

Geophysical Abstracts 190 July-September 1962

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

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 - C

*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 190 that have not been listed previously.

- Akad. Nauk Uzbek. SSR Izv. Ser. Fiz.-Mat. -- Akademiya Nauk Uzbekskoy SSR, Izvestiya, Seriya Fizicheskaya -Matemicheskaya [Academy of Sciences of the Uzbek S.S.R., Bulletin, Physical-Mathematical Series]. Tashkent, Uzbek S.S.R.
- Akita Univ. Mining Coll. Jour. -- Journal of the Mining College of Akita University. Series A - Mining Geology. Akita, Japan.
- Canada Geog. Bull. -- Canada Geographical Bulletin. Geographical Branch, Department of Mines and Technical Surveys. Ottawa, Canada.
- Com. Glaciol. Italiano Boll. -- Bollettino del Comitato Glaciologico Italiano. Consiglio Nazionale delle Ricerche. [Bulletin of the Italian Glaciological Commission. National Research Council.] Turin, Italy.
- Geofiz. Razvedka -- Geofizicheskaya Razvedka. Upravleniye Geofizicheskikh Rabot Trest Geofiznefteuglerazvedka. Gostoptekhizdat [Geophysical Prospecting. Administration of Geophysical Works, Geofiznefteuglerazvedka Trust. Gostoptekhizdat]. Moskva (Moscow), U.S.S.R.
- Geol. Notes -- Geologic Notes. Division of Geology, State Development Board. Columbia, South Carolina.
- Indian Minerals -- Indian Minerals. Geological Survey of India. Calcutta, India.
- Istanbul Üniv. Fen Fakültesi Mecmuasi -- Istanbul Üniversitesi Fen Fakültesi Mecmuasi, Seri C: Astronomi-Fizik-Kimya [Review of the Faculty of Sciences of the University of Istanbul, Series C: Astronomy-Physics-Chemistry]. Istanbul, Turkey.
- Jour. Atmos. Sci.-- Journal of the Atmospheric Sciences [formerly Journal of Meteorology]. American Meteorological Society. Boston, Massachusetts.
- L'vov. Geol. Obshch., Mineralog. Sbornik -- L'vovskoye Geologicheskoye Obshchestvo, Mineralogicheskii Sbornik [L'vov Geological Society, Mineralogical Collection]. L'vov, U.S.S.R.

- Mus. Royal Afrique Centrale Annales, Sci. Géol. -- Annales du Musée Royal de l'Afrique Centrale, Sciences Géologiques [Annales of the Royal Museum of Central Africa, Geological Sciences]. Tervuren, Belgium.
- Phys. Soc. Japan Jour. -- Journal of the Physical Society of Japan. The Physical Society of Japan. Tokyo, Japan.
- Radiocarbon -- Radiocarbon. American Journal of Science, Yale University. New Haven, Connecticut.
- Tohoku Univ. Technology Rept. -- The Technology Reports of the Tohoku University. Faculty of Engineering, Tohoku University. Sendai, Japan.
- [Tokyo] Research Inst. Nat. Resources Misc. Repts. -- Miscellaneous Reports of the Research Institute for Natural Resources. The Research Institute for Natural Resources. Tokyo, Japan.
- Tulsa Geol. Soc. Digest -- Tulsa Geological Society Digest. Tulsa Geological Society. Tulsa, Oklahoma.
- Vyssh. Ucheb. Zavedeniy Izv., Geodeziya i Aerofotos'yemka -- Ministerstvo Vysshego Obrazovaniya SSSR, Izvestiya Vysshikh Uchebnykh Zavedeniy, Geodeziya i Aerofotos'yemka [Ministry of Higher Education of the U.S.S.R., Bulletin of the Institutions of Higher Learning, Geodesy and Aero-photo Surveying]. Moskva (Moscow), U.S.S.R.

Form of Citation

The abbreviations of journal titles used are those used in the U.S. Geological Survey publications and in many geological journals. For papers in most languages other than English, the title is given in the original language as well as in translation. Slavic names and titles have been transliterated by the system used by the United States Board of Geographic Names. This system of transliteration for Russian is given in Geophysical Abstracts 148 (January-March 1952, Bulletin 991-A) and in 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 E. J. Catanzaro, B. R. Doe, H. Faul, I. Friedman, S. S. Goldich, Ruth M. Gove, J. L. Harris, C. E. Hedge, P. C. Ives, R. F. Marvin, A. P. Pierce, J. N. Rosholt, F. E. Senftle, A. J. Shneiderov, H. C. Spicer, J. S. Stacey, T. W. Stern, A. B. Tanner, F. G. Walthall, 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

- 190-1. Krueger, Harold W., and Freedman, Richard O. K^{40} -Ar age determinations aid subsurface correlation: World Oil, v. 154, no. 5, p. 119-121, 1962.

Radioactive age determinations greatly assist the oil geologist in areas of unknown or disturbed stratigraphy involving such problems as unexpected crystalline rocks, loss of stratigraphic control by faulting, thick nonmarine unfossiliferous sediments, and wildcat wells or distant step-outs in known fields. This method is also well suited for provenance studies. Ages can often be determined on a routine basis within 48 hours.—J.W.C.

- 190-2. Hatuda, Zin'itiro, and Nagai, Jiro. Geological age determination by lead:alpha-ray method—1. Determination of alpha-ray activity of zircon: Kyoto Univ. Coll. Sci. Mem., ser. B, v. 28, no. 4, p. 527-538, 1962.

Alpha-ray activity is measured in a four-pi gas-flow counter.—H.F.

- 190-3. Nagai, Jiro. Determination of thorium-uranium ratio in radioactive minerals by alpha-ray counting: *Kyoto Univ. Coll. Sci. Mem.*, ser. B, v. 28, no. 4, p. 539-547, 1962.

Pulse-height discrimination permits a Th/U ratio determination with a precision of about 7.5 percent in a gas-flow counter.—H.F.

- 190-4. Deuser, W. G. A new method for the separation of strontium from rubidium for Rb-Sr: *Geochim. et Cosmochim. Acta*, v. 26, p. 515, 1962.

A simple wet chemical means is described for making separations of strontium from rubidium.—T.W.S.

- 190-5. Herzog, Leonard F. Geological age determination by X-ray fluorescence Rb/Sr ratio measurement in lepidolite: *Internat. Geol. Cong.*, 21st, Copenhagen 1960, pt. 26, p. 7-10, 1961.

This is virtually the same as the paper published in *Science*, v. 132, no. 3422, p. 293-295, 1960 (see *Geophys. Abs.* 182-5).—D.B.V.

- 190-6. Craig, Harmon. Mass-spectrometer analyses of radiocarbon standards: *Radiocarbon*, v. 3, p. 1-3, 1961.

Samples of CO₂ from combustion of NBS oxalic-acid radiocarbon standard were analyzed for C-13 and O-18 content at the Department of Earth Sciences, University of California, La Jolla. The results are tabulated and compared with the Chicago PDB standards.—P.C.I.

- 190-7. Chessex, Ronald. Applications de la thermoluminescence à la géologie [Applications of thermoluminescence to geology]: *Soc. Vaudoise des Sci. Nat. Bull.*, v. 68, pt. 1, no. 306, p. 1-13, 1962.

A brief summary of the theory of thermoluminescent phenomena is given, methods of measurement (visual, spectral, and glow curve) are discussed, and the necessary equipment for glow-curve measurements is listed with brief descriptions. The application of thermoluminescence to stratigraphic correlation and to age determinations is discussed, and the major contributions made by various workers in the field are pointed out. Results obtained with the method in dating calcareous rocks from the Alps, the Jura Mountains, and the Swiss Plateau are given in a table.—V.S.N.

- 190-8. McConnell, Duncan. Dating of fossil bones by the fluorine method: *Science*, v. 136, no. 3512, p. 241-244, 1962.

The crystal chemistry of bone and teeth gives no evidence of systematic substitution of any of the minor constituents, or of a stoichiometric amount of carbonate substituting for phosphate. Changes in the fluorine content during fossilization have always been assumed to be in the direction of increase; however, the fossil mastodon sample considered here contains considerably less than the bovine bone. Even straight forward chemical methods can hardly be expected to give consistent age determinations. Also, because the X-ray diffraction method is unreliable for determining fluorine content, fluorine analyses that depend upon it are unreliable as a means of dating fossils.—F.G.W.

- 190-9. Davis, G. L., Tilton, G[eorge] R., and Wetherill, G[eorge] W. Mineral ages from the Appalachian Province in North Carolina and Tennessee: *Jour. Geophys. Research*, v. 67, no. 5, p. 1987-1996, 1962.

Age measurements are given for nine zircons and nine micas from the Appalachian orogenic zone in western North Carolina and eastern Tennessee.

These measurements provide further evidence for the existence of crystalline rocks as old as 1,000 m.y. in the area. A still older age of 1,300 m.y. is found for zircons from two gneissic rocks; these older zircons are probably detrital. All the zircons have discordant ages. The discordances are compatible with loss of lead by continuous diffusion or episodic loss as a result of Paleozoic metamorphism. Possible difficulties in ascribing the discordances solely to episodic loss during Paleozoic metamorphism are pointed out. The problem of loss of lead during fusion of zircon has been studied; losses are shown to be negligible.— Author's abstract

- 190-10. Deuser, W. G., and Herzog, L[eonard] F. Rubidium-strontium age determinations of muscovites and biotites from pegmatites of the Blue Ridge and Piedmont: *Jour. Geophys. Research*, v. 67, no. 5, p. 1997-2004, 1962.

Eighteen mica specimens from pegmatites of the Blue Ridge and Piedmont provinces of the southeastern United States yield apparent Rb-Sr ages of 250 to 510 m.y. Muscovites from the Piedmont generally appear to be younger (average about 285 m.y.) than those from the Blue Ridge (average about 315 m.y.). Highly discordant 'ages' were found for coexisting biotite and muscovite from two Blue Ridge pegmatites; the biotite 'ages' are about 275 m.y., whereas the muscovite 'ages' are 510 m.y. Ages of the Piedmont samples range from 255 to 330 m.y.— C.E.H.

- 190-11. Du Bar, Jules R. New radiocarbon dates for the Pamlico formation of South Carolina and their stratigraphic significance: *Geol. Notes*, v. 6, no. 2, p. 21-24, 1962.

Marine invertebrate specimens collected from the Pamlico formation, Horry County, South Carolina, yield C-14 dates in excess of 35,400 B.P. These dates strongly support a Sangamonian age for this formation.— V.S.N.

- 190-12. Deffeyes, Kenneth S., and Martin, E. L. Absence of carbon-14 activity in dolomite from Florida Bay: *Science*, v. 136, no. 3518, p. 782, 1962.

Dolomite crystals concentrated from Recent carbonate sediments of Florida Bay give a C-14 age greater than 35,000 yr. Since Recent sedimentation began here less than 4,000 yr ago, the dolomite must have been derived from older rocks, and the hypothesis that dolomite is forming today is incorrect.— R.M.G.

- 190-13. Fernald, Arthur T. Radiocarbon dates relating to a widespread volcanic ash deposit, eastern Alaska: Art. 11, in *U.S. Geol. Survey Prof. Paper 450-B*, p. B29-B30, 1962.

A conspicuous blanket of volcanic ash covers a wide area in eastern Alaska and southern Yukon Territory. Carbon-14 dated peat samples from above and below this ash fall in the upper Tanana River valley indicate that the ash fell between 1,750 and 1,520 yr B.P. Another sample from within the flood-plain deposits of the upper Tanana River gives a maximum age of $2,000 \pm$ yr B.P. for the ash fall.— V.S.N.

- 190-14. Løken, Olav. The late-glacial and postglacial emergence and the deglaciation of northernmost Labrador: *Canada Geog. Bull.*, no. 17, p. 23-56, 1962.

From detailed study of coastal areas of northern Labrador three specific strandlines are identified and found to tilt down toward the NNE; these are in turn truncated by a fourth, younger, horizontal strandline about 15 m above present sea level. Isobases are drawn for two of these strandlines. A rela-

tive, late-glacial chronology of the area is presented with the only absolute date provided by a radiocarbon-dating of $9,000 \pm 200$ yr for shells found at 29 m above present sea level.— V.S.N.

190-15. Kulp, J. L[aurence], Kologrivov, R., Haller, J., and Koch, L. Potassium-argon ages on rocks from eastern Greenland: *Nature*, v. 194, no. 4832, p. 953-955, 1962.

Nine samples of igneous and metamorphic rocks from widely scattered localities within the folded Paleozoic belt along the east coast of Greenland were dated by the K-Ar method. The isotopic ages, which are regarded as minimal, are 1,900 m.y. for an alkali granite and 490 m.y. for a migmatite from the Precambrian basement; 375 m.y. for quartz dolerite and 410-425 m.y. for two phyllites from pre-Paleozoic supracrustal rocks; 400 m.y. for a schist and 405 m.y. for a pegmatite from the Caledonian infrastructural rocks; and 395 m.y. for a pegmatite and also for a granite representing late orogenic intrusives.— A.P.P.

190-16. Cahen, L[ucien], Pasteels, P[aul], Ledent, D[olly], Bourguillot, R., Wambeke, L. van, and Eberhardt, P[eter]. Recherches sur l'âge absolu des mineralisations uranifères du Katanga et de Rhodesie du Nord [Research on the absolute age of uraniferous mineralizations of Katanga and Northern Rhodesia (with English summary)]: *Mus. Royale Afrique Centrale Annales Sci. Géol.*, ser. 8, no. 41, p. 3-53, 1961.

Absolute age determinations on uranium mineralization in Katanga and Northern Rhodesia confirm geologic and mineralogic evidence for two distinct periods of mineralization: (1) 620 ± 20 m.y. at Shinkolobwe, Kalongwe, Luishya, and probably Swambo, in Katanga; and (2) 520 ± 20 m.y. at Kamoto and Kolwezi in the western mines area of Katanga, at Musoshi, southeast Katanga, and at Kansanshi and Nkana, Northern Rhodesia. Secondary pitchblende veins in Northern Rhodesia are dated at 365 ± 40 and 235 ± 35 m.y. The older mineralization postdated the main Katanga orogeny. No major tectonic episode succeeded it, and, with the possible exception of a few hundred feet at the top, the entire Katanga succession is older than 620 ± 20 m.y. Thus, most if not all of the cryptozoic Katanga succession is Precambrian. The younger mineralization represents a metamorphism characterized by considerable metasomatism, and according to the most recent (1960) time scales is Upper Cambrian. The two pitchblendes derived from it are imprecisely dated but appear to be Late Devonian and Permian. Results of chemical and isotopic analyses and of age determinations are tabulated. A bibliography of 71 items is included.— V.S.N.

190-17. Koenigswald, G. H. R. von, Gentner, W., and Lippolt, H. J. Age of the basalt flow at Olduvai, East Africa: *Nature*, v. 192, no. 4804, p. 720-721, 1961.

A serious discrepancy exists between the K-Ar analytical ages of the basalt flow and of the overlying sediments at Olduvai, Tanganyika. The analytical age of the basalt is 1.3 ± 0.1 m.y. This age is much younger than the 1.6-1.9 m.y. ages obtained from biotite and plagioclase separates from the overlying tuffaceous sediments. Analytical errors or techniques might account for this difference, but a more probable explanation is that the minerals from the tuffaceous sediments contain inherited argon. Previous investigations of the ages of biotite and sanidine separates from Pleistocene tuffs indicate that excess argon may be a factor. Sedimentary and paleontological considerations also invoke doubt as to the validity of the analytical ages of these sediments. The indicated 50 m.y. formation time for the bottom 30 m of these sediments is not consistent with their lithologic and paleontological descriptions if present understanding of sedimentation processes is correct.— R.F.M.

- 190-18. Straus, William L., Jr., and Hunt, Charles B. Age of Zinjanthropus: *Science*, v. 136, no. 3513, p. 293-295, 1962.

Potassium-argon age determinations on a variety of minerals from tuff date Zinjanthropus from Olduvai Gorge, Tanganyika, between 1 and 1.75 m.y. If the anorthoclase in the tuff dates back to an ash fall that buried Zinjanthropus and other hominid fossils, an age of approximately 1.75 m.y. appears to be well established, and some of the younger ages that have been obtained on other materials such as biotite and basalt can be ascribed to loss of argon from these materials relative to the anorthoclase. The authors emphasize the need for caution and for additional work. The latter is now in progress.—S.S.G.

- 190-19. Schürmann, H. M. E. The Riphean of the Red Sea area: *Geol. Fören. Stockholm Förrh.*, v. 83, no. 2, p. 109-128, 1961.

Young Precambrian rocks of the Red Sea area have been compared on the basis of paleontological and radioactive age-determinations available in the literature. These data suggest that the rocks apparently belong to the youngest consolidated rim (about 600 m.y.) of the old African cratonic shield (about 3,000 m.y.) and are equal to the Riphean.—B.R.D.

Tugarinov, A. I., Gavrilova, L. K., and Golubchira, M. N. Evolution in the isotopic composition of lead of rocks in Dnieper region. See *Geophys. Abs.* 190-375.

- 190-20. Russell, R. D., and Slawson, W[illiam] F. Age of the Cuddapahs, India: *Nature*, v. 194, no. 4828, p. 565-566, 1962.

The lead isotope ratios of the Zangamrjupalle galena from the Cuddapahs, India, were recomputed using the original spectrograms obtained by Aswathanarayana (see *Geophys. Abs.* 189-28).

The discrepancy between the two calculations is due to alternative ways of reading the base lines under the peaks at the two laboratories as a result of the relatively small resolution of the instrument used. Using lead tetramethyl spectra from different laboratories, correction factors for machines with different resolutions are estimated.—E.J.C.

- 190-21. Aswathanarayana, U. Age of the Cuddapahs, India: *Nature*, v. 194, no. 4828, p. 566, 1962.

Aswathanarayana replies to Russell and Slawson (see *Geophys. Abs.* 190-20) in regard to his previous article (see *Geophys. Abs.* 189-28). The model age of the Zangamrjupalle galena from the revised data is 1,400-1,470 m.y. Thus, the Cuddapahs may belong to the end phase of the Eastern Ghats cycle (1,600 m.y.) and the period immediately following.—E.J.C.

- 190-22. Nagai, Jiro. Age of Hiei granite determined with zircon and lead-alpha method: *Kyoto Univ. Coll. Sci. Mem.*, ser. B, v. 28, no. 4, p. 471-483, 1962.

The Hiei granite (at Kitashirakawa, Kyoto Prefecture), previously determined as 67 m.y. old by the K-Ar method, gives a lead/alpha age of 111 m.y. A granite porphyry (near Omi-Hachiman, Shiga Prefecture) and a zircon-bearing clay (Fuzioka Mine, Aichi Prefecture) give lead/alpha ages of 274 m.y. and 311 m.y., respectively; both are considered to be too high by the author.—H.F.

- 190-23. Miller, John [A.]; Shido, Fumiko; Banno, Shohei; and Uyeda, Seiya. New data on the age of orogeny and metamorphism in Japan: *Japanese Jour. Geology and Geography*, v. 32, no. 1, p. 145-151, 1961.

Potassium-argon ages were determined on biotite from three dioritic rocks, one from the Ryoke and the others from the Abukuma metamorphic terrane.

An age of 94 m.y. was obtained on the older Ryoke intrusives, and 102 and 95 m.y. for the younger and older Abukuma intrusives. The age of the granitic and dioritic rocks and that of the metamorphism are considered to be late Mesozoic. The K-Ar age of biotite from the Sanbagawa belt is tentatively dated as 82 m.y., which suggests that this belt is contemporaneous with the Ryoke belt. It is concluded that the early Mesozoic orogeny caused regional metamorphism and granitic intrusion on the Japan Sea side of southwest Japan, whereas the late Mesozoic orogeny resulted in regional metamorphism and granitic intrusion of those metamorphic areas on the Pacific side of the early Mesozoic metamorphic belt.— V.S.N.

Richards, J. R. Isotopic composition of Australian leads; 2. Experimental procedures and interlaboratory comparisons. See *Geophys. Abs.* 190-374.

190-24. Jansen, H. S. Comparison between ring-dates and ^{14}C -dates in a New Zealand kauri tree: *New Zealand Jour. Sci.*, v. 5, no. 1, p. 74-84, 1962.

Carbon-14 dating at present implies the assumption that the normalized C-14/C-12 ratio in the living, pre-industrial biosphere remained essentially constant. This assumption, however, has been challenged by various workers in the field. It is important to archeology, geophysics, and other branches of science in which the method is used for determining dates to resolve the problem of variation with time of the C-14/C-12 ratio. A 1,000 yr old kauri tree from New Zealand has been ring dated and C-14 dated by CO_2 proportional counting. From A.D. 1000 to 1550 the C-14 enrichment with respect to 0.95 N.B.S. Oxalic Acid Standard ($\Delta\text{C-14}$) increased slowly from -35 to -20 percent, then rapidly to +5 percent by 1650, then slowly to +10 percent by 1800. From these results tentative corrections for ages of New Zealand archeological samples are derived, ranging up to 340 yr. Explanations suggested for the change in ratio are changes in vertical ocean currents, changes in the primary cosmic ray flux as a result of variations in the earth's magnetic moment (6.8 percent), or changes in intensity of sunspot maximums.— V.S.N.

Goldberg, E. E., and Koide, Minoru. Geochronological studies of deep sea sediments by the ionium/thorium method. See *Geophys. Abs.* 190-602.

190-25. Ralph, Elizabeth, K., and Ackerman, Robert K. University of Pennsylvania radiocarbon dates IV: *Radiocarbon*, v. 3, p. 4-14, 1961.

Radiocarbon ages determined at the University of Pennsylvania are presented; these were reported previously by Rainey and Ralph with one exception. Those determinations processed before 1956 were dated by the solid-carbon method and are so labeled; the rest were by the carbon-dioxide method. The one exception is a recount after conversion to carbon-dioxide. The dates include samples from Alaska and Canada.— P.C.I.

190-26. Gfeller, Chr., Oeschger, H., and Schwarz, U. Bern radiocarbon dates II: *Radiocarbon*, v. 3, p. 15-25, 1961.

This list covers measurements made at the University of Bern on geologic samples from Switzerland, Nepal, France, and Belgium. Radiocarbon dates are given for archeologic samples from Switzerland, Yugoslavia, Southern Rhodesia, and northwest Alaska.— P.C.I.

190-27. McAulay, I. R., and Watts, W. A. Dublin radiocarbon dates I: *Radiocarbon*, v. 3, p. 26-38, 1961.

The first series of dates from Trinity College in Dublin are given for pollen-dated bog samples, miscellaneous bog samples, archeologic samples, a check sample, and a miscellaneous sample, all from Ireland. The project was

a short-term one with two aims: to obtain key archeologic dates and to test the validity of the pollen zonation for the post-Atlantic of Mitchell.—P.C.I.

- 190-28. Barker, Harold, and Mackey, John. British Museum natural radiocarbon measurements III: Radiocarbon, v. 3, p. 39-45, 1961.

The third series of radiocarbon measurements made at the British Museum Research Laboratory is reported for archeologic samples from Africa, Egypt, Great Britain, India, Iraq, Iceland, and Spain, and a geologic sample from Switzerland.—P.C.I.

- 190-29. Walton, Alan, Trautman, Milton A., and Friend, James, P. Isotopes, Inc. radiocarbon measurements I: Radiocarbon, v. 3, p. 47-59, 1961.

The first series of radiocarbon measurements performed at Isotopes, Inc. include geologic samples from western, eastern, and northern Canada; Alaska; and the southern and eastern United States. Archeologic samples are dated from the United States and the Pacific Islands.—P.C.I.

- 190-30. Godwin, H., and Willis, E. H. Cambridge University natural radiocarbon measurements III: Radiocarbon, v. 3, p. 60-76, 1961.

Dates and activity measurements from Cambridge University include the British Isles coastal series, archeologic samples, late glacial and full glacial deposits, and problematic dates, along with a date from Greece.—P.C.I.

- 190-31. Godwin, H., and Willis, E. H. Cambridge University natural radiocarbon measurements IV; Nuclear-weapon testing and the atmospheric radiocarbon concentration: Radiocarbon, v. 3, p. 77-80, 1961.

An analysis of successive annual rings of a tree that had been growing throughout the period covered by the oat-crop assays, 1953-59, was undertaken at Cambridge University. Also measurements were made on the tropospheric radiocarbon activity since the beginning of nuclear weapons testing. Other dates include bomb-affected carbon samples of human testes and horse hair.—P.C.I.

- 190-32. Olsson, Ingrid; Cazeneuve, Horacio; Gustavsson, John; and Karlen, Ingvar. Uppsala natural radiocarbon measurements III: Radiocarbon, v. 3, p. 81-85, 1961.

Radiocarbon dates are given for geologic samples from the Mediterranean area, Spitsbergen, and North America, and for archeologic samples from Sweden. Measurements were also made on samples to evaluate the atomic bomb effect.—P.C.I.

- 190-33. Rubin, Meyer, and Berthold, Sarah M. U.S. Geological Survey radiocarbon dates VI: Radiocarbon, v. 3, p. 86-98, 1961.

Radiocarbon dates, determined at the U.S. Geological Survey radiocarbon laboratory, Washington, D. C., since the 1960 date list are given for geologic samples from eastern, central, and western United States, and Alaska, with miscellaneous sites in Hawaii, Iceland, and Saudi Arabia; and for archeologic samples from Chile and Israel.—P.C.I.

- 190-34. Ferrara, G., Fornaca-Rinaldi, G., and Tongiorgi, E[zio]. Carbon-14 dating in Pisa—II: Radiocarbon, v. 3, p. 99-104, 1961.

With no significant changes in the method used for measurements, the second dating list prepared by the University of Pisa gives dates of geologic and archeologic samples from Italy.—P.C.I.

- 190-35. Crane, H. R., and Griffin, James B. University of Michigan radiocarbon dates VI: Radiocarbon, v. 3, p. 105-125, 1961.

Radiocarbon dates from the University of Michigan are reported for geologic samples from central United States and Colorado. Archeologic samples from the upper Mississippi Valley, the Great Lakes, the lower Mississippi Valley, southeast and northeast United States and Canada, western United States, Mexico, Far East, the Pacific, and continental Old World are also dated.—P.C.I.

- 190-36. Stuiver, Minze, and Deevey, Edward S. Yale natural radiocarbon measurements VI: Radiocarbon, v. 3, p. 126-140, 1961.

The sixth series of dates reported by the geochronometric laboratory of Yale University are for geologic samples from Nova Scotia, Maine, Connecticut, Pennsylvania, Virginia, Alaska, Italy, and Guatemala; for archeologic samples from El Salvador, Costa Rica, Venezuela, and Northern Rhodesia; and for geochemical samples from Connecticut and New York.—P.C.I.

- 190-37. Olson, Edwin A., and Broecker, Wallace S. Lamont natural radiocarbon measurements VII: Radiocarbon, v. 3, p. 141-175, 1961.

Radiocarbon age determinations made at Lamont Geological Observatory are reported for samples associated with glacial deposits from midwestern and eastern United States, Canada, England, Antarctica; for samples associated with marine coastal deposits uplifted by glacial rebound from Canada; and for samples associated with marine coastal deposits in areas unaffected by glacial rebound from the Atlantic and Pacific coasts. Dates are also reported for samples associated with fluvial lake deposits from the Lahontan and Bonneville Basin; samples from deep-sea caves in the Arctic, Caribbean, Mediterranean, and Pacific; samples from cave deposits from the United States; miscellaneous samples of geologic interest from eastern, central, and southwestern United States, Alaska, Canada, Caribbean and Bahama Islands, Europe, and Africa; and samples of archeologic interest from the United States, Central and South America, Europe, Africa, and the South Pacific Islands.—P.C.I.

- 190-38. Broecker, Wallace S., and Olson, Edwin A. Lamont radiocarbon measurements VIII: Radiocarbon, v. 3, p. 176-204, 1961.

This list presented from Lamont Geological Observatory contains only results on samples of known age, as did the previous list from this laboratory. Although the system of data presentation is essentially the same as previously, a change has been made in the normalization formula. Measurements are reported for samples utilizing atmospheric CO₂ from Japan, Sweden, New Zealand, New York, the stratosphere, the Atlantic Ocean, the Mediterranean Sea, California, Nevada, New Jersey, the Pacific Ocean, Peru, Arizona, and Argentina; for samples utilizing CO₂ dissolved in sea water; and for samples utilizing CO₂ from terrestrial waters from lake, river, ground water, and hot springs samples.—P. C. I.

- 190-39. Dorn, T. F., Fairhall, A. W., Schell, W. R., and Takashima, Y. Radiocarbon dating at the University of Washington I: Radiocarbon, v. 4, p. 1-12, 1962.

The apparatus and method used for radiocarbon dating at the University of Washington are described. Dates are presented for geologic samples from the Pacific Northwest and Alaska, and for archeologic samples from Tennessee

and Washington. Measurements were made on Sequoia tree rings, and a note is given on the mechanism of radiogenic C-14 oxidation in the atmosphere.— P.C.I.

- 190-40. Dyck, W., and Fyles, J. G. Geological Survey of Canada radiocarbon dates I: Radiocarbon, v. 4, p. 13-26, 1962.

Carbon-14 ages are given for geological samples from southern and northern Canada.— P.C.I.

- 190-41. Tauber, Henrik. Copenhagen radiocarbon dates V: Radiocarbon, v. 4, p. 27-34, 1962.

Dates are listed for geologic and pollen-dated samples from Denmark and Poland, and for archeologic samples from Alaska, Greenland, Denmark, Israel, and Polynesia.— P.C.I.

- 190-42. Troutman, Milton A., and Walton, Alan. Isotopes, Inc., radiocarbon measurements II: Radiocarbon, v. 4, p. 35-42, 1962.

Carbon-14 ages are given for geologic samples from western, eastern, and northern Canada, Alaska, and eastern United States. Dates are also given for archeologic samples from Nova Scotia, Mexico, United States, and Thailand.— P.C.I.

- 190-43. Stipp, J. J., Davis, E. Mott, Noakes, John E., and Hoover, Tom E. University of Texas radiocarbon dates I: Radiocarbon, v. 4, p. 43-50, 1962.

Carbon-14 dates are listed for geologic samples from North Dakota, Alaska, and Illinois and for archeologic samples from Oklahoma and central Texas.— P.C.I.

- 190-44. Ostlund, H. Göte, Bowman, Albert L., and Rusnak, Gene A. Miami natural radiocarbon measurements I: Radiocarbon, v. 4, p. 51-56, 1962.

The C-14 ages of deep-sea cores from the Tongue of the Ocean, Bahamas, B.W.I. are reported.— P.C.I.

- 190-45. Godwin, H[arry], and Willis, E. H. Cambridge University natural radiocarbon measurements V: Radiocarbon, v. 4, p. 57-70, 1962.

Carbon-14 ages are listed for geologic samples from the Fenland Basin, Northern Ireland, Kent, North Africa, Greece, and Israel; for a group of raised-bog samples, mostly from Scotland; and for archeologic samples from Darbyshire and Somerset.— P.C.I.

- 190-46. McCallum, K. J. and Wittenberg, J. University of Saskatchewan radiocarbon dates III: Radiocarbon, v. 4, p. 71-80, 1962.

Carbon-14 measurements on geologic and archeologic samples from Canada are reported. The radiocarbon content in wheat crops from 1952 to 1961 is also given.— P.C.I.

- 190-47. Hyypä, E., Hoffren, V., and Isola, A. Geological Survey of Finland radiocarbon measurements I: Radiocarbon, v. 4, p. 81-83, 1962.

Carbon-14 ages are reported for geologic samples from Finnish Lapland, Finland, United States, and U.S.S.R.— P.C.I.

- 190-48. Kigoshi, Kunihiro; Tomikuna, Yoshio; and Endo, Kunihiro. Gaku-shuin national radiocarbon measurements I: Radiocarbon, v. 4, p. 84-94, 1962.

Carbon-14 age measurements are reported for geologic samples from Japan and for archeologic samples from the Andes, Pacific islands, and Japan.—P.C.I.

- 190-49. Dossin, J. M., Deumer, J. M., and Capron, P. C. Louvain natural radiocarbon measurements I: Radiocarbon, v. 4, p. 95-99, 1962.

Radiocarbon measurements are listed for geologic samples from Belgium and archeologic samples from Belgium, the Congo, and Egypt.—P.C.I.

- 190-50. Wendt, Immo; Schneekloth, Heinrich; and Budde, Enno. Hannover radiocarbon measurements I: Radiocarbon, v. 4, p. 100-108, 1962.

Radiocarbon measurements are reported for geologic samples from Germany and Iceland and for archeologic samples from Germany and Bolivia.—P.C.I.

- 190-51. Fergusson, C. J., and Libby, W. F. University of California, Los Angeles radiocarbon dates I: Radiocarbon, v. 4, p. 109-114, 1962.

Carbon-14 dates are given for geologic and archeologic samples from Texas, Nevada, Oregon, California, Santa Rosa Island, Mexico, Clipperton Island, and Egypt.—P.C.I.

- 190-52. Engstrand, Lars G., and Ostlund, H. Göte. Stockholm natural radiocarbon measurements IV: Radiocarbon, v. 4, p. 115-136, 1962.

Carbon-14 ages are presented for geologic samples from Sweden, Japan, and Finland; for deep-sea cores of the Albatross expedition; and for archeological samples from Sweden and Lapland.—P.C.I.

- 190-53. Geyh, M. A., Schneekloth, H., and Wendt, Immo. Hannover radiocarbon measurements II: Radiocarbon, v. 4, p. 137-143, 1962.

Carbon-14 age data are listed for geologic samples from Germany and Poland, and for archeologic samples from Germany.—P.C.I.

- 190-54. Ralph, Elizabeth K., and Stuckenrath, Robert, Jr. University of Pennsylvania radiocarbon dates V: Radiocarbon, v. 4, p. 144-159, 1962.

Carbon-14 dates are reported for geologic samples from eastern United States and for archeologic samples from Syria, the Mediterranean, Tikal in Central America, South America, and Australia.—P.C.I.

- 190-55. Nydal, Reidar. Trondheim natural radiocarbon measurements III: Radiocarbon, v. 4, p. 160-181, 1962.

Carbon-14 dates are listed for geologic samples from Norway and for archeologic samples from Norway, the Canary Islands, and northern Siberia (frozen mammoth and rhinoceros).—P.C.I.

- 190-56. Crane, H. R., and Griffin, James B. University of Michigan radiocarbon dates VII: Radiocarbon, v. 4, p. 183-203, 1962.

Results of C-14 measurements are reported for geologic samples from Michigan, Ohio, Kansas, Colorado, and Ontario; and for archeologic samples

from eastern United States, Canada, Mexico, South America, Far East, Pacific islands, and Africa.— P.C.I.

- 190-57. Hubbs, Carl L., Bien, George S., and Suess, Hans E. La Jolla natural radiocarbon measurements II: Radiocarbon, v. 4, p. 204-238, 1962.

Carbon-14 dates are listed for geologic and archeologic samples from the western United States, Mexico, Hawaii, Ceylon, and New South Wales.— H.F.

- 190-58. Damon, Paul E., and Long, Austin. Arizona radiocarbon dates III: Radiocarbon, v. 4, p. 239-249, 1962.

Carbon-14 age measurements are reported for geologic samples from the western United States and Costa Rica and for archeologic samples from Arizona, California, Mexico, Argentina, and Hungary.— P.C.I.

- 190-59. Stuiver, Minze, and Deevey, Edward S. Yale natural radiocarbon measurements VII: Radiocarbon, v. 4, p. 250-262, 1962.

Results of C-14 measurements are reported for geologic samples from northeast Greenland, New Mexico, Nebraska, Guatemala, Italy, and Iran; for archeologic samples from New York, Alaska, and Ecuador; for samples of natural carbon monoxide from Tonawanda, N. Y.; and for atmospheric carbon in Guatemala and lake samples (mostly Linsley Pond, North Branford, Conn.)— P.C.I.

- 190-60. Tauber, Henrik. Danske kulstof-14 dateringsresultater I [Danish carbon-14 dating results I (with English abstract)]: Dansk. Geol. Foren. Medd., v. 14, no. 4, p. 386-405, 1961.

Carbon-14 dates are listed with brief descriptions for samples from Alaska, Canada, Colombia, Denmark, Greenland, Germany, Holland, Iceland, Italy, Poland, Switzerland, Syria, and the United States. The measurements were made at the Carbon-14 Dating Laboratory in Copenhagen by the solid carbon technique (before 1955) and by the carbon dioxide gas-counting technique (since 1955). The list includes all previously published dates (see also Geophys. Abs. 155-14948, 167-8, 182-19, -20).— V.S.N.

- 190-61. Dicke, R. H. Dating the galaxy by uranium decay: Nature, v. 194, no. 4826, p. 329-330, 1962.

As a result of a discussion by Arp on the metal content of stars in clusters of various ages, there is some indication that the heavy elements were generated primarily in the halo population. Accepting this conclusion, Dicke makes the further assumption that Arp's data apply to the production of uranium. Using a technique similar to that of Fowler and Hoyle, an age is obtained for the galaxy based on radioactive decay of U-235. Using three hypothetically possible production-rate curves for uranium and three assumed values of the production ratio of U-235/U-238, ages of 7.4 b.y. are derived. This is about half that obtained by Fowler and Hoyle, the difference being traced to the different use of the thorium data and a different assumption as to the form of the production curve.— F.E.S.

COSMOGONY

- 190-62. Suess, Hans E. Thermodynamic data on the formation of solid carbon and organic compounds in primitive planetary atmosphere: Jour. Geophys. Research, v. 67, no. 5, p. 2029-2034, 1962.

Atmospheres of terrestrial planets lose the hydrogen originally present and produced by photolysis of CH₄, CH₃, and H₂O. With increasingly oxidizing

conditions the gases may pass through a phase during which elementary carbon and various organic compounds are thermodynamically stable. Numerical calculation of the equilibrium concentrations of H_2 , CH_4 , CO , CO_2 , and H_2O as a function of total H is difficult, but it has been carried out by Arnold Bainbridge on the La Jolla CDC-1604 computer for various temperatures, pressures, and carbon/oxygen ratios. The results show that at sufficiently low temperatures and sufficiently high carbon/oxygen ratios a range of total H will exist at which elementary carbon is thermodynamically stable. It seems possible that the surface rocks of Venus contain much more carbon than those of the earth. This would explain the presence of large amounts of CO_2 and the absence of oxygen on Venus.— Author's abstract

- 190-63. Fowler, William A., Greenstein, Jesse L., and Hoyle, Fred A. Nucleosynthesis during the early history of the solar system: Royal Astron. Soc. Geophys. Jour., v. 6, no. 2, p. 148-220, 1962.

This is a shorter version embodying the main conclusions of the work previously published (see Geophys. Abs. 189-36).— D.B.V.

- 190-64. Yanvel', A. A. Nekotoryye voprosy khimii meteoritov [Certain problems of the chemistry of meteorites]: Akad. Nauk SSSR Me-teoritika, no. 19, p. 12-23, 1960.

Basic data on the chemistry of meteorites are given under the following topics: mean chemical composition of meteoritic matter, regularities in chemical composition of various classes, distribution of elements according to phases of meteoritic matter, distribution of individual elements in meteorites, content of radioactive elements and isotopes of radiogenic elements, and isotope content of cosmogenic elements. The following absolute age scale of the evolution of meteoritic matter was derived from the study: formation of elements $\sim 7.5 \times 10^9$ yr, solidification $\sim 4.5-4 \times 10^9$ yr, thermal changes $\sim 4.3-1 \times 10^9$ yr, breaking up of the large bodies $\sim 10^9-10^7$ yr, and the falling of meteorites on the earth $\sim < 10^6$ yr.— A.J.S.

- 190-65. Kolomenskiy, V. D. Rentgenometricheskoye issledovaniye kory plavljeniya kamennogo meteorita Kunshak [X-ray investigation of the fusion crust of the Kunshak meteorite]: Akad. Nauk SSSR Me-teoritika, no. 19, p. 86-99, 1960.

A study of the fusion crust of the Kunshak stone meteorite by X-ray analysis is reported. Five pages of tabulated X-ray data are included. Olivine of varying composition is the main component of the fusion crust; enstatite and oximagnetite are also present.— A.J.S.

- 190-66. Bobrovnik, D. P., and Yasinskaya, A. A. Mineralograficheskoye issledovaniye oblomka meteorita iz kolleksii Poltusk [Mineralographic study of a meteorite fragment from the Poltusk collection]: L'vov. Geol. Obsch., Mineralog. Sbornik, no. 15, p. 313-315, 1961.

A mineralographic study was made of one of the 236 specimens of the Poltusk meteorite, which fell in Poland in 1868. The silicate phase is represented by chondrules, cemented in a felsite-like mass, and consists of olivine (40.34 percent) and hypersthene (33.80 percent). Also present are nickeliferous iron (13.10 percent), troilite (6.18 percent), chromite (0.65 percent), and ferric oxide (0.44 percent).— J.W.C.

- 190-67. Arnold, [James] R., Honda, M[asatake], and Lal, D[evendra]. Record of cosmic-ray intensity in the meteorites: Jour. Geophys. Research, v. 66, no. 10, p. 3519-3531, 1961.

Extensive data now exist on the abundance of radioactive and stable nuclides produced by cosmic rays in iron meteorites. Half lives of radioactive species

range from 16 days to 1.2 b.y. In this paper these data are compared with calculated production rates based on derived energy spectra of nuclear-active particles in meteorites and experimental excitation functions. Both relative and absolute amounts of the various species are in approximate agreement if the flux of cosmic rays is assumed not to have varied. The variation, averaged over the half life of each species, does not appear to exceed a factor of 2 in any case, except possibly K-40, for which the data are still insufficient. It is concluded that the cosmic-ray intensity has been constant, in this sense, at least over millions of years.— Authors' abstract

- 190-68. Honda, M[asatake], Umemoto, S., and Arnold, J[ames] R. Radioactive species produced by cosmic rays in Bruderheim and other stone meteorites: *Jour. Geophys. Research*, v. 66, no. 10, p. 3541-3546, 1961.

In this paper we report measurements of the activity of 16 radioactive nuclides in the chondritic meteorite Bruderheim, which fell on March 4, 1960. The data are compared with those for the iron Aroos and other stone, iron, and stony-iron meteorites. For nuclides of $A \geq 46$, the activities normalized to iron and nickel content are closely similar. For lower A, the activities in stone are mainly produced in lighter elements. The spectrum of bombarding particles is shown to be closely similar in irons and stones. The results are consistent with a constant cosmic-ray intensity. Cosmic-ray bombardment ages of 30 m.y. for Bruderheim and 130 m.y. for Admire are calculated from rare-gas data and the activities of Na-22, Al-26, and Cl-36.— Authors' abstract

- 190-69. Rowe, M. W., and Van Dilla, M. A. On the radioactivity of the Bruderheim chondrite: *Jour. Geophys. Research*, v. 66, no. 10, p. 3553-3556, 1961.

A sample of the Bruderheim chondrite (fell March 4, 1960) has been examined with a gamma ray spectrometer, K-40, Al-26, Mn-54, and Na-22 having been identified and quantitatively assayed. The concentrations found were 0.089 percent potassium, 57 disintegrations per minute per kilogram Al-26, 82 disintegrations per minute per kilogram Mn-54, and 90 disintegrations per minute per kilogram Na-22, which are in good agreement with values found by other workers for this and other meteorites. [Chemical analysis by Baadsgaard and Stelmach are included.]— Authors' abstract

- 190-70. Duke, Michael, Maynes, Donald, and Brown, Harrison. The petrography and chemical composition of the Bruderheim meteorite: *Jour. Geophys. Research*, v. 66, no. 10, p. 3557-3563, 1961.

