. 84-109, 1960.

The results of reflection and refraction surveys in 1958 on the Fedchenko Glacier are summarized. Ice thicknesses range from 100 m near the terminus to 250 m in the lower section, 800 m in the middle section, and 900 m along the axis of the upper part. The glacier is composed of two layers—an upper one of ice and an underlying one (400 m thick) possibly consisting of moraine cemented by ice or of alluvial deposits. Poisson's ratio, the shear modulus, and Young's modulus for the ice are 0.35-0.36, 27.3-29.2 m per sq cm, and 75.2-78.8 m per sq cm, respectively.—V.S.N.

Kovylin, V. M. Results of seismo-acoustic investigations in the area of the Java deep-sea trench. See Geophys. Abs. 189-613.

- 189-583. Crary, A. P., and Robinson, Edwin S. Oversnow traverse from McMurdo to the South Pole: Science, v. 135, no. 3500 p. 291-295, 1962.

Preliminary results of the fourth major U.S. Antarctic traverse, from McMurdo station to the South Pole, are presented. Elevations were determined by the multiple altimeter method. Ice thicknesses were determined by reflection shooting. Reflections were poor, and the failure of special bulk explosives to detonate reliably made it impossible to make long refraction shots to supplement the reflection data. A tentative section along the traverse, together with previous results, shows that the great transantarctic mountain system is tremendous and drops below sea level on either side.

Snow accumulation, determined by remeasurement of stakes located during the 1958-59 Victoria Land traverse, was found to be variable—at station 72 net annual snow accumulation was 35 cm and at station 84 it was 4 cm.—D.B.V.

- 189-584. Ushakov, S. A., and Lazarev, G. E. Nekotoryye vyvody po seysmicheskim i gravimetricheskim dannym na profile Littl Amerika-Berd [Some conclusions from seismic and gravimetric data for the profile from Little America to Byrd Station]: Sovetskaya Antarkt. Exped. Inf. Byull., no. 9, p. 17-20, 1959.

The causes of the discrepancy between seismic and gravimetric ice-thickness determinations along the profile from Little America to Byrd Station as found by Woollard and attributed to morainic inclusions or changes in bedrock

density are examined. Analysis of the American data, using Faye anomalies, gives good correspondence between seismic and gravimetric data, indicating that the load of the ice is compensated isostatically.— V.S.N.

- 189-585. Dubrovin, L. I. Nazemnyye marshrutnyye issledovaniya v Antarktide v period MGG [Investigations on ground traverses in Antarctica during the period of the IGY]: Sovetskaya Antarkt. Exped. Inf. Byull., no. 10, p. 5-8, 1959.

The results of seismic measurements of ice thickness in Antarctica by various expeditions are summarized. The maximum ice thickness recorded by the British-Norwegian-Swedish expedition in the west part of Queen Maud Land was 2,450 m; by the Australians at lat 70°31' S., long 32°09' E. was 2,700 m; by the British-New Zealand expedition under Fuchs at the South Pole was 2,490 m; by the Soviet Antarctic Expedition at 500 km from the coast along a profile from Mirny to the Pole of Inaccessibility was 4,060 m; by the United States at Byrd Station was 3,000 m; and by the French on a profile from Dumont-d'Urville to Charcot was 2,800 m. The Fuchs expedition found that the ice thickness increases constantly from the Weddell Sea to the South Pole and then decreases toward the Ross Sea. The Soviet expedition found that bedrock reaches 760 m above sea level at the Pole of Inaccessibility in the central regions of Antarctica; the ice here is 2,950 m thick.— V.S.N.

## STRENGTH AND PLASTICITY

- 189-586. Jaeger, J. C. Punching tests on disks of rock under hydrostatic pressure: Jour. Geophys. Research, v. 67, no. 1, p. 369-373, 1962.

A simple apparatus for making punching tests on disks of rock subjected to an additional hydrostatic pressure is described. Experiments have been made on marble, slate, and sandstone. They give an approximate value for the variation of shear strength with confining pressure. For marble and slate, confining pressure has a considerable strengthening effect, but for sandstone this effect is relatively small. The method is applicable to a number of situations not covered by the triaxial test; when both methods are applicable, there are considerable differences between the results obtained.— Author's abstract

- 189-587. Jeffreys, Harold, and Crampin, Stuart. Rock creep: a correction: Royal Astron. Soc. Monthly Notices, v. 121, no. 6, p. 571-577, 1960.

A mistake in the previous discussion of the modified Lomnitz law of creep [see Geophys. Abs. 173-356] is corrected. The index in the law is changed from 0.17 to 0.25. The other effects of creep are rediscussed, and some are calculated that had not been calculated with the former index. The results are qualitatively similar to those found previously, and no contradiction with the data is found.— Authors' abstract

- 189-588. Fisher, D. H., Carlson, R. L., and Holden, F. C. Apparatus for mechanical testing at temperatures above 2000 F: Materials Research and Standards, v. 2, no. 1, p. 26-31, 1962.

An apparatus for measuring strain of refractory materials at temperatures up to 3,600°F is described. It consists of a vacuum furnace, a loading system, a strain-measurement system, and auxiliary measuring and control equipment. The specimens are heated by radiation from a resistance-type tubular heater, and an optical pyrometer is used for temperature measurements. Strain is measured with an optical system using a specially designed strain-indicating device located at the specimen gage section. Displacements are recorded on film and measured with an optical comparator. Typical stress-strain curves obtained in tension and compression are presented.

Strain measurement readings can be repeated to within  $\pm 50$  micrometers per inch for a 2-inch gage length. Temperature gradients along the central

$1\frac{1}{2}$  inches of tension and compression specimens can be maintained within  $\pm 15^\circ\text{F}$  for temperatures up to  $3,600^\circ\text{F}$ . The vacuum system permits operating pressures below  $0.5\mu$  for temperatures up to  $3,600^\circ\text{F}$ .—J.W.C.

- 189-589. Reed, John J. Survey of developments in the field of rock mechanics: *Mining Eng.*, v. 14, no. 4, p. 60-62, 1962.

A summary is given of the latest progress in the following areas of rock mechanics that are particularly applicable to mining: ground stability determinations, concepts of pre-loaded supports with emphasis on rock bolting mechanisms, methods of detecting stress changes in mines and determination of absolute total stress on a rock at a given time, and effects of heavy dynamic loading or shock waves on underground openings. Practical work in rock mechanics has resulted in new techniques in mining; several of these are listed.—V.S.N.

- 189-590. Berry, D. S. An elastic treatment of ground movement due to mining. I. Isotropic ground: *Jour. Mechanics and Physics of Solids*, v. 8, no. 4, p. 280-292, 1960.

Berry, D. S., and Sales, T. W. An elastic treatment of ground movement due to mining. II. Transversely isotropic ground: *Ibid.*, v. 9, no. 1, p. 52-62, 1961. III. Three dimensional problem, transversely isotropic ground: *Ibid.*, v. 10, no. 1, p. 73-83, 1962.

In part 1, a comparatively deep excavation in which seam thickness may be considered infinitesimal and the convergence of opposing points in roof and floor may be treated as a discontinuity in displacement at a single point is treated. A result in plane elasticity is then used to find the solution for a partially closed excavation of infinite length in an infinite medium, and from this to derive solutions for an unclosed and a completely closed panel. Corresponding results for a semi-infinite medium are found approximately for the unclosed and partially closed panels and exactly for complete closure.

In part 2, convergence of roof and floor in an infinitely long excavation is treated as a displacement discontinuity in a transversely isotropic medium. The nonclosure, partial and complete closure solutions are found for the infinite medium, and corresponding results for the semi-infinite medium are derived.

In part 3, the complete closure of a rectangular panel excavated to a uniform thickness is considered as a constant displacement discontinuity in a transversely isotropic half-space. An explicit solution is obtained in terms of a single harmonic function, and surface displacements are calculated.—V.S.N.

- 189-591. Osterwald, Frank W. USGS relates geologic structures to bumps and deformation in coal mine workings: *Mining Eng.*, v. 14, no. 4, p. 63-68, 1962.

This is virtually the same paper as that published in U.S. Geol. Survey Prof. Paper 424-C, p. C-349-C-353, 1961 (see *Geophys. Abs.* 188-570).—V.S.N.

- 189-592. Hardy, H. R., Jr. Standardized procedures for the determination of the physical properties of mine rock under short-period uniaxial compression: Canada, Dept. Mines and Tech. Surveys, Mines Branch Tech. Bull. TB 8, 108 p., 1959.

Except for correction of minor errors, this bulletin is a reissue of Report no. FRL-242 (1957). It describes in detail the problems encountered and the standardized methods evolved in determination of the following physical properties of mine rock under short-period uniaxial compression: compression modulus, Poisson's ratio, ultimate compressive strength, fracture angle, and strain energy. Related properties such as rock-type classification, petrographic classification, apparent specific gravity, and Mohs hardness are also discussed. The analysis of the data obtained for these physical properties is discussed in detail.—V.S.N.

- 189-593. Belin, R. E. Some observations on the suppression of movement of a rock face by the application of rock bolts: *Australian Jour. Appl. Sci.*, v. 11, no. 2, p. 261-271, 1960.

Sections of an exploratory tunnel were pattern rock-bolted, and plate bearing loads applied for bolt loads of zero and 15,000 lb for evaluating the strain-arresting effect due to tightened rock bolts.

The deformation modulus of stress-relieved stable, fissured rock, determined by plate bearing methods, is not affected by rock bolting. However, a study of load-deformation curves showed that rock bolt loads of 15,000 lb are sufficient to suppress movement of the rock face into an opening created in highly stressed rock.— Author's summary

- 189-594. Hiramatsu, Yoshio, and Oka, Yukitoshi. Stress around a shaft or level excavated in ground with a three-dimensional stress state: *Kyoto Univ. Fac. Eng. Mem.*, v. 24, pt. 1, p. 56-76, 1962.