The Bruderheim meteorite, a hypersthene chondrite, has been examined both petrographically and chemically. The minerals of the meteorite are olivine (F₀₇₈), hypersthene (En₇₈), plagioclase (Ab₉₅), apatite, merrillite, chromite, troilite, and metallic iron-nickel. Comparison of petrographic and chemical analyses shows that (1) pyroxene, troilite, and metallic iron-nickel are texturally related; (2) there is substantial CaO contained in the hypersthene; (3) there are important variations in samples the size of a thin section, and it is likely that there are also sampling errors on quantities of the size used for chemical analysis. The texture of the meteorite, including the principal chondrule types, is described.— Authors' abstract

- 190-71. Baadsgaard, H[alfdan], Campbell, F. A., Folinsbee, R. E., and Cumming, G. L. The Bruderheim meteorite: *Jour. Geophys. Research*, v. 66, no. 10, p. 3574-3577, 1961.

This is a discussion of the Bruderheim meteorite, summarizing distribution of samples that have been made available for investigation. Chemical and nor-

mative mineral composition and results of K-Ar age determinations are given. The Bruderheim is a gray chondrite with apparently greater alkali content than most chondrites. The K-Ar ages appear to be low, ranging from 1.5 to 1.9 b.y.-S.S.G.

- 190-72. Clarke, W. B., and Thode, H. G. Xenon in the Bruderheim meteorite: *Jour. Geophys. Research*, v. 66, no. 10, p. 3578-3579, 1961.

Two samples of the Bruderheim meteorite contain excess Xe-129 in the order of 4.5×10^{-11} and the Xe-129/Xe-130 ratio is 7.5.—S.S.G.

- 190-73. Shima, M., and Thode, H. G. The sulfur isotope abundances in Abee and Bruderheim meteorites: *Jour. Geophys. Research*, v. 66, no. 10, p. 3580, 1961.

Data for S-32/S-34 from the the Bruderheim and Abee meteorite chondrites are given.—S.S.G.

- 190-74. Ehmann, [William] D., Amiruddin, A., Rushbrook, P. R., and Hurst, M. E. Some trace element abundances in the Bruderheim meteorite: *Jour. Geophys. Research*, v. 66, no. 10, p. 3581, 1961.

Abundance data are given for tantalum, tungsten, and iridium in the Bruderheim meteorite as determined by neutron activation analysis.—S.S.G.

- 190-75. Jeffery, P. M., and Reynolds, [John] H. Origin of excess Xe-129 in stone meteorites: *Jour. Geophys. Research*, v. 66, no. 10, p. 3582-3583, 1961.

The origin of Xe-129 in the Bruderheim and Abee meteorites is discussed.—S.S.G.

- 190-76. Stauffer, Heinz, and Honda, Masatake. Cosmic-ray-produced V-50 and K-40 in the iron meteorite Aroos: *Jour. Geophys. Research*, v. 66, no. 10, p. 3584-3586, 1961.

Isotope data on V-50 and K-40 are presented and discussed.—S.S.G.

- 190-77. Murthy, V. Rama. Isotopic anomalies of molybdenum in some iron meteorites: *Jour. Geophys. Research*, v. 67, no. 2, p. 905-907, 1962.

Molybdenum from four iron meteorites appears to have an anomalous isotopic composition compared to terrestrial molybdenum. There is an apparent progressive depletion of the lighter mass isotopes of molybdenum in iron meteorites compared to terrestrial molybdenum.—C.E.H.

- 190-78. Tilles, David. Primordial gas in the Washington County meteorite: *Jour. Geophys. Research*, v. 67, no. 4, p. 1687-1689, 1962.

The recent measurements by Singer and Nier (1962) of the isotopic composition of helium, neon, and argon in iron meteorites suggests strongly that the Washington County meteorite contains primordial gas. The He-4/Ne-20 ratio is the same as the maximum ratio in the achondrite Pesyanoe and approximately that of several other meteorites. The gas may exist in voids or nonmetallic inclusions in the meteorite. The resulting inhomogeneous distribution may account for the variations of the gas concentrations within the meteorite.—F.E.S.

- 190-79. Marshall, Royal R. Mass spectrometric study of the lead in carbonaceous chondrites: *Jour. Geophys. Research*, v. 67, no. 5, p. 2005-2013, 1962.

Measurements of the isotopic ratios of lead from the Indarch, Murray, Mokoia, and Orgueil carbonaceous chondrites show that their leads differ only slightly from the primordial type of lead which Patterson found in the Canyon Diablo iron meteorite. Formal calculation of the lead-lead ages of Murray and Mokoia yields 4.7 and 4.6×10^9 yr, respectively. Empirical justification for these lead-lead ages comes from the agreement of similarly calculated ages for ordinary chondrites with those obtained by completely independent methods. There seems to be an additional small component of the radiogenic lead isotopes. The amount of this excess is comparable to that which has been observed in the Holbrook chondrite. Indarch contains an excess of Pb-207. Either this meteorite is older (about 5.1×10^9 yr), or (more likely) some variations in isotopic composition were present at the beginning of the solar system. Carbonaceous chondrites seem to have originated from chondritic material by the addition of certain elements and the loss of others. They acquired of the order of 1 to 4 ppm of primordial lead of the Canyon Diablo type.—Author's abstract

- 190-80. Merrihue, C. M., Pepin, R. O., and Reynolds, J[ohn] H. Rare gases in the chondrite Pantar: *Jour. Geophys. Research*, v. 67, no. 5, p. 2017-2021, 1962.

Neon and helium studies by König and others for the chondrite Pantar have been confirmed, and the measurements have been extended to include Ar and Xe. The light phase of this meteorite is typical of most chondrites in its content of radiogenic He-4 and Ar-40 and cosmogenic He-3, Ne, and Ar. The dark phase, in which opaque minerals outline the chondrules, is rich in 'primordial' rare gases. Primordial xenon, exhibiting 'general' isotopic anomalies identical to those found in carbonaceous chondrites, occurs in both phases but is 12 times more abundant in the dark phase. Radiogenic Xe-129 from I-129 decay occurs in both phases but is 53 times more abundant in the dark phase. The primordial gas spectrum resembles other meteorites in its He/Ne and Xe/Ar ratios. In its Ar/Ne and Ne-20/Ne-22 ratios it resembles Pesyanoe and belongs to what can be loosely described as a 'cosmic' group of gas-rich stones.—Authors' abstract

- 190-81. Stauffer, Heinz. On the production ratios of rare gas isotopes in stone meteorites: *Jour. Geophys. Research*, v. 67, no. 5, p. 2023-2028, 1962.

The abundances and isotopic compositions of argon, neon, and helium extracted from eight stone and four stony-iron meteorites were determined, and argon-potassium ages were calculated. The production ratios of cosmic-ray-produced isotopes were compared with the chemical composition of the samples. It was found that the ratios Ne-21/Ar-38 may be predicted with an accuracy of usually better than 20 percent by the equation $\text{Ne-21/Ar-38} = 2.9 \times \frac{([\text{Si}] + 1.35[\text{Al}] + 6.8[\text{Mg}])}{([\text{Fe}] + 16.5[\text{Ca}])}$ where [Si], [Al], [Mg], [Fe], and [Ca] are the concentrations of the corresponding elements. It is concluded that the cosmogenic ratios He-3/Ne-21, He-3/Ar-38, and Ne-21/Ar-38 in stone meteorites are determined essentially by the chemical composition of the samples only and that differences in shielding and possible diffusive losses are of minor importance.—Author's abstract

- 190-82. Fireman, E. L. The Ehole meteorite, its acquisition and its radioactivity: *Jour. Geophys. Research*, v. 67, no. 6, p. 2592-2594, 1962.

The fall and acquisition of the chondrite which fell in South-West Africa on August 31, 1961, is discussed. The activities of Ar-37, Ar-39, and tritium are similar to those found in other chondrites.—C.E.H.

- 190-83. Krummenacher, D[aniel], Merrihue, C. M., Pepin, R. O., and Reynolds, J[ohn] H. Meteoritic krypton and barium versus the general

isotopic anomalies in meteoritic xenon: *Geochim. et Cosmochim. Acta*, v. 26, p. 231-249, 1962.

Comparison of superior measurements of xenon isotope ratios for terrestrial and meteorite samples shows that the xenon anomalies for all meteorites are the same. Two superior krypton analyses for carbonaceous chondrites show no anomalies that are significant in comparison with those for xenon. Xe-124 is in excess in meteorites, although it is not produced synthetically by cyclotron deuterons striking a tellurium target.

Previous hypotheses explaining the anomalies are reviewed and found to be unsatisfactory. A new mechanism is proposed requiring excess fission production for xenon in meteorites coupled with gross mass fractionation of terrestrial xenon. This accounts for the observed anomalies, but by somewhat unlikely processes.—B.R.D.

190-84. Bainbridge, A. E., Suess, H[ans] E., and Wänke, H. The tritium content of three stony meteorites and one iron meteorite: *Geochim. et Cosmochim. Acta*, v. 26, p. 471-474, 1962.

The tritium content of the Bruderheim and Harleton chondrites is consistent with the C-14 content. The Walters chondrite furnishes a check on the terrestrial age of about 15 yr of this chondrite. An iron meteorite, Aroos, is deficient in tritium.—T.W.S.

190-85. Murthy, V. Rama. The isotopic composition of silver in iron meteorites: *Geochim. et Cosmochim. Acta*, v. 26, p. 481-488, 1962.

This is a more detailed presentation of the paper previously published in *Phys. Rev. Letters*, v. 5, no. 12, p. 539-541, 1960 (see *Geophys. Abs.* 184-99).—T.W.S.

190-86. Suess, H[ans] E., and Wänke, H. Radiocarbon content and terrestrial age of twelve stony meteorites and one iron meteorite: *Geochim. et Cosmochim. Acta*, v. 26, p. 475-480, 1962.

The average contemporaneous C-14 activity of falls is 48.2 disintegrations per minute. Pleistocene ages were measured for two of the six finds. The assumption that stony meteorites would disintegrate in a few years was not substantiated.—T.W.S.

190-87. Goel, Parmatma S., and Kohman, Truman P. Cosmogenic carbon-14 in meteorites and terrestrial ages of "finds" and craters: *Science*, v. 136, no. 3519, p. 875-876, 1962.

Cosmogenic C-14 has been measured in stone and iron meteorites. For "falls," the cosmogenic C-14/Al-26 ratios in stones and the C-14/Cl-36 ratios in irons are consistent with constant irradiation. The stone "finds" have cosmogenic radiocarbon ages of up to $\geq 21,000$ yr.—P.C.I.

190-88. Crozier, W. D. Five years of continuous collection of black, magnetic spherules from the atmosphere: *Jour. Geophys. Research*, v. 67, no. 6, p. 2543-2548, 1962.

Rates of deposition of magnetic spherules from the atmosphere in central New Mexico are given for a 5-yr period, 1956-60. Both times and size distributions are shown. The average numerical rate over the period for spherules larger than 5μ in diameter was $2.8 \times 10^{-3} \text{ m}^{-2} \text{ sec}^{-1}$. The average rate of mass accretion to the earth for spherules larger than 5μ , assuming a uniform deposit, was 1.6×10^5 metric tons per year. The deposition rate drops rapidly as diameters exceed 40μ . A virtual cutoff appears at about 60μ , though a few larger spherules were seen. The rates of spherule deposition in New Mexico

are within a factor of 4 of the rates deduced by Thiel and Schmidt [see *Geophys. Abs.* 185-98] for spherules in antarctic ice, for the range of sizes covered in their study. There appears also to be reasonable consistency between the New Mexico spherule deposition rates and the deposition rates for all micrometeorites recently calculated by McCracken, Alexander, and Dubin [see *Geophys. Abs.* 187-70] from rocket and satellite data, after due allowance is made for experimental uncertainties and for the uncertainties relating to the conversion of micrometeorites (including "dust balls") into spherules.—Author's abstract

- 190-89. Soberman, R. K., Hemenway, C[urtis] L., Ryan, T. G., Chrest, S. A., Frissora, J., and Fullam, E[rnest] F. Micrometeorite collection from a recoverable sounding rocket, Article I: U.S. Air Force Cambridge Research Labs., Geophysics Research Directorate Research Notes, no. 71, p. 1-9, 1961.

The design and performance of the "Venus Flytrap" micrometeorite collector rocket used to expose specially prepared particle impactors at altitudes between 88 and 168 km are discussed. Eight different materials were used to permit an evaluation of the effectiveness of different materials and techniques for the collection and study of micrometeoritic particles. Some of these materials were shadowed with aluminum before and after the flight to aid in the discrimination of micrometeorite particles from contaminants. The experimental surfaces consisted of mylar foil for impact and cratering studies and of sealed boxes loaded with high purity materials and surfaces suitable for electron microscopy.—V.S.N.

- 190-90. Hemenway, C[urtis] L., Soberman, R. K., Fullam, E[rnest] F., Balsamo, J. J., Cole, J., Hallgren, D., Yedinak, P., Goodman, A., and Hoff, G. Micrometeorite collection from a recoverable sounding rocket, Article II: U.S. Air Force Cambridge Research Labs., Geophysics Research Directorate Research Notes, no. 71, p. 11-39, 1961.

Three independent electron microscopes and observer teams have been used to evaluate, count, electron micrograph, and measure the micrometeorite particles collected by the "Venus Flytrap" rocket. Particles have been found in structures and sizes similar to those obtained at lower altitudes by other techniques. Approximately 7 particles per sq mm were collected during the flight, and typical particles and size distributions are shown in photographs. Most of the particles are submicron in size and generally fall into three types: high density spheres, medium density irregular particles, and extremely irregular medium-density (fluffy) particles. Some of the larger particles had sufficient momentum to rupture exposed films.—V.S.N.

- 190-91. Soberman, R. K., and Hemenway, C[urtis] L. Micrometeorite collection from a recoverable sounding rocket, Article III: U.S. Air Force Cambridge Research Labs., Geophysics Research Directorate Research Notes, no. 71, p. 41-49, 1961.

Preliminary results obtained from the "Venus Flytrap" rocket are presented, and these results are compared with those from satellite observations. An unexpectedly large number of micrometeorite particles were collected; those of submicron size were in preponderance, and the particles apparently were falling at low velocities. These results are consistent with either (1) a breakup of larger low-density (fluffy) particles or, (2) the existence of a dust layer or a geocentric distribution of micrometeoritic particles about the earth, or both.—V.S.N.

- 190-92. Pinson, W[illiam] H., Jr., and Schnetzler, C. C. Rubidium-strontium correlation of three tektites and their supposed sedimentary matrices: *Nature*, v. 193, no. 4812, p. 233-234, 1962.

Three tektites and their supposed sedimentary matrices were analyzed for rubidium and strontium contents. One tektite-matrix pair was studied with respect to its strontium isotopic composition. The results were inconclusive.—C.E.H.

- 190-93. Furcron, A. S. Geologic age of the tektite shower and its associated rocks of the Georgia Coastal Plain: *Georgia Mineral Newsletter*, v. 14, no. 4, p. 115-119, 1961.

A review of the geologic age of the formations associated with the Georgia tektites indicates that the georgiites fell on or possibly in the sands and gravels where they are now found. These geologic formations may not all be of the same age, but if the K-Ar ages are correct (see *Geophys. Abs.* 189-61) the tektites are older, that is, they were formed or last heated in Oligocene times. Thus, the tektite shower postdates the Oligocene, and there is geologic evidence to suggest a probable Pliocene-Pleistocene age for the fall.—V.S.N.

- 190-94. Baker, George. The largest known australite and three smaller specimens from Warralakin, Western Australia: *Royal Soc. Western Australia Jour.*, v. 45, pt. 1, p. 12-17, 1962.

Four australites recovered from the area south of the Warralakin-Warrachuppin railway line in Western Australia have all been modified by subaerial erosion to such an extent that their original volumes cannot be accurately determined. The largest of these weighs 238 g, 20 g more than the heaviest australite recorded to date. It is estimated that its weight at the time of landing was 280 g. Reconstruction of its primary shape reveals that about 35 percent of its bulk was lost by ablation during passage through the earth's atmosphere. The three smaller specimens are described briefly.—V.S.N.

- 190-95. Ryan, J. A. The case against thermal fracturing at the lunar surface: *Jour. Geophys. Research*, v. 67, no. 6, p. 2549-2558, 1962.

It is generally believed that overlying the lunar bedrock is a layer of more or less disrupted and modified material. Thermal fracture of the surface rock has been tacitly assumed to be a contributor to this layer, and little serious thought apparently has been given to whether thermal fracture can indeed occur. In this paper, the problem of thermal fracturing is treated both theoretically and experimentally. The tensile stresses produced in spheres of various sizes, under the thermal regime extant at the lunar surface, are determined theoretically. These stresses are then compared with those calculated from experimental studies. It is found that, though theory predicts fracture can occur, the experimental results indicate that such fracture is unlikely. It is concluded that simple thermal fracture at the lunar surface is unlikely and that fatigue fracture, if it occurs at all, can at best have only a negligible effect upon the lunar surface material.—Author's abstract

- 190-96. Walker, E. H. Comments on a paper by P. D. Grannis, "Electrostatic erosion mechanisms on the Moon": *Jour. Geophys. Research*, v. 67, no. 6, p. 2586-2587, 1962.

The probability equation on which Grannis (see *Geophys. Abs.* 188-135) based his calculation of electrostatic hopping of dust grains is shown to be incorrect, as it does not include the effect of the potential of the dust grain on the statistical process. Recalculation of the correct probability function leads to the conclusion that the statistical fluctuation of charge on the lunar dust grains is not significant in any erosion process.—D.B.V.

- 190-97. Green, Jack. Lunar volcanic mechanisms: *New York Acad. Sci. Trans.*, ser. 2, v. 24, no. 1, p. 3-14, 1961.

Assuming that most of the major lunar surface features are of internal origin, the conditions for the evolution of volcanic forms and the mechanisms intensifying lunar volcanism in relation to that on earth are discussed. Tidal and gravitational forces operative on the moon to a degree not present on earth are suggested as causes of regional lunar volcanism. The tidal effects in the lunar crust—extensive fracturing, cyclic pressure release leading to generation of magma, cyclic temperature drop leading to onset of magmatic crystallization, and intensification of the second boiling point effect leading to an explosive pressure rise under crustal plates—are analyzed in some detail. The effect of the smaller value of gravity on the moon in comparison with that on earth on the nature of a magma column and its eruption is described. Finally, the most important possible sources of heat—radioactive decay and tidal heat—are discussed. Widely different values for the rate of cooling of the moon may be proposed depending upon the lithology assumed for the crust and mantle; the assumption that the surface is chondritic is thought to be incorrect because chondrites cannot supply the heat necessary to induce volcanism.—V.S.N.

- 190-98. Green, J[ack], chm. The atmosphere of the moon: Lunar and Planetary Explor. Colloquium Proc., v. 3, no. 1, p. 51-68, 1962.

A general discussion on the atmosphere of the moon is introduced by the chairman, Jack Green, who reviews the history of the study of the lunar atmosphere and discusses the four areas of interest to geologists in the lunar atmosphere: (1) The generation of radon and argon by crustal rocks, (2) the detection of meteorite flashes, (3) the significance of the coloration of rays that radiate from lunar craters, and (4) the existence of temporary local atmospheres produced by possible volcanic activity. Visual observations that lend some verification to the possibility of temporary local atmospheres are listed in a table of reports of lunar surface changes published since 1834. The major part of the ensuing discussion centers around the development of a program of surveillance of the lunar surface.—V.S.N.

- 190-99. Green, Jack. The geology of the lunar base: North American Aviation, Inc., Space and Information Systems Div., Space Sci. Lab., SID 61-358, 127 p., 1961.

The possible volcanic terrain on the surface of the moon and the advantages it would offer over a meteorite impact surface for the construction and maintenance of scientific bases are analyzed. The following are discussed: lunar volcanic mechanisms (see Geophys. Abs. 190-97), microrelief of lunar terrain, mega- and macro-relief terrain features, mineralization, thermal sources, base site considerations, and base technology.—V.S.N.

- 190-100. Salisbury, John W. The lunar environment, in Space and planetary environments: U.S. Air Force Cambridge Research Labs. [Center], Air Force surveys in geophysics, no. 139, p. 91-126, 1962.

The lunar environment is treated in great detail in view of the fact that the major space effort for the next 10 yr will be directed toward exploration of the moon. The lunar atmosphere, thermal environment, magnetic field, composition, sub-surface structure, surface characteristics, natural resources, and other parametric data (mass, mean diameter, mean density, surface gravity, velocity of escape, rotation period, and others) are discussed. A reference list of 62 items is included.—V.S.N.

- 190-101. Haynes, C. Vance. Moon rocks, pt. 1: Mines Mag. [Colorado], v. 51, no. 12, p. 10-14, 1961; pt. 2, Ibid, v. 52, no. 1, p. 26-31, 1962.

In part 1 current knowledge on the origin, internal constitution, crust, and surface petrology of the moon is reviewed. In part 2, the description of lunar surface petrology is concluded with a discussion of volcanic ash and dust; then

metallic ore deposits, chemical salts and gases, dust of non-lunar origin and spallation dust, and engineering aspects of the lunar surface and a laboratory approach to ascertaining the nature of lunar surface materials are reviewed. A listing of the development of data on the moon in chronological order and according to the contributing scientist is given in part 1, and a bibliography is appended to part 2. A reference list is included in both parts.—V.S.N.

190-102. Sadil, Josef. *Cíl Měsíc* [Target—the moon]: Praha, Orbis, 333 p., 1960.

This is a semi-popular book on the moon. Starting with mythological and historical views on the moon and the sun, the author describes the planets and their satellites, planetoids, comets, meteors, meteorites, the increase of the earth's and the moon's mass by accretion, Pointing-Robertson effect, zodiacal light, and interplanetary gas. The discussion is extended to the moon as a celestial body; selenography, selenodesy, and a map of the moon; the physical parameters, heat, and structure of the moon's surface; and the moon's morphology and various hypotheses for its explanation. The last chapter describes observed changes on the moon, the possibility of life on the moon, its origin, and concludes with a discussion on attempts to reach the moon.—A.J.S.

190-103. Markov, A. V., ed. *The Moon*: Chicago, University of Chicago Press, 391 p., 1962.

This is an English translation from the Russian of a collection of papers on the moon that was originally published in Moscow in 1960. See *Geophys. Abs.* 186-98 through 186-109.—V.S.N.

EARTH CURRENTS

190-104. Price, A. T. The theory of magnetotelluric methods when the source field is considered: *Jour. Geophys. Research*, v. 67, no. 5, p. 1907-1918, 1962.

The theory of the relationship between the tangential components of E and H for geomagnetic fluctuations over a stratified earth is extended to take account of the distribution of the ionospheric inducing field. Cagniard's simple formulas need modification to take account of the dimensions of this field; this is so even when the inducing field is much more extensive than the region under consideration and when the depth of the probe is quite moderate. For deep probing, magnetotelluric methods can be satisfactorily applied only if an analysis of the field over a region having dimensions comparable with those of the inducing field is first made. The relation between these methods and the earlier methods of determining the conductivity distribution from analyses of the components of the surface magnetic field is discussed. The evaluation of the amplitude and phase relations of E and H over the oceans is also discussed, and it is shown that some results obtained recently by Fonarev (1961) should be extended and amended.—D.B.V.

190-105. Rikitake, T[suneji]. Supplement to paper " S_q and ocean": *Jour. Geophys. Research*, v. 67, no. 6, p. 2588-2591, 1962.

The induction by S_q in a hemispherical ocean is recalculated for a deeper ocean (4,000 m compared with 1,000 m in the previous paper—see *Geophys. Abs.* 187-90). It is found that the ocean's effect on S_q is increased only slightly by increasing the depth, and is no more than about 2 gammas at most. Therefore, induced currents in a vast ocean must be controlled largely by self-inductance rather than by conductivity.—D.B.V.

190-106. Hessler, V. P. Characteristics of telluric current at land and sea based stations, in *Internat. Conference on Cosmic Rays and the*

Earth Storm Proc.: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-4, p. 32-34, 1962.

Simultaneous telluric current and magnetic measurements recorded on Arctic Drifting Station Charlie in 1959 and two years later on Arlis I show that telluric current records at sea do not display the principal direction effect characteristic of land based observations. However, correlation of telluric current and magnetic amplitude activity is very high both on land and at sea. In addition, at sea there is a pronounced directional correlation between the two measurements. The penetration of the telluric currents at sea, their contribution to the magnetic disturbance at the surface of the sea, correlation between visual observation of active overhead auroral arcs with telluric currents in the sea, and other observations are also discussed.— V.S.N.

- 190-107. Porstendorfer, Gottfried. Tellurik—Grundlagen, Messtechnik und neue Einsatzmöglichkeiten [Telluric surveying—fundamentals, technique, and new possibilities of application]: Freiburger Forschungshefte, C 107, 186 p., 1961.

The experimental foundations of telluric surveying are the variations of the natural electromagnetic field of the earth. The theoretical principles explaining these variations are discussed. Succeeding chapters treat the telluric gradient method, telluric measurements in mining areas, the equivalence of prospecting by telluric and stray currents, apparatus, accessories, the practical execution of telluric measurements, and corrections to be applied. The last chapter gives examples of the application of telluric surveying in petroleum prospecting on salt domes, on structures containing highly resistant projections of chalky material, and on unknown crystalline structures overlain by conducting sediments.— D.B.V.

- 190-108. Richter, Kurt. Interpretation tellurischer Messungen durch Modellversuche [Interpretation of telluric measurements by model experiments]: Freiburger Forschungshefte, C 112, 32 p., 1961.

The three main parts of this paper deal respectively with model experiments for the study of the absolute ellipse, evaluation and construction of the isolines of the values of the parameters of the ellipse, and interpretation by means of mathematical methods. On the basis of the model experiments described here, it should be possible to develop an accurate method of measurement to be used in preparation of test curves for practical use. For this purpose the apparatus must be further improved, and the construction and electrode arrangement must be such as to avoid contact voltage and polarization which can falsify the results.— D.B.V.

- 190-109. Rokityanskiy, I. I. O primeneni magnitotelluricheskogo metoda na anizotropnom i neodnorodnom massivakh [On application of magnetotelluric methods on anisotropic and inhomogeneous massifs]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1607-1613, 1961.

A method is proposed for determining the azimuth of the axes of anisotropy, or of nonuniform conductivity, and the coefficient of effective anisotropy from data of the magnetotelluric method. This is accomplished by measuring four horizontal components of an alternating electromagnetic field at one point on the earth's surface. The method proposed is employed for interpretation of experimental data obtained at the Alushta geophysical station.— Author's abstract, A. J. S.

- 190-110. Vladimirov, N. P., and An, V. A. K metodike obrabotki magnitotelluricheskikh ostsilogram [On the method of processing magnetotelluric oscillograms]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1649-1654, 1961.

The processing of magnetotelluric oscillograms tape-recorded in the range of 0.5-1,000 cycles per second is discussed. The operation consists mainly of determination of frequencies and amplitudes of oscillations, which are correlated. Magnetotelluric sounding curves are then constructed on a basis of the apparent electric resistivity of the medium.— A.J.S.

- 190-111. Kovtun, A. A. Magnitotelluricheskiye issledovaniya sloistoneodnorodnykh struktur [Magnetotelluric investigations of stratified non-homogeneous structures]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1663-1667, 1961.

The causes of scattering in the values of impedances calculated from records of natural electromagnetic fields of the same direction and period are studied, and a method is proposed to reduce the scattering in the case of non-homogeneities such as faults and inclinations of the crystalline basement covered with sedimentary deposits.— A.J.S.

- 190-112. Gorelov, L. A., and Shabanov, B. A. O krupnomasshtabnoys' yemke metodom telluricheskikh tokov [On large scale surveying by the method of telluric currents]: Razvedochnaya i Promyslovaya Geofizika, no. 40, p. 36-38, 1961.

Telluric current exploration on a scale of 1:25,000 is discussed. Eight electrode single and double line settings, and the method of base point sliding along a closed polygon are described. A survey of more than 43 sq km by this method produced an isoline configuration indicating the surface relief of a halogen stratum.— A.J.S.

- 190-113. Shabanov, B. A. O povyshenii tochnosti obrabotki tellurogramm [On improving the accuracy of processing tellurograms]: Razvedochnaya i Promyslovaya Geofizika, no. 40, p. 39-40, 1961.

Variants of the ellipse method of processing tellurograms are explained. (See also Geophys. Abs. 190-112.)— A.J.S.

- 190-114. Lashkhi, A. S., and Gugunava, G. Ye. K voprosu svyazi variatsiy intensivnosti kosmicheskogo elektroizlucheniya s elektrotelluricheskimi vozmushchemiyami [On the problem of correlation between intensity variation of cosmic electric radiation and electro-telluric disturbances]: Akad. Nauk Gruzin. SSR Soobshch., v. 21, no. 4, p. 413-416, 1958.

An investigation of the distribution of electrotelluric disturbances at the geophysical stations of Dusheti ($\phi=42^{\circ}05'$; $\lambda=44^{\circ}42'$) and Shatsk ($\phi=53^{\circ}39'$; $\lambda=41^{\circ}51'$) was carried out in 1951-54 to evaluate the hypothesis that a correlation exists between solar flares and electrotelluric phenomena, based on Firor's hypothesis of a correlation between cosmic radiation intensity and solar flares. The correlation coefficient of disturbance time from 6 h to 14 h was found to vary from 49 to 85, favoring in general the proposed hypothesis.— A.J.S.

Miguel [y Gonzáles Miranda], Luis de. Geomagnetic observations made at Toledo during the I.G.Y.-I.G.C. See Geophys. Abs. 190-392.

EARTHQUAKES AND EARTHQUAKE WAVES

- 190-115. Due Rojo, Antonio. Notas sísmicas de 1960 [Seismic notes for 1960]: Rev. Geofísica, v. 20, no. 80, p. 345-351, 1961.

Earthquakes that occurred in 1960 are classified according to focal depth and magnitude. The more noteworthy shocks are discussed briefly by month, and the devastating effects of some such as the tsunami from the Chilean

earthquake in May and the landslides that destroyed Lar, Iran, in April are mentioned. A map shows the location of 1,192 epicenters.—D.B.V.

- 190-116. Agarwal, R. G. Earthquake of May 15, 1909: Alberta Soc. Petroleum Geologists Jour., v. 10, no. 4, p. 198-202, 1962.

Structures resulting from salt-solution and collapse are frequently encountered in the sedimentary section of Saskatchewan. A few writers, however, consider that some of these are caused primarily by deep-seated faulting. The earthquake of May 15, 1909 has been used by various workers in the area to support both sides of the argument (see Geophys. Abs. 171-54, 179-390, 183-338). In this paper all possible facts concerning this earthquake are enumerated, and it is left for the reader to decide where the shock originated, its intensity, and what it may imply with regard to the structures encountered in the Avonlea area of Saskatchewan.—V.S.N.

- 190-117. Robinson, E., Versey, H. R., and Williams, J. B. The Jamaica earthquake of March 1, 1957: Caribbean Geological Conference, 2d, University of Puerto Rico, 1959, Trans., p. 50-57, 1959; reprinted as Jamaica Geological Survey Pub., no. 65.

An earthquake of maximum intensity 8 (Modified Mercalli Scale) occurred on March 1, 1957, 5 1/2 miles WNW offshore from Montego Bay, Jamaica. The epicenter was located at lat 18°30' N., long 78° W. where an E-W fault system along the north coast intersects a NNW-SSE trending fault system. Isoseismic lines plotted on the basis of a survey of damage to buildings and other structures show a concentric but in some respect irregular pattern around the epicenter; higher intensities are encountered along major fault lines and on the alluvial plains of the southern section of the island. The effects on man-made structures, springs, wells, and the like are discussed and illustrated by analyses of typical examples.—V.S.N.

- 190-118. Arenales, Ricardo. El Terremoto de San Salvador, Corpus-Christi-Junio 7 de 1917 [The earthquake of San Salvador, Corpus-Christi—June 7, 1917]: San Salvador, Ministerio de Educacion, Departamento Editorial, 2d ed., 139 p., 1961.

This is a reprinting of a popular account by a survivor (a journalist), published originally in 1917, of the damage both in life and property resulting from the severe earthquake that destroyed San Salvador, El Salvador, on Corpus Christi day, June 7, 1917.—V.S.N.

- 190-119. Borgel, R. Mouvements séismiques au Chili [Seismic movements in Chile]: Rev. Géomorphologie Dynam., v. 11, no. 10-12, p. 157-158, 1960.

A geomorphic expedition from the University of Chile in conjunction with Austral University visited the area affected by the earthquakes of May 21-22, 1960, particularly the vicinity of Lake Ríñihue. Unusually large displacements of fine-grained material took place here; glacial and volcanic sediments (especially ash deposits) were most affected, then marine clays and sediments and clayey fluviomarine sediments of the coastal areas, and finally natural or artificial fill on steep slopes. The observations were made as part of a systematic study of the evolution of slopes and of the materials underlying them from a granulometric and lithologic point of view. Such studies will permit delineation of the zones that are most stable for construction.—D.B.V.

- 190-120. Ruiz F., Carlos, and St. Amand, Pierre. Observations concerning the Chilean earthquakes of May 1960: Internat. Geol. Cong., 21st, Copenhagen 1960, pt. 26, p. 116-133, 1961.

This is a compilation of information collected by the staffs of the Instituto de Investigaciones Geológicas and Escuela de Geología of the University of Chile after the May 1960 earthquakes. The first shock had its epicenter at lat 37.5° S., long 73.5° W., and a magnitude of 7 1/2. The epicentral zone, with Mercalli intensity 8, was some 100x40 sq km. Focal depth was probably 50 km or more. The strongest shock came at 3:15 p.m. the next day; it lasted fully 3 1/2 min and caused most of the destruction. There were two zones of high intensity, one along the coast with intensity 8-9, and the other inland east of the lakes.

It is probable that the first earthquake had its epicenter on one of the north-trending faults near the center of the Arauco Peninsula at a depth too great to permit surface rupture. This tremor caused a redistribution in the forces in the earth, activating another great fault just offshore. The distribution of aftershocks suggests that the strongest shock was produced by slippage along about 1,200 km of this fault, which extends southward from the Arauco Peninsula. The Reloncavi fault probably moved next, and subsequently a series of others in the Central Valley and Coast Ranges slipped and gave rise to many other aftershocks. Steam, other gases, and ash erupted from a fracture that was large enough to permit ground water to seep to the level of hot rock below Puyehue Volcano; early reports that 12 volcanoes had erupted and 2 new ones formed as a result of the earthquake are untrue.—D.B.V.

190-121. St. Amand, Pierre. Los Terremotos de Mayo—Chile 1960 [The earthquakes of May—Chile 1960]: U.S. Naval Ordnance Test Station, Michelson Labs., China Lake, Calif., Tech. Art. 14, NOTS TP 2701, 39 p., 1961.

An eyewitness account of the effects of the series of earthquakes and tsunami that occurred in Chile from May through June 1960 is given. The origin, location, magnitude, intensity, and damage caused are discussed for earthquakes and tsunami, and the accompanying eruptions of Puyehue Volcano are described. Color maps give the location and magnitude of the earthquakes, and the geological structures with the location of faults and volcanoes. Several sketch maps of the affected areas and numerous photographs are included.—V.S.N.

190-122. Kondorskaya, N. V., and Vvedenskaya, N. A., eds. Bulletin silnykh zemletryaseniy SSSR za 1958 g. [Bulletin of strong earthquakes of the USSR for 1958]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 16 (183), p. 104-130, 1961.

This is the annual summary of instrumental and noninstrumental data on earthquakes of $M \geq 4$ that occurred in the territory of the U.S.S.R. during 1958. An earthquake map of the U.S.S.R. for 1958 and a table listing 250 earthquakes by area and magnitude are given. The earthquakes of January 5 and 7, February 17, May 31, July 5, September 14 and 26, October 13, November 6-12 (aftershocks), November 26, and December 21, 1958 are described, discussed, and illustrated by schematic maps. A detailed catalog for all 250 earthquakes is included.—A.J.S.

190-123. Ben-Menahem, Ari, and Toksöz, M. Nafi. Source-mechanism from spectra of long-period seismic surface-waves. 1. The Mongolian earthquake of December 4, 1957: Jour. Geophys. Research, v. 67, no. 5, p. 1943-1955, 1962.

The Pasadena seismograms of the Mongolian earthquake of December 4, 1957, were studied. Mantle Rayleigh waves R_3 , R_4 , R_5 , and R_6 were separated, digitized, filtered, and Fourier-analyzed. After the evaluation of the phase velocities and the absorption coefficients from amplitude ratios R_3/R_5 and R_4/R_6 the directivity was computed from the amplitude ratio of R_3/R_4 . A fault of 560 km, with an azimuth of 100°, and a rupture velocity of 3.5 kmps

gave the best fit to the observed directivity. Auxiliary data from aftershock distribution, initial motions, air waves from the main shock, and geological surveys of the fault area seem to support these findings. The phase spectra of R_3 and R_4 were corrected for the propagation phase and the instrumental phase shift to obtain the initial phases at the source. A rough estimate of the depth of faulting is obtained on the basis of the calculated strain release and observed displacements at the fault.— Authors' abstract

- 190-124. Hoshino, Kazuo. Fissures of alluvium deposits in the Hyuga-nada earthquake, February 27th, 1961, with some geological interpretations [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 12, no. 12, p. 972-977, 1961.

The epicenter of the Hyuga-nada earthquake, Kyushu, Japan on February 27, 1961 was at lat 32° N., long 132° E. in the sea bottom about 35 or 60 km southwest of Hyuga-nada; the focal depth was about 10 km. The magnitude is calculated as 7.2. Damage centered in Miyazaki City where almost all structures suffered some damage and a few were destroyed. No evidence of active faulting could be found in the rocks exposed on land. However, many fissures were opened in alluvial sediments, the most important of which parallel older faults in the Mesozoic and Tertiary sedimentary basement rocks of the area. It is suggested that data on alluvial fissures be collected in all future large earthquakes.— V.S.N.

- 190-125. Kats, A. Z. Seismicheskoye mikrorayonirovaniye na osnove differentsiatsii gruntov po deformatsiyam, vyzhyvayemykh prokhozhdeniym seismicheskikh voln [Seismic microregionalization on a basis of differentiation of grounds according to deformations caused by the passage of seismic waves]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 16 (183), p. 20-31, 1961.

A method is discussed for evaluating seismic intensity with respect to the ground conditions due to the dynamic deformation from passage of seismic waves. Formulas are derived for correlating the intensity of passing seismic waves with the velocity of longitudinal waves in the surface layer and the layer underlying it, and for the value of relative deformation in the ground. Several examples are given.— A.J.S.

- 190-126. Kvale, Anders. Norwegian earthquakes in relation to tectonics: Bergen, Bergen Univ., Årbok 1960, Matematisk-Naturvitenskapelig Ser., no. 10, 17 p., 1962.

This is virtually the same as the paper published in Norges Geol. Undersøkelse Skr., no. 208, p. 490-506, 1960 (see Geophys. Abs. 185-126).— J.W.C.

- 190-127. Iosif, T. Seismicheskaya aktivnost' na territorii Rumynskoy Narodnoy Respubliki (1957-1959 gg) [Seismic activity in the territory of the Rumanian Peoples Republic (1957-1959)]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1633-1639, 1961.

Descriptions of 28 earthquakes that occurred during the period from January 1, 1957 to December 31, 1958 at the Carpathian Bend (26 earthquakes), Kypulung-Muschel', and Banat in Rumania are given on a basis of the seismic records of six Rumanian stations.— A.J.S.

- 190-128. Khan', Yuan'. Seismicity of the Tsilyan'shan and adjacent regions from the point of view of seismogeology [in Chinese with Russian summary]: Acta Geophys. Sinica, v. 9, no. 2, p. 107-124, 1960.

A zonality of epicenters is noted in the Tsilyan'shan and adjacent regions. Four belts are distinguished: the margin of the Alishan massiv, the geosyn-

cline of the north range of the Tsilyan'shan, the In'chuan depression, and the folded zone of the Lyupan'shan. A new seismicity map of this region is presented, on which five zones of different seismic intensity are distinguished. The entire region had been referred earlier to the zone of 9 points intensity; however, only individual areas are now referred to this high intensity zone.—J.W.C.

- 190-129. Rustanovich, D. N., Masaytis, V. L., and Chon, Khen Suk. Seysmichnost' i voprosy seysmotektoniki i seysmicheskogo rayonirovaniya Korei [Seismicity and the problems of seismotectonics and seismic regionalization of Korea]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1441-1463, 1961.

The seismicity of Korea according to historical (27-1727) and instrumental (1905-1960) data is discussed, and a map of seismic regionalization is given.—A.J.S.

- 190-130. Sponheuer, Wilhelm. Methoden zur Herdtiefenbestimmung in der Makroseismik [Method of focal depth determination in macroseismics]: Freiburger Forschungshefte, C 88, 120 p., 1960.

The Kövesligethy, Jánosi, Staykov, Gracia-Serrano, Raimondi, Imbó and Casertano, Peterschmitt, and Martelly methods of determining focal depth of an earthquake from macroseismic data, and the empirical formulas of Inglada-Orr, Gutenberg and Richter, Blake, and Neuberger are discussed. A rapid simplified method based on Kövesligethy's equations is presented. The focal depth of a large number of German earthquakes has been calculated according to the new method; the results agree well with those determined instrumentally.

In the case of small epicentral distances, the absorption term in Kövesligethy's equation has little significance; hence for near earthquakes absorption need not be determined with great precision.—D.B.V.

- 190-131. Kárník, V[ít], Kondorskaya, N. V., Riznitchenko, Ju. V. [Riznichenko, Yu. V.], Savarensky, E. F. [Savarenskiy, Ye. F.], Soloviev [Solov'yev], S. L., Shebalin, N. V., Vaněk, Jiří[š], and Zátopek, A[lois]. Standardization of the earthquake magnitude scale [with Russian summary]: Československá Akad. Věd Studia Geophys. et Geod., v. 6, no. 1, p. 41-48, 1962.

A standardization of methods of determining earthquake magnitude (M) is proposed. The formula $M = \log (A/T)_{\max} + \sigma(\Delta)$ should be used, in which A is maximum ground amplitude in microns, T is corresponding period in seconds, and both are in the wave group with maximum ratio A/T ; $\sigma(\Delta)$ is a calibrating function expressing the variation of A/T with epicentral distance Δ and is different for different wave types. The procedure for deducing the standard $\sigma(\Delta)$ for body and surface waves is given. One representative M -value should be determined for each earthquake, taking the arithmetic mean of magnitudes determined by this standard method at many stations on the basis of only one type of wave; combining values obtained for different types of waves is not considered to be suitable at present. These representative M -values should be determined by an international center and published regularly, together with all values used in their estimation. It is further suggested that regular station bulletins publish values of maximum amplitudes (A) and corresponding periods (T) of the principal wave types (at least P , S , and L) for both shallow and deep earthquakes.—D.B.V.

- 190-132. Enesku, D[umitru]. K opredeleniyu energii, izluchayemoy ochagami zemlitryaseniy v vide seysmicheskikh voln [On the determination of energy emitted by the focuses of earthquakes in the form of seismic waves]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1472-1474, 1961.

Equations are derived for the energy flux of longitudinal and transverse elastic waves from a disturbance source that has the form of a limited plane of disruption, the displacements in which are represented by Bürger's vector, b . The direction and magnitude of b and the radius of the disruption area can be determined by Vvedenskaya's method (see Geophys. Abs. 166-80 and 183-142).—A.J.S.

190-133. Medvedev, S. V. Vozdestviya zemletryaseniy 8 i 7 ballov na sistemy s odnoy stepen'yu svobody [Effects of earthquakes of 8 and 7 points on systems of one degree of freedom]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 16 (183), p. 3-19, 1961.

The actual values are determined for displacements and accelerations of earthquakes from 7 to 8 points intensity in systems of one degree of freedom with periods of natural oscillations between 0.1 and 2.0 second and a decrement of oscillation attenuation of 0.50. Tables and graphs for the deviation, κ , of systems of one degree of freedom for periods of natural oscillations, T , are given separately. Similarly, graphs and tables are given for accelerations (in terms of g) and for spectral coefficients.—A.J.S.