The results are described of an investigation of stress distribution around a vertical shaft, an inclined shaft, and a level, taking into account the fact that the ground is in a three-dimensional stress state. The stress around a circular shaft or level is analyzed theoretically; then, the general method of experimental analysis is discussed with emphasis on evaluation of indeterminate stresses. Stress around shafts and levels with square and with two rectangular cross sections, all having rounded corners, is found by two- and three-dimensional photoelastic experiments, and based on the results, a discussion on the influence of the state of stress in undisturbed ground upon stress around a shaft or level is presented.— V.S.N.

- 189-595. Panek, Louis A. Measurement of rock pressure with a hydraulic cell: *Am. Inst. Mining Metall. Petroleum Engineers Trans.*, v. 220, p. 287-290, 1961.

This is virtually the same paper as that previously published in *Mining Eng.*, v. 13, no. 3, p. 282-285, 1961 (see *Geophys. Abs.* 185-580).— V.S.N.

- 189-596. Hill, F. G., and Denkhaus, H. G. Rock mechanics research in South Africa, with special reference to rockbursts and strata movement in deep level gold mines: *Commonwealth Mining and Metall. Cong.*, 7th, South Africa, 1961, *Trans.*, v. 2, p. 804-829 (discussion), p. 830-835, 1961.

This paper covers the same material as the paper published previously in *Inst. Mining and Metallurgy [London] Trans.*, v. 68, 1958-59, p. 285-309, 1959 (see *Geophys. Abs.* 184-584). Brief mention is made of additional work in rock mechanics since 1959.— V.S.N.

- 189-597. Bjerrum, L., Kringstad, S., Kummeneje, O. The shear strength of a fine sand [with French abstract]: *Norges Geotek. Inst. Pub.*, no. 45, 9 p., 1961.

The results are reported of a series of triaxial tests on drained and undrained samples of fine sand in both dense and loose condition; the tests were made to study the nature of the flow slides that occur at intervals in the subaqueous sand deposits of the fjords on the west coast of Norway. Tests on loose sand showed several unexpected results. The angle of internal friction was found to decrease rapidly as the porosity increased above 44 percent. In undrained tests with pore-pressure measurements, values as low as  $11^\circ$  were found in the very loose sand and high pore-pressures developed. The pore-pressure parameter,  $A$ , was found to be as high as 2.7 in the very loose sand with initial porosity of 47-48 percent.— V.S.N.

- 189-598. Bjerrum, L. The effective shear strength parameters of sensitive clays [with French abstract]: Norges Geotek. Inst. Pub., no. 45, 6 p., 1961.

Investigations of the stability of natural slopes in the late-glacial sensitive clays in Sweden and Norway involve the determination of the effective shear strength parameters of the clays. The ratio between undrained shear strength and effective overburden pressure in the clays is given, and an attempt is made to explain the low values observed in terms of effective stress. By analogy with recent tests on very loose sand and silt, it is concluded that the apparent friction angle  $\phi'$  in sensitive clays is of the order of  $10^\circ$ . This low value is confirmed by an in-place shear box test. The divergence of laboratory tests from this value is explained, and it is shown that in undrained tests on soils with an unstable structure, failure may occur before friction is fully mobilized.— V.S.N.

- 189-599. Moore, D[avid] G., and Richards, A[drian] F. Conversion of "relative shear strength" measurements by Arrhenius on East Pacific deep-sea cores to conventional units of shear strength: Géotechnique, v. 12, no. 1, p. 55-59, 1962.

A conversion formula is presented graphically for the conversion of "relative shear strengths" obtained by Arrhenius (1952) on 23 East Pacific Ocean basin cores to conventional units. Arrhenius's converted shear strength measurements range from about 15 to 1,500 g per sq cm. The configuration of the converted strength profile versus depth on an arithmetic plot of Arrhenius's core 51 indicates a change in the relative rate of deposition of the sediment; a faster rate of deposition apparently occurred in the middle part of the core as compared to the top and bottom parts. The profile also indicates an increase in strength with depth of burial.— V.S.N.

- 189-600. Serata, Shosei, and Gloyna, Earnest [F.]. Design principles for underground salt cavities: Am. Soc. Civil Engineers Trans., v. 126, pt. 3, paper no. 3146, p. 251-270, 1961.

Theoretical equilibrium relationships as substantiated by experimental studies are presented here for use in the design of salt cavities. Also included are studies on reduction of cavity volume, development of the plastic zone, and stress redistribution around the cavity as functions of cavity depth, strength of salt, and physicochemical effects of the waste. [See also Geophys. Abs. 182-515.]— Authors' abstract

- 189-601. Wakahama, Gorow. On the plastic deformation of ice. I. Plastic deformation and dislocation networks in a single crystal of ice. II. An interpretation of the plastic deformation of a single crystal of ice based upon the theory of dislocation. III. Stress relaxation of ice. IV. The length of the Frank-Read source, the layer structure and the work softening in ice [in Japanese with English abstracts]: [Hokkaido Univ.] Low Temperature Sci., ser. A, no. 20, p. 57-75, 77-100, 101-116, 117-130, 1962.

Experiments were made under a constant strain rate on lateral extension and compression of thin rectangular plates cut from single crystals of ice from Mendenhall glacier in Alaska. In part 1, a theory of plastic dislocations in ice crystals is developed by which it is demonstrated that dislocations in single crystals of ice make three dimensional networks, and those located in the basal planes of the crystals act as Frank-Read sources of different lengths generating new dislocation loops when subjected to shear stresses. The generated loops expand causing slips on the basal plane to which the main part of the plastic deformation is due. In part 2, experimental results concerned with relaxation of stress are discussed. Stress in an ice crystal begins to relax when

movement of the metal plate attached to its end for compression is stopped. In part 3, a formula is given to represent the relationship between the time from the moment compression is stopped and the reciprocal of the relaxing stress (shear stress on the base plane of the ice). An illustration is given to show schematically how the dislocations in the basal planes disappear during stress relaxation. In part 4, the frequency distribution of the different lengths of the Frank-Read sources is considered. The phenomena of work-softening in ice (the ice crystal becomes soft as work done by the load accumulates) is explained by taking into consideration that the advancing speed of dislocation in a crystal is very small and that the Frank-Read sources are located at different distances from the surfaces of the ice crystal. A formula is given for the time needed to reach the final state of steady creep.— V.S.N.

- 189-602. Kinoshita, Seiiti. Transformation of snow into ice by plastic compression [in Japanese with English abstract]: [Hokkaido Univ.] Low Temperature Sci., ser. A, no. 20, p. 131-157, 1962.

A snow cylinder contracts plastically without breaking provided it is compressed at a constant speed which lies below a certain critical speed. The shortening process of a snow cylinder at a certain temperature and contracting speed during an extremely large plastic compression is described and illustrated. As long as the degree of contraction remains below 0.6 (height of cylinder in compressed state-initial height/initial height) the cylinder contracts uniformly. The changes in texture during compression are also discussed.— V.S.N.

- 189-603. Tabata, Tadashi. Studies on mechanical properties of sea ice, IV. Bending tests of sea ice beams [in Japanese with English abstract]: [Hokkaido Univ.] Low Temperature Sci., ser. A, no. 20, p. 187-198, 1962.

The elastic modulus and viscosity of sea ice are obtained by analyzing mathematically the deflection-time curve obtained from bending tests on 22 sea ice beams in place. Rectangular beams were sawed out from an ice sheet leaving both ends attached, a weight was loaded at the center, and the amount of deflection relative to the neighboring ice recorded on a drum. The elastic modulus was about  $1 \cdot 10 \times 10^9$  d per sq cm. Viscosity was found to change in proportion to the square of the strain produced within a beam or in proportion to the square of the deflection.— V.S.N.

- 189-604. Nakaya, Ukichiro. The deformation of single crystals of ice, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 229-240, 1958.

When a single crystal of ice is subjected to deformation, gliding takes place on the basal plane. A small angle boundary is likely to occur at the point of intense stress concentration and once this is formed the sample behaves somewhat like an assemblage of blocks. This basal or elementary layer is flexible but not stretchable, accordingly the thickness is not changed by deformation.— V.S.N.

- 189-605. Butkovich, T. R., and Landauer, J[oseph] K. The flow law for ice, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 318-327, 1958.

This is the same paper as that published in U.S. Army Snow, Ice, and Permafrost Research Establishment Research Rept. 56, 7 p., 1959 (see Geophys. Abs. 182-519).— V.S.N.

- 189-606. Shoumsky [Shumskiy], P. A. The mechanism of ice straining and its recrystallization, in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice: Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 244-248, 1958.

Preliminary results of laboratory research on crystallization processes taking place in ice as a result of application of stress are summarized. The purpose of the investigation was to study various glacier-ice fabrics and the behavior of ice under load as well as the regularity of flow under different deformation conditions; the latter information is necessary to develop a quantitative theory of glacier movement. Based on various ice fabrics, magnitudes of tangential stresses, and normal pressure and temperature values, six different mechanisms of ice deformation are outlined, each of which leads to individual changes of fabric. Limits of stress determining one or another character of strain depend to a great extent upon initial fabric, but the main determinant in the mechanism of ice deformation is the relationship between strain and recrystallization rates. The fluidity of ice having a uniform fabric decreases rather than increases with depth. The importance of each of the six different mechanisms of deformation are discussed. [See also Geophys. Abs. 187-267, -268.]— V.S.N.