190-134. Ruprechtová, L[ibuše], and Vvedenskaya, A. V. On the stresses acting at the foci of earthquakes near the bend of the Carpathian arc (with Russian summary): Československá Akad. Věd Studia Geophys. et Geod., v. 6, no. 2, p. 140-151, 1962.

This is virtually the same as the paper published in Akad. Nauk SSSR Izv. Ser. Geofiz., no. 7, p. 953-965, 1961 (see Geophys. Abs. 186-159).—D.B.V.

190-135. Gorshkov, G. P. Sovremennyye tektonicheskiye dvizheniya i geologiya zemletryaseniy [Recent tectonic movements and the geology of earthquakes], in Sbornik trudov geologicheskogo fakul'teta Moskovskogo Universiteta: Moscow, Izdatel'stvo Moskov. Univ., p. 105-110, 1961.

Cosmic and exogenic factors are regarded as negligible as causes of earthquakes; only endogenic factors are effective. Among the hypotheses based on endogenic forces there are many unacceptable ideas: Earthquakes are not necessarily associated with mountainous terrain, tectonic lines, or Tertiary geosynclines. Earthquakes are generally associated with sections where recent tectonic activity is in evidence.—J.W.C.

190-136. Ohya, Masahiko. The relationship between abnormal tidal waves "tsunami" caused by the Chilean earthquakes and topography of the coasts of Kii Peninsula in the western part of Japan [in Japanese with English abstract]: [Tokyo] Research Inst. Nat. Resources Misc. Repts., nos. 56/57, p. 62-75, 1962.

A survey of the coastal areas of the Kii Peninsula, Honshu, Japan, immediately following the disastrous tsunami caused by the Chilean earthquake of May 1960 revealed a distinct difference between tsunami produced by earthquakes at distant points and those produced by near-by earthquakes. In general, those from afar are more gentle. The types of flood produced by tsunami are classified, and it is shown that the type can be determined according to the shorelines and microtopography of the plains along the coasts. It is possible to foretell the kind of tidal wave that can be expected and the damage that will be caused by studying the topography of the shoreline.—V.S.N.

190-137. Båth, Markus, and López Arroyo, Alfonso. Attenuation and dispersion of G waves: Jour. Geophys. Research, v. 67, no. 5, p. 1933-1942, 1962.

Unusually well developed G-waves up to the eighth order from the Peru earthquake of January 13, 1960, were recorded by long-period instruments at Uppsala, Sweden. A Fourier analysis of amplitude readings permitted construction of amplitude spectrums, which display a clear effect of selective attenuation in the shift of their maximums toward lower frequencies with increasing order of G. Absorption coefficients are derived and internal friction is computed for the period range 75-300 sec and compared with earlier results. Phase-velocity dispersion curves are computed and compared with results of other authors. Group-velocity dispersion derived from the phase-velocity curves agrees well with that derived directly from the record, giving an essentially constant value of 4.45 km/s for the period range 40-300 sec. The impulsive large-amplitude G_1 and G_2 are preceded by waves of smaller amplitude and shorter period, interpreted as S_a waves. Continued detailed investigations of G-waves will be of great importance for elucidating the properties of the upper mantle.—D.B.V.

- 190-138. Nakagawa, Ichiro. Some problems on time change of gravity, Pt. 5. On free oscillations of the earth observed at the time of the Chilean earthquake on May 22, 1960: Kyoto Univ. Disaster Prevention Research Inst. Bull., no. 57, p. 85-107, 1962.

Spectral analyses were made of the records of two Askania-111 gravimeters at Kyoto, Japan, to detect the free oscillations of the earth excited by the Chilean earthquake of May 22, 1960. The free oscillations of spheroidal modes S_0 - S_5 were clearly detected with periods ranging between 18 and 60 min. The spectral peak at the period of 53.4 min, which had a magnitude of about $0.34 \mu\text{gal}^2$, corresponds to the fundamental spheroidal oscillation of the earth. The gravity variation due to the earth's free oscillation of 53.4-min period was about $0.58 \mu\text{gal}$ in amplitude and attained its negative maximum at the origin time of the Chilean earthquake, 19h11m, May 22, 1960 (UT). The amplitude of vertical displacement corresponding to the gravity variation of 53.4-min period was calculated to be as follows: when motion was quasi-statical, 0.29 cm; when motion was periodical, 0.52 cm.—V.S.N.

- 190-139. Payo [Subiza], Gonzalo. Dispersión de las ondas Love a través de muy largos caminos euroasiáticos [Love wave dispersion along very long Euro-Asiatic paths]: Rev. Geofísica, v. 19, no. 76, p. 341-361, 1960.

Love wave dispersion along very long (about $\Delta=110^\circ$) continental paths through Europe and Asia has been investigated using records obtained at Toledo, Spain, from 7 earthquakes near the eastern coast of Asia. Surface waves from shocks originating in northern Japan and the Kurile Islands traveled homogeneous paths across the lowlands of northern Siberia and Europe; those from the Philippines, Celebes, and Sinkiang traveled relatively homogeneous paths across the highlands of central Asia and northern Europe. The results are shown graphically; differences between the curves for the two paths are interpreted as due to differences in thickness rather than in the nature of the crust.—D.B.V.

- 190-140. Saha, B. P. The seismic Lg waves and their propagation along the granitic layer of the crust of Indian sub-continent: Indian Jour. Meteorology and Geophysics, v. 12, no. 4, p. 609-618, 1961.

Channel waves of Lg type were recorded at Colaba (Bombay) from the earthquakes of March 5, 1960 in Nepal and of July 29, 1960 on the Assam-Bhutan border. No such waves, however, were recorded by similar seismographs at

Shillong or Madras; nor were they recorded at Quetta by seismographs of different characteristics. They are also absent in records of shocks originating in the zones to the north of the Himalayas. These records support previous reports that Lg waves are limited to continental paths and that mountain chains form a barrier to their propagation. Similarity to microseisms of 4-10 sec periods is considered, and the problem of why microseisms propagate through the ocean bottom when Lg waves are completely deleted is discussed. The well-defined Lg and Rg phases in records of the Assam-Bhutan border shock probably show the importance of the location of the focus in the granitic layer for the generation of these types of guided waves.— V.S.N.

- 190-141. Kumazawa, Mineo. Disturbances in electromagnetic field in rocks due to piezoelectric effects in connection with seismic waves: *Nagoya Univ. Jour. Earth Sci.*, v. 9, no. 1, p. 54-79, 1961.

In a piezoelectric solid the electromagnetic and elastic factors are found to couple in the case of both elastic and electromagnetic waves. Of the two types of distortional elastic and electromagnetic waves—ordinary or uncoupled and extraordinary or coupled—only the extraordinary is much affected by a piezoelectric medium and it couples strongly. At the discontinuity plane of piezoelectricity, electromagnetic waves and elastic waves of reflected and refracted types are generated by incidence of elastic or electromagnetic waves. Such piezoelectric effects are reduced by a decrease in electrical resistivity and in frequency of oscillation. Under the conditions common to the earth's crust the coupling of the electromagnetic and elastic factors are weak as a rule. However, piezoelectric effects, such as the electric field in the direction of wave propagation, may become important in seismological problems associated with strong earthquake shocks.— V.S.N.

- 190-142. Sutton, George H. Note on long-period noise in seismographs: *Jour. Geophys. Research*, v. 67, no. 5, p. 2082-2084, 1962.

Long-period noise due to thermal instability of the air within the seismometer case, observed on long-period instruments at Palisades during cold spells in the winter, was completely eliminated by covering the seismometer with a styrofoam box containing an electric light bulb near its top as a heat source. Similar noise observed with a short-period Sprengnether seismometer is also reported to have been eliminated by heat and insulation.— D.B.V.

- 190-143. Oilweek. Electro-Tech has portable seismograph: *Oilweek*, v. 13, no. 17, p. 38, 1962.

A completely portable electronic, long period, vertical seismograph that can be set up on any firm surface in five minutes is described briefly; it is known as the EV-100. The instrument can be operated unattended for 24-hr periods, making it ideal for monitoring earthquakes, seismic background noise, and explosions.— V.S.N.

- 190-144. Kirnos, D. P., Rulev, B. G., and Kharin, D. A. Seismograf VEGIK dlya raboty po inzhenernoy seysmologii i pri registratsii slabykh blizkikh i mestnykh zemletryaseniy [The seismograph VEGIK for use in engineering seismology and in recording of weak near and local earthquakes]: *Akad. Nauk SSSR Inst. Fiziki Zemli Trudy*, no. 16 (183), p. 32-56, 1961.

A detailed description is given of the seismograph VEGIK, which was designed mainly for study of the seismic effects of explosions. The elements of its theory, the method of determining its constants, and examples of its operation in recording weak near and local earthquakes for purposes of engineering seismology are discussed.— A.J.S.

- 190-145. Rulev, B. G., and Kharin, D. A. Seysmografy dlya registratsii bol'shikh peremeshcheniy [Seismographs for recording large displacements]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 16(183) p. 57-71, 1961.

The selection of an inertial type seismograph with an oscillation period of 1.6-2.0 sec, its design, and the principles of operation in recording large displacements in the ground caused by explosions are discussed. Testing of the apparatus on vibration platforms, its installation, and field tests are described. (See also Geophys. Abs. 169-64.)— A.J.S.

- 190-146. Shteynberg, V. V. Zapis' zemletryaseniy s bol'shoy skorost'yu razvertki [Recording of earthquakes with high speed scanning]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 16 (183), p. 84-86, 1961.

An apparatus is described for running seismograph tape at 1-2 cm per sec instead of at the usual 6 to 24 cm per min. This operation facilitates identification of separate amplitudes of seismic waves recorded on the tape, determination of the periods, and also the amplitude-frequency spectrums. Using a loop oscillograph of type POB-12 and POB-14 and a signalizer of type FE SS3 with a strong current relay of type PKS-2 or PKS-3 adapted, a high speed seismograph was constructed and put into operation.— A.J.S.

- 190-147. Eto, Tsuneo. On the electromagnetic seismographs at Syowa Base, Antarctica [with Japanese abstract]: Antarctic Rec., no. 14, p. 48-50, 1962.

The instrumental set-up for the seismological observatory at Syowa Base, Antarctica, is described briefly and illustrated. The constants for the pickups and galvanometers are tabulated.— V.S.N.

EARTH TIDES AND RELATED PHENOMENA

- 190-148. Longman, I. M. A Green's function for determining the deformation of the earth under surface mass loads. 1. Theory: Jour. Geophys. Research, v. 67, no. 2, p. 845-850, 1962.

A method is given for determination of surface deformation of the earth and perturbation in its superficial gravity field caused by an idealized unit point-mass load placed on the surface. By use of this Green's function the response of an accepted earth model to any superficial mass layer such as the variable ocean tide can readily be calculated. The theory is presented in this paper. Numerical results will be given in a later publication.

The results provide a theoretical basis for correcting earth-tide observations for the effects of ocean tides. More generally, the theory makes it possible to compute the gravitational anomaly at a point on the earth caused by an arbitrary superficial mass distribution, taking into account the effects of the elastic deformation.— D.B.V.

- 190-149. Mandelbaum, Hugo. On Rogassi's note on "Faults and earth tides" (Geophysics, October, 1961, p. 643): Geophysics, v. 27, no. 2, p. 276, 1962.

Gillett, M. F. On Rigassi's note on "Faults and earth tides" (Geophysics, October, 1961, p. 643): *ibid.*, p. 276, 1962.

Mandelbaum shows that differential tidal movement cannot be the cause of the results reported by Rigassi (see Geophys. Abs. 188-192). Gillett believes Rigassi's technique is thought-provoking and, in addition to its exploration applications, may aid in predicting earthquakes and volcanic activity.— D.B.V.

- 190-150. Fedorov, Ye. P. *Izucheniyе dvizheniya polyusov* [Study of the motion of the poles]: *Priroda*, no. 11, p. 59-68, 1959.

Studies of the motion of the earth's poles conducted in the framework of the International Geophysical Year (see *Geophys. Abs.* 180-78, -79, -80) by eight latitude variation stations are described. A model is proposed to explain the effect of elastic deformation of the earth on the motion of the poles. It consists of a sphere having a fixed bulge similar to the equatorial bulge of the earth, and a bulge that slides over the surface of the earth so as always to remain perpendicular to the axis of rotation. The processes that cause the earth's pole to move on its surface are discussed from data of latitude observations from 1947 to 1951. The instruments used in these observations are described. In calculations of the period of free motion of the pole the value of the earth's flattening that should remain if the earth stopped its axial rotation should be used, rather than the flattening of the rotating earth.—A.J.S.

- 190-151. Schneider, Manfred. *Eine Bemerkung zur Bestimmung der Eigenperiode von Horizontalpendeln* [A remark on the determination of the natural period of horizontal pendulums (with Russian summary)]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 6, no. 1, p. 86-94, 1962.

The classic method of determining the sensitivity of a horizontal pendulum to inclination by measuring oscillation time is subject to systematic error, and the results should be interpreted with this in mind. Experimental investigations on different types of horizontal pendulums show that the natural period of the pendulum depends on amplitude, and that vibrations induced by microseismic agitation can falsify the natural period for small amplitudes. Horizontal pendulums should be calibrated by a direct method that eliminates the measurement of oscillation time and avoids the interruption of station operations.—D.B.V.

ELASTICITY

- 190-152. Hudson, J. A. *Love waves in a heterogeneous medium*: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 2, p. 131-147, 1962.

The existence of Love waves in a layer of finite depth with a stress-free upper surface and rigidly fixed lower boundary is investigated. The density and rigidity of the medium vary arbitrarily with depth. Sturm-Liouville theory indicates the form of variation of the wavelength of the waves with period, and also the variation of group velocity with period. The same theory shows the effect on Love-wave periods of a change in rigidity or density in some depth ranges and the effect of a change in total depth of the layer. It is found that Love waves exist for any variation in density that is integrable as a function of depth and for any variation in rigidity that is a piecewise, continuous function of depth. The periods of waves of a given wavelength are reduced if rigidity is increased or density decreased in some range of depth; this result holds when the depth of the layer becomes infinite.—D.B.V.

- 190-153. White, J. E. *Elastic waves along a cylindrical bore*: *Geophysics*, v. 27, no. 3, p. 327-333, 1962.

This paper concerns axially symmetric solutions for waves propagating along a cylinder in an infinite elastic solid. Solutions are presented describing unattenuated propagation along the axis at phase velocities higher than shear and compressional speeds in the solid, in contradiction to earlier publications. Special attention is given to the limiting case of phase velocity equal to compressional speed in the solid, which at low frequencies very closely approximates the coupling of a fluid-filled borehole to a plane compressional wave in the surrounding solid. Comparison with some experiments in a uniform sec-

tion of Pierre shale shows excellent agreement at low frequencies. In the low-frequency limit, these solutions reduce to an approximate expression for borehole coupling published earlier by the author.— Author's abstract

- 190-154. Bortfeld, R[einhard]. Exact solution of the reflection and refraction of arbitrary spherical compressional waves at liquid-liquid interfaces and at solid-solid interfaces with equal shear velocities and equal densities: *Geophys. Prosp.*, v. 10, no. 1, p. 35-67, 1962.

A new method of treating three-dimensional elastic wave problems is described by applying it to the most simple case of the reflection and transmission of arbitrary homogeneous spherical compressional waves at plane liquid-liquid interfaces. The case of plane solid-solid interfaces with equal shear velocities and equal densities can be treated under the same heading. The step-response is obtained from the expressions for sinusoidal source excitation by a simple direct integration. The solutions for arbitrary source excitations are given in the usual way by the superposition integral. The solutions are proved by inserting them into the differential equations, followed by an application of the uniqueness theorem. The method is simple; all stages of establishing the solution (with the exception of the proof) are carried through in detail.— Author's abstract

- 190-155. Kunz, Bruno. The hyperbolic increase of depth with time: *Geophys. Prosp.*, v. 10, no. 1, p. 93-102, 1962.

The geometric description of wave fronts and ray paths has previously always started from the velocity distribution which has been chosen as simple as possible in order to be able to solve the integrals occurring in the basic equations. As the velocity is derived from the measured values of path and time, it is preferable to start from the path-time function. There are exponential, parabolic, and hyperbolic path-time functions; the first and the second case correspond to the known linear and parabolic velocity functions. The hyperbolic case, on the other hand, has not yet been covered in literature. In the first two cases, two parameters— a and v_0 —can be chosen arbitrarily. In the hyperbolic case, we have 3 parameters (a , b and v_0) at our disposal; this makes for a better approximation to actual conditions. A special advantage is seen also in the fact that the velocity does not become infinite with increasing depth but approaches a finite limit.— Author's abstract

- 190-156. Červený, Vlastislav. On the length of the interference zone of a reflected and head wave beyond the critical point and on the amplitudes of head waves [with Russian summary]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 6, no. 1, p. 49-64, 1962.

The length of the interference zone (the distance beyond the critical point in which the "reflected wave" is actually the superposition of a head wave and a reflected wave) is analyzed mathematically. The exact and approximate formulas for amplitude of head waves at the boundaries of the interference zone are compared. It is shown that outside the interference zone the amplitudes of head waves at an arbitrary distance from the critical point and for a refractive index arbitrarily near to unity can be described by the simple equation. The exact formulas are significant only when studying the amplitude of a "reflected wave" within the interference zone.— D.B.V.

- 190-157. Pěč. Karel. Theorie der im elastischen Halbraum durch eine flächenförmig Quelle erregten Wellen (2. Teil) [Theory of waves excited in an elastic half space by a plane source (Part 2) (with Russian summary)]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 6, no. 1, p. 65-74, 1962.

The field of body waves excited by a plane source situated on the surface of an elastic half space is discussed. Formulas are derived for the elastic dis-

placement components of the waves. The wave field of the plane source is composed of a series of natural areas that are divided chiefly into the forward and trailing fronts of the direct longitudinal and transverse waves and conical waves. The forward front corresponds to the deformation propagated from the nearest point of the plane source, whereas the trailing front is the arrival of deformation from the farthest point of the source. (See also Geophys. Abs. 189-145).—D.B.V.

- 190-158. Pěč, Karel. Theorie der im elastischen Halbraum durch eine flächennormige Quelle erregten Wellen (3. Teil) [Theory of waves excited by a plane source in an elastic half space (Part 3) (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 6, no. 2, p. 152-167, 1962.

Asymptotic formulas are derived for the field of body waves from a plane source situated on the surface of an elastic half space. These formulas are valid for large distances from the source and comprise only the more rapidly varying portion of the field. The elastic displacements due to a plane source on the surface of a half space are compared to those from a point source, other things being equal. The components of body waves from the point source are distinct, whereas those from a plane source are mainly continuous; the u_0 component is a band with two sharp extremes that correspond to the disturbance from the nearest and farthest points of the source. Conversely, the dimensions of the source can be calculated from the traveltime of the u_0 component on the basis of the distance between these extremes. (See also Geophys. Abs. 189-145 and 190-157).—D.B.V.

- 190-159. Chauveau, J[ean]. Étude analogique de la propagation d'un signal sismique [Analogical study of the propagation of a seismic signal (with English, German, and Russian abstracts)]: Annales Géophysique, v. 18, no. 1, p. 92-109, 1962.

It is shown how an analog model can be conceived to give the reflections and transmissions of a nonuniform velocity layer. The results are compared to the exact solutions of the equations of propagation and to the solutions resulting from a sampling of the velocity distribution in the layer. The equivalent filters to the propagation and to the sampling are deduced from these comparisons.—Author's English abstract

- 190-160. Gratsinskiy, V. G. Ob iskazheniyakh spektrov seysmicheskikh impul'sov rezonansnymi analizatorami i metode ikh ustraneniya [On distortions of spectrums of seismic impulses by resonance analyzers, and methods of their corrections]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1488-1501, 1961.

The spectrums of seismic impulses obtained with resonance analyzers are distorted, the character and magnitude of the distortions depending on the form and duration of impulses and on the parameters of the analyzer. A method is proposed for correcting errors in the spectrum by multiplying the impulse by a correcting function.—A.J.S.

- 190-161. Obukhov, V. A. Avtomaticheskii analizator spektra ul'tra-zvukovykh kolebaniy, registriruyemykh pri seysmicheskoy modelirovani [Automatic spectrum analyzer of ultrasonic vibrations registered in seismic modeling]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1510-1521, 1961.

Various methods of automatic frequency analysis of seismic impulses and the requirements that an analyzing apparatus should satisfy are discussed. The construction of the analyzer is described in detail. The frequency spectrum of an investigated wave is seen on the screen of a cathode-ray tube while the wave is being recorded.—A.J.S.

- 190-162. Bershteyn, P. Ya. Otrazheniye voln ot granitsy anizotropnogo popluprostranstva [Reflection of waves from a boundary of an anisotropic half-space]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1525-1526, 1961.

The reflection of elastic monochromatic waves by an anisotropic half-space boundary of axial symmetry is analyzed mathematically, and formulas for the direction of wave vectors of reflected waves, their group velocities, and amplitudes are derived.— A.J.S.

- 190-163. Sato, Yasuo, and Matumoto, Tosimatu. Vibration of an elastic globe with a homogeneous mantle over a homogeneous core. Vibrations of the first class: Jour. Physics of Earth [Tokyo], v. 9, no. 1, p. 1-16, 1961.

Calculations are made to determine the effect of finite rigidity on the period and mode of vibration of an elastic globe with a homogeneous mantle over a homogeneous core. Although a homogeneous mantle and core are not satisfactory in view of current knowledge of the earth, such a simplified assumption makes the general nature of the problem clear and suggests clues for further study. It is concluded from the calculations that a core of large rigidity causes the frequency of torsional oscillation to be higher; a core with small rigidity causes a decrease in the frequency of the fundamental mode and the period becomes very long; when the core rigidity is small, there are higher modes whose periods are nearly equal to those in the case of a perfectly liquid core, and the motion in the mantle is similar; and even when the displacement in the core is very large and is completely different from that of a perfect liquid, the observed period will be that for modes with undeveloped displacement distribution in the core.— V.S.N.

- 190-164. Hu, Hai-Chang. On reciprocal theorems in the dynamics of elastic bodies and some applications: Scientia Sinica, v. 7, no. 2, p. 137-150, 1958.

Reciprocal theorems in the dynamics of elastic bodies and structures are discussed systematically, and the results are generalized to fit bodies with anisotropic and nonhomogeneous elasticity with linear damping. The applications of these theorems are illustrated in problems of theory of elasticity, theory of structures, and vibration prevention in relation to foundation construction in earthquake resistant structures.— V.S.N.

- 190-165. Nomura, Yukichi, and Takaku, Koshun. Propagation of elastic waves in a layered inhomogeneous earth sphere: Tohoku Univ. Technology Repts., v. 26, no. 2, p. 103-203, 1962.

If the elastic coefficients and density of a spherical medium are given as slowly varying functions of the distance from the center of the medium, the equations of elastic waves can be derived from the equations of motion and separated into longitudinal and transverse parts approximately. The particular solutions of these approximate equations can be superposed so as to describe traveling waves in an inhomogeneous medium. These solutions are connected by boundary conditions where the medium varies continuously or discontinuously, and the general representations obtained are applied to seismic waves assuming that the earth is composed of many-layered inhomogeneous spherical shells and a fluid core that vary slowly with the distance from the center. The general form of the elastic waves is calculated by the saddle point method, and the results obtained agree well with actual seismic waves. The diffracted waves due to the liquid core are calculated also and are shown to form a clear shadow where they damp off rapidly in the geometric optical shadow region. All expressions in the paper have a rotational symmetry about the radius through the source point. The method may also be used to obtain formulas for examination of material by ultrasonic waves.— V.S.N.

- 190-166. Auberger, Michel, and Rinehart, John S. Method for measuring attenuation of ultrasonic longitudinal waves in plastics and rocks: *Acoust. Soc. Am. Jour.*, v. 32, no. 12, p. 1698-1699, 1960.

An extension of Hughes pulse technique is described for measuring attenuation of ultrasonic longitudinal waves in plastics and rocks. Data are given for plexiglas and granite in the frequency range: 250-1,000 kc.—Authors' abstract

- 190-167. Klíma, K[arel], Pros, Z[deněk], and Vanek, J[iřf]. Ultrasonic attenuation of longitudinal waves in solids: *Jour. Geophys. Research*, v. 67, no. 5, p. 2078-2080, 1962.
Rinehart, John S., and Auberger, Michel. Authors' reply to preceding discussion: *ibid*, p. 2081, 1962.

Klíma, Pros, and Vaněk criticize recent works by Auberger and Rinehart (see *Geophys. Abs.* 184-229, 190-166), claiming that their approximation 1 is not suitable for specimens of finite dimensions and that their values of the attenuation coefficient are questionable. Rinehart and Auberger reply that the approximation should be valid in view of the shapes of the specimens (relatively thin and extending laterally well beyond the area of application of the transducers), and that their attenuation measurements were relatively free from specimen geometry, unlike those of Pros and Vaněk (see *Geophys. Abs.* 186-271).—D.B.V.

- 190-168. Nicholls, Harry R. In situ determination of the dynamic elastic constants of rock: *U.S. Bur. Mines Rept. Inv.*, no. 5888, 13 p., 1961.

The elastic constants for rocks in place may be calculated from the longitudinal and shear velocities by a simple and economical method. Small charges of high explosives are detonated in shallow drill holes near a free surface, and the traveltimes for the longitudinal and shear waves are measured by accelerometers and velocity gages mounted on the rock surface at distances from 50 to 450 feet from the explosion. The elastic constants are then calculated using the velocities determined and the density of the rock. In testing the method, measurements were made in salt and granite gneiss. The dynamic elastic constants of drill core samples of these two types of rocks were determined in the laboratory by the resonant-frequency method, and the results compared with the "in-place" measurements. In general, there is less spread in the field data than in the laboratory data, and Poisson's ratio does not fall outside the theoretical limits for the former as is often the case for laboratory-determined elastic constants. Results are illustrated in tables and graphs.—V.S.N.

- 190-169. Neunhöfer, Horst. Theoretische Untersuchungen über die Reflexion und den Durchlass von Schall und Ultraschall an Spalten in Sylvinit, Hartsalz und Steinsalz, die mit Schnitkohlensäure gefüllt wird [Theoretical investigations of the reflection and transmission of sonic and ultrasonic waves at cracks in sylvinit, hard salt, and rock salt that are filled with carbon dioxide]: *Freiberger Forschungshefte*, C 84, 62 p., 1960.

The reflection and transmission coefficients and phase shifts for plane P- and S-waves at a CO₂-filled crack in three kinds of salt rock (rock salt, "hard" salt, and sylvinit) are calculated on the basis of the thermodynamic properties of carbon dioxide at 26°C and pressures of 300 atm, and the properties of the rocks. The S-waves are polarized in the plane of incidence. Shear waves polarized perpendicular to the plane of incidence are not considered, as they would be completely reflected at the crack. The change in shape of a series of impulses or an individual impulse at the crack is also investigated. The

results calculated for CO_2 can be transferred to other fluid fillings such as methane, nitrogen, or a mixture of the two. Finally, suggestions are given for applying these theoretical results to the use of acoustic impulses for detecting CO_2 -filled cracks in salt rocks.—D.B.V.

- 190-170. Šamina [Shamina], O. G. Modelluntersuchung von Kopf- und Reflexionswellen ausserhalb des kritischen Winkels [Model investigation of head waves and reflected waves beyond the critical angle]: Freiburger Forschungshefte C 116, p. 15-21, 1961.

Head waves and waves reflected beyond the critical angle were investigated by means of model experiments. The velocity of longitudinal and transverse waves and the absorption coefficients were measured by means of the usual ultrasonic arrangement IKL-5 with a piezoelectric transmitter. The two-dimensional models imitated probable crustal structure, with a layer 20 cm thick overlying a half-space 50 cm thick in a profile 100 cm long. Three combinations of materials were used: viniplast/getinax ($v_1/v_2=0.50$), plexiglass/getinax ($v_1/v_2=0.65$), and viniplast/plexiglass ($v_1/v_2=0.80$). Head waves and waves reflected beyond the critical angle appear in all three models. The phase velocity curves of the reflected waves were less steep than the theoretical curves. Reflections lying beyond the critical angle showed amplitudes comparable to those of the head waves. In the first two models there was good agreement between experimental and theoretical amplitude curves.—D.B.V.

- 190-171. Šamina [Shamina], O. G. Untersuchung elastischer Wellen an zwei-dimensionalen bimorphen Modellen [Investigation of elastic waves on two-dimensional bimorphous models]: Freiburger Forschungshefte, C 116, p. 23-34, 1961.

The propagation of spatially generalized waves in bimorphous models (plates made of two layers in various combinations of iron, brass, dural, plexiglass, and getinax) was investigated. The waves were generated by ultrasonic impulse apparatus. The various waves that were observed are described. It was found that double interference phenomena led to the formation of a simple wide bundle of waves consisting of longitudinal, transverse, and under certain conditions Rayleigh waves. The lower the frequencies or the higher the wavelength, the longer the path; and the smaller the contrast between the layers of the plate, the more readily were such generalized waves formed.—D.B.V.

- 190-172. Belikov, B. P. Uprugiye svoystva gornyykh porod [Elastic properties of rocks]: Akad. Nauk SSSR Izv. Ser. Geol., no. 11, p. 34-40, 1961; English version in Československá Akad. Věd Studia Geophys. et Geod., v. 6, no. 1, p. 75-85, 1962.

The results of laboratory measurements of the elastic properties of various rocks, using the static method on $5 \times 5 \times 15$ -cm prisms, are presented. The effect of weathering on density, porosity, compressive strength, deformation coefficient, and Young's modulus is illustrated by values tabulated for 5 samples of the same granite from depths of 0, 1.5, 3, 17, and 49 m. Another table gives density, porosity, compressive and breaking strengths, and 4 elastic constants for 42 sample rocks of 5 different groups—the Ukrainian shield, Baltic shield, geosynclines, quartzites and sandstones, and carbonate rocks. The elastic constants evidently depend mainly on mineralogic composition; the effect of other factors such as porosity or structure is significant only when there is no difference in composition. Results are summarized in another table that gives density, porosity, compressive strength, deformation factor, bulk modulus, and acoustic velocity for basic intrusive rocks, granitoids, migmatites, some intermediate and basic extrusives, some silicic intrusives, ferruginous quartzite, quartzites and quartzitic sandstones, marbles and marmorized calcitic and dolomitic limestones, and limestones and dolomites.—D.B.V.

- 190-173. Hurtig, Eckart. Untersuchungen über die Fortpflanzungsgeschwindigkeit longitudinaler Wellen in petrographischen Modellkörpern [Investigations of the propagation velocity of longitudinal waves in models of petrographic bodies (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 6, no. 2, p. 168-175, 1962.

The relation between longitudinal wave velocity and clay content was investigated on a number of artificial samples resembling natural limestones and sandstones. In samples consisting of cement and clay (imitating limestones with different clay contents) the velocity decreased sharply as clay content increased up to 70 percent; above that, an increase in clay content had little effect on velocity. Changes in mineral composition of the clay fraction were reflected in changes in P-wave velocity in cement-clay samples. In the sandstone models, changes in the proportions of cement and clay in the bonding agent had only a slight effect on the P-wave velocity. These results demonstrate the importance of petrographic investigations in the clarification of differences in elastic wave velocities in rock samples.— D.B.V.

- 190-174. Fay, Vey-Tsin. Dinamicheskiy impul'snyy metod opredeleniya uprugikh parametrov obraztsov gornykh porod pri vysokikh vvestoronnikh davleniyakh [Dynamical impulse method of determination of elastic parameters of specimens of rocks under high confining pressures]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1538-1543, 1961.

The shear modulus, bulk modulus, Poisson's ratio, and Young's modulus of samples of diabase, basalt, granite, and limestone were investigated at confining pressures up to 1,000 kg per cm² in a Volarovich-Balashov apparatus (see Geophys. Abs. 170-86). These constants were determined by the impulse method on a basis of simultaneous measurement of longitudinal and transverse wave velocities. The elastic wave velocities in the samples investigated increase with increasing pressure; the velocity increase for longitudinal waves is greater than that for the transverse waves. The elastic parameters of these rocks increase with rising pressure. The changes in the bulk modulus with pressure are greater than those of any other elastic parameter, and the changes in the shear modulus are the least.— A.J.S.

- 190-175. Gil'bershteyn, P. G. O proyektirovaniy dyrchatykh modeley seismicheskikh sred [On designing of perforated models of seismic mediums]: Geofiz. Razvedka, no. 2, p. 100-119, 1960.

Problems in the design of two-dimensional perforated models for improving the effectiveness and applicability of two-dimensional ultrasonic modeling of seismic waves are discussed. Tests of the models and the traveltime curves of longitudinal waves are described.— A.J.S.

- 190-176. Tandon, A. N. Seismic recording at Delhi of the Russian nuclear explosions on 23 and 30 October 1961: Indian Jour. Meteorology and Geophysics, v. 12, no. 4, p. 604-608, 1961.

The seismic records of nuclear explosions detonated at 50 to 60 km above the Arctic icecap east of Novaya Zemlya on October 23 and 30, 1961 are analyzed. Surface waves in which Rayleigh waves predominate were identical in both records. Long period waves having 3-4 min periods were recorded about 4 hr and 10 min after the arrival of the Rayleigh waves; they have normal dispersion and travel with the velocity of sound in air. The presence of these waves on the seismograms demonstrates the effectiveness of ground to air coupling and supports the theory of Press and Ewing (see Geophys. Abs. 146-13011). About 1/10,000 of the total energy of the explosions in air appears to have been transmitted to the ground.— V.S.N.

- 190-177. Nicholls, Harry R. Coupling explosive energy to rock: *Geophysics*, v. 27, no. 3, p. 305-316, 1962.

Two types of explosive-to-rock coupling were investigated—geometrical and impedance. Strain amplitudes generated by an explosion in a borehole are shown to vary with charge and hole dimensions. Strain amplitudes and strain energy in the rock also are shown to be dependent on the properties of the explosive and the medium surrounding the shothole. Maximum seismic energy (amplitude) is generated in a rock by the detonation of an explosive when the charge diameter equals the drill hole diameter and if the characteristic impedance of the explosive equals that of the rock.—D.B.V.

- 190-178. Wright, J. K., and Carpenter, E. W. The generation of horizontally polarized shear waves by underground explosions: *Jour. Geophys. Research*, v. 67, no. 5, p. 1957-1963, 1962.

In the seismic records from underground explosions there has been a weight of experimental evidence to show the existence of horizontally polarized shear waves. An interesting problem is whether such shear waves are generated at the source or are formed as the result of conversion from other wave forms during transit. The experimental evidence for conversion is mainly negative. Theoretically it is shown that a small amount of shear wave energy near the source can become relatively more important at large distances. Possible mechanisms for the generation of shear waves are Taylor instability in a soft medium and cracking in a hard medium. Geological inhomogeneities can be important in either case.—Authors' abstract

- 190-179. Aoki, Harumi. Free oscillations of spherical seismic origins [in Japanese with English abstract]: *Zisin*, ser. 2, v. 14, no. 2, p. 113-118, 1961.

Free oscillations of spherical seismic origin, initiated by an explosion, are calculated on the assumption that the elastic constants in a fractured region change in proportion to the square of the radial distance from the origin. The calculations show that the lowest frequency does not always increase with the thickness of the fractured region, and frequency becomes nearly twice as large as that of spherical origin in a non-fractured region. The variations of damping ratios of free oscillations are illustrated.—V.S.N.

- 190-180. Yoshikawa, Soji. The ground motion near explosion: *Kyoto Univ. Disaster Prevention Research Inst. Bull.*, no. 49, 14 p., 1961.

The propagation of waves near an explosion and related problems are discussed as a continuation of a paper published earlier (see *Geophys. Abs.* 174-96). A spherical origin is assumed that is applicable to a deep seated blast from which surface fracture is negligible. It is found that the wave generation is dependent on loading conditions, geologic structure, and types of blasts. A method for estimating the effect of the blast on ground motion from experimental results of minor blasts is discussed also.—V.S.N.

- 190-181. Gil'bershteyn, P. G., and Koloskov, I. A. Malogabaritnyy polevoy seysmoskop dlya izmereniya skorostey uprugikh voln [A small-scale field seismoscope for measurement of the velocity of elastic waves]: *Geofiz. Razvedka*, no. 2, p. 87-100. 1960.

The portable field seismoscope for measurement of elastic wave velocity in rock samples and in outcrops and mines is described; schematic diagrams are also given. The apparatus weighs 11.4 kg, its storage battery 17.6 kg, and its dimensions are 393×195×262 mm. The longitudinal wave velocities in a granite determined by the seismoscope are 3,980 and 3,450 m per sec as compared with parametric measurements of 4,040 and 3,430 m per sec, respective-

ly. Those in a keratophyre are 3,830 m per sec by the seismoscope and 3,800 m per sec by seismic logging data.— A.J.S.

ELECTRICAL EXPLORATION

- 190-182. Negi, Janardan G. Inhomogeneous cylindrical ore body in presence of a time varying magnetic field: *Geophysics*, v. 27, no. 3, p. 386-392, 1962.

The secondary fields are evaluated for the case of an inhomogeneous conducting cylinder embedded in an infinite homogeneous medium under the influence of a time varying magnetic field. Both sinusoidal and step function responses are studied in detail for a practical case of interest in geophysical prospecting in which the exterior medium is relatively poorly conducting, the propagation constant in the cylinder is varying linearly across the section of the core, and the magnetic permeability is the same everywhere.— Author's abstract

- 190-183. Glyuzman, A. M. Pole tochechnogo istochnika toka, raspolozhennogo v tochkakh dnevnoy poverkhnosti, imeyushchey formu parabolicheskogo tsilindra [Field of a point-source current, located at points on a surface having the form of a parabolic cylinder]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 11, p. 1659-1662, 1961.

A mathematical analysis is given of the field intensity of a point-source current located at any point on the boundary of a nonhomogeneous isotropic space having the form of a parabolic cylinder. The results obtained can be applied to certain anticlines or synclines.— A.J.S.

- 190-184. Grachev, A. A., and Petrovskiy, A. D. Nekotoryye rezul'taty radiovolnovogo prosvechivaniya na zhelezorudnykh mestorozhdeniyakh srednego Urala [Some results of radiowave translucence on iron-ore deposits of the middle Urals]: *Geofiz. Razvedka*, no. 6, p. 72-83, 1961.

Radiowave translucence was used successfully to map ore bodies in the space between shafts and drill holes in iron deposits of the middle Urals. Utilization of frequencies of the order of 1.5-2.5 mc guarantees a radius of translucence of 150-180 m, which is a fully satisfactory resolving capacity. Using a method of suppressing the influence of the attenuation effect of artificial conductors (cables, wires, tubes) on the measurements, broader application of radio-translucence is now possible. However, for increased dependability in interpreting results, a large quantity of experimental work is usually necessary for determining the nature of the effect of the artificial conductors.— J.S.W.

- 190-185. Wait, James R. A note on the electromagnetic response of a stratified earth: *Geophysics*, v. 27, no. 3, p. 382-385, 1962.

The response of an oscillating magnetic dipole over a continuously stratified flat earth is considered. As a result of certain simplifying approximations, which are valid at low audio frequencies, solutions for exponentially varying conductivities can be obtained in relatively simple form.— Author's abstract

- 190-186. Suoninen, E. J. On the correction to be applied for variations in the mutual position of the transmitter and receiver in airborne electromagnetic measurements: *Geophysica [Helsinki]*, v. 7, no. 3, p. 161-171, 1961.

The effect of changes in the mutual position of transmitter and receiver is investigated for the single loop and rotary field systems used in airborne elec-

tromagnetic surveying. The error in measurement of the phase and amplitude of the signal is estimated assuming a certain statistical law to account for the most important variations. Some recent experiments on the problem with the single loop system are reported. The importance of constructional and aerodynamic factors is discussed for both systems. Calculations of the root mean square errors for both systems are given in appendixes.— V.S.N.

- 190-187. Seigel, H[arold] O. Induced polarization and its role in mineral exploration: Canadian Mining Metall. Bull., v. 55, no. 600, p. 242-249, 1962.

Induced polarization is defined, and some of its causes and effects are discussed. The transient and the frequency variation methods of measurement and their field application are described and illustrated. Induced polarization extends the range of detectable sulfide occurrences to concentrations far below those detectable by electromagnetic means, and it is of value in Canada primarily for base metal occurrences where there is an association with disseminated sulfides. The method is not yet capable of differentiation between sulfide and graphite polarization. Despite this and other limitations the method has broadened the scope of geologic problems amenable to a geophysical approach.— V.S.N.

- 190-188. Pris, G. V. Parametry silindricheskikh provodnikov v induktivnom metode razvedki [The parameters of cylindrical conductors in the induction method of prospecting]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1640-1648, 1961.

A new physical quantity, the parameter of the field, $p = \omega \mu \gamma Q$, which characterizes the electrical and geometric properties of a conducting body is discussed; ω is the circular frequency of the exciting magnetic field; μ is the magnetic permeability of the conductor; γ is its electric conductivity; and Q is the coefficient which, in first approximation, depends on the size and form of the body. Its value for cylindrical conductors (circular, elliptical, and rectangular) resulting from induction in a uniform magnetic field is determined. Since p of one of two bodies of the same Q -value is greater for the body of higher conductivity, the field parameter p permits an ore-anomaly to be distinguished from a nonmetallic one.— A.J.S.

- 190-189. Zaborovskiy, A. I. Vyzvannaya polarizatsiya [Induced polarization (with English summary)], in Sbornik trudov geologicheskogo fakul'teta Moskovskogo Universiteta: Moscow, Izdatel'stvo Moskov. Univ., p. 3-12, 1961.

Induced polarization is dependent on the magnitude of electrokinetic potential and not on the specific resistance of the solution filling rock pores. Induced polarization drops to zero when the electrokinetic potential sign, usually positive, becomes negative. With a positive electrokinetic potential, it is possible for the values of the induced potential to be large even in rocks the pores of which are not completely filled by solutions.

Induced polarization depends on the grain size; it has a low value in rocks, increases sharply with increased grain size to a definite maximum, and then drops slowly.

In mediums that contain components with metallic conductivity, the phenomenon is more complicated. Experiments with a metal plate indicate that polarization decreases substantially with an increase in the frequency of the current.— J.W.C.

- 190-190. Nazarenko, O. V., and Belitskaya, S. G. K voprosu o vyzvannoy polarizatsii izmeritel'nykh elektrodov, nablyudayemoy pri vypolnenii elektrorazvedochnykh rabot [On the problem of induced polarization of measuring electrodes observed during the process of

electric prospecting]: Azerbaydzhan. Nauchno-Issled. Inst. po Dobyche Nefti Trudy, v. 4, p. 223-229, 1956.

The effect of induced polarization of the measuring electrodes on the oscillogram analysis obtained during electrical prospecting is discussed. It is shown that the rectangular form of primary impulses ΔV^0 is distorted by the superposition of secondary voltages ΔV^P , which are opposite in sign to ΔV^0 and obey approximately an exponential law in their variation. The apparent sensitivity of the channel may be reduced by a factor 3 when the polarization is substantial. Nonpolarizing electrodes are recommended for field exploration by the electric potential method.—A.J.S.

190-191. Shapovalov, O. M. Opyt primeneniya metoda vyzvannoy polyarizatsii [An experiment in applying the method of induced polarization]: Razvedka i Okhrana Nedr, no. 12, p. 35-42, 1961.

The method of induced polarization (VP) was applied to ore prospecting in the Chelyabinsk Region of the Urals and the results were substantiated by drilling. Measurements by the VP method are not affected by variations in topography, thickness of alluvium and weathering, fracturing, or excessive moisture. These factors usually distort the data obtained by the resistivity method. The depth of penetration reaches 150-200 m and can be increased farther by combining VP and the charged body method.—A.J.S.

190-192. Chzhan', Se-Chzhen'. Sounding by the method of induced potentials [in Chinese with Russian summary]: Acta Geophys. Sinica, v. 9, no. 1, p. 74-79, 1960.