- 189-607. Gorazdovskiy, T. Ya. Teoreticheskiye predposylki metoda prognoza razrusheniya ledyanykh i merzlotnogruntovykh poley [Theoretical premises of a method for predicting mechanical failure of ice and permafrost fields]: Problemy Arktiki, no. 5, p. 81-92, 1958.

A method for determining absolute stresses within permafrost and ice under natural conditions and the moment and point at which destruction will begin is described, and its principles are discussed. The two principal stress vectors in a borehole are determined by use of a device with a 3-tube rotameter permitting angular measurements of linear values of one micron. Measurements on 2-3 sides of the point of interest give 2-3 cross-sections of the stress ellipsoid from which the main components of the stress tensor at the point may be determined analytically.— V.S.N.

- 189-608. Serikov, M. I. Opredeleniye modulya uprugosti l'da rezonansnym metodom [Determination of the modulus of elasticity of ice by the resonance method]: Problemy Arktiki, no. 6, p. 81-87, 1959.

The methods used and results of laboratory studies on Young's modulus, the modulus of shear, and Poisson's ratio for river ice at 0°C to -32°C as a function of ice structure are described and discussed. The average modulus of elasticity for all samples was 94,500 kg per sq cm for vibrations in flexure and 101,000 kg per sq cm for longitudinal vibrations. The modulus of shear for transverse vibrations was 36,000 kg per sq cm, and Poisson's ratio was 0.370. Data are given in tables and graphs on the elastic properties of ice with varying crystal orientations and with variations in modulus of elasticity and Poisson's ratio with temperature. A diagram of the apparatus is included.— V.S.N.

- 189-609. Voytkovskiy, K. F. Skorost' plasticheskoy deformatsii polikristallicheskogo l'da [Speed of plastic deformation of polycrystalline ice]: Akad. Nauk SSSR Sibirskoye Otdeleniye. Izv., no. 4, p. 3-16, 1959.

Results of laboratory tests on the bending of ice bars and the shearing of ice cylinders are reported in detail. The effects of temperature, stress, and ice structure on deformation are examined. In all tests elastic deformation occurred at the moment of stress application and was immediately followed by plastic deformation. The initial speed of deformation was high but gradually diminished to a constant value, the so-called speed of ice flow. As shear stress exceeds a certain limiting value, however, the speed of plastic deformation increases. Data are illustrated in tables and graphs.— V.S.N.

- 189-610. Hersey, J. B. Findings made during the June 1961 cruise of *Chain* to the Puerto Rico Trench and Caryn sea mount: *Jour. Geophys. Research*, v. 67, no. 3, p. 1109-1116, 1962.

Rock samples were dredged from outcrops on the north wall of the Puerto Rico Trench in a place where nearby seismic refraction measurements can be projected. Reasonable projection indicates that the top of layer 3 (P-wave velocity 6.5 km/s) crops out on the north wall at a depth of 7 km below sea level. Probably all productive dredge hauls were made at depths greater than 7 km. Altered ultrabasics, some apparently freshly broken, probably came from layer 3; sedimentary rocks, varied in type and degree of consolidation, probably came from rock slides derived from layer 2 (P-wave velocity 4-5.2 km/s) and shallower layers. New topographic studies together with older knowledge of local structure suggest multiple normal faulting as the dominant structural type along the north wall.

New instrument developments permitted studying sub-bottom sediment structures in great detail by a seismic reflection method in which an electrically powered sound source is used. Observations suggest horizontal bedding underlying an uneven top surface of layer 2 on the outer ridge north of the Puerto Rico Trench. Later observations in the vicinity of Caryn peak suggest that a considerable thickness of sediments now flanking the peak actually post-date the formation of Caryn peak itself.— D.B.V.

- 189-611. Hunkins, Kenneth. Seismic studies of the Arctic Ocean floor, in *Geology of the Arctic*, v. 1: *Internat. Symposium on Arctic Geology*, 1st, Calgary, Alberta, 1960, Proc., p. 645-665, 1961.

Reflection and refraction seismic measurements from drifting station Alpha revealed a prominent submarine rise (Alpha Rise) trending across the Arctic Ocean subparallel to the Lomonosov Ridge. A minimum depth of 1,426 m was found in the central portion at lat 85°03' N. and long 171°00' W., descending to 3,000 m to the north and south. Differences in the reflection records between the eastern and western ends of the Alpha Rise indicate a stratigraphic or structural difference between the two ends and a rougher bottom texture for the eastern area.

Dips and strikes of the ocean floor from reflection records aid in interpretation of several short unreversed refraction profiles. The upper or unconsolidated layer is 0.38 km thick on the average as compared to 1/2-1 km in the North Atlantic. The 4.70 km/s-layer is 2.80 km thick according to a single measurement, and the oceanic layer velocity is 6.44 km/s, which is in close agreement with the North Atlantic velocity of 6.5 km/s.— V.S.N.

- 189-612. Il'in, A. V. Riftovayadolina v Atlanticheskom okeane [A rift valley in the Atlantic Ocean]: *Priroda*, no. 3, p. 93-96, 1961.

The Mid-Atlantic range and its rift valley are described. No sedimentary deposits are found on the bottom of the rift. This indicates its geologically recent formation.— A.J.S.

- 189-613. Kovylin, V. M. Rezul'taty seysmo-akusticheskikh issledovaniy v rayone Yavanskogo glubokovodnogo zheloba [Results of seismo-acoustic investigations in the area of the Java deep-sea trench]: *Akad. Nauk SSSR Izv. Ser. Geol.*, no. 11, p. 16-25, 1961.

A seismic profile across the Java trench obtained by the research ship "Vytyaz'" is presented. The effect of structure on sediment thickness is apparent. The Bali basin and Java trench are areas of abundant deposition of land-derived material, up to 1.5 km being measured in the trench compared to about 0.4 km in the open sea. The submarine topography in this island arc region favors the redistribution of masses of sedimentary material and piling up of great thicknesses of sediments in the tectonic basins, which thus constitute contemporary geosynclines.— D.B.V.

- 189-614. Sato, Takahiro, and Ao, Shunji. A guyot at the north margin of the West Philippine Sea Basin: *Japanese Jour. Geology and Geography*, v. 32, no. 2, p. 153-157, 1961.

In the West Philippine Sea Basin, the area south of the Okinawa Island-Parece Vela Island line and north of Luzon Island is below 2,000 m in depth and has a simple topography with several seamounts. A seamount recently discovered in this area at lat 22°38.2' N. and long 128°52.2' E. has a flat top at 3,787 m below sea level, is 2.7 km in width, and is about 1,520 m in height; it is one of several seamounts along the outer zone of the Nansei Shoto Trench where it branches into 2 troughs south of Okinawa. The seamount is characterized by a distinct shelf and, at its base, by a moat-like depression about 250 m deep. The flat top of the guyot suggests that the Nansei Shoto seamounts are older than the Daito Mountains to the north (Daito, Kita Daito, and Oki Daito Island). Also the presence of a guyot within a presumably more stable area far from the Pacific Basin proper may be favorable to Revelle's (1955) theory of a recent increase of sea water to explain the submergence of guyots.— V.S.N.

- 189-615. Zatonskiy, L. K., Kanayev, V. F., Tikhonov, V. I., and Udintsev, G. B. Podvodnyy rel'yef Kurilo-Kamchatskoy dugi i yeye vulkanizm [The submarine relief of the Kuriles-Kamchatka Arc and its volcanism]: *Okeanologiya*, v. 1, no. 2, p. 265-269, 1961.

Seismic sounding and gravimetric study have shown that the Kurile-Kamchatka Arch is composed of two parallel ranges: the Outer Range which produces the Little Kuriles, and the Inner Range, the highest points of which form the Large Kurile Islands. The rows of volcanos oriented along the arc follow crustal breaks in the basaltic anticline of the arc, whereas the transverse rows of volcanos are related to distention zones on the flanks of anticlines that are structurally older.— A.J.S.

- 189-616. Sysoyev, N. N., Udintsev, G. B., Neprochnov, Yu. P., and Kovylin, V. M. Seysmo-akusticheskiye issledovaniya dna okeana i voprosy tektoniki [Seismoacoustic studies of the ocean bottom and problems of tectonics]: *Okeanologiya*, v. 1, no. 2, p. 270-273, 1961.

The results of seismoacoustical studies of the ocean bottom in the Pacific Ocean, Indian Ocean, Black Sea, and Mediterranean Sea are reported briefly.— A.J.S.

#### VOLCANOLOGY

- 189-617. Harris, P. G., and LeMaitre, R. W. Volcanic activity on Tristan da Cunha on December 16-17: *Nature*, v. 193, no. 4817, p. 719-721, 1962.

Although the island of Tristan de Cunha in the south Atlantic Ocean is entirely volcanic, activity was thought to be extinct until a series of tremors began about August 6, 1961 and culminated with the updoming or extrusion of a plug of solid rock, red hot beneath the surface, on October 9-10. The plug, a typical tholoid, was about 100 feet high within 24 hours, 240 feet high four days later, and about 300-400 feet high by October 20. When inspected on December 16-17, the tholoid had been breached on the seaward side; within the small U-shaped caldera thus formed was a small cone of about the same height, from the summit of which issued a stream of lava. Clouds of white smoke often accompanied by audible bangs, flames and lava jets, and blocks and bombs were emitted. A second vent located about 100 yds behind the crater emitted mushroom-shaped clouds of yellowish-gray smoke but apparently no bombs. The lava field in front of the volcano extended as much as 400 yds beyond the original shoreline over a front of 1,000 yds. The lava appears to have changed in appearance with successive stages of extrusion and flow.— D.B.V.

- 189-618. Zbyszewski, G. L'éruption du volcan des Capelinhos dans l'île de Faial (Açores) [The eruption of Capelinhos volcano in the island of Faial (Azores)]: *Internat. Geol. Cong.*, 21st, Copenhagen 1960, pt. 26, p. 108-115, 1961.