A description is given of the method of induced potentials, whereby the position of an ore body or rock mass can be investigated by the change in the effective depth of a polarizing current. The results are presented of qualitative interpretation of measurements made above known ore bodies and barren wall rock, and also on models of ore beds with vertical and horizontal attitudes. These studies indicate a definite practical value of the new method.—Author's abstract, J.W.C.

190-193. Ri, Sok-Hang. Das Gleichstromdipolverfahren für geoelektrische Prospektion [The direct current dipole method of geoelectrical prospecting]: Freiburger Forschungshefte, C 114, 98 p., 1961.

The theory of the direct current dipole method is first reviewed, including discussion of the mathematical bases of the 4-point method, the theory of dipole sounding, and resistivity mapping with dipole configurations. The practical application of these principles then is described. The characteristics of individual dipole configurations, effective distances of dipole configurations, determination of coefficients of different dipole configurations, factors affecting apparent resistivity, the reference point for the results of measurements, and methods of interpretation of dipole sounding curves are treated. Practical examples of the method are given, and its advantages and disadvantages compared to the AMNB method are listed. The method described is one of the newest geophysical prospecting techniques and is still in its infancy.—D.B.V.

190-194. Enenshteyn, B. S., and Ivanov, A. P. Metod nepreryvnykh chastotnykh zondirovaniy [The method of continuous frequency sounding]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1655-1658, 1961.

A new modification of the method of frequency electromagnetic sounding used in geological exploration is proposed. The method consists of a continuous excitation of electromagnetic fields in the earth, and measurements of amplitudes and phases of signals received not on discrete frequencies but on a selected band of continuously varying frequencies. The theory of the modi-

fication and its instrumentation are discussed. A complete curve of frequency sounding can be recorded by the new method in 4-5 minutes instead of the 40-60 minutes required by the old method. Greater detail and less interference are claimed.— A.J.S.

- 190-195. Cheremenskiy, G. A. Teoriya ellipsoidal'nogo zonda metoda soprotivleniya ekranirovannogo zazemleniya [Theory of an ellipsoidal sonde in the resistivity method with a shielded ground]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1527-1532, 1961.

The current fields produced by automatically regulated electrical sondes are discussed. The equipotential field produced by such sondes is analyzed using curvilinear-coordinates represented by families of confocal ellipses and hyperbolas. Formulas for the parameters of such a field and for the values of apparent resistivity are derived for limited mediums and variable resistivity. The electric field produced by an ellipsoidal sonde is similar to that of a shielded cylindrical electrode in a borehole.— A.J.S.

- 190-196. Kalenov, Ye. N. Izmeneniye S po dannym elektricheskogo zondirovaniya vblizi vertikal'nogo kontakta [Change of S according to data of electrical sounding near a vertical contact]: Razvedochnaya i Promyslovaya Geofizika, no. 40, p. 27-35, 1961.

The difference in the values of the total longitudinal conductivity, S, of the sedimentary overburden covering a basement of high resistivity determined for the same point by dipole electrical sounding (DEZ) and by vertical electric sounding (VEZ) using different azimuths of the electrode spread is investigated. Assuming that the differences observed are due to vertical contacts of two layers of different resistivities, the sounding curves are compared with values of the generalized conductivity parameter. The conclusion was reached that the value of the total longitudinal conductivity, determined from the curves of horizontal-vertical contacts of three mediums, varies depending on the type of the electrodes, the direction of their spread, the position of the center of the set, and its distance from the line of vertical contact.— A.J.S.

- 190-197. Pichugin, N. I. Kartirovaniye krutykh kontaktov i tektonicheskikh narusheniy po dannym VEZ [Mapping steep contacts and tectonic dislocations according to VEZ data]: Razvedka i Okhrana Nedr, no. 9, p. 38-41, 1960.

A method for locating and interpreting steep contacts and faults from vertical electrical sounding (VEZ) data is proposed. The apparent electrical resistivity ρ_k of rocks over a vertical contact of two mediums, determined with a symmetrical 4-electrode array perpendicular to the dislocation plane, is found for the case when the resistivities ρ_1 and ρ_2 of the rocks on either side of the dislocation are unequal. The result obtained is $(\rho_2 + \rho_1)/2 = \rho_k$. For a VEZ array of 4 electrodes oriented parallel to a vertical contact, $\rho_k = 2\rho_2\rho_1/(\rho_2 + \rho_1)$ if the array is directly over the dislocation. Several examples are given for steeply dipping and vertical dislocation planes.— A.J.S.

- 190-198. Polyakov, A. S. O fizicheskoy sushchnostikazhushchegosya soprotivleniya [On the physical nature of apparent resistivity]: Razvedka i Okhrana Nedr, no. 9, p. 34-38, 1960.

Apparent electrical resistivity is interpreted as an electrical parameter directly proportional to the current density and to the resistivity of the medium between the receiving electrodes. The median gradient and combined profiling methods are used as an illustration of current density distribution depending on the presence and position of disturbing bodies on a profile. From the value of the median current gradient, a qualitative evaluation of the terrain and of the effects of the disturbing body can be obtained.— A.J.S.

- 190-199. Yamashita, Shiro. The electromotive force generated within the ore body by the temperature difference: Akita Univ. Mining Coll. Jour., ser. A, v. 1, no. 1, p. 69-78, 1961.

Most of the theoretical studies of spontaneous polarization phenomena have been made under constant temperature conditions. However, since in nature temperatures vary with depth (particularly in hot springs areas), a laboratory study was undertaken to measure the electromotive force of a sulfide ore sample under temperature conditions that vary from one end of the sample to the other. Results show that the part of the sample with the higher temperature has a negative potential. Although part of the electromotive force generated in the system is caused by the electrode system used (copper sulfate solution in this case), the other part is due to the thermo-electromotive force of the ore sample, and in any spontaneous polarization surveys of subsurface ore bodies, temperature differences must be considered. It is believed that these results with a sulfide ore sample are applicable to other ore bodies also, particularly to hot springs areas where negative self-potentials are known to exist.—V.S.N.

- 190-200. Yungul, S. H. The role of the surface electrical methods of geophysical prospecting in the petroleum industry: Geophysics, v. 27, no. 3, p. 393-396, 1962.

Four case histories are described briefly, in which electrical methods provided information of critical value that could not have been obtained as effectively by any other method: resistivity sounding in the Atlantic Basin of Gabon, West Africa (see Geophys. Abs. 168-93), dipole sounding in the Caspian Sea (see Geophys. Abs. 178-415), telluric survey in the Hodna Basin, Algeria (see Geophys. Abs. 161-62), and telluric survey at N'Daminze, Gabon, West Africa (see Geophys. Abs. 172-83). Reasons why the United States petroleum industry makes little or not use of surface electrical methods are discussed. It is concluded that these methods could serve the industry well, provided that the right amount of the right kind of field process is used by the right kind of personnel. Large companies seem to have difficulty tailoring their programs to the technical requirements of these methods.—D.B.V.

- 190-201. Fritsch, V[olker], and Mosetti, F[erruccio]. Problemi geofisici nella ricerca di bauxite, con particolare riguardo alle ricerche sui giacimenti del bacino Adriatico [Geophysical problems in prospecting for bauxite with particular regard to the prospecting for its deposits in the Adriatic basin (with German summary)]: Boll. Geofisica Teor. ed Appl., v. 2, no. 8, p. 575-598, 1960.

The possibilities of discovering bauxite deposits in Istria and Puglia in south Italy by geophysical methods are discussed. The magnetic and electrical resistivity methods are analyzed, and an example of finding a bauxite deposit by electric profiling is given.—A.J.S.

- 190-202. Ogil'vi, A. A. Rol' geofizicheskikh metodov pri izuchenii podzemnykh vod [Role of geophysical methods in study of ground water (with English summary)] in *Sbornik trudov geologicheskogo fakul'teta Moskovskogo Universiteta: Moscow, Izdatel'stvo Moskov. Univ.*, p. 13-28, 1961.

Four examples are described in which geophysical methods are used in hydrogeological research. (1) In areas of sandy rocks, electrical and seismic studies permit determination of depths to ground water; contour maps of the water table can thus be constructed. (2) Water circulating in pores and fissures generates electrical fields in the enclosing rocks. The intensity of these fields is dependent on the rate of movement of the water and can be used to determine the direction of subsurface flow. (3) The method of a charged body

permits determination of the direction and actual velocity of movement of ground water by a single borehole. An electrolyte is introduced into the well and is drifted by the subsurface flow; deformation of the natural electric field is then measured to determine the character of this flow. (4) Rate of filtration can be measured with a resistivity meter in a single hole. An artificially salted well is subjected to repeated measurements. The salinity and consequently the conductivity decrease in those portions where the rate of filtration is greatest.—J.W.C.

- 190-203. Vantsyan, G. M. O nekotorykh faktorakh iskazhayushchikh rezul'taty magnitorazvedki i elektroprofilirovaniya na rudnykh mestorozhdeniyakh Armyanskoy SSR [On certain factors distorting the results of magnetic prospecting and electrical profiling of ore deposits in the Armenian SSR]: Akad. Nauk Armyan. SSR Izv., Ser. Geol. i Geog. Nauk, v. 14, no. 4, p. 55-61, 1961.

The strong topographic relief in the Armenian S.S.R. introduces considerable error in electric profiling. Conductivity anomalies are produced by local increases in the thickness of alluvium and by its heterogeneity. A study of such effects was conducted on models, and suggestions are made for their reduction.—A.J.S.

- 190-204. Yakupov, V. S. Vozmozhnosti elektrorazvedki v usloviyakh mnogoletney merzloty [The possibilities for electrical prospecting under permafrost conditions]: Razvedka i Okhrana Nedr, no. 10, p. 29-32, 1960.

The hypothesis that the electrical resistivity of permafrost is a function of temperature only within the range of 0°C-2°C and is constant for lower temperatures was studied experimentally in the northeast permafrost territory of the U.S.S.R. This hypothesis permits the temperature effect on resistivity to be disregarded in electrical sounding for ore deposits in and beneath permafrost since the layer of 0°C-2°C is generally thin.—A.J.S.

- 190-205. Arogyaswamy, R. N. P. Prospecting for clay deposits: Indian Minerals, v. 15, no. 3, p. 217-219, 1961.

Various methods of prospecting for kaolin deposits are discussed. The resistivity method is applicable if the deposit is overlain by sand or sandstone and is of sufficient thickness in comparison with the thickness of cover. If the clay is of minor thickness as compared to the overburden or if the overburden is composed of clayey beds, resistivity methods may not be successful. Resistivity methods are also unsuccessful in very rugged or uneven terrain.—V.S.N.

- 190-206. Svetov, B. S., and Turchin, Yu. A. Uproshchennaya apparatura dlya amplitudno-fazovykh izmereniy nizkochastotnogo elektromagnitnogo polya (AFI-U) [A simplified apparatus for amplitude-phase measurements of a low frequency electromagnetic field (AFI-U)]: Geofiz. Razvedka, no. 2, p. 68-87, 1960.

A description is given of an apparatus for amplitude and phase measurements of electromagnetic fields on frequencies of 75, 375, and 1,125 cycles per second. This apparatus, AFI-U, is a simplified version of the rather bulky AFI-2 model adopted in 1959. The block and schematic diagrams are given. Three sets of the apparatus were built and tested in the field. The rate of performance is 8-10 km per day at steps of 20 m.—A.J.S.

- 190-207. Yoshizumi, Eizaburo, and Irie, Tsuneji. A study of the resistivity method using a resistance network analyzer: Kyoto Univ. Fac. Eng. Mem., v. 24, pt. 1, p. 77-92, 1962.

The application of a resistance network analyzer to the resistivity method of exploration is discussed. It is shown that the resistance network analyzer is capable of high accuracy in the solution of Laplace equations with given boundary conditions. The curves obtained agree with curves calculated theoretically, and it is concluded that this is an indispensable instrument in the solution of resistivity problems that can not be solved theoretically.— V.S.N.

- 190-208. Bergey, W. R. Geophysical and geochemical surveys in the Connors area, St. Catherine, Jamaica: *Geonotes*, v. 3, pt. 4, p. 121-123, 1960.

Magnetic, self-potential, and resistivity surveys, and geochemical prospecting were carried out in the Connors area, Parish of St. Catherine, Jamaica, in a search for copper deposits. Significant anomalies were indicated by both the self-potential and geochemical methods, and these two methods were then utilized for a detailed survey. Because of the obvious similarity in the pattern of anomalies from both methods, it is concluded that the locality is underlain by sulfide-bearing rock containing an appreciable copper content. Drilling located sufficient copper mineralization to warrant further work.— V.S.N.

- 190-209. Shaw, S. H., and Cole, J. A. The use of the electrical resistivity method for prospecting deep leads in the Jos Plateau tinfield: *Nigeria Geol. Survey Recs. for 1959*, p. 21-30, 1961.

The applicability of resistivity survey methods for locating the buried river channels or deep leads on the Jos Plateau, Nigeria, that are filled with cassiterite- and columbite-bearing alluvium and volcanic material was tested in three areas where some drilling data were available. Constant separation traverses and expanding electrode depth probes were employed, and satisfactory correlation between resistivity results and drilling data was obtained. Surveys of previously unexplored ground indicated the probable course of deep leads, and drilling has since proved the predictions to be substantially correct. Results of the surveys at Tente, Gona, and Gero are discussed.— V.S.N.

- 190-210. Borovinskiy, B. A., and Vilesova, L. A. Opyt primeneniya elektrometrii v izuchenii gidrologicheskikh osobennostey moren [Application of electrometric methods to the study of hydrologic characteristics of moraines], in *Glyatsiologicheskkiye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kazakh. SSR, p. 106-111, 1961.

Self-potential and resistivity methods are used to study the hydrologic regime of the frontal moraine of the Central Tuyuksuy glacier in the Zailiysky Alatau. Salt is used as tracer.— H.F.

- 190-211. Fomina, V. I. Povysheniye tochnosti opredeleniya moshchnosti osadochnogo kompleksa porod putem ispol'zovaniya dannykh o zakonomernostyakh izmereniya srednego prodol'nogo soprotivleniya ρ_l [Improvement in the accuracy of determination of the thickness of a sedimentary complex by using data on regularities of measurement of the mean longitudinal resistivity ρ_l]: *Prikladnaya Geofizika*, no. 27, p. 73-95, 1960.

The electrical characteristics of the sedimentary section change from the margins toward the center of the East Gobi depression in Mongolia. Mean electrical resistivity has been correlated with thickness of the sediments and therefore can be used to determine depth to basement without auxiliary drilling.— A.J.S.

- 190-212. Ono, Yoshihiko, Suyama, Junji, and Takagi, Shin'ichiro. Geoelectrical prospecting at Matsukawa geothermal field [in Japanese with

English abstract]: Japan Geol. Survey Bull., v. 12, no. 9, p. 677-685, 1961.

Vertical electric sounding using the direct current method was carried out to investigate subsurface geologic structures and geophysical phenomena in the Matsukawa hot spring district surrounding Marumori Volcano, Iwate Prefecture, Japan. From measurements in the caldera of Marumori Volcano it was found that the curve of vertical resistivity distribution has the form of descending steps, and a low resistivity zone estimated to be equivalent to the altered zone covers the whole of the area surveyed. Possible geologic structures are interpreted from a qualitative comparison between electrical data and the resistivities of rock, soil, and water or porosities of the rock samples. Results are illustrated in graphs and tables.— V.S.N.

190-213. Shibato, Kihei; Iida, Kumizi; and Sano, Shun-Ichi. Geophysical prospecting studies of uranium resources at Hirase Mine, Gifu Prefecture [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 11, no. 11, p. 721-732, 1960.

Electrical and radioactivity test surveys were made at the Hirase molybdenite mine, Gifu Prefecture, Japan, in order to determine the best prospecting methods for locating the molybdenite veins. Both methods were successful in tracing veins in the mine. On the surface no anomalies associated with the ore veins could be identified; the spontaneous polarization method, however, was successful in isolating the liparite zone and small anomalies associated with the silicified zone.— V.S.N.

190-214. Ono, Yoshihiko, Suyama, Junji; and Takagi, Shin'ichiro. On the electrical prospecting by the direct current method in Izu-Oshima Island [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 12, no. 11, p. 813-830, 1961.

The possibilities of applying electrical surveying to investigation of the subsurface and groundwater geology of Oshima Island in the Izu Island group, Japan, are discussed on a basis of vertical electric soundings using the direct current method carried out in 1958-59 in the northwest plain of the island, in the Oshima Park-Yuba district, and in the caldera of Oshima Volcano (Mihara). The depth of seawater intrusion and possible water-bearing zones were detected, the zone of hot water associated with the volcano was delineated, and the vertical and horizontal distribution of the volcanic sediments was determined.— V.S.N.

ELECTRICAL LOGGING

190-215. Shakina, V. Opredeleniye kollektorskikh svoystvi polozheniya VNK geofizicheskimi i radiometricheskimi metodami [Determination of reservoir properties and the position of the water-oil contact by geophysical and radiometric methods]: Vses. Neftgaz. Nauchno-Issled. Inst. Trudy, v. 29, p. 142-146, 1960.

The results of study of several SP methods of porosity determination for sandstone and carbonate strata are discussed. The method of Vilkov (see Geophys. Abs. 179-170) was found to produce a maximum error up to 12.9-18.3 percent compared with values obtained by core analysis. The maximum error by other methods is as high as 67 percent. Neutron logging in the Orenburg area is discussed.— A.J.S.

190-216. Maletskaya, T. S. Ispol'zovaniye metodov promyslovyoy geofiziki dlya opredeleniya poristosti i produktivnosti kollektorov nizhnego mela i miotsena na primerakh Leningradskoy, Kalininskoy i Severo-Ukrainskoy ploshchadey [Application of the methods of log-

ging geophysics for determination of porosity and productivity of the Lower Cretaceous and Miocene reservoirs as exemplified by the Leningrad, Kalinin, and north Ukrainian areas]: *Vses. Neftegaz. Nauchno-Issled. Inst. Trudy*, v. 29, p. 147-149, 1960.

Total porosity is correlated with the relative SP anomaly which is expressed as a ratio of the amplitudes of self-potential observed to the maximum negative anomaly in the borehole investigated. The values of relative resistivity and data from neutron-gamma logging in oil- and water-bearing strata are compared. — A.J.S.

- 190-217. Chekhovskaya, G. Yu., and Repina, V. L. Nekotoryye rezul'taty ispol'zovaniya geofizicheskikh metodov issledovaniya dlya opredeleniya parametrov plasta [Some results of application of geophysical methods of investigation for determination of the parameters of a stratum]: *Vses. Neftegaz. Nauchno-Issled. Inst. Trudy*, v. 29, p. 150-155, 1960.

Evaluation of porosity, permeability, and oil saturation in the Tashkalin and Staryy Grozny oilfield is discussed. Porosity and permeability were measured by comparing the reduced amplitudes of SP anomalies in boreholes with data of core analysis. The correlation thus obtained was applied for evaluation of reservoir parameters for boreholes from which no core samples were taken. — A.J.S.

- 190-218. Shapiro, D. A., and Neyman, V. S. Obotsenke poristosti plastov po diagrammam PS [Evaluation of porosity of strata according to SP diagrams]: *Vses. Neftegaz. Nauchno-Issled. Inst. Trudy*, v. 29, p. 156-165, 1960.

The SP method of porosity determination is analyzed. The ohmic characteristics and electrochemical factors are discussed with reference to their effect on accuracy. The effectiveness of the method is questioned because the average error of the method is 6-7 percent of the total volume of the pores for strata of more than 18 percent porosity, and about 11 percent for strata of 11-18 percent porosity. — A.J.S.

- 190-219. Potapov, V. P. Nekotoryye itogi opredeleniya poristosti produktivnykh plastov yasnopol'skogo podyarusa nizhnego karbona Permskogo Prikam'ya po diagrammam PS [Some results of determination of porosity of the Yasnoye Pole substage of the Lower Carboniferous of the Perm region of the Kama River according to SP diagrams]: *Vses. Neftegaz. Nauchno-Issled. Inst. Trudy*, v. 29, p. 176-179, 1960.

Laboratory data on the porosity of core samples from 128 boreholes in the Lower Carboniferous strata of the Kama region near Perm were compared with the porosity calculated from SP logs. The porosity estimated from the SP logs by different methods has different values for the same borehole. — A.J.S.

- 190-220. Sokhranov, N. N. O perekhodnoy zone i opredelenii vodo-neftyanogo kontakta po geofizicheskim izmereniyam [On the transition zone and determination of the water-oil contact according to geophysical measurements]: *Geologiya Nefti i Gaza*, no. 5, p. 55-59, 1960.

The changes in resistivity that are characteristic of the transition zone between an oil pool and the underlying water are examined. Such zones are marked by a gradual increase in resistivity as the base of the oil is approached. — J.W.C.

- 190-221 Kulinkovich, A. Ye. Zakonomernosti krivyykh karotazha soprotivleniy [Regularities in curves of resistivity logging]: Prikladnaya Geofizika, no. 24, p. 121-158, 1960.

The results of grid modeling in logging a finite layer with varying ratios of the resistivity of the medium to that of the drilling mud and with varying geometrical parameters of the layer are analyzed and discussed on the assumption of a cylindrical symmetry of the electric field with reference to the axis of the borehole. In particular, an unlimited and infinitely thick isotropic layer, the case of two media in contact, and the finite thickness layer are treated mathematically and illustrated in graphs.—A.J.S.

- 190-222 Kozina, Z. K. Opredeleniye poristosti po krivym soprotivleniya [Porosity determination from resistivity curves]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, v. 29, p. 166-175, 1960.

The method of porosity determination by measuring the relative electrical resistivity of the reservoir rock (ratio of its resistivity to the resistivity of the water that saturates it) is discussed. A combination of microsounding and small gradient sounding generally gives a better accuracy than either one applied separately. Under specific conditions one method can be more practical than the other. The average error in determination of relative resistivity and porosity by these methods is given in tables.—A.J.S.

- 190-223 Dobrynin, V. M. Opredeleniye pronitsayemosti peschanno-glinistykh porod metodom potentsialov vyzvannoy polarizatsii [Determination of permeability of sandy and clayey rocks by the method of potentials of induced polarization]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 29, p. 136-141, 1960.

The method of induced polarization for determining the permeability of sandstone reservoir rocks is discussed. It was found that the coefficient of induced polarization, A_V , determined as the coefficient of electrochemical activity of the rock is inaccurate, and that a more accurate result is obtained with the formula $A_V = 4\pi\alpha\Delta U_{V,p} / \beta\rho_V\Delta U_{KS}$, where $\Delta U_{V,p}$ is the potential difference taken from the diagram of induced polarization in mV; ΔU_{KS} is the potential difference of ohmic origin taken from the diagram in mV; α is the coefficient that takes into account the variation of the depth of penetration of the filtrate of the drilling mud; β is the coefficient that accounts for the variation of the ionic composition of the solution and ρ_V is the specific resistance of the electrolyte.—A.J.S.

- 190-224 Aksel'rod, S. M. O masshtabe krivyykh induktzionnogo karotazha [On the scale of the curves of induction logging]: Vyssh. Ucheb. Zavedeniye Izv., Neft' i Gaz, no. 3, p. 3-8, 1961.

In induction logging the relationship of the active and reactive components of the field signal to the specific conductivity is not linear. The character of this relationship is determined by the frequency of the magnetic field and by the distance between the coils. Calculations using linear scales thus lead to errors. In order to encompass the entire range of specific conductivities found in boreholes, induction logging apparatus should be provided with a means for changing the frequencies of the exciting field. Several curves at different frequencies should also be recorded simultaneously.—J.W.C.

- 190-225. Popov, V. K. Nekotoryye voprosy ispol'zovaniya kerna i promyslovoy geofiziki dlya otsenki kollektorskikh svoystv plastov [Some problems in using cores and logging geophysics for evaluation of reservoir properties of strata]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, v. 29, p. 180-194, 1960.

The accuracy of quantitative evaluation of properties of oil-bearing strata from core analysis is discussed, and a comparison is made with the accuracy

of geophysical methods. The probable error in quantitative determinations by core analysis may be 10-25 percent on the average and reach 30-35 percent for individual samples. The accuracy of geophysical methods is up to 20 percent, and costs are considerably lower. — A.J.S.

- 190-226. Ellanskiy, M. M. O vozmozhosti otsenki pronitsayemosti vodonosnykh kollektorov po dannym promyslovoy geofiziki [On the possibility of estimating the permeability of water-bearing reservoirs from geophysical logging data]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, v. 29, p. 207-217, 1960.

Permeability and tortuosity of terrigenous water-bearing rocks are discussed with particular emphasis on the degree of displacement of the formation water from the zone adjoining the borehole. — A.J.S.

- 190-227. Vandel'shteyn, B. Yu. Analiz rezul'tatov eksperimental'nogo issledovaniya diffuzionno-adsorbtsionnykh potentsialov [Analysis of the results of an experimental study of diffusion-adsorption potentials]: Vyssh. Ucheb. Zavedeniy Izv., Neft' i Gaz, no. 2, p. 9-15, 1959.

The nature of diffusion-adsorption potentials as arising from a change of the Hittorf number in the capillaries of the rock is discussed. Assuming the adsorbed anions to be immobile and considering the concentration and mean effective mobilities of cations and anions within the pore volume, a formula for diffusion-adsorption potential at the boundary between two layers can be derived. The accuracy of the formula suffers, however, from the unknown effect of the concentration of the external electrolyte (outside the capillaries), because this effect cannot be accounted for by the formula derived. — A.J.S.

- 190-228. Gryzlov, V. S. K voprosu povysheniya effektivnosti i kachestva karotazhnykh rabot pri razvedke ugol'nykh mestorozhdeniy [On the problem of improving the effectiveness and quality of logging in prospecting for coal deposits]: Razvedka i Okrana Nedr, no. 3, p. 35-38, 1961.

The improvement of logging methods for determining thickness, depth, and structural characteristics of coal seams is discussed. Seams 0.4-0.6 m thick require special attention, and gamma and gamma-gamma radioactive logging are recommended in addition to the methods of electrical logging. — A.J.S.

- 190-229. Laboratory of Logging of the Academy of Petroleum of the MNP. Laterologging [in Chinese with Russian summary]: Acta Geophys. Sinica, v. 9, no. 1, p. 79-82, 1960.

A new method of laterolog is presented. A simple apparatus for measuring current has been worked out. This method was tested in a region where a thick salt unit occurs, and excellent results were obtained in comparison with logging data from conventional electrical logging. — Author's abstract, J.W.C.

- 190-230. Hargrave, D. R. F. Digital computers in log interpretation: Oil in Canada, v. 14, no. 29, p. 38-41, 1962.

A simple electronic digital computer system utilizing the pure binary (base 2) arithmetic method of interpreting numbers constitutes an important advance in log interpretation. The small computer system that will handle the relatively small volume of interpretation necessary is described briefly, and the procedure to be followed in using the LGP-30 model computer is outlined. The relative speed of information storage and retrieval in comparison with human search and calculation is emphasized. It is pointed out also that once automatic tape digitizing becomes commonly available, digital well log information will be obtained at a relatively low cost. — V.S.N.

- 190-231. Chukin, V. T. Nekotoryye voprosy apparatury semielektrodnogo bokovogo karotazha [Certain problems of the seven-electrode apparatus for lateral logging]: *Prikladnaya Geofizika*, no. 27, p. 175-200, 1960.

This is an analytical discussion of a seven-electrode laterolog, which can be used in a range of 0.5 to 3,000 ohm-m of formation resistivity and 0.05 to 1 ohm-m of drilling mud resistivity.—A.J.S.

- 190-232. Sell Cantalapedra, Juan I., and Gutiérrez Díez, José Luis. Investigación geofísica en los lignitos mallorquines [Geophysical investigation in the lignites of Majorca]: *Rev. Geofísica*, v. 19, no. 76, p. 363-393, 1960.

The Tertiary lacustrine sediments of the Alaro area of Majorca, which contain beds of lignite, were investigated by the resistivity method. The geography and geology of the area are outlined. After the results of a preliminary investigation using the OM system proved unsatisfactory, a variation of the single probe method was tried. This method, here called the "OP" system, uses fixed MN electrodes at equal distances on each side of a point O, and one current electrode is moved away from O; the set-up is analogous to an asymmetrical Schlumberger configuration in which the B electrode is at infinity. Curves of apparent resistivity are reproduced, and details of each profile are discussed. Two boreholes showed good agreement between the geophysical results and the actual stratigraphy. In the first hole, the lignite was encountered at 49 m, very near the depth predicted from the resistivity data; in the second the lignite was encountered at 76 m rather than the predicted 90 m.—D.B.V.

- 190-233. Plewa, Stanisław. Wykrywanie horyzontów wodnych i gazowych metodami geofizyki wiertniczej w warunkach Rybnickiego okręgu węglowego [Detection of water and gas horizons by the methods of drilling geophysics under the conditions of Rybniki Coal District]: *Przegląd Geol.*, v. 9, no. 8, p. 425-430, 1961.

Geophysical logging methods used in connection with sealing off the water and gas horizons under the geologic conditions of the Rybniki Coal Basin in Poland are discussed. Resistivity, temperature, and gas logging are used in conjunction with one another.—A.J.S.

- 190-234. Itenberg, S.S. Ispol'zovaniye promyslovo-geofizicheskikh dannykh dlya unifikatsii stratigraficheskikh razrezov [Use of geophysical logging data for unification of stratigraphic sections]: *Geologiya Nefti i Gaza*, no. 2, p. 37-41, 1960.

Use of geophysical logs to solve stratigraphic problems is discussed. One case history shows how resistivity and gamma logs were used to refine correlations, and another illustrates how a facies change was traced by resistivity logs.—J.W.C.

- 190-235. Sulimov, I. N. Opornyye skvazhiny SSSR. Zhigalovskaya opornaya skvazhina (Vostochnaya Sibir') [Research drill holes of the U.S.S.R. Zhigalov research drill hole (east Siberia)]: *Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy*, no. 173, 92 p., 1961.

A complete description is given of the Zhigalov research drill hole in east Siberia. The lithologic column is described in detail; it consists entirely of Lower Cambrian sediments. The resistivity log of the drill hole is reproduced.—J.W.C.

- 190-236. Gorbachev, I. F. Opornyye skvazhiny SSSR. Rybinskaya opornaya skvazhina (Krasnoyarskiy kray) [Research drill holes of the U.S.S.R. Rubin research drill hole (Krasnoyars Territory)]: *Vses.*

Neft. Nauchno-Issled. Geol. -Razved. Inst. Trudy, no. 175, 119 p., 1961.

The Rubin research drill hole in central Siberia penetrates Jurassic and Devonian sediments and bottoms in the Precambrian. The Precambrian was reached at 1,032 m depth instead of at 2,000 m as was expected from previous electrical surveys. Specific gravity, magnetic susceptibility, porosity, and permeability were determined on a large number of specimens. A very detailed description is given of the lithologic column, and the resistivity log is reproduced.— J.W.C.

ELECTRICAL PROPERTIES

- 190-237. Bradley, R. S., Jamil, A. K., and Minro, D. C. Electrical conductivity of fayalite and spinel: *Nature*, v. 193, no. 4819, p. 965-966, 1962.

The electrical conductivity of pure fayalite has been measured in a range of temperatures and pressures. The results suggest that conductivity probably arises from electron transfer $Fe^{2+} \rightleftharpoons Fe^{3+} + e$. In the mantle additional conductivity would arise from other ions capable of electron transfer, such as Mn^{2+} . Solid solution of fayalite in forsterite would reduce the conductivity.

Fayalite was also converted to spinel under pressure of 35,000 bars at 510°C-520°C for 3 hr in the presence of a trace of water. The electrical conductivity of the spinel at that pressure and over a range of 27°C-343°C was found to be much greater than that of fayalite at the same pressure; the difference is presumably related to the ease with which iron atoms of different valency can be accommodated in the spinel structure.— D.B.V.

- 190-238. Keller, George V. Electrical resistivity of rocks in the Area 12 tunnels, Nevada Test Site, Nye County, Nevada: *Geophysics*, v. 27, no. 2, p. 242-252, 1962.

Electrical resistivity measurements provide a semiquantitative method for estimating the water content of a rock. Techniques for measuring resistivity along tunnel walls and in horizontal drillholes were used in the Area 12 tunnel complex at the Nevada Test Site prior to the Atomic Energy Commission's Hardtack Phase II test series during the fall of 1958. The results indicate that in future underground tests where the amount of water in the rock must be determined, resistivity measurements can be used to estimate water content, with only a limited number of samples needed to check the results.— Author's abstract

- 190-239. Ivanov, A. G. Über die Frequenzabhängigkeit des spezifischen Wirkwiderstandes bei Gesteinen [On the dependence on frequency of the specific effective resistance in rocks]: *Freiberger Forschungshefte*, C 116, p. 5-13, 1961.

Laboratory investigations of the dependency of electrical resistance of rocks on frequency, using the electrothermal method, are described. The frequencies ranged from 0 to 200,000 cycles per second, and the samples consisted of sand, loam, and a weak aqueous electrolytic solution of $CuSO_4$. The results show that the effective component of the electrical resistance of rocks essentially depends on the frequency of the current flowing through them. The resistance of the loam fluctuated as much as 25 percent and that of the sand almost 80 percent; resistance decreased as frequency increased. The resistance of the electrolyte was practically unchanged up to 200 kc. It is concluded that the change in resistance with frequency is due to the structure of the rocks, which constitutes a complicated dispersion system. Rocks show a large specific internal boundary surface between solid and fluid phases and the phenomenon observed is connected with the existence of an electrical double layer at this boundary surface. It therefore can be expected that a change in specific electrical effective resistance with frequency is closely related to the phenomenon of induced polarization. In the pure electrolyte solution, on the other

hand, there is no dependence on frequency in the lower and medium frequency ranges because the relaxation time in such a medium is very small.— D.B.V.

- 190-240. Dokouřil, Stanislav; Karpinsky, Jurij; and Kaspar, Milan. The attenuation of electromagnetic waves in rocks [with Russian summary]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 6, no. 2, p. 176-192, 1962.

The dependence of attenuation of electromagnetic waves in rocks on frequency is investigated theoretically, assuming the rocks to be homogeneous and isotropic. Then the results are given of laboratory studies of the dependence on frequency of the electrical conductivity and the dielectric constant of actual rock samples. These results can be used for determining the attenuation factor of electromagnetic waves for a given frequency. The relation between the required transmitter power, sensitivity of the receiver, and range of the electromagnetic method can be determined from the value of the attenuation factor by means of graphs that are given.— D.B.V.

- 190-241. Noritomi, Kazuo. The electrical conductivity of rock and the determination of the electrical conductivity of the earth's interior: *Akita Univ. Mining Coll. Jour.*, ser. A, v. 1, no. 1, p. 27-59, 1961.

The electrical conductivity of the earth's interior is estimated on the basis of experimental studies of the electrical properties of rocks. Measurements were made on silicic and intermediate rocks (granites and andesites), and on ultrabasic rock and minerals (serpentine and olivine). Measurements in the temperature range of 300°C-1,300°C show that with rising temperature the mechanism of conduction changes from impurity- to ionic-conduction. In estimating the conductivity of the earth's interior the influence of pressure on conductivity is taken into account, and in this case the compressibility of rock is treated as a function of pressure. For an idealized "normal" model of the crust, the conductivity value reaches $10^{-6}\text{ohm}^{-1}\text{cm}^{-1}$ at a depth of 30 km. In the mantle, conductivity is a nearly constant $10^{-6}\text{ohm}^{-1}\text{cm}^{-1}$ to depths of about 400 km; at depths greater than 400 km, conductivity increases abruptly and reaches about $10^{-2}\text{ohm}^{-1}\text{cm}^{-1}$. These results are in good agreement with those of Rikitake (see *Geophys. Abs.* 148-13323) who estimated electrical conductivity of the earth by a study of the electromagnetic induction resulting from geomagnetic disturbances.— V.S.N.

- 190-242. Bukhnikashvili, A. V., Dzhashi, G. G., and Khvitiya, G. P. Nekotoryye osobennosti lokal'nogo yestestvennogo elektricheskogo polya na primere Adzharskogo polimetallicheskogo mestorozhdeniya v Gruzinskoy SSR [Certain features of the local natural electric field exemplified by the Adzhar polymetallic deposits in Georgian SSR]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 10, p. 1533-1537, 1961.

Observations in the Adzhar polymetallic deposits in the Georgian S.S.R. show that a negative field can be found in both the country rock and the ore body. Measurements in a chalcopyrite vein in the Varaza district have disclosed negative fields up to -240 mv (with reference to a zero point outside the ore deposit). Similar measurements in the Tskalbokela district revealed a positive anomaly where a lead-zinc mineralization predominates and a negative anomaly in the lower levels of the ore body where a pyrite-chalcopyrite mineralization predominates. This shows that the field direction is determined by the relative intensities of processes in different parts of the ore body where in different amounts of electrical charge are acquired.— J.W.C.

- 190-243. Davydov, A. Ya. Polozhitel'nyye anomalii yestestvennogo elektricheskogo polya nad sul'fidnymi rudnymi telami [Positive anomaly]

lies of the natural electric field over sulfide ore bodies]: *Sovetskaya Geologiya*, no. 7, p. 142-144, 1961.

Positive anomalies in the natural electric field over sulfide ore bodies and the possible causes of these anomalies are discussed. Negative anomalies of 145 and 56 Mev over such ore bodies were found to reverse smoothly to positive anomalies of 140 and 50 Mev, respectively, during the period 1953-58. This change was related to observed changes in the water table and to subsequent changes in the intensity of oxidation processes in the ore body.— A.J.S.

EXPLORATION SUMMARIES AND STATISTICS

- 190-244. Pakiser, L[ouis] C., and Kane, M[artin] F. Geophysical study of Cenozoic geologic structures of northern Owens Valley, California: *Geophysics*, v. 27, no. 3, p. 334-342, 1962.

A narrow gravity minimum anomaly of amplitude 30 mgals indicates that northern Owens Valley, Calif., is a narrow fault-bounded trough or graben filled with Cenozoic clastic deposits to a depth of as much as 8,000 feet. Seismic-refraction measurements support this conclusion. Aeromagnetic and gravity measurements define a small, dense, magnetic body buried by the valley fill of northern Owens Valley.— Authors' abstract

- 190-245. Carsey, J. Ben, and Roberts, Marion S. Exploratory drilling in 1961: *Am. Assoc. Petroleum Geologists Bull.*, v. 46, no. 6, p. 725-771, 1962.

During 1961 a total of 10,992 exploratory holes were drilled in the United States; 1,970 or 17.92 percent produced some oil or gas; of 6,909 new-field wildcats, 745 or 10.78 percent produced some oil or gas (but only about 2.7 percent discovered commercial fields); of 1,919 new-pool tests (including new-pool wildcats, deeper-pool tests, and shallower pool tests), 535 or 27.88 percent produced some oil or gas; and of 2,164 outposts, 690 or 31.89 percent produced some oil or gas. Total exploratory footage was 54,442,127 feet averaging 4,952 feet per hole, compared to the 55,830,636 feet drilled in 11,704 holes averaging 4,770 feet in 1960. Data on natural gas reserves in a 17-state area in Canada and Mexico are presented.— D.B.V.

- 190-246. Rattew, Arthur R. Helicopterborne electromagnetic, magnetic, and radiometric survey, Coronation mine, Saskatchewan: *Canadian Mining Metall. Bull.*, v. 55, no. 600, p. 234-241, 1962.

A detailed, low-altitude airborne combined in-phase electromagnetic, magnetometer, and scintillometer survey was made in 1960 over the area of the Coronation mine, Saskatchewan, Canada. The airborne electromagnetic data are compared with "horizontal-loop" ground data with reference to the size and nature of conductors detected and criteria in selection of targets for drilling. The merits of combining a sensitive airborne magnetometer with an airborne electromagnetic unit are discussed. The value of the simultaneously recorded magnetic information is unquestionable; both of the orebodies in this area have coincident or closely-parallel magnetic anomalies on every traverse across them, and the magnetic data are important for assessing conductors as prospects. The survey illustrates the value of EM in-phase measurements in detecting high-conductivity bodies and in providing diagnostic information concerning the geological nature of conductors. Radiometric records were used to aid in the positioning of conductivity and magnetic anomalies and in interpreting the nature of certain conductors. Use of this in-phase equipment in conjunction with airborne magnetometers and scintillation counters has drastically altered the role of airborne electromagnetic surveys in overall exploration programs. Recognition of different types of conductors and selection of specific targets can now be accomplished from the air.— V.S.N.

- 190-247. Shirokov, A. S. Metodika geofizicheskikh rabot pri razvedke poleznykh iskopayemykh [Methods of geophysical work in prospecting for mineral resources]: Razvedka i Okrana Nedr, no. 4, p. 27-34, 1961.

The application of seismic, electrical, magnetic, gravimetric, and radiometric methods to prospecting for mineral resources in the U.S.S.R. is summarized. Of the geologic structures explored for oil and gas in 1959 and recommended for commercial prospecting, 61 percent were discovered by geophysical methods, 27 percent by combined geophysical and drilling operations, and only 12 percent without using geophysical methods.—A.J.S.

- 190-248. Kozlenko, S. P. Tektonicheskoye rayonirovaniye Nizhnego Povolzh'ya [Tectonic regionalization of Lower Volga region]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 28, p. 59-70, 1960.

A tectonic regionalization is presented for the Lower Volga region based on geophysical exploration. The structures are classified as platforms, mono-platforms, plates, structures of the 1st, 2d, and 3d orders, and tectonic zones. Descriptions are given of the Russian platform and its middle-Russia and cis-Caspian plates, and of the Scythian platform with its Azov-Caspian plate. (See also Geophys. Abs. 181-220.)—A.J.S.

- 190-249. Ayzenshtadt, G. Ye.-A., Grinberg, I. G., D'yakov, B. F., Nevolin, N. V., Trofimov, N. K., Cherepanov, N. N., and Eventov, Ya. S. Perspektivy neftenosnosti i gazonosnosti Zapadnogo Kazakhstana i osnovnyye napravleniya regional'nykh, poiskovykh i razvedochnykh rabot [Prospects for oil and gas productivity of west Kazakhstan and the main directions of regional, exploration, and prospecting operations]: Geologiya Nefti i Gaza, no. 2, p. 10-15, 1960.

Geophysical exploration in the Kazakh S.S.R. in the area to the east and north of the Caspian Sea is reviewed. Seismic profiles were made in conjunction with core drilling in the Caspian depression, Ustyurt, and Mangyshlak; their objective was to study the nature of the regional gravity anomalies and to search for uplifts beneath the Permian salt beds. Experimental telluric current surveys in Ustyurt demonstrated that this method is capable here of distinguishing structural elements of the first and second order and even local uplifts. Comparison of gravity with telluric current maps makes it possible to determine whether a gravity anomaly is due to relief of the surface of the basement or to petrographic inhomogeneities in the basement.—J.W.C.

- 190-250. Tishchenko, V. Ye. Ob ogranichenii vliyaniya sezonnosti na protsess geofizicheskikh issledovaniy v zapadnoy Sibiri [Limitation of the effect of seasonality on the process of geophysical investigations in west Siberia]: Vyssh. Ucheb. Zavedeniya Izv., Neft' i Gaz, no. 3, p. 119-123, 1961.

In spite of an increase with each year in the volume of field work during the winter months, there has been no improvement in the seasonal nature of these operations. Efforts are to be made to convert to parties that will work the year round.—J.W.C.

- 190-251. Indian Minerals. Progress in geophysical exploration in recent years by the Geological Survey of India: Indian Minerals, v. 15, no. 4, p. 363-381, 1961.

The results of some of the more important geophysical surveys undertaken by the Geological Survey of India in recent years are summarized briefly. They include magnetic and gravity surveys for manganese in Madhya Pradesh and Andhra Pradesh States; electrical surveys for sulfide ores (pyrite) in My-

sore, Madras, and Bihar States; electrical, electromagnetic, and magnetic surveys for copper in Rajasthan, Bihar, and Andhra Pradesh States; electrical surveys for lead in Maharashtra and Orissa States; gravity, magnetic, and electrical surveys in Bihar State; electrical and magnetic surveys in Jammu and Kashmir State; magnetic and electrical surveys for volcanic pipes in the Panna diamond belt; spontaneous potential surveys for graphite in Kerala State; seismic reflection, gravity, and magnetic surveys for petroleum in the Cambay, Gujarat, and Kutch areas, and in the coastal belt of Madras; electrical and seismic surveys for ground water in Delhi and Madhya Pradesh States; and seismic surveys for various engineering projects. The program for the third 5-year plan is outlined briefly.— V.S.N.

- 190-252. Shumskiy, P. A. Glyatsiologicheskiye issledovaniya v Antarktide [Glaciological investigations in Antarctica], in *Sbornik Materialov Rasshirennogo Soveshchaniya Rabochey Gruppy po Glyatsiologii Sovetskogo Mezhduvedomstvennogo Komiteta Mezhdunarodnogo Geofizicheskogo Goda 20-24 maya 1958 g. v Moskve*, p. 17-19, Moscow, 1959.

The International Geophysical Year work conducted by the 2d Soviet Continental Antarctic Expedition in 1957-58 is outlined briefly. Seismic and gravity studies and ice-temperature measurements in 100 m deep boreholes were made during an oversnow traverse from Mirnyy to Pionerskaya. Studies of ice movement and stratigraphy were made along a profile 50 km inland from Mirnyy. Vertical temperature distribution in the ice was measured in two boreholes, one 86 m and the other 371 m deep. Other associated studies on snow and ice are also mentioned.— V.S.N.

GENERAL

- 190-253. Berkner, Lloyd V. Geophysics today: *Am. Geophys. Union Trans.*, v. 43, no. 2, p. 159-166, 1962.

The state of geophysics, or more generally, the earth sciences as a unified group, is reviewed briefly. The geosciences no longer relate solely to the earth but with the advent of space travel are being extended to the moon and planets. Studies of such dissimilar regions as the solid earth and the high atmosphere are integrated by the behavior of waves, fields, particles, and the physics and chemistry of matter—indeed through specialized application of all basic scientific method and theories to the critical investigation of the earth. Intimately related to the growth of basic geoscience and strongly interacting with it has been the development of applied geoscience; however, a clear distinction must be made between science and engineering in the geosciences if scientific progress is to be healthy. The historical development of geophysics is reviewed briefly. On the whole, the great advances have arisen as a consequence of group effort and a higher sense of scientific social responsibility in which scientists plan and work together in order that as a group they can see planet earth as a whole; the International Geophysical Year has been the epitome of organized geophysical research.— D.B.V.

- 190-254. Smith, Waldo E. Geophysics on the move: *Am. Geophys. Union Trans.*, v. 43, no. 2, p. 167-173, 1962.

The work of the various sections of the American Geophysical Union is outlined in order to give an idea of what is encompassed by geophysics. In addition to the present sections of geodesy, seismology, meteorology, geomagnetism and aeronomy, oceanography, volcanology-geochemistry-petrology, hydrology, and tectonophysics, it is possible that a new section of interplanetary and planetary sciences will be established in the near future.— D.B.V.

- 190-255. Drake, C[harles] L. Geophysics, GEOPHYSICS, and engineering: Geophysics, v. 27, no. 2, p. 193-197, 1962.

The engineering applications of geophysics have developed in a different pattern from methods applicable to petroleum exploration. The degree of sophistication of the engineering techniques is rather less because there has been less incentive to develop them, but the situation is changing. Seismic methods are most important in engineering, particularly refraction; electrical methods are next most important. Logging methods have not been used extensively in engineering, except in ground water hydrology. Gravity measurements can be of value in large scale operations where geodetic measurements are significant; magnetic and radioactive methods have been used in special cases.—D.B.V.

- 190-256. Brundage, Harrison T. Productivity in exploration: World Oil, v. 154, no. 5, p. 97-98, 1962.

Current progress in exploration methods is reviewed. A new method of radar geology is a supplement to photogeology; the radar can penetrate about 6 feet of soil cover. Sequential seismic shooting has been applied in a variety of systems, and a spring device has been developed to provide greater impact in the weight-drop method. Lighter, more portable equipment is being developed to permit seismic operations in shallow water and on mud flats, helping to bridge the chronic gap between onshore and offshore work.—J.W.C.

- 190-257. Kulinkovich, A. Ye. O primenenií metoda Monte-Carlo dlya resheniya zadach teorii geofizicheskikh metodov razvedki [Use of the Monte Carlo method for solution of problems of geophysical methods of prospecting]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 4, p. 111-116, 1961.

The Monte Carlo statistical method of a "wandering point" is applied to theories of prospecting geophysics and particularly to electrical prospecting and radioactive logging. An analytic calculator combined with the Monte Carlo method is suggested for solution of electrical prospecting problems such as the distribution of the potential field from a source point under conditions of a fault discontinuity or a vertical lode covered with alluvium.—A.J.S.

- 190-258. Cailleux, A[ndré], and Tricart, J. Bruit de fond, information et sciences de la Terre [Background noise, information, and earth sciences]: Rev. Géomorphologie Dynam., v. 11, no. 10-12, p. 145, 1960.

General concepts of information that are applicable to the earth sciences are discussed. Because of discontinuities of matter and its state of agitation, the intensity of any phenomenon is not that measured at the instant t but the mean intensity during a time interval Δt ; for no measurement can be infinitely short. The precision of this mean, and therefore the information obtained, is limited by background noise. The amount of information H obtained in a signal can be expressed by the formula $H = n \times \log q$, where n is the number of distinct symbols in the message and q is the number of distinct states each symbol may take (for example, in a telegram, the number of letters of the alphabet). A superfluity of data is useless and even misleading; it is better to organize the data into groups (symbols, and states of the same symbol) in order to overcome background noise, as the information theory allows.—D.B.V.

- 190-259. Morrison, Lawrence S. How useful are electronic computers in exploration?: World Oil, v. 154, no. 5, p. 103-107, 1962.

Applications of electronic computers to oil exploration are reviewed. An example cited is that of a sedimentary basin where thousands of wells have been drilled. The computer data can be presented in the form of contour maps showing formation depths, rock types, porosity, permeability, or fluid content. A magnetic map contoured by a computer and printed out by an accounting machine is illustrated. Applications to electrical logging, velocity studies, reduction of gravity data, and derivative maps are suggested.—J.W.C.

190-260. Stoian, E. Geophysical applications of computers: Canadian Oil and Gas Industries, v. 15, no. 5, p. 24-30, 1962.

The applications of the electronic digital computer to exploration for oil and gas are reviewed briefly. The following fields of utilization are discussed: geodetic surveying; gravitational, electromagnetic, radioactivity, and seismic methods; velocity or sonic, dipmeter, and compositional logs; statistical exploration; and management techniques. The preparation of data for computers, communication of information, and data processing are also discussed.—V.S.N.

190-261. Frantz, Forrest H., Sr. Boost bridge accuracy with a null amplifier: Radio-Electronics, v. 31, no. 8, p. 32-33, 1960.

A transistor null-amplifier circuit is described that may be used anywhere an extra sensitive null-meter is needed. It may be used, for example, to replace the galvanometer in a Wheatstone bridge, as a sensitive zero-center microammeter, and for the null-meter in an electronic calculator (Radio-Electronics, June 1958). Constants, suggested parts, and construction details are given. The unit uses one 2N407 transistor and is powered by 2 "D" flashlight cells.—H.C.S.

190-262. Izakowski, Andrzej. Postep techniczny w pracach geofizycznych [Technical progress in geophysical work (with English summary)]: Przegląd Geol., v. 9, no. 10, p. 507-511, 1961.

Geophysical apparatus developed recently in Poland is discussed. Production has begun on small dynamic geophones, low frequency geophones for refraction work, apparatus for induction measurements of 20 kc frequency, resistivity meters and electronic autocompensators, geoelectric instruments for deep symmetrical electroresistance logging, shot apparatus and sending-receiving instruments, antishock immersion galvanometers, and telluric apparatus.—J.W.C.

190-263. Bażyński, Józef. Zadania i efekty zastosowania geofizyki w geologii inżynierskiej [Tasks and results of applying geophysics in geological engineering]: Przegląd Geol., v. 10, no. 3, p. 162-165, 1962.

The application of gravity, magnetic, electrical, and seismic surveying methods to engineering geology is reviewed.—J.W.C.

190-264. Semenov, A. S. Rudnaya geofizika v SSSR [Ore geophysics in the USSR]: Leningrad. Univ. Uchenyye Zapiski, Voprosy Geofiziki, no. 278, p. 3-55, 1959.

Exploration geophysics in Russia since the end of the 15th century and in the U.S.S.R. since 1919 is reviewed. Dates are given for the introduction of magnetic, gravity, seismic, and electrical methods of prospecting for ores. Geophysicists and other scientists who contributed to the theory, application, and instrumentation of geophysical exploration are also enumerated. The bibliography consists of 212 titles.—A.J.S.

- 190-265. Vakhromeyev, G. S. Vozmozhnosti geofizicheskikh metodov pri poiskakh i razvedke redkometal'nykh karbonatitov [The possibilities of geophysical methods in prospecting and exploration for rare metal carbonatites]: *Razvedka i Okhrana Nedr*, no. 10, p. 25-28, 1960.

Coordinated geophysical exploration for rare metals in alkalic rocks and carbonatites by magnetic, electrical, radioactivity, metallometric, and biogeochemical methods is described. Magnetic exploration was found to provide the basic data at the initial stage. Gamma surveying and metallometric tests provided additional data for the interpretation of the magnetic anomalies. Emanation surveys and electrical prospecting were used for obtaining more detailed information.—A.J.S.

- 190-266. Nordyke, M. D. An analysis of cratering data from desert alluvium: *Jour. Geophys. Research*, v. 67, no. 5, p. 1965-1974, 1962.

From the large amount of data available for explosion craters in the desert alluvium at the Nevada test site it has been possible to establish very reliable relationships among charge size, depth of burst, crater radii, and crater depths. A scaling law for crater dimensions of $W^{1/3.4}$ is derived, together with an efficiency factor for nuclear explosives relative to high explosives. In addition, a curve for the dependence of crater radii and depth on the depth of burst of the explosive is given.—Author's abstract

- 190-267. Stearns, Harold T. Eustatic shorelines on Pacific islands, in Pacific Island terraces: Eustatic?: *Zeitschrift für Geomorphologie*, supp. 3, p. 1-16, 1961.

This article is a summary of a paper given to introduce a symposium on Pacific island terraces at the 10th Pacific Science Congress, Honolulu, Hawaii, 1961. Sufficient work has been done throughout the world to indicate that the Pleistocene stands of sea level correlative with glacial and interglacial epochs were about 300 feet above and 300 feet below present sea level. Shorelines higher or lower than these altitudes require more than the addition and subtraction of water from glaciers as an explanation. Worldwide concordance of terraces at approximately 600 feet is highly suggestive that at least this level is a eustatic shoreline. This and other pre-glacial high shorelines support a hypothesis that the continents were uplifted en masse at the end of the Pliocene with relation to the ocean basins. Such continental uplift would reduce the surface area of the ocean basins and cause water to rise rapidly on the islands in the central Pacific. Various possible causes are listed. Rise of the Atlantic Ridge from the ocean floor in Pliocene time would have caused a great rise of level in the world's oceans.—V.S.N.

GEODESY

- 190-268. Heiskanen, W. A. Is the earth a triaxial ellipsoid?: *Jour. Geophys. Research*, v. 67, no. 1, p. 321-327, 1962.

The possible triaxiality of the earth, or the ellipticity of the earth's equator, has been studied for a century. Artificial satellites now provide another method in addition to the gravimetric and astrogeodetic methods of approaching the problem. The results so far obtained by the different methods have led to more or less different interpretations. The gravimetric results suggest that the earth is triaxial, but it has not been possible to obtain as high an accuracy as desirable—not for any reason inherent in the method, but for lack of gravity material. Heiskanen is skeptical about the possibility of obtaining the triaxiality from satellite tracking.—D.B.V.

- 190-269. Brovar, V. V., Magnitskiy, V. A., and Shimbirev, B. P. *Teoriya figury Zemli* [Theory of the figure of the earth]: Moskva [Moscow], Geodezizdat, 556 p., 1961.

This is a text on the theory of the figure of the earth. It consists of ten chapters: 1-5 are devoted to physical-mathematical principles of the theory; 6-9 consider the application of the general theory to geodetic and gravimetric work; and 10 discusses applications of the potential theory to gravimetric prospecting. The Molodensky formulation and solution of the basic problem of determination of the figure, and the external gravity field of the earth are briefly treated in chapter 3. The value of the Krasovski ellipsoid, $a=6,378,245$ m, and the earth's flattening, $\alpha=1:298.3$, are given, the latter being in good agreement with the value of 1:298.20 determined with artificial satellites.—A.J.S.

- 190-270. Mikhaylov, A. A., ed. *Stat'io silye tyazhesti i figure zemli* [Papers on the force of gravity and the figure of the earth]: Moscow, Izdatel'stvo Geodizicheskoy Literatury, 152 p., 1961.

Russian translations are given of the following four classic papers on gravity and the figure of the earth:

Stokes, George Gabriel. On the variation of gravity at the surface of the earth: Cambridge Philos. Soc. Trans., v. 8, pt. 5, p. 672-695, 1849.

Bruns, Heinrich. *Die Figure der Erde. Ein Beitrag zur europäischen Gradmessung* [The figure of the earth. A contribution to European grid measurement]: Berlin, Konigl. Preus. Geod. Inst., 1878.

Poincaré, Henri. *Les mesures de gravité et le géodésie* [Measurements of gravity and geodesy]: Bull. Astron., v. 18, p. 5, 1901.

Vening Meinesz, F. A. A formula expressing the deflection of the plumb-line in the gravity anomalies and some formulae for the gravity-field and the gravity potential outside the geoid: Communicated at the Amsterdam Academy of Sciences on January 28, 1928.—J.W.C.

- 190-271. Marych, M. I. *Novyy vyvod formuly NK. Migaya opredelyayushchey figuru Zemli* [A new derivation of N. K. Migay's formula for determination of the figure of the earth]: Vyssh. Ucheb. Zavedeniy Izv., *Geodeziya i Aerofotos"yemka*, no. 4, p. 75-82, 1961.

The method of determining the external level surface of the earth without using the normal gravity field formulated by Migay in 1949 and 1959 is simplified. His formula is derived by setting up an integral which permits a solution without use of Lamé functions. The solution of the integral is given in detail.—A.J.S.

Szabo, Bela. The external terrestrial gravity field. See *Geophys. Abs.* 190-297.

- 190-272. Arnold, K[urt]. *Die Bestimmung des Geoids aus Schwerewerten und die Theorie von Molodensky* [The determination of the geoid from gravity values and the theory of Molodenskiy]: *Deutsch. Geod. Komm., Veröffentlich., ser. A*, no. 38, p. 119-124, 1961.

Methods of determining the figure of the earth from gravity anomalies are discussed briefly, emphasizing the advantages of the use of free-air anomalies. Molodenskiy's method is outlined briefly; with regard to the corresponding corrections, the free-air anomaly method should be very much simpler. It is also easier to determine deflections of the vertical from the free-air anomalies, and the assumptions necessary with the use of isostatic anomalies are avoided.—D.B.V.

- 190-273. Tanner, William F. Components of the hypsometric curve of the earth: *Jour. Geophys. Research*, v. 67, no. 7, p. 2841-2843, 1962.

The method of first and second differences often permits the separation of zigzag curves (on probability paper) into two or more Gaussian components. Where the procedure can be employed, it yields means and percentages. By this method the hypsometric curve of the earth can be made to produce four components, having means at -5.2, -4.85, 0.3, and 0.35 km. Not all curves permit analysis of this type. For those that do, the procedure is partly subjective.— Author's abstract

- 190-274. U.S. Army Map Service. Isostatically reduced topographic deflections of the vertical at selected stations in both eastern and western hemispheres: U.S. Army Map Service Tech. Rept., no. 30, 259 p., 1960.

Numerical data expressing the effect of isostatically compensated topography on the deflection of the vertical at certain geodetic stations according to the Pratt-Hayford theory of isostasy are listed. The stations selected cover more or less evenly the present net of geodetic triangulation around the world. Values already computed by Hayford in 1906 and 1909 are included in the listing.— V.S.N.

- 190-275. Jung, F. R. Höhensysteme und Höhenreduktion [Altitude systems and altitude reduction]: *Deutsch. Geod. Komm. Veröffentl.*, ser. A, no. 38, p. 49-64, 1961.

Different systems of altitude reduction of geodetic leveling networks are compared, and the Baden-Württemberg main altitude network is shown as reduced according to the Helmert system and the modified spheroidal ("normal heights") system. Several advantages of the Helmert reductions have been mentioned in an earlier paper (1957); another is the fact that these reductions will be almost uninfluenced by the impending revision of the Potsdam gravity system and a change in the formula for normal gravity. In practice, however, the use of normal heights is attended by fewer difficulties, and Helmert heights can be calculated from normal heights if desired. A further argument for use of the modified spheroidal reduction by Germany is the fact that although Switzerland still uses the Helmert reduction, two of Germany's large neighbors—France and U.S.S.R.—have adopted the normal heights.— D.B.V.

- 190-276. Honkasalo, Tauno. Ausgleichung der Nord-Europäischen Präzisions-nivellementsnetze [Compensation of the north European precise leveling network]: *Deutsch. Geod. Komm. Veröffentl.*, ser. A, no. 38, p. 65-66, 1961.

Problems encountered in the compensation of the north European precise leveling network, entrusted to the Finnish Geodetic Institute in 1955, are discussed briefly. The three parts of the network (Norway, Sweden, and Finland) are very loosely tied to each other. Postglacial uplift (as much as 9 mm per year in the Gulf of Bothnia) is the most serious complicating factor, for it requires that measurements be reduced to the same time before compensation can be effected. At present, land uplift can be calculated with sufficient accuracy only in Finland, where two precise surveys of 1892-1910 and 1935-56 have about 1,000 stations in common. Mean error of the Finnish network is $\pm 0.64 \times 10^{-3}$ GPE/km, of the Norwegian $\pm 2.0 \times 10^{-3}$ GPE/km, of the old Swedish $\pm 4.4 \times 10^{-3}$ GPE/km, and of the new Swedish $\pm 0.84 \times 10^{-3}$ GPE/km. The final results are provisionally referred to the Finnish base station and can be reduced to the European system as soon as compensation of the latter is defined.— D.B.V.

- 190-277. Arnold, Kurt. Ein graphisches Hilfsmittel zur gravimetrischen Verbesserung astronomischer Nivellements [A graphic aid for the gravimetric correction of astronomic levelings]: Potsdam Geod. Inst. Veröffentl., no. 18, 21 p., 1961.

A transparent template for use in gravimetric correction of astronomic levelings is presented, which is more easily legible and simpler to use than other types. The principles of its construction are discussed.—D.B.V.

- 190-278. Kašpar, Jan. Konforme Abbildung einer Fläche auf eine Andere unter wählbaren Bedingungen [Conformal representation of one surface on another under selected conditions (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 6, no. 2, p. 105-139, 1962.

Formulas are derived that permit the transfer of trigonometric networks from one reference surface to another by means of conformal representation, and eventually to an analytical surface approximating the geoid, if the system of orthogonal curvilinear coordinates on this analytical surface is known.—D.B.V.

GEOTECTONICS

- 190-279. Weeks, Lewis G. Geologic architecture of circum-Pacific: Am. Assoc. Petroleum Geologists Bull., v. 43, no. 2, p. 350-380, 1959.

The circumpacific mobile belt is described as typical of peripheral mobile belts throughout geologic history that were initiated, developed through several hundred million years, and were finally stabilized, now along one continental margin, then along another. Many additions were made to the margins of the continental crust by this process. Accompanying this build-up of various continental nuclei, the always stable basaltic ocean crustal plates correspondingly have diminished in area and their waters have deepened. All stages in the diastrophic-sedimentary cycle of the typical mobile belt are represented in the circumpacific architecture, and these are described against the background of the sequence of stages in the life history of a typical mobile belt.—V.S.N.

- 190-280. Eygenson, M. S. Kosmicheskiye faktory geotektoniki [Cosmic factors of geotectonics]: Akad. Nauk SSSR Izv. Ser. Geol., no. 4, p. 7-12, 1962.

The deep fractures that divide the earth's crust into a mosaic of blocks are genetically related to changes in the angular velocity of the earth's rotation. Such changes are of three types: extremely slow or secular; relatively slow, with semiannual, annual, or 14-month periodicity; and sporadic (rather abrupt). All three have operated throughout geologic history, and the last would have the greatest geotectonic effect. It is suggested that these changes in angular velocity of rotation in turn are controlled by solar activity rhythms of different periods. Such solar rhythms should produce corresponding rhythms in the frequency of occurrence and violence of sporadic changes in the rotational regime, and these in turn would affect geotectonic processes. Reinforcement of the amplitudes of endogenetic and exogenetic processes due to resonance could happen more than once in geologic history, corresponding to solar activity. Geotectonic rhythms of 6×10^8 yr duration or greater could ultimately be due to solar activity. If this is so, there is a possibility of predicting geotectonic events. The earth's figure should pulsate rhythmically, and there would be not only "critical parallels" but also "critical meridians" of geotectonic activity. Shifting of the earth's axis of rotation, with attendant paleoclimatic changes, is probably also a related phenomenon dependent ultimately on solar activity.—D.B.V.

- 190-281. Carey, S. Warren. Folding: Alberta Soc. Petroleum Geologists Jour., v. 10, no. 3, p. 95-144, 1962.

Concentric and similar folding are reviewed in detail and their tectonic implications discussed to demonstrate that the time-honored axiom that folding and orogenesis are necessarily due to crustal shortening is a myth. Similar folds persist in depth, whereas concentric folds imply a décollement at depth of the same order as the fold amplitude. The bedding surface area shows great expansion in similar folding, but crustal shortening is not implied; bedding surface area remains constant in concentric folding which implies a superficial shortening that vanishes at the décollement but does not imply over-all crustal shortening. Analysis of similar folds shows that in general the original thickness of any stratigraphic unit is not less than the maximum orthogonal thickness of the same bed in the folded and refolded condition. Diapiric folds (salt domes, mantled gneiss domes, or orogenic axial zones) have an over-all toroidal pattern analogous to the circulation of convection cells. All of the characteristic structures of an orogen may develop in the absence of crustal shortening and may develop even during progressive secular extension of the orogenic zone transverse to its folds.—V.S.N.

190-282. Charlesworth, H. A. K. Some observations on deformation, crustal shortening, and uplift in the Canadian Rocky Mountains: *Alberta Soc. Petroleum Geologists Jour.*, v. 9, no. 9, p. 255-269, 1961.

The fields of deformation that may result when three principal stresses of a stress-system acting on strata at any point in a geosyncline are not equal are treated briefly as an introduction to a discussion of the stress-strain relationships in the Rocky Mountain geosyncline before and during the orogeny. Under deformation of the geosyncline the following are discussed and illustrated. The standard state before orogeny, stress leading to folding and faulting, anisotropy and structural style, and attitude of thrust-faults. Finally, the crustal shortening and uplift characterizing the Canadian Rocky Mountains are discussed.—V.S.N.

190-283. Sougy, J. West African fold belt: *Geol. Soc. America Bull.*, v. 73, no. 7, p. 871-876, 1962.

A belt of folded early and middle Paleozoic rocks is reported; it extends along the Atlantic coast of Africa from Morocco at least as far south as Senegal. The name "Mauritanides" is proposed for this major orogenic belt. Future studies concerning the permanence of continents and oceans versus continental drift will have to consider that the western rim of Africa from Guinea to Morocco is made not of a Precambrian basement but of a mainly Hercynian fold belt, which in some respects is symmetrical to the Appalachian belt.—D.B.V.

190-284. Hawkes, Donald D. The structure of the Scotia Arc: *Geol. Mag.*, v. 99, no. 1, p. 85-91, 1962.

It is suggested that the Scotia Arc was formed after the disruption of a Paleozoic continental strip between South American and Antarctica by an eastward advance of the Pacific crust in post-Carboniferous to pre-Jurassic times. Volcanic island arcs and associated trenches developed at the junction of the Pacific and Atlantic crustal types, and as a result of the igneous activity and orogeny, the Pacific crust underlying the Scotia Sea has become more sialic and is in the process of changing from oceanic to continental type. A further eastward advance of the already modified Pacific crust by development of volcanic island arcs in the South Shetland and South Sandwich Islands probably took place late in the Tertiary.—V.S.N.

190-285. Gamkrelidze, P. D. Mezo-kaynozoiyskiye orogenicheskiye fazyal'nyy zony yuga SSSR [Meso-Cenozoic orogenic phases of the Alpine zone of southern U.S.S.R. (with English summary)]: *Inter-*

nat. Geol. Cong., 21st, Copenhagen 1960, DokladySovet. Geologov, Problema 18, p. 193-203, 1960.

A number of general conclusions are drawn from available information on the Alpine orogenic zone of the southern U.S.S.R. The present structure is the result of a series of Mesozoic and Cenozoic orogenic phases, combined with continuous epeirogenic movements. The orogenic movements took place simultaneously with sedimentation and epeirogeny and were directly related to deep-seated crustal movements. Phases of geosynclinal subsidence were of longer duration than those of uplift. Fourteen orogenic phases can be established for the southern Alpine zone of the U.S.S.R., 9 of regional and 5 of local significance. Only the regional phases can be dated accurately. Some phases consisted of several pulses or subphases; the Wallachian and Baku pulses are considered to be subphases of a Quaternary phase. Each phase was manifested with different intensity in different parts of the Alpine zone and within individual fold systems. — D.B.V.

190-286. Bose, Mihir K. Concept of continental growth and origin of the Indian Peninsula: *Indian Minerals*, v. 15, no. 3, p. 211-216, 1961.

The present note testifies that the Indian shield has grown gradually by a repeated process of orogenesis (evolution of primary arcs) and marginal accretion and coalescence of the mobile belts as parts of the craton, causing the platform to expand. The shield nucleus and its characteristics have been recognized and the history of gradual development of the craton deciphered. It is shown that the shield showing marginal younging has grown subsequent to nucleation and has certainly not been derived from a still larger continent.— Author's abstract

Brouwer, H. A. Vulcanism and tectonics. See *Geophys. Abs.* 190-605.

190-287. Alexander, Ira H. Horizontal earth movement in the Baldwin Hills, Los Angeles area: *Jour. Geophys. Research*, v. 67, no. 6, p. 2469-2475, 1962.

In the Baldwin Hills region of Los Angeles, Calif., where vertical subsidence has been noted for many years, the amount and direction of horizontal movement has been determined by triangulation. Recommendations are made for a systematic program of reobservations to be made in the future.— D.B.V.

190-288. Ivanhoe, L. F. Right-lateral strike-slip movement along the Lake Clarke fault, Alaska: *Geol. Soc. America Bull.*, v. 73, no. 7, p. 911-912, 1962.

A series of several distinctive rock types shows an apparent right-lateral offset of approximately 8 miles on the north and south sides of Lake Clarke and the Tlikakila River in Alaska. It is concluded that movement along this fault is of relatively recent age, as all beds from Lower Paleozoic or Tertiary are offset by a similar amount. This is substantiated by the topography, which suggests recent erosion along a young weak fracture zone. The Lake Clarke fault may be merely one of the more recent of many subparallel faults of various age in the region. Total horizontal movement may be very large, but the offset on each fault may be comparable to that at Lake Clarke. The presence of such faulting should be borne in mind during prospecting for mineral deposits or petroleum.— D.B.V.

190-289. Farrand, W. R., and Gajda, R. T. Isobases on the Wisconsin marine limit in Canada: *Canada Geog. Bull.*, no. 17, p. 5-22, 1962.

A compilation is presented to demonstrate the altitude of maximum extent of postglacial marine submergence, that is, the marine limit, throughout that

sector of North America covered by the Laurentide-Baffin-Ellesmere ice-sheet complex. All available data have been plotted on a map and isobases drawn including isobases of large glacial lakes in the north-central United States and southern Canada to produce a coherent isobase system for approximately 80 percent of the perimeter of the Wisconsin ice sheet. The isobase system is an additional strong argument in favor of isostatic depression and recovery due to glacier loading and unloading as outlined by Flint (1957). Although no radiocarbon dates apply directly to the marine limit, numerous slightly younger marine features have been dated and prove the late-Wisconsin and postglacial age of the marine submergence and uplift. These dates are tabulated.— V.S.N.

- 190-290. Gantar, C., Morelli, C[arlo], and Sancin, S. Confronto fra la livellazione di precisione 1949 nella zona portuale di Trieste ed una ripetizione effettuata nel 1958 [A comparison between the precise leveling of 1949 in the harbor zone of Trieste and a repetition carried out in 1958]: *Boll. Geofisica Teor. ed Appl.*, v. 1, no. 4, p. 349-357, 1959.

Some bench marks established by geodetic leveling in 1949 in the harbor of Trieste were relevelled during 1958. Twenty-two old bench marks that had been destroyed were replaced. The maximum elevation difference between the old and the new bench marks was found to be -27.7 mm, indicating a subsidence of the area at a maximum rate of 2.9 mm per year.— A.J.S.

- 190-291. Meshcheryakov, Yu. A. Vekovni dvizheniya na zemnata kora i svyazaniye s tyakh problemi [Secular movements of the earth's crust and related problems]: *Priroda [Sofia]*, no. 2, p. 52-58, 1961.

Secular movements of the crust are discussed on a basis of geodetic leveling data from the United States, Canada, Finland, Japan, Netherlands, and the western part of the European U.S.S.R. The methods of investigation, results obtained, and their analysis are given. The effect of secular tectonic movements of the crust in the realms of geography, geodesy, geophysics, and geology is indicated, and the relationship of these movements to practical problems is treated.— A.J.S.

- 190-292. Hamilton, Wallis S. Structural model of large part of the earth: *Am. Assoc. Petroleum Geologists Bull.*, v. 46, no. 5, p. 610-639, 1962.

The problem of whether an authentic model of a large part of the earth's crust and mantle is feasible has been analyzed. Dimensionless elastic and plastic property diagrams, based on estimated and simplified characteristics of the earth, show that no ordinary material will fit both the elastic and plastic requirements for a model of reasonable size.

A plastic model was used for tests involving the formation of a geologic basin. The results showed that moderate strains were widely distributed when an elliptical basin was caused by contraction of a deep interior region; there were no areas where strains were concentrated. Because of gravity fill-in the amount of strain is not necessarily related to the final depth of a basin.

Because the initial condition, the boundaries and their displacements, and the long-term properties of the earth all must be estimated, a model cannot determine what mechanism produced a known topographic feature; rather it will show whether or not a hypothesis is reasonable, and it will suggest mechanisms that otherwise might be overlooked.— D.B.V.

GLACIERS

- 190-293. Millecamps, M. M. Rolland, and Lafargue, Maurice. Présentation d'une méthode electro-acoustique originale pour l'étude du méca-

nisme de l'écoulement et des déformations de la glace sur l'épaisseur d'un glacier [An account of an original electro-acoustic method for the study of the mechanism of ice-flow and deformation in the depth of a glacier], in Symposium of Chamonix, Sept. 1958, Physics of the movement of the ice; Internat. Assoc. Sci. Hydrology Pub., no. 47, p. 370-376 (French version), p. 377-382 (English version), 1958.

Four boreholes 140 m deep and 8 cm in diameter were sunk in a section of the Mer de Glace (Mount Blanc massif) below Montenvers, and 14 barium titanate piezoelectric ceramic elements were permanently anchored at 10 m intervals in each of the boreholes. These were attached by coaxial cables to electronic equipment at the surface. The experiment consisted of accurate measurement at regular intervals of the transit time for an ultrasonic signal sent from one ceramic element used as a transmitter to several others acting as receivers. The propagation time was used to ascertain the distances between elements and any variations that developed without disturbing the medium. The signals are recorded by a 35 mm high-speed continuously moving camera. By the end of the field season in 1957 it was found that the distance between ceramic elements could be measured with a precision of 1 percent, that variations in distance against time are related to direction and dependent on depth, and that the variation in speed of propagation of signals is of the order of 20 percent for a thickness of 50 m of ice and increases with depth. Readings taken in 1958 show a general reduction in all propagation times indicating that each of the polyhedra bounded by the ceramic elements has undergone contraction; a special study of this settling of the ice is under way. As in the 1957 readings, contraction increases with every advance in depth into the glacier.—V.S.N.

190-294. Carabelli, Edmondo. Rilevamenti di ghiacciai e studi glaciologici in occasione dell'anno geofisico (Ghiacciaio del Miage)—explorazione geofisica [Glacier surveys and glaciological studies on the occasion of the International Geophysical Year (Miage Glacier)—geophysical exploration]: *Com. Glaciol. Italoano Boll.*, ser. 2, no. 9, pt. 1, p. 87-92, 1959-60 (1961).

Geophysical studies were conducted on the Miage glacier in Italy in August 1957 in connection with the International Geophysical Year. Ice thickness was measured by the seismic reflection method along 4 profiles, one along the valley and the other three perpendicular to it. A longitudinal wave velocity in ice of 3,650 m per sec was assumed in the calculations of ice depth. Ice thickness increased from 250 m in the lower part of the valley to 400 m near the middle, then decreased rapidly to about 150 m at the upper end of the profile. The profiles are reproduced, and a contour map of bedrock is given.—D.B.V.

190-295. Lundbergh, Holger. Swedish "Operation Ice Tunnel": *Am. Geophys. Union Trans.*, v. 43, no. 2, p. 175-176, 1962.

Work has been resumed on "Operation Ice Tunnel", in which a tunnel 300-450 feet long is being driven along the bottom of a large glacier on Sweden's highest mountain, Kebnekajse (6,400 feet), near the Tarfala polar research station (near Kiruna in Swedish Lapland). The investigation is expected to furnish information on how the landscape was formed by the glaciers that once covered Sweden.—D.B.V.

190-296. Crary, A. P., Robinson, Edwin S., Bennett, Hugh F., and Boyd, Walter W., Jr. Glaciological regime of the Ross ice shelf: *Jour. Geophys. Research*, v. 67, no. 7, p. 2791-2807, 1962.

The Ross ice shelf in Antarctica is described on the basis of information obtained from various studies made between 1957 and 1960. Contour maps

show ice thickness, ocean floor depth, surface snow density, average annual temperature, and average annual snow accumulation. The thickness of the ice varies from about 700 m in the southeast part of the shelf to about 250 m near the barrier edge; it is demonstrated from theoretical strain values for floating ice that the main portion of the shelf must be under abnormally large horizontal stresses which prevent the ice from thinning rapidly, thus accounting for its presence over such a large area. Wide variations in snow densities at 40 m depth in different parts of the shelf can be explained in part by variations in strain rates. Horizontal velocity components of the ice particles are inferred from accumulation and other data. In order for these inferred velocities to conform to observed values near the shelf barrier, considerable melting is required at the ice-water boundary at the bottom of the shelf; such melting is confirmed by local data and increases from east to west. Vertical velocities of ice particles with respect to the surface are determined from snow accumulation and strain rates. These velocity components are combined in a numerical-integration method in order that the ice particle paths can be followed forward or backward in time or in space. This method is illustrated by reference to cores from a drillhole at Little America station.—D.B.V.

Borovinskiy, B. A., and Vilesova, L. A. Application of electrometric methods to the study of hydrologic characteristics of moraines. See *Geophys. Abs.* 190-210.

GRAVITY

190-297. Szabo, Bela. The external terrestrial gravity field, in *Space and planetary environments: U.S. Air Force Cambridge Research Laboratories [Center], Air Force surveys in geophysics no. 139*, p. 33-39, 1962.

The information given in this chapter supplements that in the *Handbook of Geophysics*, Chapter 12, section 5, (see also *Geophys. Abs.* 183-294) and presents recent developments in gravimetry with special regard to the external field of the earth. Recent gravimetric, astrogeodetic, and satellite data indicate that the equatorial radius, the flattening of the reference ellipsoid, and the equatorial gravity should be changed to provide the best mathematical model for the normal gravity of the earth. Increased knowledge of the earth's gravitational potential, derived from observation of motions of earth satellites, will furnish improved data for geometrical interpretations.—V.S.N.

190-298. Fajkiewicz, Zbigniew. Approximierung der Regionalfelder der Schwerkraft durch Polynome höherer Grade im Licht der Möglichkeit ihrer numerischen Ausrechnung [Approximation of the regional fields of gravity by higher order polynomials in the light of the possibility of their numerical calculation]; *Freiberger Forschungshefte*, C 98, 62 p., 1961.

This work gives the theory of the application of the concept of Cracovians and polynomials of second and third order, as well as least squares, for approximating regional gravity fields. The formulas and initial equations have been put in such form that automatic computers are not needed, but can be used. By using the Cracovian calculation the formulas assume a very simple form and can be referred to a standard table. Three examples illustrate the use of the method in the Bełchatow, Swidn, and east central Carpathian regions of Poland. The relation between the shape of the regional field and the approximating order of the polynomial is discussed, and attention is drawn to the limitations and advantages of the methods described.—D.B.V.

190-299. Nakagawa, Ichiro. Some problems on time change of gravity, Pt. 1. On effect of oceanic tides upon the tidal variation of gravity: *Kyoto Univ. Disaster Prevention Research Inst. Bull.*, no. 53, p. 1-65, 1962.

The results of a harmonic analysis of gravity values based on data for 34 days at each of eleven gravity stations in Japan using an Askania gravimeter No. 111 over the period July 1957-May 1959 are discussed. The effects of such factors as oceanic tides, local geologic structure, and meteorological disturbances are discussed in detail, and it is established that the most reliable value for the tidal factor of gravity in Japan, free from the influence of oceanic tides, is 1.14 and that the phase lag is very small or nonexistent. The observed hourly values of gravity at each station are tabulated.— V.S.N.

- 190-300. Nakagawa, Ichiro. Some problems on time change of gravity, Pt. 2. On analytical treatments for data of the tidal variation of gravity: Kyoto Univ. Disaster Prevention Research Inst. Bull., no. 53, p. 67-105, 1962.

The effects produced by different methods of drift-elimination and harmonic analysis on the results of analysis of earth tidal data obtained by gravimeter are discussed in detail. Several new and more accurate methods of elimination of instrumental drift are proposed, and a correction factor is introduced for full elimination of drift. The Lecolazet, Doodson-Lennon, and Darwin methods of harmonic analysis of gravity data are applied to Japanese data from eleven stations, and results are compared as to accuracy, drift-elimination, and ease of calculation. Results of the calculations are tabulated.— V.S.N.

- 190-301. Nakagawa, Ichiro. Some problems on time change of gravity, Pt. 3. On precise observation of the tidal variation of gravity at the gravity reference station: Kyoto Univ. Disaster Prevention Research Inst. Bull., no. 57, p. 2-65, 1962.

The change in the tidal factor of gravity with time was studied by precise and continuous observation of tidal variations at the gravity reference station in Kyoto, Japan, from July 1959 to August 1960. It was found that when disturbing effects such as meteorological changes are excluded from the results of harmonic analysis of the data, there is a diversity of only 3 percent in the tidal factor of gravity during a year. Observed hourly values of gravity are tabulated.— V.S.N.

- 190-302. Nakagawa, Ichiro. Some problems on time change of gravity, Pt. 4. On continuous and precise gravity observation during the period of annular eclipse on April 19, 1958: Kyoto Univ. Disaster Prevention Research Inst. Bull., no. 57, p. 67-84, 1962.

Observations of gravity change were carried out during a solar eclipse in Japan on April 19, 1958 to study the effect on gravity of a third body interposed between two attracting bodies. Readings were made at 10-min intervals for seven days at the time of the eclipse. From the residual and smoothed residual curves obtained after elimination of temperature and pressure variations, instrumental drift, and tidal wave effects from the observed values, it was concluded that no significant systematic effect related to gravitational absorption was observed during the eclipse, and that the screening effect of gravitation, if it existed at all, did not exceed 3 μ gal.— V.S.N.

- Nakagawa, Ichiro. Some problems on time change of gravity, Pt. 5. On free oscillations of the earth observed at the time of the Chilean earthquake on May 22, 1960. See *Geophys. Abs.* 190-138.

- 190-303. Ramsayer, K. Die Genauigkeit der Schwerereduktion von Nivellements [The accuracy of the gravity reduction of levelings]: *Deutsch. Geod. Komm. Veröffentl.*, ser. A, no. 38, p. 31-47, 1961.

In compensation of the European leveling network, geopotential heights are calculated instead of metric altitudes. In an earlier paper Ramsayer (1954)

showed that the accuracy of gravity reduction of leveling measurements depends essentially on the altitude and gravity interpolation errors and on the altitude and gravity errors of the gravity observation point. In this paper, practical formulas are derived for calculating the effect of these errors on geopotential height differences and for calculating the admissible spacing of gravity points in flat, hilly, and moderately mountainous terrain.—D.B.V.

- 190-304. Marzahn, K[urt]. Untersuchung der Pendel- und Gravimetermessungen auf dem europäischen Gravimetereichsystem (Stand: 1.7. 1959) [Investigations of the pendulum and gravimeter measurements on the European gravimeter calibration system (status as of July 1, 1959)]: *Deutsch. Geod. Komm. Veröffentl., ser. A, no. 38*, p. 93-112, 1961.

Adjustment of pendulum measurements that are applicable to the European gravimeter calibration system at present shows that measurements made with different apparatus are equivalent and free of essential systematic errors. The mean error of a gravity difference measured with pendulum apparatus is ± 0.46 mgal. The results of pendulum measurements are compared by a simplified method with the adjusted values of the Martin-Morelli gravimeter network, giving a scale factor of $y = (+14.1 \pm 3.8) \times 10^{-4}$ for the gravimeter network.

A test network corresponding essentially to the European gravimeter calibration lines was adjusted by using the rigorous error equations weighted according to values of 1:10, 1:20, and 1:30 for the ratio of pendulum to gravimeter measurements. In this way the maximum effect of the different weights on mean error is only 14 percent. The adjustment of the test network suggests that the mean error of the gravity differences between stations at which absolute measurements have been or will be made will not exceed 0.10 mgal in the final adjustment of the European gravimeter calibration lines. For the maximum gravity differences between Bodö, Norway, and Catania, Sicily, a mean error of 0.7 mgal must be reckoned with. The adjustment furthermore shows that the present calibration factor mean error of 0.3 percent, and with it the mean errors of the adjusted gravity values and gravity differences, cannot be decreased in practice by supplementary measurements with a pendulum and gravimeter of very large gravity differences.—D.B.V.

Longman, I. M. A Green's function for determining the deformation of the earth under surface mass loads. 1. Theory. See *Geophys. Abs.* 190-148.

Arnold, K[urt]. The determination of the geoid from gravity values and the theory of Molodenskiy. See *Geophys. Abs.* 190-272.

- 190-305. Bott, M[artin] H[arold] P[hillips]. A simple criterion for interpreting negative gravity anomalies: *Geophysics*, v. 27, no. 3, p. 376-381, 1962.

The second derivative of gravity across a profile above a two-dimensional semi-infinite horizontal slab with a sloping edge has two turning values. Their relative magnitudes provide a simple criterion for determining the direction of the slope. Since the boundary between sedimentary basins and the underlying denser basement rocks characteristically slopes inwards toward the basin, and the contacts of granite batholiths usually slope outward, this simple criterion provides a means for distinguishing between buried granites and sedimentary basins from their gravity anomalies. The reliability of the criterion is confirmed for observed gravity profiles in Great Britain.—Author's abstract

- 190-306. Winkler, H. A. Simplified gravity terrain corrections: *Geophys. Prosp.*, v. 10, no. 1, p. 19-34, 1962.