The volcanic structure of Faial Island in the Azores, its tectonics, the Capelinhos eruption of 1957-58, and the aspect of the volcano in October, 1959, a year after the end of the activity, are described briefly. The total disappearance of fumarolic activity in the bottom of the Caldeira do Faial after the end of the eruption indicates that pressure had decreased at depth.—D.B.V.

- 189-619. Murozumi, Masayo [Masayoshi]. Exo- and endo-magmatic hydrothermal differentiations observed among the chemical components exhaled by Noboribetsu volcanic activity [with Japanese abstract]: *Japan Geol. Survey Bull.*, v. 12, no. 8, p. 627-645, 1961.

The Noboribetsu Volcano in south Hokkaido, Japan, is surrounded by numerous other volcanoes and is one of the largest areas of hydrothermal activity in Japan. The area has a history of repeated variations in intensity of activity for the last 100 yr. The results of a quantitative study are presented on the relation between the variation of volcanic activity and the chemical composition of the materials (steam, water, molten sulfur) exhaled through its craters. During periods of increasing activity the chloride ion content gradually increases along with an increase in the amount of water and steam exhaled; conversely, the chloride ion content decreases with decreasing activity. Studies of various geochemical elements are summarized in tables. It is concluded that quantitative analysis of the Na/Cl and Ca/Cl ratios and of the chloride ion concentration is a clue to changes in activity in the volcano. Moreover, it is possible at Noboribetsu to make preliminary forecasts of future variations as much as 20 months in advance of occurrence. It is thought that this type of investigation may be useful for forecasts of volcanic eruptions.—V.S.N.

- 189-620. Taneda, Sadakatu. Moving of the magma chamber of the Sakurajima Volcano: *Geol. Soc. Japan Jour.*, v. 67, no. 793, p. 593-605, 1961.

Sakura Volcano in Kagoshima Bay, Kyushu, Japan, on the southern rim of Aira caldera, the greater part of which forms northern Kagoshima Bay, is one of the most active volcanoes in Japan. A study of eruptions since the 15th century shows that there has been a tendency for the centers of activity to erupt at successively higher points on the flank of the volcano; this has culminated in the current activity centered in the summit crater (Minami-dake). This trend toward the summit has been accompanied by a successive decrease in the length of the dormant period between eruptions and in the degree of differentiation of the effused magma (lavas and bombs); except for the 1946 eruption, lavas have changed chemically toward a more basic composition. It is concluded that there are two magma chambers: a large one at 10 km under Aira caldera and a second smaller one at a comparatively shallow depth below Sakurajima. The shift in location of centers of eruption indicates that the shallow magma chamber has moved upward during historic time. It is probable that this chamber has been in existence since the earliest period of activity at Sakurajima and has gone through repeated cycles of rising and sinking.—V.S.N.

- Lotze, Franz. Actuo-geologic characteristics of the year 1959. See *Geophys. Abs.* 189-84.

- Zatonskiy, L. K., Kanayev, V. F., Tikhonov, V. I., and Udintsev, G. B. The submarine relief of the Kuriles-Kamchatka Arc and its volcanism. See *Geophys. Abs.* 189-615.

- 189-621. Yoshikawa, Keizo. On the crustal movement accompanying with the recent activity of the Volcano Sakurajima (Pt. 1): Kyoto Univ. Disaster Prevention Research Inst. Bull., no. 48, 15 p., 1961.

The modes of crustal movement produced by the movement of magma under a volcano toward the surface vary with the physico-chemical conditions of magma and with the geologic structure in the vicinity of each volcano. In order to understand the mechanism and to predict volcanic eruptions, it is necessary to carry out continuous geodetic observations and measurements on each volcano to determine the characteristic mode of crustal movements. The results are reported of four successive levelings made along a line around Sakurajima and of sea-level observations during the active period of the volcano that began in 1955. From these observations it is found that the ground in the neighborhood of the two major geologic structure lines moved during the active period, and bench marks showing abnormal depression are located near these lines. The position of the pressure center and the change in the value of  $a^3P/\mu$  ( $a$ =radius of small sphere where hydrostatic pressure takes place,  $P$ =change of hydrostatic pressure in small sphere,  $\mu$ =Lame's constant) were estimated on the basis of the elasticity theory, and the supposed positions of the pressure center for each period (1957-58, 1958-59, 1959-60) are given. It is noted that the estimated values of  $a^3P/\mu$  increase with time. Comparison between mean sea level at Kagoshima and that at Hakamagoshi Harbor shows that the former was raised about 60 cm relative to the latter during July 1958-August 1960. It is concluded that the pressure in the magma reservoir increased during this active period.— V.S.N.

- 189-622. Matsuo, Sadao. On the chemical nature of fumarolic gases of Volcano Showashinzan, Hokkaido, Japan: Nagoya Univ. Jour. Earth Sci., v. 9, no. 1, p. 80-100, 1961.