The method of Far Terrain Corrections is described which permits contouring of terrain effects for distant topography; near terrain effects must be

computed separately. The method is only slightly less accurate than standard graphical techniques and saves computing time. It is most useful in medium size surveys involving 100 to 2,000 observation points where the application of electronic computers is uneconomic.— Author's abstract

- 190-307. Crenn, Y[vonne]. Definition d'un indice caractérisant l'irrégularité des profils gravimétriques [Definition of an index characterizing the irregularity of gravity profiles (with English and Russian abstracts)]: *Annales Géophysique*, v. 18, no. 1, p. 121-124, 1962.

A method of calculating an index to represent the irregularity of a gravity profile is explained. The effect on the index value of such factors as change in depth to the disturbing body, homogeneous terrain, and the distance between gravity stations is analyzed. In western Africa the index is high (0.40 mgal/km/km) over the fractured areas of the 0° meridian, shows little variation (between 0.20-0.25 mgal/km/km) over the Precambrian crystalline areas, and shows the lowest values over recent sedimentary basins (0.11-0.15 mgal/km/km). This contrast in values between crystalline rocks and sediments makes the index a valuable tool for interpreting gravity anomalies and for estimating thickness of sediments. A tentative application to the Paris Basin is discussed also.— V.S.N.

- 190-308. Andreyev, B. A. Razrabotka i vnedreniye metodov obrabotki i interpretatsii rezul'tatov gravirazvedki [Development and adoption of methods of processing and interpretation of the results of gravity surveys]: *Geofiz. Razvedka*, no. 2, p. 16-30, 1960.

A general discussion is presented of methods of interpretation of gravity exploration data. Some errors published in the literature on data processing and interpretation of gravity anomalies are pointed out, and the automation of gravity observations is analyzed. The effectiveness of four methods of determination of basement depth (see *Geophys. Abs.* 177-182) is discussed.— A.J.S.

- 190-309. Tyapkin, K. F. Graficheskoye vychisleniye v_x i v_{zz} po rezul'tatam izmereniya Δg dlya sluchaya konechnykh po prostiraniyu lineynykh anomalii [Graphical calculation of v_x and v_{zz} from results of measurement of Δg for the case of linear anomalies that are finite along strike]: *Geofiz. Razvedka*, no. 2, p. 60-67, 1960.

Master charts for graphical calculation of v_x and v_{zz} gravity values are presented and applied to calculating values of Δg on a finite cylindrical surface. These master charts are also applicable to calculations of magnetic anomalies.— A.J.S.

- 190-310. Pavlovskiy, V. I., and Serebryakov, Ye. B. Nomogramma dlya opredeleniya formi, razmerov i izbytochnoy plotnosti dvukhmernykh tel pryamougol'nogo secheniya po krivym U_{xz} [Nomogram for determining the form, dimensions, and density contrast of two-dimensional bodies of rectangular cross section from the U_{xz} curve]: *Geofiz. Razvedka*, no. 6, p. 12-18, 1961.

Utilization of the horizontal gradient of the gravity field, (U_{xz}), along a line perpendicular to the strike of linear geologic bodies allows a rapid estimation of the dimensions and density contrast of a body, provided that the cross-sectional area is more or less rectangular and that the depth to the top of the body is known. Nomograms showing the relationship of selected parameters of the U_{xz} curve to dimensions and density contrasts of bodies are presented along with derivations and instructions for use of the nomograms.— J.S.W.

- 190-311. Yarosh, A. Ya. Otsenka glubinnosti gravirazvedki pri poiskakh mestorozhdeniy [Estimation of the depth of penetration of gravity exploration in the search for ore deposits]: *Razvedka i Okhrana Nedr*, no. 5, p. 36-42, 1962.

A formula relating the maximum gravity anomaly value, the area of a gravity anomaly, and the excess mass and depth to the center of an anomaly producing body is studied in detail. Application of reasonable geological assumptions of density, shape, and volume in this formula leads to the derivation of a nomogram indicating the maximum depth at which ore bodies can be detected gravimetrically. Some ways of eliminating or reducing anomalies produced by extraneous bodies are discussed, and gravity surveys of actual deposits are examined. On the basis of theory and actual exploration, it can be seen that the depth of investigation of gravity exploration exceeds that of electrical methods, and bodies similar to the economic chalcopyrite deposits of the Ural Mountains can be detected at depths of 50 to 100 m. — J.S.W.

- 190-312. Avdulov, M. V. Opredeleniye oshibki predstavitelstva anomalii sily tyazhesti metodom srednikh gradiyentov [Determination of the error in the representation of gravity anomalies by the method of mean gradients]: *Vyssh. Ucheb. Zavedeniy Izv., Geodeziya i Aerofotos"yemka*, no. 4, p. 67-74, 1961.

This paper analyzes Graf-Hunter's formula, $E=K(x^{\frac{1}{2}}-y^{\frac{1}{2}})$ for determination of the representation error, E, for a sector on a gravity anomaly map, having x and y as sides of the sector in kilometers, and K as a constant equal to 0.55 mgal/km². Assuming a mean value of the anomaly for each sector, the error, E, is introduced except when the anomaly is linear within the sector. The coefficient, K, changes with change in the values of x and y. The inconstancy of K is corrected by the method of mean gravity gradients. — A.J.S.

- 190-313. Bryusov, B. A. Ob odnom metode opredeleniya mestopolozheniya vozmushchayushchey massy po dannym gravirazvedki. II [On a method of determination of the location of a disturbing mass from gravimetric data]: *Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka*, no. 8, p. 92-98, 1960.

This is a continuation of a paper on determination of the depth of an anomalous mass of isometric form and is based on calculation of the second derivative V_{ZZ} of the gravity vertical gradient. The accuracy of the method is investigated in a theoretical example of a spherical disturbing body 2 km in radius and 4 km deep, and also on maps of V_{ZZ} of the northwestern Cis-Caucasus. The error in calculation by this method is $E_{V_Z}=E_{V_Y}=E_{V_X}=\pm 0.1$ mgal. — A.J.S.

- 190-314. Golomb, V. E. Opyt razvedki s gravimetrami-vysotometrami na neft i gaz v Sibiri [Experience in prospecting with gravimeter-altimeters for oil and gas in Siberia]: *Razvedochnaya i Promyslovaya Geofizika*, no. 40, p. 40-41, 1961.

Experience in oil and gas exploration in Siberia and the Far Eastern Region with gravimeter-altimeters of the type GV-52 is discussed, and elements of the apparatus and principles of operation are described. — A.J.S.

- 190-315. Lange, Wolfgang. Seegravimetrie [Gravimetry at sea]: *Freiberger Forschungshefte*, C 109, 90 p., 1961.

The history of gravity surveying at sea and the theory, instruments, and methods involved are discussed in the first two chapters. The principles of

modern underwater and surface sea gravimeters are then treated in more detail, along with the necessary corrections, supplemental measurements, and accessory equipment. Finally, the present state of work in the Baltic Sea is reviewed. A bibliography of 188 entries is appended.— D.B.V.

Klushin, I. G. On evaluation of the depth of the crystalline basement from data of magnetic and gravity anomalies. See Geophys. Abs. 190-467.

Andreyev, B. A., Boronin, V. P., and Krylov, S. V. Geophysical characteristics of oil-bearing structures of the Volga-Ural province. See Geophys. Abs. 190-531.

190-316. Wolf, H[elmut]. Möglichkeiten für genauere relative Schweremessungen durch Pendel [Possibilities for more accurate relative gravity measurements by means of a pendulum]: Deutsch. Geod. Komm., Veröffentl., ser. A, no. 38, p. 115-116, 1961.

A test carried out by Hoffrogge, comparing the position of two stationary clock pendulums with a quartz clock, showed that there is a drift of the position-differences (as against the quartz clock) that is undoubtedly the effect of earth tides. It is shown that by reversing the problem, taking the times as given by the quartz clock and seeking the gravity acceleration, it should be possible to measure gravity differences with greater accuracy than is possible with pendulum apparatus constructed for field use (see also Geophys. Abs. 187-307).— D.B.V.

190-317. Romanyuk, V. A., and Mikisha, A. M. Vliyaniye geometricheskoy formy lezviya nozha mayatnika na yego dvizheniye [Effect of the geometric form of the knife edge of a pendulum on its movement]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 18 (185), p. 98-124, 1961.

The effect of the shape of the knife edge of a pendulum on its motion is investigated, and a differential equation of motion of a pendulum having a cylindrical blade of an arbitrary form is derived. The derivation of the differential equation in various coordinate systems is given in detail. A formula is also derived for the form correction of the blade. Possible errors in the period of a pendulum having a circular cylindrical blade reach a value of 10×10^{-7} sec when the classical correction for the effect is used.— A.J.S.

190-318. Gantar, C., Morelli, C[arlo], and Pisani, M. Some effects of internal pressure variations at various temperatures on the scale factor of Worden gravimeters (with Italian summary): Boll. Geofisica Teor. ed Appl., v. 2, no. 8, p. 599-606, 1960.

Two sets of calibration tests for checking the scale factors were carried out on several Worden gravimeters at different pressures inside the element container assembly and at various ambient temperatures. The scale factor was found to decrease with an increase in pressure inside the element container, reaching -0.05 percent per +10 mm Hg. Periodic checking of the vacuum in Worden gravimeters and standard internal temperature and pressure are suggested for a "master" gravimeter to be employed in geodetic work of long duration.— A.J.S.

190-319. Romanyuk, V. A. Opredeleniye uskoreniya sily tyazhesti gravimetrom, ustanovlennym na podvishnom osnovanii [Determination of gravity acceleration by a gravimeter installed on a moving base]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 18 (185), p. 3-97, 1961.

After a brief review of the theory of gravimetric observations at sea proposed and developed by Veselov and others (see *Geophys. Abs.* 174-194, 179-210), a monographic study is presented of the theory and performance of marine gravimeters for accelerations up to 100 gals. In chapter 1 a model of a gravimeter and its operation are discussed. The forces acting on the pendulum angles that specify the orientations of gravimeter and pendulum are considered, and the conditions imposed on the motions of the pendulum are defined. A differential equation of the pendulum motion relative to a support that has 6 degrees of freedom is set up; terms up to the fourth order of smallness with regard to the angles and accelerations are retained. The second chapter gives the solution to the equation, the possible effects of its separate terms on the gravimeter reading, and the effect of damping. The third chapter is devoted to an investigation of gravimeter performance for acceleration amplitudes less than 50 gals, and the last chapter deals with observations with a gravimeter installed on a gyro-stabilized platform with acceleration amplitudes less than 100 gals. A mathematical treatment of the problems is given in detail in six appendices.—A.J.S.

- 190-320. Romanyuk, V. A. *Opredeleniye koeffitsiyenta zatukhaniya sil'no-dempfirovannogo gravimetra* [Determination of the damping coefficient of a highly damped gravimeter]: *Akad. Nauk SSSR Inst. Fiziki Zemli Trudy*, no. 18 (185), p. 125-131, 1961.

The idea of a sea gravimeter having a highly damped elastic system is discussed (see *Geophys. Abs.* 179-210). The damping coefficient of such a gravimeter is determined as $\mu = 2p/n^2$, where p and n are parameters of the gravimeter pendulum. The value of μ was determined for the entire interval of variation of the deflection angle of the pendulum.—A.J.S.

- 190-321. Romanyuk, V. A. *Nablyudeniya mayatnikov na girostabilizirovannoy platforme* [Observations of pendulums on a gyro-stabilized platform]: *Akad. Nauk SSSR Inst. Fiziki Zemli Trudy*, no. 18 (185), p. 132-137, 1961.

Methods of installation of gravimeters for duty at sea are discussed. After a brief consideration of the Cardan joint, the motions of the pendulum of a marine gravimeter rigidly installed on a gyro-stabilized platform are analyzed.—A.J.S.

- 190-322. Tsuboi, Chuji, Tomoda, Yoshibumi, and Kanamori, Hiroo. *Continuous measurements of gravity on board a moving surface ship: Japan Acad. Proc.*, v. 37, no. 9, p. 571-576, 1961.

A recently constructed vibration string gravimeter designed for continuous measurements of gravity on board a moving ship is described, and tests made during two voyages are discussed. A weight is suspended from a thin metallic strip which under the tension due to the weight makes rapid chord vibrations. The weight is connected sideways also to the supporting frame so that no pendulous swinging of the weight can be caused by the ship's movements. Any change in the value of gravity causes a corresponding change in the tension of the string and hence in its vibration period. The recording system and ship mounting are described also. The overall accuracy obtained in sea tests is estimated to be 3-5 mgals which is good when the difficulties in determining the ship's position, speed, sea-bottom topography, and other relevant factors are considered. Almost continuous records of satisfactorily accurate gravity data were obtained during the two test voyages.—V.S.N.

- 190-323. Mann, Virgil I. *Bouguer gravity map of North Carolina: Southeastern Geology*, v. 3, no. 4, p. 207-220, 1962.

A Bouguer gravity map of North Carolina ($d=2.67$) is presented from the data collected from 4,000 gravity stations in the state. In the piedmont and mountain portions of the state, some correlation between Bouguer values and rock types may be readily observed; however, in the Coastal Plain important Bouguer changes appear to be caused by subsurface rock variations. The general pattern for the state of North Carolina shows strong negative values in both the east and west portions, with a persistent positive zone in the central Piedmont. Local variations from this general Bouguer pattern are discussed briefly for each physiographic province.— Author's abstract

- 190-324. Lyons, Paul L. Geophysical background of Arkoma basin tectonics: Tulsa Geol. Soc. Digest, v. 29, p. 94-104, 1961.

Gravity and magnetic data are assembled that contribute toward an understanding of the origin of the greater Ouachita Mountain structural belt and particularly of the Arkoma basin, a broad northward extension or salient of the uplifted Ouachita geosyncline. The Oklahoma salient of the Ouachitas, including the Arkoma basin, is the site of a great gravity minimum—one of the most significant on the North American continent because of its areal extent and departure from isostatic equilibrium. This gravity minimum has an uncompensated 80 mgal negative value at the center and covers approximately 12,000 sq mi; only a downwarping of the crust into the mantle will explain the minimum satisfactorily. Calculations from gravity, based on seismic fixes of the M-discontinuity at Tulsa and Little Rock, indicate that a low closure on the M-discontinuity some 59 km deep occurs in coincidence with the gravity minimum. South of the great minimum is an elongate gravity maximum representing the Broken Bow-Benton uplift, a part of the greater system of the Ouachita uplift. It is possible to follow the Ouachita province across the entire southern part of the continent from the gravity map. Large magnetic maximums in the Arkoma, Anadarko, and East Texas basins possibly represent heavy masses within the crust, wide in areal extent and deep enough not to contribute to the gravity picture, that may have contributed toward the initial foundering or sinking of the basins.— V.S.N.

Andreasen, G[ordon] E., Kane, M[artin] F., and Zietz, Isidore. Aeromagnetic and gravity studies of the Precambrian in northeastern New Mexico. See Geophys. Abs. 190-477.

- 190-325. Joesting, H[enry] R. Discussion of "Gravity and aeromagnetic exploration in the Paradox Basin," by Nelson C. Steenland (Geophysics, February, 1961, p. 73-89): Geophysics, v. 27, no. 3, p. 396-398, 1962.
Byerly, P. Edward. Discussion of "Gravity and aeromagnetic exploration in the Paradox Basin," by Nelson C. Steenland (Geophysics, February, 1961, p. 73-89): *ibid.*, p. 398, 1962.

Joesting claims that Steenland has attempted to obtain more from the magnetic data than is warranted in view of the probable 10 percent or greater error that is inherent in depth estimates using the methods of Vacquier and others. The use of horizontal cylinders to represent the thickened salt masses is also an oversimplification.

Byerly states that Steenland's cylinder calculations are entirely dependent upon the regional anomaly removed; he disagrees with some of Steenland's discussion of gravity data in U.S. Geol. Survey Prof. Papers 316-A and 316-C (see Geophys. Abs. 178-306, 182-218).— D.B.V.

- 190-326. Qureshy, Mohammed N. Gravimetric-isostatic studies in Colorado: Jour. Geophys. Research, v. 67, no. 6, p. 2459-2467, 1962.

Isostasy in Colorado is found to prevail on a broad scale only. Gravity data show the process of compensation to be more complete in the plains than in

the mountains. Local anomalies exceeding 35 mgal are observed in both regions, however. These anomalies are here interpreted in terms of variations in thickness of the earth's crust. Estimates of crustal thickness in a few selected areas show variations of the order of 20 km within the state of Colorado. It is suggested that these variations are perhaps caused by warping of the sub-crust (mantle?). When and how the warping occurred, however, is not clear. Correlation between the major tectonic elements in Colorado and the undulations postulated here suggest a genetic relationship between the two.— Author's abstract

- 190-327. Kovach, Robert L., Allen, Clarence R., and Press, Frank. Geophysical investigations in the Colorado delta region: Jour. Geophys. Research, v. 67, no. 7, p. 2845-2871, 1962.

Combined gravity and seismic refraction techniques were used to determine depths of the Cenozoic section and fault patterns of the Colorado delta region. Bouguer anomalies range from -10 to -88 mgal with respect to the International Ellipsoid, and the trend of isogal contours is northwesterly. Basement depths in the center of the basin estimated from gravity data are less than known minimum depths determined from refraction profiles. This discrepancy suggests density complexities within the deeper parts of the stratigraphic section, an interpretation that is supported by sparse measurements from well samples; local isostatic compensation may also contribute to the discrepancy. Seismic velocities range from 5,650 to 20,000 fps, and several consistent velocity zones are widespread above the pre-Tertiary basement; indicated depths to basement vary from 2,200 feet to at least 15,400 feet, the maximum being near the Mexican border.

Many members of the San Andreas fault system are well delineated by gravity and seismic data, including the Elsinore and San Jacinto faults and a fault beneath the Sand Hills. The San Jacinto is the more continuous through the delta region, but all appear to be en echelon to the trend of the San Andreas system as a whole.— D.B.V.

- 190-328. Crowley, Francis A. Gravity observations along the northern coast of Ellesmere Island: U.S. Air Force Cambridge Research Labs., Geophysics Research Directorate Research Notes, no. 53, 7 p., 1961.

Free air gravity anomalies are tabulated for a remote section of the northern Ellesmere coast in the vicinity of Ward Hunt Island. A moderately positive reduced free air anomaly is found over a section of known bathymetry. The free air values show the transition to be expected between Arctic Ocean values and the dominantly negative free-air values over the high relief of the interior of Ellesmere.— V.S.N.

- 190-329. Kopf, Manfred, Grosse, Siegfried, and Sonntag, Klaus. Dichtebestimmung an Gesteinen des Westerzgebirge [Density determination on rocks of the western Erzgebirge]: Freiburger Forschungshefte, C110, p. 5-53, 1961.

The density of numerous rock samples was determined in connection with reduction of gravity values in the western Erzgebirge. A suitable field method was developed, the accuracy of which is controlled by petrophysical determinations in the laboratory. A total of 4,280 samples from 390 outcrops was measured. The results show that careful sampling can eliminate systematic error. Outcrops that yielded little fresh rock were not considered.

The Kirchberg, Eibenstock, and Bergen granite plutons have a mean density of 2.62, and the Aue-Schneeberg and Geyer granites—2.64. Granite patches of somewhat lower density (below 2.55) can be explained as decomposed zones; no traces of a so-called light granite were found. Complete results are tabulated in an appendix.— D.B.V.

- 190-330. Grosse, Siegfried, Kopf, Manfred, and Sonntag, Klaus. Ergebnisse der Gravimetermessungen im Westerzgebirge [Results of gravimeter measurements in the western Erzgebirge]: Freiburger Forschungshefte, C 110, p. 55-102, 196 .

The results of a regional gravity survey in the western Erzgebirge, the Erzgebirge basin, and part of the Vogtland are presented in the form of maps and profiles. The Bouguer anomalies show a minimum in the western Erzgebirge beginning at the west edge of the Kirchberg-Eibenstock granite massif and extending eastward to the Elbe valley region. Its lowest value lies near Karlovy Vary in Czechoslovakia. On the south this low is bounded by the Erzgebirge border fault. The cause of the minimum is believed to be a large wedge-shaped deep granitic body underlying the whole Erzgebirge. (See also Geophys. Abs. 181-280).—D.B.V.

- 190-331. Aue, L. F. K voprosy geologicheskogo istolkovaniya kart vtornykh vertikal'nykh proizvodnykh anomalii sily tyazhesti [Concerning the question of the geologic utilization of maps of the second vertical derivative of potential fields]: Geofiz. Razvedka, no. 6, p. 18-21, 1961.

Second vertical derivative maps constructed from detailed gravimetric surveys of the southern part of the Udmurtsk A.S.S.R. show higher resolution relative to the observed anomalies and therefore reveal many smaller structural elements not evident on earlier maps. Comparison of geologic interpretations based on second derivative maps with well data and other geophysical data generally confirms the interpretations; however, second derivative maps should always be considered as accessory material and be compared with other data.—J.S.W.

- 190-332. Mudretsova, Ye. A. Podzemnyye gravimetricheskiye raboty na medno kolchedannykh mestorozhdeniyakh Srednego Urala [Underground gravimetric work at chalcopyrite deposits of the Middle Urals]: Geofiz. Razvedka, no. 2, p. 31-59, 1960.

Experimental gravimetric investigations in the chalcopyrite mines of the Middle Urals are reported. Blind ore bodies were sought using gravimeters and variometers installed in worked out parts of the mines. Satisfactory results were obtained with gravimeters of 0.04 mgal accuracy; however, better result could be expected if the accuracy were to 0.01 mgal.—A.J.S.

- Vol'vovskiy, I. S., Ryaboy, V. Z., and Shraybman, V. I. Subsurface geology of the Fergana depression according to geophysical data. See Geophys. Abs. 190-587.

- 190-333. Geyman, B. M. O geologicheskoy istolkovanii anomalii sily tyazhesti Zapadnogo Uzbekistana [Geologic interpretation of the gravity anomalies of west Uzbekistan]: Geologiya Nefti i Gaza, no. 4, p. 21-22, 1960.

The gravity field of the west part of the Uzbek S.S.R. is strongly disjointed; there are a multitude of local anomalies of different orientations, dimensions, and intensities. Without exception the local maximums are related to outcrops of Paleozoic rocks, and the gravity lows correspond largely to intermontane depressions. The positive and negative anomalies are generally separated by belts of steep gradients, which according to seismic evidence are faults. Only Alpine faults or older faults reactivated during the Alpine orogeny are expressed in the gravity field; Hercynian faults are not detected.—J.W.C.

- 190-334. Gaynanov, A. G., and Smirnov, L. P. Stroyeniye zemnoy kory v oblasti perekhoda ot Aziatskogo kontinenta k Tikhomu okeanu [Crustal structure in the area of transition from the Asiatic continent to the Pacific Ocean]: *Sovetskaya Geologiya*, no. 5, p. 108-118, 1962.

Results are reported of a gravity study of the transition zone from the Asiatic continent to the Pacific Ocean. A map shows the relief of the M-discontinuity in the Sakhalin—Sea of Okhotsk—Kamchatka region, and profiles illustrate crustal thickness along the line Sakhalin—Iturup and through the Kurile—Kamchatka depression. The methods used in the interpretation are discussed.—J.W.C.

- 190-335. Ogawa, Kenzo. Gravity survey at Yamagata basin, Yamagata Prefecture [in Japanese with English abstract]: *Japan Geol. Survey Bull.*, v. 12, no. 12, p. 947-971, 1961.

The subsurface structures in the Yamagata basin, Yamagata Prefecture, Japan, are interpreted from the distribution of the Bouguer anomalies and from the residual gravity data. The basin was found to be narrow and elongate in a N-S direction with the town of Nakayama at the center of maximum sedimentation. Various high and low gravity anomalies in the area of the survey are described, and the gravity data are tabulated.—V.S.N.

HEAT AND HEAT FLOW

- 190-336. Nekhoroshev, A. S. To the problem of the methods for determining the presence of volcanic vapours at depth: *Bull. Volcanol.*, v. 23, p. 271-276, 1960.

Two methods of calculating volcanic steam pressures at depth are outlined. In actual conditions, heat content will be approximately constant but with a tendency to decrease during the movement of steam to the surface. Such an assumption permits determination of the maximum possible pressure for certain depths, not only for superheated steam of volcanic origin but also for steam formed by underground heating of percolating waters. If the heat content increases with depth due to losses of heat by radiation, the intersection of the isothermal line and heat content shifts into the zone of lower pressures. Comparison of theoretical computations of pressure with experimental results makes it possible to determine heat losses during the movement of steam within rocks. Application of this method will throw light on the origin of some steam deposits and solve a number of problems related to geothermal power development.—D.B.V.

- 190-337. Garland, G. D., and Lennox, D. H. Heat flow in western Canada: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 2, p. 245-262, 1962.

Heat flow values have been determined for three areas in western Canada by a combination of temperature gradient measurements in abandoned oil wells and thermal conductivity determinations on core samples. The heat flux ranges from 1.46×10^{16} cal $\text{cm}^{-2}\text{s}^{-1}$ in central Alberta to 2.00×10^{-6} cal $\text{cm}^{-2}\text{s}^{-1}$ for a well near the Arctic Circle. Possible disturbances in the temperature gradients resulting from oil production and from surface temperature inequalities are considered.—Authors' summary

- 190-338. Foster, Theodore D. Heat-flow measurements in the northeast Pacific and in the Bering Sea: *Jour. Geophys. Research*, v. 67, no. 7, p. 2991-2993, 1962.

Results of heat flow measurements made at 50 stations in the northeast Pacific Ocean and Bering Sea are tabulated and shown on a map. Accuracy was between ± 10 and ± 15 percent except at three stations. The four values obtained in the Bering Sea, the first for this area, are all near the average value for oceanic heat flow. At a station on the bench just north of the Aleutian Trench off Unimak Pass heat flow is considerably less than normal, whereas at a station in the Aleutian Trench proper south of the Alaska Peninsula, it is higher than normal. This seems to run counter to the lower than normal heat flow in the South American Trench and mid-American Trench. The sharpness of the transition from low or normal to high values at two other stations within 90 km of each other seems to indicate that the source of the high heat flow in this region (near lat 40° N., long 130° W.) may be near the surface; this might be interpreted as evidence against the hypothesis of large-scale convection currents in the mantle as the general explanation for regions of high heat flow.—D.B.V.

- 190-339. Vorob'yeva, K. I. O geotermicheskikh osobennostyakh neftyanogo mestorozhdeniya Ozek-Suat i drugikh rayonov Tersko-Kumskoy ravniny [On the geothermal characteristics of the Ozek-Suat oilfield and of other regions of the Tersko-Kuma Plain]: *Geologiya Nefti i Gaza*, no. 6, p. 42-45, 1960.

Geothermal investigations were carried out in several deep boreholes in the Ozek-Suak oilfield in the northwest part of the Tersko-Kuma Plain. The results are summarized in tables. Superposed on the gradual rise in temperature with depth is a drop in the magnitude of the geothermal step connected with the Maykop sediments, a shale unit which acts as a barrier to rising heat.—J.W.C.

- 190-340. Tsaturyants, A. B., and Shabanov, S. F. K voprosu ob ustanovlenii zakonomernostey izmeneniya geotermicheskoy stupeni s gubiniy dlya mestorozhdeniy Azerbaydzhana [Problem of establishing systematic variations in the geothermal step with depth for the fields of Azerbaijan]: *Akad. Nauk Azerbaydzhan. SSR Izv.*, no. 5, p. 109-117, 1961.

As part of a study to determine heat distribution in the crust, systematic temperature measurements were made in deep wells up to 4,200 m depth in the oilfields of the Azerbaijan S.S.R. The change in temperature with depth has two phases. The initial phase extends to a depth of 1,000-1,200 m and is curvilinear in nature; the geothermal step increases with depth. The second phase, which persists through the lowest point measured, is rectilinear and the geothermal step is stabilized at 56 m per $^{\circ}$ C.—J.W.C.

- 190-341. Mekhtiyev, Sh. F., and Aliyev, S. A. O faktorakh, vliyayushchikh na geotermicheskuyu stupen' neftyanikh mestorozhdeniy Azerbaydzhana [Factors affecting the geothermal step of the oil fields of Azerbaijan]: *Geologiya Nefti i Gaza*, no. 3, p. 25-28, 1960.

Extensive measurements were made of the geothermal step (m per 1° C) in the oil fields of the Azerbaijan A.S.S.R.; these data are summarized in tables. The following geothermal regionalization is recognized: Caspian-Kuban oil-gas region with a step of 32-33 m per 1° C, South Apsheron oil-gas region—21-27 m per 1° C, Kura oil-gas region and the Neftechala and Kyurodag oil fields—30 m per 1° C, and the Kirovabad oil-gas region—18 $^{\circ}$ C.—J.W.C.

- 190-342. Penta, F[rancesco]. Vapori naturali ("forze endogene"): stato delle ricerche e considerazioni [Natural vapors ("endogene forces"): state of research and considerations]: *Bull. Volcanol.*, v. 23, p. 219-235, 1960.

The published results of research on natural steam or hot water resources in different parts of the world are compiled into a table that lists the area; nature of surface formations; surface manifestations; type of study (geological, geophysical, etc.); number of holes drilled; maximum surface and bottom temperatures, pressure, and yield of each hole; uses (exclusive of therapeutic); and references.—D.B.V.

190-343. Bödvarsson, Gunnar. Exploration and exploitation of natural heat in Iceland: *Bull. Volcanol.*, v. 23, p. 241-250, 1960.

Exploitation of natural heat in Iceland began in 1925. At present about 45,000 homes are heated, in addition to many greenhouses and swimming pools. Geological, geophysical, and geochemical methods are being used in prospecting for natural heat resources. Electrical, magnetic, gravimetric, and thermal methods have been applied on a large scale with considerable success, and chemical and isotopic studies of the waters and steam have revealed some important facts. Seismic and radioactivity methods have been of minor importance. The scope of the surveys and some results are reviewed briefly.—D.B.V.

190-344. Gennai, N. Résultat des forages effectués à Bagnore (Monte Amiata, Italie) [Result of drilling at Bagnore (Monte Amiata, Italy)]: *Bull. Volcanol.*, v. 23, p. 237-239, 1960.

The results of the first two geothermal borings at Bagnore, Italy, about 70 km southeast of the classic Larderello area, are presented briefly. It appears that the mixed gases and steam obtained can be used directly in the turbines to generate power.—D.B.V.

190-345. Averiev [Averyev], V. V., Ivanov, V. V., and Piip [Piyp], B. I. Problems of using volcanic thermae of the Kurile-Kamchatka island arc for power: *Bull. Volcanol.*, v. 23, p. 257-263, 1960.

The principal genetic types of thermal waters in the Kurile-Kamchatka region are tabulated. They differ substantially in hydrogeologic conditions of formation, gas and ionic composition, and areas of development. The first experimental borings for power resources were begun in 1957-58 at Pauzhetka hot springs at the southern tip of Kamchatka. The results established the presence of waters suitable in both heat content and chemical composition for use as a source of power. Further investigations and prospecting work are in progress.—D.B.V.

190-346. Sviatlovsky, A. E. [Svyatlovskiy, A. Ye.]. Thermal underground waters of the Kamchatka and the role of recent tectonics and volcanism in their dynamics: *Bull. Volcanol.*, v. 23, p. 265-270, 1960.

The tectonic and volcanic conditions that give rise to the artesian basins that can be developed for geothermal power are outlined.—D.B.V.

190-347. Neumann van Padang, M. The steam borings in Kawah Kamodjang: *Bull. Volcanol.*, v. 23, p. 251-255, 1960.

Five test borings were drilled in 1926 in the Kawah Kamodjang fumarole field in west Java. Two of these were observed over 12 years. In borehole III the temperature and pressure were still higher after 12 years than at the time of drilling, and had decreased but little since their maximum in 1928. In borehole V the temperature was the same or a little higher than at the beginning, but the pressure had dropped from the maximum of nearly 6 (in 1928) to only 0.5 atm.—D.B.V.

- 190-348. Studt, F. E., and Doyle, D. Electric power generation from geothermal steam at Wairakei, New Zealand: *Bull. Volcanol.*, v. 23, p. 277-282, 1960.

The geology of the volcanic belt of North Island, New Zealand, is outlined and the structure at Wairakei is described. Holes drilled to depths of 300 to 4,000 feet produce a mixture of steam and water that was being used to generate 20 MW of electricity as of August 1959. In the near future it is expected that 150 MW will be produced.—D.B.V.

- 190-349. Goguel, Jean. Quelques considérations sur l'utilisation de l'énergie géothermique, à propos de la Nouvelle Zélande [Some considerations on the utilization of geothermal energy, a propos of New Zealand]: *Bull. Volcanol.*, v. 23, p. 283-299, 1960.

The use of volcanic energy is limited at present to abnormally heated areas where the heat is conveyed by water or steam. This source of heat can be used directly or transformed into energy. For the latter it is more convenient to use steam rather than hot water of the same temperature, because of the latent heat of vaporization. The New Zealand geothermal project is described, with emphasis on the distribution of heat in the area. There are two radically different hypotheses concerning the future of this geothermal field. One view assumes that the heat reserves, stored at the time of some past volcanic event, will become exhausted within a century and would have died out in time even without the intervention of man. The second view holds that the present diffuse discharge throughout the mass of permeable tufts will gradually be replaced by a concentrated discharge at the point where the heat emerges from depth and will last as long as the deep source endures.

The energy released by volcanic eruptions is of a completely different order of magnitude but cannot be used directly because of the fundamental irregularity. Probably the ultimate mechanism that produces volcanic eruptions and exploitable local heat accumulations is the same. A larger scale heat source such as a cooling laccolith that could yield large quantities of heat steadily for thousands of years would be ideal, but no such source is yet known.—D.B.V.

- 190-350. Krylova, M. D. K voprosu ob opredeleniya temperatur obrazovaniya porod po metodu T. F. Barta [On the problem of determining the temperatures of formation of rocks by T. F. Barth's method (with English summary)]: *Geokhimiya*, no. 6, p. 529-535, 1962.

The temperatures of formation of pegmatites, granites, and gneisses from the Stanovoi Range and Aldan shield in the U.S.S.R. were determined according to Barth's method (feldspar geologic thermometers) and found to reflect an environment of the amphibolite and granulite metamorphic facies. These formation temperatures were compared with those obtained for the same rocks of analogous metamorphic facies in northern Karelia and Norway. It is concluded that Barth's method can be used as a basis of metamorphic correlation to aid in reconstructing the sequence of geological events in a metamorphic area.—D.B.V.

- 190-351. Ewing, Maurice, and Engel, Leonard. Seismic shooting at sea: *Sci. American*, v. 206, no. 5, p. 116-126, 1962.

The application of explosion seismology to exploration of the structure of the suboceanic crust and the techniques used are discussed. The seismic refraction method is described, and it is shown that although the depth and thickness of the crustal layers can be determined by this method, details of structure are missed. To determine such details, submarine geophysics is now equipped with a technique of reflection shooting that will obtain detailed records of the suboceanic crust to 15,000 feet below the bottom. A new device, the seismic profiler (see *Geophys. Abs.* 186-583) automatically records the echoes. The basic structure of 3 layers above the M-discontinuity so far determined is described. One of the recent findings using the new method of deep-water reflection shooting is that the second layer of the oceanic crust, not always detected by refraction shooting, lies everywhere beneath the sea; detailed profiles disclose that the surface of this layer is quite rough. This roughness is accounted for by assuming that the layer crystallized directly from the molten state, and, if this is true, the second layer may represent the primordial surface of the earth. There is no evidence in the reflection records of any disturbance in the overlying sediments, as would have occurred if the second layer had been formed after the sediments had begun to be deposited.— V.S.N.

- 190-352. Båth, Markus. Die Conrad-Diskontinuität [The Conrad discontinuity]: *Freiberger Forschungshefte*, C 101, p. 5-34, 1961.

The results of all available refraction and reflection investigations of the internal structure of the earth are compiled in the form of tables and graphs. It is shown by means of examples that differences in results are due not to methods of measurement nor, in general, to actual structural differences, but rather to differences in interpretation. It cannot be concluded on the basis of observations available up to the present time that the continents differ in structure. The indications of internal layering are strong enough to justify the assumption of the existence of a Conrad layer or Conrad discontinuity. Possibly the continents differ to the extent that in some areas there is a sharp Conrad discontinuity whereas in others it consists of a transitional layer. More enthusiastic international cooperation should facilitate solving this problem and related difficulties of interpretation.— D.B.V.

- 190-353. Shimazu, Yasuo. Physical theory of generation, upward transfer, differentiation, solidification, and explosion of magmas: *Nagoya Univ. Jour. Earth Sci.*, v. 9, no. 2, p. 185-223, 1961.

The generation of magmas is considered as the cause of tectonic activity within the crust and the upper mantle. Assuming that the parental basaltic magmas are generated a few hundred kilometers below the surface during some stage of terrestrial evolution, the sequence of generation, upward transfer, differentiation, and solidification is reviewed. If the rate of convection (W) within the magma is less than 0.1 cm per yr the magma degenerates in place; if $W \sim 0.1$ cm per yr the molten layers float upward with decreasing mass and disappear at some depth, but if the initial thickness is greater than 200 km they will approach the surface; and if W is greater than or equal to 1 cm per yr the magma maintains its mass as it is transferred toward the surface. The differentiation of a magma accompanied by solidification is studied using an albite-anorthite binary model. It is concluded that no differentiation takes place if the diffusivity of the cover rocks is greater than 0.1 cm^2 per sec. If the vapor pressure of the magma increases beyond the strength of the surrounding rocks the magma may explode as a volcanic eruption. A possible mechanism of explosion based on the rapid rise of magma through the crust is discussed briefly. The minimum rate of rise to realize explosion would be 10^2 m per yr.

The effect of oxygen pressure upon the variation in FeO concentration in a magma is quantitatively calculated (see also Geophys. Abs. 185-347, -348, -349).— V.S.N.

- 190-354. Godin, Yu. N., Vol'vovskiy, B. S., Vol'vovskiy, I. S., and Fomenko, K. Ye. Izucheniye stroyeniya zemnoy kory pri regional'nykh seismicheskikh issledovaniyakh na Russkoy platforme i v Sredney Azii [A study of the structure of the earth's crust in regional seismic investigations on the Russian platform and in central Asia]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1464-1471, 1961.

The results of seismic crustal studies in the southeast part of the Russian platform (along 1,900 km of profiles), and in Fergana (430 km), Turkmenia (300 km), and Bukhara (300 km) of central Asia are reported and discussed. The correlation method of direct and reversed traveltime curves which permitted recognition of reflections from deep layers and the M-discontinuity was used. The thickness of the crust was determined to be 40 km for the Russian and Kara-Kum platforms, 45 km in Bukhara, and up to 55 km in Fergana.— A.J.S.

- 190-355. Tatevosyan, L. K. Nekotoryye cherty glubinnogo stroyeniya zemnoy kory v oblasti Kavkaza po gravimetricheskim dannym [Some features of the deep structure of the crust in the region of the Caucasus according to gravimetric data]: Akad. Nauk Armyan. SSR Izv., Ser. Geol. i Geog. Nauk, v. 14, no. 5, p. 31-42, 1961.

An attempt is made to correlate the gravity anomalies, deep structure, and tectonic zones of the Caucasus. Profiles of the crust to the M-discontinuity were calculated for the Leninkan-Astrakhan' and Batumi-Stepnoy traverses. These show a gradual increase in crustal thickness from Astrakhan' to Leninkan, and a 12 km bulge (mountain root) in the Mount Elbrus region below the 49-km average thickness of the crust along the Batumi-Stepnoy traverse.— A. J. S.

- 190-356. Ulomov, V. I. Statisticheskiy analiz zapisey blizkikh zemletryaseniy i stroyeniye zemnoy kory v Sredney Azii [Statistical analysis of records of local earthquakes and crustal structure in central Asia]: Akad. Nauk Uzbek. SSR Izv., Ser. Fiz.-Mat., no. 6, p. 78-92, 1960.

A new method is presented for study of crustal structure; it is based on first arrivals of elastic waves from local earthquakes as recorded by seismic stations of all types. Statistical analyses were made on 96 earthquakes recorded by 22 seismic stations, and traveltimes of P* and P longitudinal waves were studied. By comparing the result of the analyses with existing maps of the basaltic basement, the profiles of the M-discontinuity, and gravimetric data, the conclusion was reached that the P* and P-waves are head waves reflected from the basaltic basement and the Mohorovičić zone, respectively.— A.J.S.

- 190-357. Aver'yanov, A. G., Veytsman, P. S., Gal'perin, Ye. I., Zverev, S. M., Zayonchkovskiy, M. A., Kosminskaya, I. P., Krakshina, R. M., Mikhota, G. G., and Tulina, Yu. V. Glubinnoye seismicheskoye zondirovaniye v perekhodnoy zone ot aziatskogo kontinenta k Tikhomu okeanu v period MGG [Deep seismic sounding in the transition zone from the Asian Continent to the Pacific Ocean during the International Geophysical Year]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 2, p. 169-184, 1961.

Methods of observation and apparatus employed in deep seismic sounding in the transition zone between the Asian Continent and Pacific Ocean during

the International Geophysical Year are described. The areas of continental, intermediate, and oceanic crust were delineated. The thickness of the continental crust ranges from 20 to 30 km. The intermediate areas differ from the continental by the absence of the 6-kmps granitic layer and from the oceanic by the presence of a thick stratum over the basaltic layer. The oceanic type crust was found to consist of a 1-km sedimentary layer above a 5-12 km basaltic layer.—A.J.S.

190-358. Research Group for Explosion Seismology. Observations of seismic waves from the second Hokoda explosion: Tokyo Univ. Earthquake Research Inst. Bull., v. 37, pt. 3, p. 495-508, 1959.

This is the English version of a paper published in Japanese in Zisin, ser. 2, v. 13, no. 2, p. 90-96, 1960 (see Geophys. Abs. 184-433).—D.B.V.

Savit, Carl H., Blue, Donald M., and Smith, Jennings G. Exploration seismic techniques applied to oceanic crustal studies. See Geophys. Abs. 190-581.

Payo [Subiza], Gonzalo. Love wave dispersion along very long Euro-Asiatic paths. See Geophys. Abs. 190-139.

Gaynanov, A. G., and Smirnov, L. P. Crustal structure in the area of transition from the Asiatic continent to the Pacific Ocean. See Geophys. Abs. 190-334.

190-359. Vozdvizhenskiy, B. I. O burenii sverkhglubokikh skvazhin [On drilling super-deep boreholes]: Razvedka i Okhrana Nedr, no. 12, p. 24-30, 1961.

This is a general discussion of current attempts to drill through the crust to reach the M-discontinuity. After a brief description of the Mohole project, the plans of the U.S.S.R. for drilling super-deep holes on land are discussed. Drilling is scheduled in the Caspian depression north of the sea, in Transcaucasia, in the Urals, and in the Kurile Arc; the latter may reach the M-discontinuity at a depth of about 12 km. Drilling from a deep mineshaft and two-stem holes are considered. In the latter one stem is intended for geophysical, inclinometric, thermal, and other studies, whereas the other will supply core-samples. Petroleum and polyacrylate drilling muds are being tested.—A.J.S.

190-360. Garland, G. D. The Upper Mantle Project: Nature, v. 193, no. 4817, p. 721-723, 1962.

The Upper Mantle Project established in 1960 by the International Union of Geodesy and Geophysics at the Helsinki assembly is a research program that will extend from January 1962 through December 1964. It will emphasize not only the study of the upper mantle (the portion above 1,000 km depth) but also its influence on the development of the earth's crust. The general organization will be along the lines of the International Geophysical Year. The Upper Mantle Committee has summarized the methods available for gaining such information on the earth's interior. Most nations will not be in a position to undertake costly drilling investigations like the Mohole project, but much can be done by seismological studies.

The Canadian program, recently announced, is one of the first to win government support. One of its important phases will be the accelerated completion of a network of seismological stations at intervals of 500 miles extending over all of Canada including the Arctic. At each of these stations holes will be drilled to 1,000 feet for temperature gradient and heat flow determinations. Government and university groups will cooperate in crustal studies using large explosions, and the study of earthquake mechanisms now in progress at the Dominion Observatory will be intensified.

Gravity measurements and drilling to 10,000 feet in olivine-rich rock bodies; chemical analysis of Precambrian rocks; geomagnetic and earth current studies seeking areas of anomalous conductivity in the mantle; and isotopic measurements on rocks and ores that will throw light on their source will all be included in the Canadian program.—D.B.V.

190-361. Canadian Mining Journal. Upper mantle project: Canadian Mining Jour., v. 83, no. 5, p. 50-53, 1962.

The Canadian program for the Upper Mantle Project, an international scientific study of the earth's interior that began in January 1962 and will continue through December 1964, is outlined briefly. The Geological Survey of Canada will carry out (1) detailed petrological, chemical, mineralogical, and isotopic studies of igneous intrusions composed of mantle material as windows to observe chemical and physical conditions at depth; (2) deep drilling of two 10,000 feet holes—in the Muskox intrusion, Coppermine area, Northwest Territories, and in Mount Albert, Gaspé, Quebec, in the thin part of the crust near the continental margin; (3) a speed up in the compilation of the tectonic map of Canada; and (4) paleomagnetic studies of the mantle and crustal structure with focus on the diabase dike system which spreads across most of the Canadian Shield. The Dominion Observatory will use geophysical studies—seismology, gravity, earth currents, and heat flow—for depths in the earth beyond the reach of drilling. This program includes the establishment of a seismic network of some 30 stations at 500-mile intervals throughout the country.—V.S.N.

190-362. Ringwood, A. E. A model for the upper mantle: Jour. Geophys. Research, v. 67, no. 2, p. 857-867, 1962.

If the upper mantle is homogeneous, the temperature gradients required to account for the occurrence of the low-velocity zone would lead to extensive melting, a consequence that is unacceptable. Nonhomogeneous models must therefore be considered. The model presented here consists dominantly of dunite and peridotite immediately below the surface of the mantle; this passes downward into more primitive material, chemically equivalent to a mixture of 1 part basalt to 4 parts dunite, called here "pyrolite." This pyrolite might occur in either of two principal mineral facies, an olivine-pyroxene-plagioclase assemblage or an olivine-pyroxene-garnet assemblage. There would also be a substantial transition zone between these facies, in which all four minerals coexisted. It is suggested that the low-velocity zone is caused by downward transition from the sub-Mohorovičić peridotite into plagioclase pyrolite (which has a relatively low seismic velocity) and then into garnet pyrolite. The low-velocity zone is thus due to the presence of plagioclase as a primary phase.

The depths of these various zones probably differ between oceanic, continental margin, and Precambrian shield regions. The model implies that a low-velocity zone may not be present beneath Precambrian shields. In regions of recent diastrophism the characteristic geotherm may pass for a considerable distance through the transition zone between the plagioclase and garnet pyrolite facies; this can give rise to acute thermal and mechanical instability, which in turn may cause diastrophism in the crust. The possibilities for instability are far greater with this model than with the hypothesis of MacDonald and Ness (see Geophys. Abs. 182-358). Evolutionary relationships between oceanic, active orogenic, and Precambrian shield regions are also discussed in terms of the model.—D.B.V.

190-363. Takeuchi, H[itoshi] Saito, M[asanori], and Kobayashi, N[aota]. Study of shear velocity distribution in the upper mantle by mantle Rayleigh and Love waves: Jour. Geophys. Research, v. 67, no. 7, p. 2831-2839, 1962.

A method is proposed for calculating group velocity in surface wave problems without using numerical differentiation. This method is then applied to

study of shear velocity distribution in the upper mantle by mantle Rayleigh and Love waves. The results show that the Dorman 8099 model of upper mantle structure in oceanic regions (see Geophys. Abs. 181-130) and the Lehmann model for continental regions (see Geophys. Abs. 186-443) best fit observations. The Lehmann model is adopted for continental structure as a compromise between explosion seismology and studies of mantle Rayleigh and Love waves.—D.B.V.

- 190-364. Vening Meinesz, F. A. Continental and ocean-floor topography; mantle convection currents. Revised paper: Koninkl. Nederland. Akad. Wetensch. Proc., ser. B, v. 64, no. 4, p. 512-527, 1961.

The spherical harmonic analysis to the 31st order of the earth's topography is discussed more fully (see Geophys. Abs. 187-377). There cannot be much doubt that convection currents are operating in the mantle at present. Reasons are given why the vertical velocity components of these currents are no longer distributed mainly according to the 3rd and 4th order spherical harmonics, but why the 5th and 6th order terms play the largest part.

In the earth's history the mantle currents, probably as a result of cooling and crystallization of the mantle, have changed from a viscous or pseudo-viscous flow to flow in crystalline matter, the vertical component of which has a sectorial harmonic distribution; the drag effect on the crust has therefore also changed its character. The crystalline state of the mantle may also lead to an elastic limit below which only elastic deformation is possible. This elastic limit is shown to explain the episodic character of mantle currents and the orogeny caused by them in the crust.

The mid-ocean ridges are present as high ridges as long as mantle currents are flowing. Their distribution appears to be dominated by the 7th and 14th order terms; possibly this is caused by the sialic core of these ridges, which, because of a larger content of radioactive matter, brings about a higher temperature in the underlying mantle and favors the localization of rising mantle currents, thus causing the ridge to become higher.—D.B.V.

- 190-365. Magnitskiy, V. A. Verkhnyaya mantiya i yeye vliyaniye na razvitiye zemnoy kory [The upper mantle and its effect on the development of the crust of the earth]: Akad. Nauk SSSR Vestnik, no. 11, p. 18-24, 1961.

The character and processes of formation of the crust as influenced by the constitution and tectonism of the upper mantle (B and C layers by Bullen) are discussed. The "basalt deluge" and the basalt differentiation hypotheses are described to account for the compositional and structural differences between the oceanic and continental types of the crust. The cause of the quasi-periodic vertical crustal displacements of millions and hundreds of millions of years to tens of years and even shorter periods remains undetermined. The unsolved problem of the mineralogical composition of the upper mantle is discussed, and its solution by experiments at high temperatures and pressures is suggested.—A.J.S.

- 190-366. Ringwood, A. E., and Seabrook, Merrin. Olivine-spinel equilibria at high pressure in the system $\text{Ni}_2\text{GeO}_4\text{-Mg}_2\text{SiO}_4$: Jour. Geophys. Research, v. 67, no. 5, p. 1975-1985, 1962.

Investigation of olivine-spinel solid solution equilibria in the system $\text{Ni}_2\text{GeO}_4\text{-Mg}_2\text{SiO}_4$ shows that the solubility of Mg_2SiO_4 in Ni_2GeO_4 (spinel) increases from 27 to 70 mole percent in the pressure range 0-90 kilobars at 600°C, and that the corresponding solubility of Ni_2GeO_4 in Mg_2SiO_4 (olivine) decreases from 12 to less than 5 mole percent over the same pressure interval. On the basis of extrapolation of the phase boundaries and consideration of possible errors it is concluded that an olivine-spinel transition will occur in Mg_2SiO_4 at 130 ± 20 kilobars at 600°C.

A detailed study of the effects of pressure and composition on the lattice parameters of spinel solid solutions was made using a uniaxial pressure apparatus and 15 different starting compositions. The results show that variation is complex, and positive deviations from Vegard's rule are large. The extent of these deviations decreases at very high pressures. The irregularities are due apparently to an order-disorder equilibrium involving the distribution of Mg and Ge ions between normal and inverse sites in the spinel lattice. The minimum density change accompanying the olivine-spinel transition in Mg_2SiO_4 is determined by extrapolation to be 9 percent.— D.B.V.

- 190-367. Newton, R. C., Jayaraman, A., and Kennedy, George C. The fusion curves of the alkali metals up to 50 kilobars: *Jour. Geophys. Research*, v. 67, no. 6, p. 2559-2566, 1962.

The fusion curves of Li, Na, K, Rb, and Cs have been determined to pressures of 50 kb. The normal melting points, steepness of initial slopes, and curvatures combine in complicated ways to give many intersections of these fusion curves. A double maximum in the curve of Cs was found, with Cs III, or "collapsed" Cs, having a positive melting slope. No maximum was found in the curve of Rb to 50 kb, although the flatness of this curve at 50 kb suggests an imminent maximum. The eutectic melting point in the system Na-K was traced to 30 kb, where it became indiscernible. The pressure effect on this melting point is much lower than that on either Na or K. This may be a general effect for eutectic mixtures and may have some geophysical significance.— Authors' abstract

- Bradley, R. S., Jamil, A. K., and Minro, D. C. Electrical conductivity of fayalite and spinel. See *Geophys. Abs.* 190-237.

Sato, Yasuo, and Matumoto, Tosimatu. Vibration of an elastic globe with a homogeneous mantle over a homogeneous core. Vibrations of the first class. See *Geophys. Abs.* 190-163.

ISOTOPE GEOLOGY

- 190-368. Eckelmann, Walter R., Broecker, Wallace S., Whitlock, David W., and Allsup, Jerry R. Implications of carbon isotopic composition of total organic carbon of some recent sediments and ancient oils: *Am. Assoc. Petroleum Geologists Bull.*, v. 46, no. 5, p. 699-704, 1962.

Data on the carbon isotopic composition of organic carbon were obtained from C-13/C-12 analyses of marine sediments from the southeastern Pacific, South Atlantic, equatorial Atlantic, Caribbean Sea, and the Mediterranean Sea. The C-13/C-12 analyses for organic materials from fresh-water sediments show that the total organic matter is isotopically several per mil lower than the material from oceanic sediments. Data on C-13/C-12 ratios of oils and associated shales show that the crude oils and shales have essentially the same isotopic composition, and that the deposition of the marine sediments occurred in areas receiving sizeable influxes of terrestrial runoff.— P.C.I.

- 190-369. Landergrén, Sture. The content of ^{13}C in the graphite-bearing magnetite ores and associated carbonate rocks in the Norberg mining district, central Sweden: *Geol. Fören. Stockholm Förh.*, v. 83, no. 2, p. 151-156, 1961.

The average isotopic composition of carbon in marbles of the Norberg mining district is -3.5 per mil on the Chicago scale with a standard deviation of 1.5 per mil. The average is somewhat lighter than that of average marine limestone (-0.2, Craig, see *Geophys. Abs.* 153-14548). The average isotopic composition of graphite in the Norberg region is -9.6 per mil with a range of

-7.4 to -11.2 per mil. The values are similar to those of Craig. The author suggests tentatively that the graphite is formed by means of inorganic reactions associated with the formation of magnetite in a carbonate assemblage.—B.R.D.

- 190-370. Brown, F., Goldsmith, P., Green, H. F., Holt, A., and Parham, A. G. Measurements of the water vapour, tritium and carbon-14 content of the middle stratosphere over southern England: *Tellus*, v. 13, no. 3, p. 407-416, 1961.

Measurements of the water vapor, tritium and C-14 content of the stratosphere at heights of between 80,000 and 100,000 feet made over England during the years 1956-60 are described. The bulk of the tritium and C-14 present at these heights was injected there during thermonuclear explosions. The deuterium/hydrogen ratio of the water and the C-13/C-12 and O-16/O-18 ratios of the carbon dioxide collected at these heights were the same as those for samples near the ground. The humidity above 80,000 feet is greater than that in the lower stratosphere. It is concluded from the humidity and tritium results that large scale meridional circulation in the stratosphere does not reach heights of 90,000 feet over temperate latitudes.—E.J.C.

- 190-371. Hulston, J. R. Isotope geology in the hydrothermal areas of New Zealand: United Nations Conference on New Sources of Energy, Rome, 11 p., 1961.

A promising use of the stable C-13 isotope has been in estimation of underground temperatures from the isotopic equilibrium between the carbon atoms of carbon dioxide and of methane. Temperatures calculated by this method are in good agreement with the bottom-hole temperatures (~250°C) at Wairakei and with the vent temperature (450°C) of a fumarole measured on White Island. Measurements of S-32/S-34 isotopic ratios were made for steam and water phases of borehole discharges. Natural deuterium measurements have been made as the first step in obtaining H/D vs. O-16/O-18 graphs. The variation of H/D has been found to be rather small (~5 percent).—R.M.G.

- 190-372. Fireman, E. L., and Rowland, F. S. An additional measurement of the tritium content of atmospheric hydrogen of 1949: *Jour. Geophys. Research*, v. 66, no. 12, p. 4321, 1961.

A sample of atmospheric hydrogen collected on August 4, 1949 shows a T/H ratio of $(5.7 \pm 1.0) \times 10^{-15}$.—C.E.H.

- 190-373. Wolfgang, Richard. Origin of high tritium content of atmospheric methane, hydrogen and stratospheric water: *Nature*, v. 192, no. 4809, p. 1279-1280, 1961.

Tritiated methane is postulated to originate in the fireball from the explosion of thermonuclear weapons. These weapons are thought to be constructed of reducing substances. The hot gas formed from bomb material will form a reducing core within the fireball. The rising gas will not all be oxidized. The partial oxidation of this tritiated methane and hydrogen will give tritiated water. The atmospheric hydrogen produced by this mechanism should also be highly enriched in deuterium.—I.F.

- 190-374. 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.

Instrumental techniques for measuring lead isotope ratios by the lead tetramethyl method are discussed. Results obtained agree satisfactorily with those of other laboratories. Common-lead ages of galenas from the Captain's

Flat and Wee Jasper deposits in southeast Australia are in fair agreement with radioactivity ages of minerals from nearby granitic rocks. The sulfide mineralization, therefore, could be due to igneous activity about 300 m.y. ago. Common-lead ages of a galena from Yerranderee, N.S.W., are younger than the age of nearby igneous rocks. This galena is from a vein deposit that probably formed in a more complex manner than did the Captain's Flat deposit.—B.R.D.

- 190-375. Tugarinov, A. I., Gavrilova, L. K., and Golubchira, M. N. Evolytsiya izotopnogo sostava svintsa gornyx porod Pridneprov'ya [Evolution in the isotopic composition of lead of rocks in Dnieper region]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 79-87, 1958(1960).

The genetic relationship between lead ores and intrusive rocks is established by correlating the isotopic composition of the lead with that of the intrusion at the time of ore formation. The isotopic ratios of lead in the mica schists at the time of their metamorphism 1,900 m.y. ago were calculated to be 16.5, 5.04, and 34.93 for Pb-206/Pb-204, Pb-207/Pb-204, and Pb-208/Pb-204, respectively. The age of the earth calculated from the schists by their Pb-207/Pb-204 ratio is 7.8 b.y., which is more than $1\frac{1}{2}$ times greater than the most probable age of the earth.—A.J.S.

Marshall, Royal R. Mass spectrometric study of the lead in carbonaceous chondrites. See Geophys. Abs. 190-79.

Murthy, V. Rama. Isotopic anomalies of molybdenum in some iron meteorites. See Geophys. Abs. 190-77.

- 190-376. Taylor, Hugh P., Jr., and Epstein, Samuel. Relationship between O^{18}/O^{16} ratios in coexisting minerals of igneous and metamorphic rocks: Pt. 1: Principles and experimental results: Geol. Soc. America Bull., v. 73, no. 4, p. 461-480, 1962.

The O-18/O-16 ratios of most of the common rock-forming minerals have been measured with a precision of 0.2 per mil by a fluorine-extraction technique. A correlation was found between the O-18/O-16 ratio of an igneous rock and its chemical composition. The more mafic the rock, the lower is its O-18/O-16 ratio. The δ -values of common sedimentary rocks are larger than in igneous rocks by as much as 20 per mil. Quartz invariably has the highest O-18/O-16 ratio of any of the minerals in a given igneous rock. Data are given for rock types of the Southern California batholith, including gabbro, tonalite, granodiorite, and quartz monzonite. O-18/O-16 ratios for minerals from rocks from a number of localities are also given.—S.S.G.

- 190-377. Taylor, Hugh P., Jr., and Epstein, Samuel. Relationship between O^{18}/O^{16} ratios in coexisting minerals of igneous and metamorphic rocks: Pt. 2: Application to petrologic problems: Geol. Soc. America Bull., v. 73, no. 6, p. 675-694, 1962.

The observed variations in the O-18/O-16 fractionations among the minerals of igneous rocks are explained on the basis of equilibrium crystallization of magmas with incomplete reaction. The O-18/O-16 fractionations among coexisting minerals in metamorphic rocks in general are larger than in igneous rocks. This is explained on the basis of the lower temperature of origin of the metamorphic rocks. The higher the grade the greater the tendency for a metamorphic rock to approach the igneous rocks in range of oxygen isotopic composition. Data are given for a variety of rock types from California and from other areas.—S.S.G.

- 190-378. Degens, Egon T., and Epstein, Samuel. Relationship between O^{18}/O^{16} ratios in coexisting carbonates, cherts, and diatomites: Am. Assoc. Petroleum Geologists Bull., v. 46, no. 4, p. 534-542, 1962.

Oxygen isotope analyses were obtained for cherts and diatomites and co-existing limestones from formations ranging in ages from Cambrian to Pleistocene. The δ -values for limestones change with age as expected if they re-equilibrated with post-depositional surface or subsurface waters. The O-18/O-16 ratio is highest for the youngest samples and decreases with age, approaching the O-18/O-16 ratios of fresh-water carbonates. The O-18/O-16 ratios of the cherts behave in a similar manner.

Studies of three diatomites indicate that the O-18/O-16 ratios of diatomites when dehydrated in vacuum are similar to those of well preserved cherts of equivalent environments, indicating that the oxygen of amorphous material does not undergo major isotopic fractionation during the reorganization of silica.

The C-13/C-12 ratios of limestones show no obvious time trend as do the oxygen isotopes. This may be due to the greater difficulty in exchanging the carbon in the carbonate ion with foreign carbon, or to the low availability of isotopically different carbon during the consolidation and diagenesis of limestone. — J.L.H.

190-379. Krouse, H. R., and Thode, H. G. Thermodynamic properties and geochemistry of isotopic compounds of selenium: Canadian Jour. Chemistry, v. 40, no. 2, p. 367-375, 1962.

Using "normal vibration equations" and statistical mechanics, the isotopic vibrational frequencies and the partition function ratios for various Se-76- and Se-82-containing compounds have been calculated. The equilibrium constants for selenium isotope exchange reactions derived from these partition function ratios indicate that noticeable fractionation of selenium isotopes can be expected in the laboratory and in naturally occurring processes. The Se-82/Se-76 ratios for 16 natural samples have been compared mass spectrometrically. Variations of up to 1.5 percent found in these ratios are discussed. A kinetic isotope effect of 1.5 percent found in chemical reduction of ionic selenite to elemental selenium is also discussed. — J.S.S.

190-380. Dobronravova, A. N., Levskiy, L. K., Murin, A. N., and Titov, N. Ye. Izucheniye vykhodov izotopov Xe i Kr, obrazuyushchikhsya pri oblucheni urana protonami s energiy 680 Mev [Study of the yields of Xe and Kr isotopes formed by irradiation of uranium by protons having an energy of 680 Mev]: Geokhimiya, no. 6, p. 540-542, 1962.

The relative amounts of the isotopes of Xe and Kr produced by bombardment of U by high energy protons were measured mass spectrometrically. Results are tabulated. Another table compares the isotopic composition of atmospheric Xe and Kr with the isotopic compositions obtained by bombardment of U by thermal neutrons and by fast neutrons. — D.B.V.

MAGNETIC FIELD OF THE EARTH

190-381. Spreiter, John R., and Alksne, Alberta Y. On the effect of a ring current on the terminal shape of the geomagnetic field: Jour. Geophys. Research, v. 67, no. 6, p. 2193-2205, 1962.

The intersection between a neutral stream of ionized solar corpuscles and the combined magnetic fields of a three-dimensional dipole and an equatorial ring current is investigated. It is assumed that the stream is confined to the exterior and the magnetic field to the interior of a hollow, the boundary of which is defined by a thin current sheath. The shape of the hollow is sought by application to an approximate method of solution. Results are presented for the traces of the boundary in the equatorial plane and the meridian plane containing the dipole axis and the sun-earth line for the case in which the dipole axis is normal to the sun-earth line. It is found that the presence of the ring current has the effect of greatly increasing the size, as well as altering the form, of the region bounded by the current sheath. The calculated results are, moreover, in essential agreement with the observations when represen-

tative values are inserted for the properties of the ring current and the solar corpuscular stream.— Authors' abstract

- 190-382. Mlodnosky, R. F., and Helliwell, R. A. Graphic data on the earth's main magnetic field in space: *Jour. Geophys. Research*, v. 67, no. 6, p. 2207-2214, 1962.

The applicability of a dipole representation of the earth's main magnetic field at high altitudes is discussed. Useful characteristics of the centered dipole approximation are presented in simple graphical form. Data that can be obtained from the charts include location of field lines, arc length along a field line, electron gyrofrequency, inclination (or dip), magnetic field intensity, magnitude and direction of the gradient of the earth's field, and radius of curvature of the lines of force. The resulting accuracy is believed sufficient for many purposes.— Authors' abstract

- 190-383. Fougere, Paul. The terrestrial magnetic field, in *Space and planetary environments*: U.S. Air Force Cambridge Research Labs. [Center], Air Force surveys in geophysics, no. 139, p. 15-31, 1962.

The material in this chapter is intended as a supplement to Chapter 10 (Geomagnetism), section 1 (The main field of the earth) in the *Handbook of Geophysics* (see *Geophys. Abs.* 183-294). The theory of the earth's magnetic field and new material obtained from sounding rockets, earth satellites, and deep space probes are discussed. Data from sounding rockets and balloons are tabulated. A reference list of 30 items is included.— V.S.N.

- 190-384. Bonnet, G. Les possibilités nouvelles des magnétomètres a protons (1) [New possibilities in proton magnetometers (1) (with English and Russian abstracts)]: *Annales Géophysique*, v. 18, no. 1, p. 62-74, 1962.

The advantages of the proton magnetometer in exploration for new scales of microvariations of the terrestrial and circumterrestrial magnetic fields are discussed. New methods are suggested to improve the accuracy and the linear characteristics of field-into-frequency transformations. The problem of reading the transformations is studied, and a continuous process is proposed which optimizes the resolving power of the system and the compensation for noise effects. A reference list of 86 items is included.— V.S.N.

- 190-385. Kalinowska-Widomska, Ewa; Marianiuk, Janusz; and Gnoiński, Adam. Sygnalizator burz magnetycznych w Obserwatorium Geofizycznym w Świdrze [A signaling apparatus for magnetic storms at the Świder Geophysical Observatory (with English summary)]: *Przegląd Geofiz.*, v. 7, no. 3-4, p. 171-177, 1959.

An apparatus is described which records the course of geomagnetic field variations and signals the beginning of disturbances with storm character.— A.J.S.

- 190-386. U.S. Coast and Geodetic Survey. Magnetograms and hourly values, Fredericksburg, Virginia, 1959: U.S. Coast and Geodetic Survey, Magnetic Observatory, Fredericksburg, Virginia, MHV-Fr59, 153 p., 1962.

The records of the Fredericksburg Magnetic Observatory for 1959 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.

- 190-387. U.S. Coast and Geodetic Survey. Magnetograms and hourly values, Tucson, Arizona, 1958: U.S. Coast and Geod. Survey, Magnetic Observatory, Tucson, Arizona, MHV-Tu58, 144 p., 1961.

The records of the Tucson 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.

- 190-388. U.S. Coast and Geodetic Survey. Magnetograms and hourly values, Sitka, Alaska, 1959: U.S. Coast and Geodetic Survey, MHV-S159, 160 p., 1962.

The records of the Sitka Magnetic Observatory for 1959 are presented in the form of quarter-size reproductions of the magnetograms and tables of hourly mean values of each of the magnetic elements D, H, and Z.—V.S.N.

- 190-389. Cardús, J. O[riol]. Nota relativa a la actividad solar, geomagnética e ionosférica (enero-marzo 1960) [Note concerning solar, geomagnetic, and ionospheric activity (January-March 1960)]: Rev. Geofísica, v. 19, no. 76, p. 427-439, 1960.

Results of observations of geomagnetic, earth current, solar, and ionospheric activity made at the Ebro Observatory in Spain during January, February, and March 1960 are compiled in tables and discussed briefly.—D.B.V.

- 190-390. Cardús, J. O[riol]. Nota relativa a la actividad solar, geomagnética e ionosférica (octubre-diciembre 1960) [Note concerning solar, geomagnetic, and ionospheric activity (October-December, 1960)]: Rev. Geofísica, v. 20, no. 79, p. 271-283, 1961.

Results of observations of geomagnetic, earth current, solar, and ionospheric activity at the Ebro observatory in Spain during October, November, and December of 1960 are tabulated and discussed.—D.B.V.

- 190-391. Cardús, J. O[riol]. Nota relativa a la actividad solar, geomagnética e ionosférica (enero-marzo 1961) [Note concerning solar, geomagnetic, and ionospheric activity (January-March 1961)]: Rev. Geofísica, v. 20, no. 80, p. 353-365, 1961.

Results of observations of geomagnetic, earth current, solar, and ionospheric activity at the Ebro Observatory in Spain during January, February, and March of 1960 are compiled in tables and discussed.—D.B.V.

- 190-392. Miguel [y Gonzáles Miranda], Luis de. Observaciones geomagnéticas realizadas en Toledo durante el A.G.I.-C.G.I. [Geomagnetic observations made at Toledo during the I.G.Y.-I.G.C. (with English summary)]: Rev. Geofísica, v. 20, no. 80, p. 305-316, 1961.

Geomagnetic and earth current observations made at Toledo, Spain, during 1957-58 (International Geophysical Year) and 1959 (International Geophysical Cooperation) are described and compared with solar activity, which was at a maximum in that period. The solar influence is apparent both in the rapid and slow variations.—D.B.V.

- 190-393. Siráň, Gustáv. On the determination of secular changes in the geomagnetic field [with Russian summary]: Československá Akad. Věd Studia Geophys. et Geod., v. 6, no. 1, p. 95-96, 1962.

Secular changes in the geomagnetic field, judged from the point of view of its elements, do not give a true picture of the changes in the magnetic properties of the earth as a whole. The changes are shown more clearly either by a change in the magnetic moment of the earth, the mean value of the energy density of the geomagnetic field, or by a change in the parameters of the corresponding spherical functions into which the magnetic potential of the earth is introduced. The dipole component is relatively stable with time, but the quad-

rupole component is subject to large changes that seem to prove the existence of a prevailing world periodical component of secular variations in the geomagnetic field.

This paper gives the parameters $\lambda_1, \theta_1, \lambda_2, \theta_2$, and $\delta_2(\Gamma)$ of the function $Y_2(\theta, \lambda)$ for 6 different epochs from 1829 to 1958. The tabulated results show clearly that there has been a westward and northward motion of the quadrupole axes, the western motion being dominant, and that the moment of the function $Y_2(\theta, \lambda)$ increased by 54 percent between 1829 and 1958. This moment has no physical interpretation but shows graphically the changes that occur in the magnetic properties of the earth as a whole.—D.B.V.

- 190-394. Rao, K. S. Raja. Lunar and solar geomagnetic tides in the geomagnetic equatorial region. II. Geomagnetic tidal variations at Alibag: Indian Jour. Meteorology and Geophysics, v. 13, no. 1, p. 106-109, 1962.

The lunar and solar geomagnetic tides at Alibag are determined by the fixed age method following the Chapman-Miller technique for the three seasons—December solstice, equinoxes, and summer solstice. The seasonal variation in the amplitudes and phases of L(H) are compared with similar results for Kodaikanal, Huancayo and Ibadan. Confirmation has been obtained for an earlier suggestion of the author (see Geophys. Abs: 190-407) that the southern hemispheric currents in the ionosphere which cause L variations extend up to 10° N. geomagnetic latitude in December season. The nature of the seasonal variations of L(H) at Alibag is the same as that at Ibadan, and different from what is obtaining at Kodaikanal and Huancayo.— Author's abstract

- 190-395. Priestler, W., and Cattani, D. On the semiannual variation of geomagnetic activity and its relation to the solar corpuscular radiation: Jour. Atmos. Sci., v. 19, no. 2, p. 121-126, 1962.

A reexamination of the data for geomagnetic activity calculated by Bartels (1932, 1940) shows that a strong modulation of the amplitude of the semiannual variation during the eleven year period of the solar cycle exists that is apparently related to the heliographic latitudes of the sunspot-zones and provides indirect support for the axial hypothesis for the semiannual variation of geomagnetic activity. Axial-symmetric models are derived that give the statistical distribution of the solar particle flux for three different 3-year periods during the solar cycle according to mean sunspot-latitudes of 20°, 15°, and 10°. These models explain the observed semiannual geomagnetic variations except for a phase-lag of 20 to 30 days. It is suggested that a semiannual density variation of charged solar particles trapped in the earth's magnetosphere can provide the required phase-lag mechanism. This implies a lifetime for these particles of the order of one month. The models also provide a quantitative explanation of the observed delay of geomagnetic activity behind solar activity during the 11-year cycle, and are in reasonable agreement with preliminary results on the statistical latitude distribution of comets with ionized tails.—V.S.N.

- 190-396. Moffatt, H. K. Intensification of the earth's magnetic field by turbulence in the ionosphere: Jour. Geophys. Research, v. 67, no. 8, p. 3071-3073, 1962.

If the magnetic diffusivity of a fluid in turbulent motion is greater than its kinematic viscosity, any magnetic field initially present must ultimately decay to zero. If a magnetic field is externally maintained, however, the turbulence will generate fluctuations that may be quite large if the magnetic Reynolds number is large compared with unity. The spectrum of these fluctuations increases up to a wave number k_c marking the threshold of conduction effects, and falls off rapidly beyond k_c . The net effect of the turbulence can be expressed in terms of an eddy conductivity equal to the molecular conductivity multiplied by the $(-5/2)$ th power of the magnetic Reynolds number.—D.B.V.

- 190-397. Pedersen, Arne. Time, height, and latitude distribution of D layers in the subauroral zone and their relation to geomagnetic activity and aurora: *Jour. Geophys. Research*, v. 67, no. 7, p. 2685-2694, 1962.

Echoes from the D-region have been obtained during disturbed periods with sweep-frequency ionosondes at stations in the northern part of Sweden. Typical D-layer situations are described, and the time and height distribution of D-layers is shown for one of the stations in the subauroral zone. Arguments are advanced in support of the hypothesis that these D-layers are caused by precipitation of energetic electrons from the outer Van Allen belt.—Author's abstract

- 190-398. Silverman, S. M., Ward, Fred, and Shapiro, Ralph. The correlation between the 5577 Å night airglow intensity and geomagnetic activity: *Jour. Geophys. Research*, v. 67, no. 6, p. 2255-2264, 1962.

The correlation of the 5577 Å [O I] airglow intensity at Sacramento Peak, N. Mex. with magnetic activity for the period 1953-60 was studied. The results show an inverse relationship between airglow intensity and the geomagnetic index K_p for values of the index between 0 and 7 and a direct relationship for index values of 8 and 9. Statistical tests show the inverse relationship to be marginally significant at the 5 percent confidence level. The direct relationship for K_p values of 8 or 9 depends on a total of 10 data points; although much emphasis on this result is premature, it is not inconsistent with previous results.—D.B.V.

- 190-399. Gintzburg, M. A. Ob odnom novom mekhanizme voznikoveniya mikropul'satsiy zemnogo magnitnogo polya [On a new mechanism of producing micropulsations of the earth's magnetic field]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 11, p. 1679-1687, 1961.

It is shown that solar corpuscular streams emit magnetohydrodynamic waves of frequencies of 10^{-1} - 10^{-3} cycles per second, and that these waves contribute to the short-period variations of the magnetic field of the earth.—Author's abstract, A.J.S.

- 190-400. Watanabe, Tomiya. On the origins of geomagnetic pulsations: *Tohoku Univ. Sci. Repts., Geophysics*, ser. 5, v. 13, no. 3, p. 127-140, 1961.

Mathematical calculation and interpretation of important features of geomagnetic pulsations are presented based on the assumption that geomagnetic pulsations are caused by hydromagnetic oscillations of the terrestrial exosphere. Oscillations symmetric with respect to the geomagnetic axis are classified as poloidal and torsional. Poloidal oscillations in regions lower than an altitude of several thousand kilometers roughly represent pc- and spc-type pulsations; torsional oscillations represent pg's. In nonaxisymmetric oscillations, radial oscillations may be induced from torsional oscillations. This explains the close association between pg's and pt's.—V.S.N.

- 190-401. Kato, Yoshio. Geomagnetic micropulsations: *Tohoku Univ. Sci. Repts., Geophysics*, ser. 5, v. 13, no. 3, p. 141-163, 1961.

Observational knowledge of geomagnetic pulsations is summarized. The continuous pulsation, observed in the daytime, increases in amplitude with latitude reaching a maximum in the auroral zone. The pulsation train (pt), observed at nighttime, also attains a maximum in the auroral zone. The pt pulsation is emitted from the midnight point in the auroral zone, and there is a close relation between the "hiss" noise burst and the occurrence of the pulsation. The primary source of the continuous pulsation is attributed to intense hydromagnetic disturbances in the outermost exosphere as reported by Sonett and others (see *Geophys. Abs.* 186-480).—V.S.N.

- 190-402. Fukushima, Naoshi. Some remarks on the morphology of geomagnetic bays: *Jour. Geomagnetism and Geoelectricity* [Kyoto], v. 10, no. 4, p. 164-171, 1959; reprinted in *Tokyo Univ. Geophys. Inst. Geophys. Notes*, v. 12, no. 2, contr. 22, 1959.

The unequal occurrence frequency of positive and negative geomagnetic bays at various places in the world is attributed to the fact that most geomagnetic bays are polar elementary storms - usually negative ones - the typical or idealized disturbance field of which is represented by an overhead current system composed of an intense westward current of narrow longitudinal width along the auroral zone and a counter current flow over the remaining part of the world. The systematic rotation sense of the disturbing force vectors of bays observed everywhere in middle latitudes, clockwise in the forenoon and counter-clockwise in the afternoon, is a result of the systematic progressive change in this overhead current-system during the course of bays. Pt-type pulsations that accompany geomagnetic bays and the question of whether an equatorial ring current is present at the time of geomagnetic bays are also discussed.— V.S.N.

- 190-403. Davis, T. N[eil], and Kimball, D. S. The auroral display of February 13-14, 1958: *Alaska Univ. Geophys. Inst., Sci. Rept.*, no. 2, 24 p., 1962.

Detailed synoptic maps of the auroral display of February 13-14, 1958 are presented. These maps depict both the auroral configurations and the magnitude and direction of the magnetic disturbance at intervals of five minutes as determined from several observing stations in Alaska.— V.S.N.

- 190-404. Duclaux, Françoise. La variation diurne du champ magnétique terrestre à Tamanrasset de 1948 à 1955 (composante horizontale) [The diurnal variation in the terrestrial magnetic field at Tamanrasset from 1948 to 1955 (horizontal component)] (with English summary): *Annales Géophysique*, v. 18, no. 1, p. 110-115, 1962.

The diurnal variation of the horizontal component of the magnetic field at Tamanrasset between 1948 and 1955 has been studied in two ways. First, the Egedal method is utilized to indicate the semidiurnal lunar variation for three seasons of the year and for the whole year. This variation is never more than about 1 γ with maximum in the winter and minimum in the summer. The influence of changes in magnetic activity and in the lunar-earth distance, both of which could alter the amplitude of the variations, is discussed. The second method consists of determining the total solar and lunar variation based on a classification of sequences according to the age of the moon. The amplitude of this total variation is larger at the equinoxes than in summer and winter; it varies between 30 and 50 γ . An analysis of the constituent parts of the variation makes it possible to obtain the lunar and solar variations in a lunar day. The semi-diurnal lunar variation agrees with that found by the Egedal method, and the diurnal variation is of the same order. The amplitudes of the semi-diurnal and diurnal solar variations are 10 times those of the lunar.— V.S.N.

- 190-405. Özdoğan, İhsan. Baies géomagnétiques en Turquie. Première Partie: Etude Statistique [Geomagnetic bays in Turkey. Part I: Statistical study (with Turkish abstract)]: *Istanbul Üniv. Fen Fakültesi Mecmuası*, ser. C, v. 26, no. 3-4, p. 139-143, 1961.

A statistical study of bays, registered at Kandilli Observatory in Istanbul from 1957 to 1960, was made in order to compare results with theoretical results obtained from a model of dynamo action on an ionosphere having a spherical form. The agreement between statistical and theoretical results for the intensity of the vector of perturbation is quite satisfactory, but that for the speed of rotation of the same vector is poor.— V.S.N.

- 190-406. Rikitake, T[suneji]. Geomagnetic bays in Turkey. Part II: A theory on current systems of geomagnetic bays [with Turkish abstract]: Istanbul Üniv. Fen Fakültesi Mecmuası, ser. C, v. 26, no. 3-4, p. 144-152, 1961.

It has been shown previously by Nagata and Fukushima (see *Geophys. Abs.* 157-31) that the current system for a geomagnetic bay is equivalent to that produced by an electric dipole placed at a point along the auroral zone. The electric current system is calculated by assuming an elliptical patch of high ionization in a plane ionosphere. In this paper it is shown that a more exact account can be given of the electric current system by assuming an elliptical patch of high ionization on a spherical ionosphere. The theoretical current systems and magnetic fields for a spherical ionosphere are compared with those obtained from observations at Kandilli.— V.S.N.

- 190-407. Rao, K. S. Raja. Lunar geomagnetic tides in the low latitudes region: *Indian Jour. Meteorology and Geophysics*, v. 13, no. 1, p. 97-105, 1962.

Lunar geomagnetic tides at a few representative stations in low latitude regions have been synthesized to get a unified picture of the L-field in the equatorial region. The general features in the low latitudes—such as the equatorial anomaly, seasonal variations, geomagnetic control, and latitudinal variation—have been studied. The characteristics of low latitude variations are compared with those of high latitude variations. The large amplitudes of lunar geomagnetic tides at Huancayo, Ibadan, and Kodaikanal indicate that there must be an equatorial electrojet for the L-field also. The L-field shows clear seasonal variations, larger amplitudes of $L_2(H)$ occurring at the December solstice and smaller ones in June up to about $10^\circ N$. geomagnetic latitude. Plots of the annual mean amplitudes for the main lunar components against geographic, geomagnetic, and magnetic latitudes indicate geomagnetic control of the L-field. Dependence on magnetic latitudes appears to be clearer than the dependence on the geomagnetic latitudes. There is no dependence on geographic latitude, and thus it is necessary to modify the dynamo equations in order to allow for the variation in magnetic latitude of the amplitudes of the semidiurnal lunar geomagnetic tides.— V.S.N.

- 190-408. MacDowall, J. Geomagnetic activity at Halley Bay on disturbed days: *Nature*, v. 184, no. 4698, p. 1543-1545, 1959.

This is a preliminary report on diurnal variation of geomagnetic activity at Halley Bay, Antarctica, based on Q-indices during the five most disturbed days in each month. The results given here are included in the comprehensive report on the Royal Society's International Geophysical Year Expedition (see *Geophys. Abs.* 187-408).— D.B.V.

- 190-409. Vestine, E. H., and Kern, J[ohn] W. Cause of the preliminary reverse impulse of storms: *Jour. Geophys. Research*, v. 67, no. 6, p. 2181-2188, 1962.

The possibility that the preliminary reverse impulse of magnetic storms may be interpreted as an initial hydromagnetic effect is discussed. Two equivalent ionospheric-current systems are examined, that given by Nagata and Abe (1955) and that given by Jacobs and Obayashi (1956). Electric-charge distributions that would drive these current systems are derived from potential analyses. Finally, the interaction between an approaching solar stream and the magnetosphere is discussed. It is supposed in these calculations that only the Hall electric conductivity need be taken into account, and that compression of the magnetosphere by the solar stream is nearly adiabatic. It is shown that a simple extension of the Chapman-Ferraro theory can provide the observed polar-charge distributions.— D.B.V.

- 190-410. Pisharoty, P. R., and Srivastava, B. J. Rise times versus magnitudes of sudden commencements of geomagnetic storms: *Jour. Geophys. Research*, v. 67, no. 6, p. 2189-2192, 1962.

The relationship of rise times to magnitudes of the positive sudden commencements of 41 randomly selected geomagnetic storms recorded at Alibag, India, for 1949-60 has been investigated. The results show that rise times are 1 to 6 min and have an inverse relationship to magnitude. The Chapman-Ferraro theory of SC's predicts rise times of less than about 2 min with an inverse relationship between rise time and amplitude. Numerical computations by Dessler and others from a hydrodynamic model also showed this inverse relationship and rise times of the order of 1 to 6 min; this fits the Alibag data better. — D.B.V.

- 190-411. Kanellakos, D. P., and Villard, O. G., Jr. Ionospheric disturbances associated with the solar flare of September 28, 1961: *Jour. Geophys. Research*, v. 67, no. 6, p. 2265-2277, 1962.

The ionospheric changes brought about by the solar flare of September 28, 1961, and the geomagnetic sudden commencement that followed it on September 30 are discussed. It is concluded that the changes were brought about by ionizing agents that increased the electron density of the ionosphere at a rate of about 3×10^8 electrons per m^3 -sec at a height between 140 and 180 km. — D.B.V.

- 190-412. Haurwitz, M. W. Dependence of interval between flare and associated sudden commencement storm on prestorm conditions: *Jour. Geophys. Research*, v. 67, no. 7, p. 2979-2982, 1962.

Statistical study of the relation between solar flares and sudden commencements shows that short values of delay time, flare to magnetic storm, are related to a high level of magnetic activity during the three-day period preceding the storm. The linear association is significant at the 1 percent level. Possible physical mechanisms that can explain this statistically significant result are mentioned briefly. — D.B.V.

- 190-413. Hughes, M. P. Solar radio emissions and geophysical disturbances during July 1959: *Jour. Geophys. Research*, v. 66, no. 2, p. 651-653, 1961.

Spectral observations of solar radio bursts taken at Fort Davis, Tex., and Sydney, Australia, during July 1959 are summarized and correlated with the geophysical disturbances of that time. A diagram shows the time relationship between the solar flares, solar bursts of types II and IV, polar-cap absorption events, planetary magnetic indices, and the neutron monitor count at Climax, Colo. Solar-terrestrial conditions at this time were complex, and it is not possible to be sure with which flare and radio burst the various terrestrial events were associated. — D.B.V.

- 190-414. Sobouti, Y. The relationship between unique geomagnetic and auroral events: *Jour. Geophys. Research*, v. 66, no. 3, p. 725-737, 1961.

From magnetic data obtained at eleven Canadian stations, the ionospheric current patterns in the auroral zone during several magnetic storms have been sketched and the predominant current patterns determined for each phase of an "average" storm. It is found that the auroral displays tend to occur along current lines. A high correlation is found between the geomagnetic latitudes of the southern extents of auroral displays and the most southerly current lines. When these two sets of data are plotted against a "storm-phase," a southward shift of the aurora is seen to accompany the southward motion of ionospheric currents. — Author's abstract

- 190-415. Smith, Edward J., and Sonett, Charles P. Satellite observations of the distant field during magnetic storms: Explorer VI, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-1, p. 17-20, 1962.