Assuming that chemical reactions in fumarolic gases are nearly in equilibrium, a study is made of the components in fumarolic gases from Showashinzan Volcano, Hokkaido, Japan. Virtual equilibrium constants calculated from the analytical data of Showashinzan gases are used to determine the temperature-pressure conditions governing chemical reactions in fumarolic gases. It is concluded that many reactions in fumarolic gases are quenched more or less as the gases ascend through the conduit. The temperature and pressure necessary to attain virtual equilibrium are higher than those found at the outlet. Extrapolation of the relationship between the virtual equilibrium temperature and the temperature of a fumarole suggests that the magmatic temperature of Showashinzan Volcano is near 1,000°C. From a study of analytical data of various volcanoes, it is concluded that methane in the fumarolic gases of The Geysers and Yellowstone Park may be of magmatic origin but the methane in gases from Showashinzan and Wairakei has no definite relation to the temperature of the fumaroles and has probably been added from shallower areas. The constancy of the chemical composition of fumarolic gases is discussed briefly also.— V.S.N.

- 189-623. Roux, Jean. Séquelle d'activité du volcanisme en Haute-Auvergne [Sequel to the volcanic activity in Haute-Auvergne]: Soc. Géol. France Comptes Rendus, pt. 2, p. 38, 1962.

Fumaroles and hot waters of the Haute-Auvergne region are discussed briefly as the last manifestation of the volcanism which produced mostly in the Pliocene time the great volcanoes of the region.— V.S.N.

- 189-624. Sato, Koji. On the types of Japanese volcanic thermal water: Japanese Jour. Geology and Geography, v. 32, no. 2, p. 293-315, 1961.

The chemical composition of thermal waters issuing from summits or flanks of 38 volcanoes in Japan, in the unusually active thermal areas of Yellowstone

Park, New Zealand, and Iceland, as well as that of gases from 25 lava samples of different acidity observed by Shepherd (1938) and of emanations from Showa Shinzan, Hokkaido, and Kilauea and Mauna Loa, Hawaii, all point to a systematic and consistent distribution of the S/Cl ratios according to the varying acidity of the magmas. The S/Cl ratio in thermal waters and in magmatic emanations decreases with progressive stages of differentiation of a magma. A statistical study of the thermal waters of 171 Japanese volcanic hot springs confirms this trend. It is also observed that the richer the chlorine ion content in thermal water, the higher the temperature and the larger the amount of soluble matter in the water. The variation in original composition of thermal waters separates them into restricted or free systems of circulation. Those in a free system mix with vadose water and vary accordingly. Variations in chemical character and age of thermal activities in the Tamagawa hot springs area are discussed; a genetic relationship is found between the thermal waters and the volcanic actions.— V.S.N.

189-625. Nakamura, Hisayoshi, and Maeda, Kenjiro. Thermal waters and hydrothermal activities in Arima hot spring area, Hyogo Prefecture [with Japanese abstract]: Japan Geol. Survey Bull., v. 12, no. 7, p. 489-497, 1961.

The thermal waters of the Arima hot spring area, Hyogo Prefecture, Japan, have a remarkably high concentration of  $\text{Cl}^{-1}$  and contain gases of more than 50 percent  $\text{H}_2$ , which is unparalleled in Japanese hot springs. The presence of these gases high in  $\text{H}_2$  content suggests that the Arima thermal waters represent a residue of magmatic water, possibly from the volcanic activity that formed the Tertiary liparite. Core samples from the altered liparite were found to contain galena, sphalerite, and siderite, as well as pyrite and calcite. It is suggested that the hydrothermal activity in the Arima area may represent the genetic conditions for some types of epithermal ore deposits.— V.S.N.

189-626. Matsuo, Sadao. The behavior of volatiles in magma: Nagoya Univ. Jour. Earth Sci., v. 9, no. 1, p. 101-113, 1961.

The transfer of volatiles in a magma is discussed in relation to the thermal history of a model of a spherical magma reservoir with a radius of 2 km and an initial temperature of 1,200°C. It is shown that with no available inside source of heat the magma would solidify in 50,000 yr after its formation. In the period of fluid state, the transfer of water vapor by means of molecular diffusion is practically impossible, and thus the concentration of water added to the margin of a magma body through assimilation or dissolution remains unchanged. A concentration of volatiles at the top of the reservoir is possible when some event brings about a supersaturation of volatiles. Assuming the nucleation rate to be 0.1 ml per sec, the water content at the top of the magma reservoir would be double the initial content in 100 yr after initiation of bubbling. During that time the volume of accumulated gases would increase by about 10 percent of the volume of the reservoir; this would tend to deform the cap rocks of the reservoir. If the cap rocks yield to deformation, phreatic explosion may occur. However, if the nucleation rate is lower than  $10^{-4}$ , the accumulation of vapor at the top of the reservoir would not be sufficient to cause explosions until the magma has solidified.— V.S.N.



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