A search-coil magnetometer mounted on the earth satellite Explorer VI measured the amplitude B and direction ϕ of a vector component of the extra-terrestrial magnetic field out to 8 earth radii (R_E). Results are illustrated in diagrams, and each diagram is discussed. Comparison of the time variation of the field amplitude in the outer radiation zone and at the earth's surface indicates that there is a main phase decrease and recovery of the field at $4R_E$ coincident with the storm field at the surface; the magnitude of the decrease is about 2.5 times greater at $4R_E$ than at $1R_E$. This suggests that a ring current in the magnetosphere is responsible for the D_{St} field. By contrasting the departure of the observed field direction (ϕ) from the direction of the geomagnetic field (ϕ_G) on storm days and magnetically quiet days, it is found that the perturbation of the distant field during a storm is qualitatively similar to that which exists on nonstorm days, and that field fluctuations with periods of minutes are characteristic of magnetic storms. The time variation of the direction of the distant field at 40,000 km indicates that the direction of the field out to $7R_E$ is correlated with variations in the horizontal component of the surface field. The geomagnetic field dominates the disturbance field, and this influence places a limit on the magnitude of the disturbance field at $7R_E$ on the geomagnetic equatorial plane. If the disturbance field is still opposed to the geomagnetic, its magnitude must be less than that of the geomagnetic field ($\sim 100\gamma$). Thus the D_{St} field surrounding the earth has a magnitude of -100γ at $1R_E$, -360γ at $4R_E$, and less than -100γ at $7R_E$. The disturbance field is concave upward and shows a strong dependence on geocentric distance.—V.S.N.

- 190-416. Paghis, Irvine. Magnetic impulses and sun-earth relations, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-2, p. 21-24, 1962.

A total of 817 magnetic impulses that occurred between 1949 and 1959 are examined. The time interval between the impulses is not random, but shows marked periodicities even when considered over the entire sunspot cycle. It seems possible that the observed periodicities are directly related to the timing of solar disturbance events. The solar flare to SSC time analysis indicates that such solar disturbance events may occur within 1/4 day of flare time.—V.S.N.

- 190-417. Chernosky, Edwin J. Changes in the geomagnetic field associated with magnetic disturbance, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-3, p. 25-32, 1962.

A study is made of the longer term changes in H and Z and of occurrences of Quiet Days, Disturbed Days, Storm Sudden Commencements, Sudden Impulses, Small Changes, and others for several days before and during a magnetic disturbance. It is found that H rises, and Z generally falls for three or four days before the disturbance as if in anticipation of it. The rise in H is lowest at middle latitudes and greatest near the auroral zone. This behavior suggests that the predisturbance variations may be linked to the disturbance mechanism.—V.S.N.

- 190-418. Nagata, Takesi, Kokubun, Susumu, and Fukushima, Naoshi. Similarity and simultaneity of magnetic disturbance in the Northern and Southern Hemispheres, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-5, p. 35-39, 1962.

This is virtually the same paper as that published in *Rept. Ionosphere and Space Research Japan*, v. 14, no. 3, p. 273-290 and in *Antarctic Rec.*, no. 11, p. 204-290, 1961 (see *Geophys. Abs.* 186-495, 187-417).—V.S.N.

- 190-419. Nishida, A[tsuhiro], and Jacobs, J. A. World wide changes in the geomagnetic field, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-6, p. 39-44, 1962.

This is virtually the same as the paper published in *Jour. Geophys. Research*, v. 67, no. 2, p. 525-540, 1962 (see *Geophys. Abs.* 188-402).— V.S.N.

- 190-420. Maeda, H[iroshi], Sakurai, K., Ondoh, U., and Yamamoto, M. Solar-terrestrial relationships during the IGY and IGC, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-7, p. 45-49, 1962.

An examination of solar geophysical data during the period of the International Geophysical Year and International Geophysical Cooperation has led to the conclusion that almost all ssc geomagnetic storms during the period were associated with solar flares accompanied by great type IV continuous radio bursts and type II outbursts. The records show that total flux density of the associated radio outbursts correlates well with the magnetic storm intensity; also, the magnitude of ionospheric storms correlates well with the presence of the nonsymmetrical part of the earth storm DS. Radio emission near the central meridian and possibly in the northern hemisphere of the sun is found to be the most important; however, flares near the east limb seldom gave rise to a storm with strong Dst.— V.S.N.

- 190-421. Roosen, J., and de Feiter, L. D. Details of the relation between type IV-outbursts and sc-geomagnetic storms, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-8, p. 49-56, 1962.

A statistical examination of type IV-outbursts and ssc's at 200, 550, and 3,000 mc per sec that occurred in 1956-61 leads to the conclusion that a magnetic storm with sudden commencement is accompanied by outbursts over a wide range. At these frequencies, thresholds in average energy flux of relative numerical value 150, 10, and 5, respectively, are ordinarily necessary. Outbursts near the center of the solar disc are followed by stronger sc-storms than are outbursts far from the central meridian. Near the central meridian more universal great outbursts occur in the northern than in the southern hemisphere, and the geomagnetic storms in the northern hemisphere are stronger than in the southern hemisphere.— V.S.N.

- 190-422. Vestine, E. H. Morphology of magnetic storms, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan, Jour., v. 17, supp. A-1, paper I-1-P1, p. 61-69, 1962.

A number of the major descriptive features of magnetic storms are summarized briefly, some recent rocket and satellite magnetometer measurements are integrated in a systematic way into previous surveys of the morphology of disturbances (see *Geophys. Abs.* 130-9372, 185-432), and some electric current configurations and their driving forces are discussed. The morphology of magnetic storms can be simply represented in terms of ionosphere current systems changing in form and intensity with time. Using such models, the sudden commencement or initial phase of storms at ground level will be due to a worldwide west-east circulation of current, plus two opposed atmospheric polar current circulations flowing away from the sun near each geomagnetic pole. After some minutes to an hour or more, the current systems reverse in sign and the two opposed polar circulations extend equatorwards and develop electrojets at the auroral zone.— V.S.N.

- 190-423. Fukushima, Naoshi. Morphology of magnetic storms, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-1-P2, p. 70-76, 1962.

Some important features of the magnetic disturbance field on the earth are examined, particularly for the part of the field that has its origin in the electric current in the ionospheric region caused by the impinging of energetic particles from the outside into the auroral zone ionosphere. The following are discussed: the reversal in a short time of the direction of the electric current across the polar cap during a sudden commencement; the equatorial anomaly of the disturbance field in the early part of magnetic storms; the characteristics of the polar elementary storm as the fundamental element of the polar disturbance field; small local disturbances taking place often in high latitudes and their remarkable seasonal dependence of occurrence tendency; and the presence of persistent polar-cap disturbance of considerable magnitude caused by the persistent solar wind.— V.S.N.

- 190-424. Leonard, Robert S. Measurements of localized distortions in the earth's magnetic field near the auroral zone, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-2-12, p. 135-137, 1962.

Radar echoes from aurorally associated ionization are quite sensitive to the angle between the ray from the radar and the direction of the earth's magnetic field. This feature of the auroral echoes is utilized to measure changes in the orientation of the magnetic field. The ratio is found to fluctuate widely; this is interpreted as being caused by changes in the direction of the magnetic field. Field distortions of greater than 2 degrees are very localized, which suggests the presence of fairly restricted line currents in the E layer of the ionosphere. Instruments and methods used in this work are described.— V.S.N.

- 190-425. Nagata, Takesi. Polar magnetic storms, especially in the southern polar region, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-2-P4, p. 157-163, 1962.

This paper covers the same material as that in the paper by Nagata and Kokubun in the *Rept. Ionosphere and Space Research Japan*, v. 14, no. 3, p. 273-290, 1960 (see *Geophys. Abs.* 186-495).— V.S.N.

- 190-426. Akasofu, Syun-Ichi, and Chapman, Sydney. The ring current and a neutral line discharge theory of the Aurora Polaris, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-3-2, p. 169-172, 1962.

This is a shorter version of the paper published in *Jour. Geophys. Research*, v. 66, no. 5, p. 1321-1350, 1961 (see *Geophys. Abs.* 185-432).— V.S.N.

- 190-427. Dessler, A. J., Hanson, W. B., and Parker, E. N. A mechanism to establish the magnetic storm ring current, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-3-4, p. 178-182, 1962.

This is a brief version of the paper published in *Jour. Geophys. Research*, v. 66, no. 11, p. 3631-3637, 1961 (see *Geophys. Abs.* 187-439).— V.S.N.

- 190-428. Singer, S. F. Theory of magnetic storms, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-1, paper I-3-P1, p. 329-337, 1962.

The main features of the theory of the main phase of magnetic storms based on the idea of drift of trapped particles (see *Geophys. Abs.* 185-431) is reviewed.— V.S.N.

- 190-429. Cole, K. D. Hydromagnetic radiation of the sun and its effect at the earth, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-2, paper II-1A-2, p. 6-9, 1962.

Hydromagnetic radiation continually split out of the sun or generated in the inner corona is believed to be responsible for the bulk of geomagnetic disturbance. The earth environment acts as a hydromagnetic lens to radiation of period less than 10 sec and concentrates its energy at the central polar region (less than 80° lat). Waves of longer period create winds of variable speed and direction about the earth. The earth's outer atmosphere constitutes an inhomogeneity in the path of the large hydromagnetic waves, and the wave currents create a space charge distribution in the lower ionosphere. This can cause currents in the E regions that contribute to geomagnetic disturbance. (See also *Geophys. Abs.* 182-374, 189-410.)—V.S.N.

- 190-430. Hutton, V. Rosemary S. Equatorial micropulsations, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-2, paper II-1B-1, p. 20-23, 1962.

At Legon, Ghana (magnetic lat -3° S.), the peak to peak amplitude of normal magnetic pulsations is seldom more than 0.1γ . An earth current system provides a satisfactory and extremely sensitive method for the detection of small amplitude pulsations such as are observed at the equator. Regular pulsations, pc, are observed more or less continuously and often with excellent sinusoidal form. Pulsations with both shorter and longer periods may be regarded as relatively rare phenomena. The daily variation of occurrence of pc has three distinct maximums at 6, 12, and 19 hours, and, in addition to the fact that the greatest of these maximums is at 19 hours, it has been found that the amplitude of pc pulsations is greatest at this time of day. (See also *Geophys. Abs.* 182-384.)—V.S.N.

- 190-431. Ohl, A. I. Pulsations during sudden commencements of magnetic storms and long period pulsations in high latitudes, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-2, paper II-1B-3, p. 24-26, 1962.

Long-period giant pulsations (Pgl) with periods from ~ 100 to ~ 600 sec and pulsations during sudden commencements (Psc) with periods from 120 to 270 sec observed at U.S.S.R. polar observatories and at one middle latitude observatory are discussed. The periods for both of these pulsations increase with an increase in geomagnetic latitude; this dependence upon ϕ indicates that these pulsations are Alfvén hydromagnetic waves traveling to the earth along the geomagnetic lines of force from the day side of the boundary of the outer atmosphere where they are generated by solar corpuscular streams.—V.S.N.

- 190-432. Ness, N[orman] F., Skillman, T. L., Searce, C. S., and Heppner, J. P. Magnetic field fluctuations on the earth and in space, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.*: Phys. Soc. Japan Jour., v. 17, supp. A-2, paper II-1B-4, p. 27-33, 1962.

Extremely precise and accurate determinations of the magnetic field on earth and in space are possible with the rubidium-vapor magnetometer. Moreover, the data obtained are amenable to analysis by automatic digital computers; as a result, measurements of fluctuations of the terrestrial magnetic field make it possible to determine accurately the frequency spectrum characteristics of the fluctuations. Measurements of the field in space were made from Explorer X launched in 1961.

Power spectrum analyses of terrestrial data indicate distinct frequency bands in which the fluctuating magnetic field energy is concentrated. Data collected at the Fredericksburg Magnetic Observatory (Virginia) show a strong

spectral peak for fluctuations with a period of around 10 seconds. These peaks are both amplitude and frequency modulated on a daily basis. Additional spectral peaks have been observed and studied. Data from space measurements are less extensive. Time correlations were made with terrestrial data to study fluctuations, and the fluctuations of the field were then viewed with respect to the existence and propagation characteristics of hydromagnetic waves.— V.S.N.

- 190-433. Kato, Yoshio, and Saito, Takao. Morphological study of geomagnetic pulsations, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.: Phys. Soc. Japan Jour.*, v. 17, supp. A-2, paper II-1B-5, p. 34-38, 1962.

From magnetograms obtained during the International Geophysical Year at various observatories around the world, three types of pc-type pulsations (10-50, 50-150, and 150-900 sec periods, respectively) and pt-type pulsations are analyzed. Pc-types 1 and 2 show remarkable enhancement in the daytime, whereas type 3 has two vague maximums in the morning and evening. The higher the geomagnetic latitude, the larger the range of all three types of pc pulsations. The latitudinal dependence of pt-type pulsations is compared with that of bay disturbances. Observations on a worldwide basis show that the direction of pt-type oscillations is toward the midnight meridian in the northern or southern auroral zone.— V.S.N.

- 190-434. Kato, Y[oshio], and Tamao, T. Hydromagnetic waves in the earth's exosphere and geomagnetic pulsations, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.: Phys. Soc. Japan Jour.*, v. 17, supp. A-2, paper II-1B-6, p. 39-43, 1962.

It is suggested that daytime continuous pulsations may be attributed primarily to large amplitude hydromagnetic disturbances in the outermost exosphere as found by Sonett (1960). Since these disturbances may have a very wide band width of spectrum, the observed characteristics of daytime pulsations at the surface can be explained in terms of the filtering effect of the dispersive inner exosphere. The damped type pulsation, pt's, may be caused by the hydromagnetic compression of local hot gas in the outer exosphere near the equatorial plane in the dark hemisphere. This compression will occur as a result of the precipitation of trapped energetic electrons from this local region to the auroral zone.— V.S.N.

- 190-435. Bouška, Jan. The microstructure of ISc of geomagnetic storms, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.: Phys. Soc. Japan Jour.*, v. 17, supp. A-2, paper II-1B-8, p. 45-47, 1962.

The complicated and variable characteristics of the first phase of a geomagnetic storm are investigated by analyzing quickrun magnetograms from the Budkov Observatory. The basic characteristics of the phase are defined, and a positive correlation is found between the increase of H and the length of the initial phase in selected cases. Several types of rapid variations occur in the initial phase; pulsation periods of the first daytime group are about 30 sec and at night only a few sec.— V.S.N.

- 190-436. Romañá, A[ntonio], and Cardús, J. C. Geomagnetic rapid variations during IGY and IGC, in *Internat. Conf. on Cosmic Rays and the Earth Storm Proc.: Phys. Soc. Japan Jour.*, v. 17, supp. A-2, paper II-1B-P1, p. 47-55, 1962.

The type of results that may be obtained from the monthly data sent to the IAGA Committee 10 on Geomagnetic Rapid Variations for the period of the International Geophysical Year and International Geophysical Cooperation is illustrated by a statistical study of pt pulsations, bays, and pulsations from rapid run magnetograms (pt and pc).— V.S.N.

- 190-437. Jacobs, J. A. Characteristics of geomagnetic pulsations, in Internat. Conf. on Cosmic Rays and the Earth Storm Proc.: Phys. Soc. Japan Jour., v. 17, supp. A-2, paper II-1B-P2, p. 55-62, 1962.

The classification of geomagnetic micropulsations is discussed, and the question is raised of a revision of the definitions of changes in the geomagnetic field over a much broader spectrum. The paper then gives an account of the research, both observational and theoretical, at present being carried out in the field of micropulsations at the Institute of Earth Sciences, University of British Columbia.— Author's abstract

- 190-438. Troitskaya, V. A., Alperovich, L. A., Mel'nikova, M. V., and Bula-tova, G. A. Fine structure of magnetic storms in respect of micropulsations ($T < 20$ sec), in Internat. Conf. on Cosmic Rays and the Earth Storm Proc.: Phys. Soc. Japan Jour., v. 17, supp. A-2, paper II-1B-P3, p. 63-70, 1962.

Rapid run earth-current records at stations in the Arctic, the Antarctic, and mid-latitudes of the Northern Hemisphere were analyzed to determine the microstructure of magnetic storms. Pulsations with periods from fractions of a second to 15-20 sec were used. Special attention was given to the differences in the fine structure of the SSC of the initial and of the main phases of the storm. Also the general state of the magnetic field during 48 hours before the storm was investigated. Examples of such analyses are given in the supplement for two storms.— V.S.N.

- 190-439. Kato, Yoshio. Geomagnetic pulsations and hydromagnetic oscillations of exosphere, in Internat. Conf. on Cosmic Rays and the Earth Storm Proc.: Phys. Soc. Japan Jour., v. 17, supp. A-2, paper II-1B-P4, p. 71-73, 1962.

Statistical and theoretical studies of the two main classes of geomagnetic micropulsations—continuous pulsations and pulsation trains (pt)—are discussed. Pulsations of 10-50 sec and of 50-150 sec occur in the daytime and their amplitudes increase with latitude; the latter group reaches a maximum amplitude in the auroral zone. Pulsations of 150-600 sec period appear in daytime and nighttime, and the amplitude also attains a maximum in the auroral zone; this amplitude characteristic also applies to the nighttime pt-type pulsations. It is shown from model studies that hydromagnetic waves propagated downwards in equatorial regions, or perpendicular to the geomagnetic lines of force, will be reflected at a level depending upon the period of the wave; part of their energy will be transported as transverse waves along a line of force into higher latitudes. The source of hydromagnetic waves is considered to be exospheric and in the range 1-300 sec in period. The paper is well illustrated; characteristics of each pulsation type are tabulated.— V.S.N.

- 190-440. Sugiura, Masahisa. A study of the morphology of geomagnetic storms: Alaska Univ. Geophys. Inst. Final Rept., UAG -R 125, 22 p., 1961.

The average morphology of magnetic storms with sudden commencements was studied from records at 26 observatories of 346 magnetic storms that occurred in the period 1902-45. The magnetic storms are classified into three intensity groups: great, moderate, and weak. Their morphology is investigated separately. Storm variations are analyzed in two parts, Dst and Ds; Ds is analyzed harmonically and its changes with storm time studied in great detail. Sugiura's views on storm sudden commencements and on the abnormal nature of the storm variations at the geomagnetic equator are reviewed briefly.— V.S.N.

- 190-441. Sugiura, Masahisa. A note on the DS variation of geomagnetic storms: A critical examination of method of analysis: Alaska Univ. Geophys. Inst. Sci. Rept., no. 4, UAG -R 123, 10 p., 1961.

The determination of DS variation of magnetic storms as a function of storm time is critically examined. The regular changes in the phase angles of harmonics for DS, found by Yokouchi (1958), are attributed to irregular features that are not adequately averaged out. This apparently paradoxical circumstance is explained with an illustrative example.— Author's abstract

- 190-442. Ondoh, T. Geomagnetic bay-like disturbances before geomagnetic sudden commencements or sudden impulses [with French and Russian abstracts]: *Annales Géophysique*, v. 18, no. 1, p. 45-61, 1962.

During the period of the International Geophysical Year there were 19 geomagnetic sudden commencements or sudden impulses which followed major solar radio outbursts of type IV and polar-cap blackouts. From a study of these it has been found that geomagnetic bay-like disturbances occur several hours before the geomagnetic sudden commencements or sudden impulses. These pre-sc or pre-si geomagnetic bay-like disturbances may be caused by the penetration of relatively low-energy solar particles into the ionospheric E-layer.

For geomagnetic sudden commencements preceded by both solar radio outbursts of type IV and polar-cap blackouts, the time difference between the starting times of polar-cap blackouts and the geomagnetic storm has a negative correlation to the size of horizontal component of the geomagnetic sudden commencement and the percentage of intensity decrease of cosmic rays (Forbush decrease). Models explaining the pre-sc or pre-si disturbances are discussed.— V.S.N.

- 190-443. Sugiura, Masahisa, and Chapman, Sydney. The average morphology of geomagnetic storms with sudden commencement [with German abstract]: *Akad. Wiss. Göttingen Abh. Math.-Phys. Kl.*, no. 4, 53 p., 1960.

The average morphology of geomagnetic storms with sudden commencement is described for each of 346 storms occurring in 1902-45. Weak, moderate, and great storms are analyzed separately. New features of storm morphology during the first few hours of storm time were discovered: namely, that DS (disturbance longitudinal inequality) reaches its maximum in about two or three hours from the storm commencement, and that its phase changes rapidly during the first few storm hours. The results confirm and extend those obtained previously by Chapman. Some features of the storm field at Huancayo, which lies nearly on the geomagnetic equator, are found to be abnormal.— V.S.N.

- 190-444. Antsilevich, M. G. Vzaimodeystviye korpuskulyarnykh potokov Solntsa s magnitnym polem Zemli [Interaction of the sun's corpuscular streamers with the earth's magnetic field]: *Akad. Nauk Uzbek. SSR Izv., Ser. Fiz.-Mat.*, no. 3, p. 44-51, 1960.

Using Alfvén's hypothesis that the corpuscular emission from the sun has the nature of Hall's currents, and applying an appropriate analysis to the dextrorotatory system of vectors in the streamer (electric field, \vec{E}_0 , magnetic field, H_0 , and corpuscular velocity, \vec{v}), an inaccuracy is discovered in Alfvén's formulation, which prevents proton and electron trajectories from being differentiated. A different formula is proposed for conservation of magnetic moment, μ , in the drift of corpuscles in their trajectories. By differentiating between the solar proton and electron trajectories around the earth, an explanation of the second phase of magnetic storms (a protracted decrease in the magnetic field intensity) and of other peculiarities in the behavior of magnetic storms is found.— A.J.S.

- 189-445. Fukushima, Naoshi, and Abe, Siro. The initial phase of the magnetic storm on Feb. 11, 1958: *Rept. Ionosphere [and Space] Research Japan*, v. 12, no. 1, p. 44-49, 1958.

The rapid and abnormal change that immediately followed the sudden commencement of the magnetic storm of February 11, 1958 (see also Geophys. Abs. 189-420) has been observed rarely in Japan. The decrease in horizontal intensity immediately after sudden commencement is mainly of polar origin, and the subsequent increase is probably of equatorial origin. Results of detailed statistical study (Obayashi and Jacobs, 1957) have shown that geomagnetic changes of this type are generally observed in the forenoon hemisphere in middle or rather high latitudes. In this case, however, the decrease in horizontal intensity was observed at stations of geomagnetic latitude as low as 20°. The geomagnetic pulsation observed at the time of this storm is discussed. The record of a spectrum analyzer for geomagnetic pulsations at Kakioka is reproduced, and the principle of the equipment is described briefly.—V.S.N.

190-446. Kozłowski, M. On some special cases of magnetic storms recorded at the Polish-Vietnamese station at Cha-Pa (Vietnamese Democratic Republic): *Internat. Geophys. Year Annals*, v. 11, p. 61-62, 1961.

In general the magnetic storms recorded at Cha-Pa ($\phi = 22^{\circ}20' N.$, $\lambda = 103^{\circ}49' E.$, $\phi = 10^{\circ}9'$, $\Lambda = 173^{\circ}2'$, altitude = 1,550 m) agree well with Chapman's average storm-time characteristics of magnetic storms at low latitudes, but on August 3, September 2 and 4, and November 6, 1957 the initial and main phases of the storm were separated by an interval of 2 to 10 min in which the H component was of normal value. It is suggested that the main phase could be delayed with respect to the initial phase if the thickness of the ionized stream is such that even at the moment when the stream has actually passed the earth, the conditions for establishment of a ring current have not yet been created; if the ring current is created during the initial phase, however, then there will be no delay.—D.B.V.

190-447. *International Geophysical Year Bulletin No. 60. The Year of the Quiet Sun; proposed program of the United States: Am. Geophys. Union Trans.*, v. 43, no. 2, p. 261-276, 1962.

The proposed United States program for the International Quiet Sun Year is outlined. Synoptic programs of the International Geophysical Year-International Geophysical Cooperation period will be continued in solar patrols, geomagnetism, aurora and airglow, ionosphere, and cosmic rays; and special programs will be undertaken to study "quiet" sun activity, the interplanetary medium, sun-earth relationships, aeronomy, and cosmic rays.—D.B.V.

190-448. Jiříček, František. On the types and dispersions of whistlers as observed in Czechoslovakia [with Russian summary]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 6, no. 1, p. 98-102, 1962.

Comparison of the results of observations of whistlers in Czechoslovakia in 1958-59 (including all known types except nose whistlers) with results from equal geomagnetic latitudes shows that the dispersions of short whistlers are smaller in Czechoslovakia. The variations in dispersion during the night are obviously related to electron density of the F2 layer. These results agree with current opinions concerning the exosphere.—D.B.V.

MAGNETIC PROPERTIES AND PALEOMAGNETISM

190-449. Bates, L[eslie] F. *Modern magnetism*: Cambridge, England, The University Press, 4th ed., 514 p., 1961.

This textbook discusses the subject of magnetism with emphasis on descriptions of fundamental experiments while at the same time presenting an account of modern magnetic theory. The fourth edition includes much new work on fer-

romagnetic domains and on magnetothermal phenomena. The text includes the following 12 chapters: fundamental conceptions in magnetism, the production and measurement of magnetic fields, susceptibility measurements with isotropic substances, the magnetic properties of crystals, experiments with single particles, nuclear spins and magnetic moments, gyromagnetic effects, magnetic saturation and equation of state, energy changes associated with reversible magnetization, the investigation of lattice and spin interactions, magnetostriction, and the domain concept and the hysteresis cycle. An appendix includes further discussion of ferrimagnetism, low temperature susceptibility of an antiferromagnetic substance, and neutron diffraction experiments.— V.S.N.

190-450. Parasnis, D. S. Magnetism, from lodestone to polar wandering: London, Hutchinson and Co., 128 p., 1961.

A short review of magnetic phenomena from the natural magnetic lodestone to the theory of polar wandering is presented. The treatment is essentially nonmathematical and is designed for the scientific reader who is neither a physicist nor engineer. The following subjects are discussed: the stationary magnetic field; diamagnetism and paramagnetism; ferromagnetism, antiferromagnetism, and ferrimagnetism; magnetic resonances; and the earth's magnetism.— V.S.N.

190-451. Ponomarev, V. N., and Zakharchenko, V. F. Opredeleniye azimuta namagnichennogo shara [Determination of azimuth of a magnetized sphere]: Prikladnaya Geofizika, no. 27, p. 171-174, 1960.

A method of determination of the azimuth of a magnetized sphere located to the side of a borehole is discussed. The horizontal component of the total intensity H of the magnetic field is recorded by a horizontal pickup, and the azimuth of the borehole with respect to the disturbing magnetized spherical body is determined in cylindrical coordinates using an equation which is given. The ambiguity of the four possible solutions of this equation is resolved by determining the component of the magnetic field along the polar radius vector from two horizontal pickups perpendicular to each other.— A.J.S.

190-452. Khan, M[ohammed] Aftab. The anisotropy of magnetic susceptibility of some igneous and metamorphic rocks: Jour. Geophys. Research, v. 67, no. 7, p. 2873-2885, 1962.

The anisotropy of magnetic susceptibility of some mafic igneous and metamorphic rocks has been found to be due to preferred orientation of the long axes of grains of magnetite. The degree of anisotropy may be as much as 40 percent but usually is less than 10 percent. The variation in anisotropy is believed to be due to variation in the degree of preferred orientation and in susceptibility due to grain size and chemical composition. Half of the susceptibility ellipsoids determined approached an oblate shape; only a quarter of the remainder approached prolate shapes. The magnetic ellipsoids of a number of Tertiary lavas, banded gabbros, dikes, cone sheets, a ring dike, and Precambrian basic gneiss were determined. The principal susceptibility directions of most of the lavas were widely dispersed, but in some flows they were tightly grouped with the minimums around the pole of the flow plane, the maximums normal to the flow direction in the flow plane, and the intermediates in the flow direction. Similar groupings were found in banded gabbros but not in other intrusives. Mafic gneisses show a very marked concentration of maximums in the direction of the visible lineations and of minimums normal to the observed foliation. The use of anisotropy of magnetic susceptibility as a petrofabric tool is discussed.— D.B.V.

190-453. Books, Kenneth G. Remanent magnetism as a contributor to some aeromagnetic anomalies: Geophysics, v. 27, no. 3, p. 359-375, 1962.

An investigation of some aeromagnetic anomalies in north-central Montana shows that remanent magnetization is the dominant factor in anomalies over some rocks and a contributing factor in anomalies over others. Remanence in volcanic rocks, commonly south-seeking down and about 10 times more intense than the induced magnetization, is the dominating factor in anomalies over those rocks; this is shown by the agreement between the profiles of an observed anomaly and one calculated from the resultant of induced and remanent magnetizations. A consistent relationship between the axis of the anomaly (the direction between the anomaly high and low) and the horizontal direction of magnetization suggests that the direction of the anomaly axis can be used to indicate the horizontal direction of magnetization in this area.—D.B.V.

- 190-454. Kume, S[hoichi]. Sur des changements d'aimantation rémanente de corps ferrimagnétiques soumis à des pressions hydrostatiques [On the changes in remanent magnetization of ferromagnetic bodies subjected to hydrostatic pressures (with English and Russian abstracts)]: *Annales Géophysique*, v. 18, no. 1, p. 18-22, 1962.

Hydrostatic pressures up to 10,000 kg per cm² were applied to some ferrites and rocks (andesites). The remanent magnetization was observed to decrease in intensity after application of pressure. The decrease is closely related to the coercive force of the specimens, and its amount is greater when the specimens possess a remanent magnetization of lower coercivity.— Author's abstract

- 190-455. Vlasov, A. Ya., and Zvegintsev, A. G. O stabil'nosti termo-ostatochnoy namagnichennosti magnetita k odnovremennomu vozdeystviyu temperatury i magnitnogo polya obratnogo napravleniya [On the stability of thermoremanent magnetization of magnetite under the simultaneous effects of temperature and reversed magnetic field]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 10, p. 1522-1524, 1961.

The stability of thermoremanent magnetization, I_{rt} , of magnetite (sulfur - 0.27 percent and titanium oxide - 0.17 percent) in a field reversed with respect to I_{rt} and at temperatures of 560°C-570°C was investigated. The experiment showed that I_{rt} of the samples tested remained unaffected by the reversed magnetic field when their temperature remained below the Curie point. The results of the experiment indicate that the reversed remanent magnetization of magnetite-bearing rocks found in nature is unlikely to be caused by self-reversal of magnetization due to various physical-chemical processes.—A.J.S.

- 190-456. Petrova, G. N. Razlichnyye laboratornyye metody opredeleniya geomagnitnoy stabilnosti gornykh porod [Various laboratory methods of determination of geomagnetic stability of rocks]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 11, p. 1585-1598, 1961.

Various types of laboratory determination of the magnetic stability of rock samples are discussed. There is no universal method for reliable determination of the relationship between the primary and secondary magnetization of rock samples. The method of permanent magnetic field (H_c) in combination with curves of demagnetization obtained by an alternating field has more advantages in extensive paleomagnetic investigations. For individual samples the Tel'ye method was found more suitable for volcanic rocks, and the method of comparison of stability parameters is better for sedimentary rocks.—A.J.S.

- 190-457. Vlasov, A. Ya., and Kovalenko, G. V. Vliyaniye uplotneniya na yestestvennyuyu ostatochnuyu namagnichennost' donnykh otlozheniy Atlanticheskogo okeana [The effect of compaction on the natural remanent magnetization of the bottom sediments of the Atlantic Ocean]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 5, p. 639-643, 1962.

Laboratory experiments on compaction of deep-sea sediments taken from the Atlantic Ocean under a pressure up to 3,333 kg per cm² showed that the value of the inclination vector of remanent magnetization decreases up to 10 percent. This is in agreement with compaction results of artificial sediments.— A.J.S.

- 190-458. Mikhaylova, N. P. Pro zalyshkove namagnichennya devladovs'kykh perydotyiv [On the remanent magnetization of the Devladov peridotites]: Akad. Nauk Ukrain. RSR Dopovīdī, no. 5, p. 626-629, 1960.

The remanent magnetization of the peridotites of the Devladov massif in the central part of the Ukraine crystalline shield is discussed. A correlation between remanent magnetization and magnetic susceptibility of the rock suggests that the absolute value of I_z — the three-dimensional distribution of the remanent magnetization vector — and K — the susceptibility — depend on the composition and structure of the rock, and can therefore be completely different for the rocks of the same age. It was found that the ratio I_r/I_i , where I_i is induced magnetization, is independent of the rocks' composition, and therefore can be used for absolute age determination.— A.J.S.

- 190-459. DuBois, R. L. Magnetic characteristics of a massive hematitic body: Jour. Geophys. Research, v. 67, no. 7, p. 2887-2893, 1962.

The magnetic properties of a massive hematitic body have been determined. Measurements were made of direction and intensity of remanent magnetism with an astatic magnetometer. One group of specimens has a northeast direction, and a second group has a southwest direction. Of these two groups the southwest direction is considered the normally magnetized position. Average values are calculated for the two groups and then combined to give the total remanent magnetism. The induced magnetism was determined and added to the remanent to give gross magnetic effects.— Author's abstract

- 190-460. Wilson, R. L. Palaeomagnetism in Northern Ireland. Pt. 2. On the reality of a reversal of the earth's magnetic field: Royal Astron. Soc. Geophys. Jour., v. 5, no. 1, p. 59-69, 1961.

A large variety of evidence is presented concerning reversal of the earth's magnetic field during the Tertiary igneous activity in Northern Ireland. Different magnetic minerals, which acquired their natural moments in different ways, all support the reality of a field reversal, as opposed to self-reversal of the rocks in a normal field.— Author's summary

- 190-461. Kropotkin, P. N. Paleomagnetizm, paleoklimaty i problema krupnykh gorizontallynykh dvizheniy zemnoy kory [Paleomagnetism, paleoclimates, and the problem of large horizontal movements of the crust]: Sovetskaya Geologiya, no. 5, p. 16-38, 1961.

Variations of geomagnetic latitude estimated for various parts of the earth on the basis of paleomagnetic data agree fully with paleoclimatic data. Differences in pole positions established from the paleomagnetism of Paleozoic and Mesozoic rocks are to be explained by extensive horizontal movements of the continents.— J.W.C.

- 190-462. Kruglyakova, G. I. Rezul'taty paleomagnitnykh issledovaniy na Ukraine [Results of paleomagnetic investigations in the Ukraine]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1674-1678, 1961.

Paleomagnetic investigations were made in the Ukraine crystalline shield (various Precambrian complexes), Dniester River region (Cambrian, Ordovician, Silurian, and Devonian), the Crimea (Triassic, Jurassic, Cretaceous, and Paleogene), and the Kerch peninsula (Neogene) to evaluate the possibility of con-

structing a geochronological scale in paleomagnetic units. Polar coordinates were calculated from the remanent magnetization of these rocks, and the results are presented in 11 stereographic projection diagrams.—A.J.S.

- 190-463. Vekua, L. V. Nekotoryye rezul'taty paleomagnitnykh issledovaniy na izvershennykh porodakh Gruzii [Some results of paleomagnetic investigations on volcanic rocks of Georgia]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1668-1673, 1961.

An investigation was made of the remanent magnetization of volcanic rocks collected in the Georgian S.S.R. The accuracy of orientation of the samples was 0.5°. Khramov's method of determining paleomagnetic stability (S) was used: $S = I_n^0 / (I_n^0 + I_n^h)$, where I_n^0 is the primary, and I_n^h the secondary magnetizations. Data on samples collected at 18 localities are tabulated. The positions of the magnetic poles (the central dipole hypothesis) were determined for the Quaternary, Neogene, Paleogene, and Cretaceous periods; they show good agreement with other studies. A clearly defined alternation of normal and reversed magnetization in volcanic rocks of different geologic periods was noticed.—A.J.S.

- 190-464. Akopyan, Ts. G. Paleomagnetism effusivnykh porod Armyanskoy SSR i peremeshcheniye polyusov Zemli v Kaynozoykskuyu eru [Paleomagnetism of effusive rocks of the Armenian SSR, and the migration of the earth's poles during the Cenozoic era]: Akad. Nauk Armyan. SSR Izv., Ser. Geol. i Geog. Nauk, v. 13, no. 5, p. 33-46, 1960.

The magnetization of 750 oriented samples of effusive rocks taken from various places in the Armenian S.S.R. and in the adjacent regions of the Lesser Caucasus was studied. The results are given in a table and plotted on stereographic projections of the vectors of natural remanent magnetization. The latter show the path of migration of the north pole during the Paleogene-Anthropogene. It was found that the earth's magnetic field changed its polarity 4 times: at the beginning of the Tertiary, at the end of the Miocene, at the beginning of the Pliocene, and during the late Pliocene.—A.J.S.

- 190-465. Van, Zi-Chan; Den, Sin-Khuey; Li, Chi-Kon; and Ye, Su-Tien. Initial results of study of the positions of ancient poles on a basis of analysis of natural remanent magnetism of rocks of China [in Chinese with English summary]: Acta Geophys. Sinica, v. 9, no. 2, p. 125-138, 1960.

Paleomagnetic measurements were made on 175 specimens of Devonian, Carboniferous, Permian, Triassic, and Jurassic age from north, south central, and southwest China. The pole position for the Devonian is located in the north part of the Atlantic Ocean. The position for the Carboniferous is disordered, due possible to relatively weak remanent magnetism and to low accuracy of the measurements. The poles for the Permian and Triassic are located in the north part of the Pacific Ocean, and the Jurassic pole in the Indian Ocean. These results are in disagreement with measurements made in Europe and America. The cause of this disagreement has not yet been established. Climatic conditions for these times indicate, however, that China was in an equatorial belt; therefore, the results presented here appear more plausible.—J.W.C.

MAGNETIC SURVEYS

- 190-466. Orlov, G. G. O nekotorykh formulakh, primenyayemykh v sluchayakh kosogo namagnicheniya tel [On some formulas applied to cases of oblique magnetization of bodies]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1544-1546, 1961.

The anomalies X, Y, and Z, and ΔT for an oblique magnetization are analyzed mathematically for two- and three-dimensional cases. The analysis shows an additional term V_{yy} of gravitational potential entering the expression for a three-dimensional body. Where this term is present in a formula, the expressions are different for the components of anomalous fields of two- or three-dimensional bodies.— A.J.S.

190-467. Klushin, I. G. Ob otsenke glubiny zaleganiya kristallicheskogo fundamenta po raschetam magnitnykh i gravitatsionnykh anomalii [On evaluation of the depth of the crystalline basement from data of magnetic and gravity anomalies]: *Prikladnaya Geofizika*, no. 27, p. 96-115, 1960.

Two opposing views of geophysicists are discussed: (1) That no practically accurate geophysical interpretation of depths from magnetic and gravity anomalies is possible because the inverse solution permits several variants, and (2) that the interpretation can be highly accurate (10 percent of mean square error) insofar as the indeterminacy probability of the inverse solution varies from 1 to zero depending on the quality and accuracy of the initial data. The first view represented by Devitsyn and Lapina (see *Geophys. Abs.* 172-176) is criticized on the basis of the analysis presented here, and the conclusion is reached that under stipulated conditions the depth of the crystalline basement in the southeast part of the Russian platform can be determined from gravimetric and airborne magnetic data with the mean-square accuracy of 20-25 percent.— A.J.S.

190-468. Strakhov, V. N. Opyt interpretatsii magnitnykh anomalii KMA metodom postroyeniya isoliniy ΔZ v vertikal'noy ploskosti [Experience in interpretation of magnetic anomalies of the KMA by the method of ΔZ isolines construction in a vertical plane]: *Prikladnaya Geofizika*, no. 27, p. 116-130, 1960.

A mathematical analysis is applied to the analytic extension of the field for solution of inverse problems of magnetic prospecting. Examples of interpretation by a method proposed here are given for the magnetic anomalies of Shchigry, Saltykovo, Smorodino, and Yakovlevo of the Kursk magnetic anomaly (KMA). The relative error in determination of H is found to be 10 percent on the average.— A.J.S.

190-469. Nassonov, V. A. Resheniye nekotorykh zadach magnitometrii s ispol'zovaniyem podobiya anomalii [Solution of certain problems in magnetometry by using the similarity of anomalies]: *Geofiz. Razvedka*, no. 3, p. 69-72, 1961.

The similarity of the anomalies, $Z/Z' = Z_i/Z'_i$, due to the same magnetic body measured at different altitudes is discussed. Z and Z' are epicentral values of magnetic field intensity at different altitudes, and Z_i and Z'_i are the values of the field vertical component for similar anomalistic points of the anomalies (similar points are the intersections of the same magnetic ray, emerging from a magnetic pole, with the lines of observation at different altitudes). Using this similarity principle and the regularities resulting from it, formulas are derived for determination of depth of the disturbing body and anomalistic intensities at different altitudes.— A.J.S.

190-470. Tyapkin, K. F. Dva sposoba opredeleniya napravleniya namagnichenosti gornyykh porod po rezul'tatam magnitnykh izmerenii [Two methods of determining the direction of magnetization of rocks from the results of magnetic measurements]: *Razvedochnaya i Promyslovaya Geofizika*, no. 40, p. 49-54, 1961.

Two methods of determining the direction of the total vector (I) of magnetization of geologic objects of arbitrary shape and limited volume (three-dimen-

sional case), or extended horizontally to infinity but having a limited width (two-dimensional case) are discussed. By using the basic Poisson's correlation for X and Z in three dimensions the directing cosines of I are determined from the results of magnetic measurements only, assuming a uniform magnetization of the body. The asymptotic values of the components of the magnetic field intensity of a two-dimensional case are obtained from measurements of the Z-component at the surface of the earth by calculating them at a height 3-5 times greater than the greatest dimension of the body.— A.J.S.

190-471. Tyapkin, K. F. Pro vykorystannya formul ploskoї zadachi dlya interpretatsii magnitnykh anomalii, zumovlenykh kintsevymy po prostyagannuyu geologichnymy ob'yektamy [Application of formulas of the two-dimensional problem to interpretation of magnetic anomalies caused by geologic objects of finite dimensions along strike]: Akad. Nauk Ukrain. RSR Dopovid, no. 10, p. 1396-1399, 1960.

The method of preliminary summation of observed values of the components of an anomalous magnetic field along parallel contours is proposed for interpretation of anomalies caused by finite geologic bodies. Formulas for the two-dimensional problem in potential theory can be used for determination of the magnetic anomaly values directly from the summation curves, and these values can be reduced to values that are proportional to the second derivatives of gravity potential by considering the direction of the body's magnetization vector.— A.J.S.

190-472. Zä, Su-Ho. Luftmagnetik (Stand und Auswerteverfahren) [Aeromagnetism (Status and evaluation methods)]: Freiburger Forschungshefte, C 115, 104 p., 1961.

This paper first reviews the problems of aeromagnetic surveying, the planning and execution of aeromagnetic measurements, and the construction of aeromagnetic maps. Then the possibilities and methods of evaluating the anomalies obtained are reviewed. A bibliography of 154 entries is given.— D.B.V.

190-473. Bareja, Henryk. Mikromagnetyka jako pomocnicza metoda badań utworów geologicznie najmłodszych [Micromagnetism as an auxiliary method for investigation of the youngest geological deposits]: Przegląd Geol., v. 7, no. 12, p. 547-552, 1959.

Micromagnetic study of weak magnetic anomalies (about 2.5 γ) in areas of sedimentary rocks is discussed. Correlation of micromagnetic data with the geology is shown by profiles and contour maps. The quality of interpretation depends much on the duration of the survey (one day surveys are recommended), the petrographic characteristics of the rock, and the calibration of the magnetometer.— A.J.S.

190-474. Legar, A. P. Uskorennyy sposob opredeleniya skloneniya magnitnogo polya [Rapid method of determination of the declination of the magnetic field]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 10, p. 110-115, 1961.

A simplified method of determining magnetic declination is presented for use in magnetic exploration. The position of the sun is determined by a theodolite and the magnetic azimuth by a compass.— J.W.C.

190-475. Orlov, V. P. Nazemnoye obespecheniye aeromagnitnykh s'emok [Surface correlations of airborne surveys]: Geofiz. Razvedka, no. 3, p. 72-81, 1961.

Measures for improving results of airborne magnetic surveys by conducting simultaneous and correlated land magnetic surveys are discussed.— A.J.S.

- 190-476. D'yachkov, N. P., Davydov, V. F., and Vershinin, V. I. Ispol'zovaniye pantografa dlya transformatsii krivyykh ΔT [Use of a pantograph for transformation of ΔT curves]: Geofiz. Razvedka, no. 2, p. 120-124, 1960.

A pantograph is described which can replace the usual procedure of transformation of airborne magnetic ΔT curves from tape.— A.J.S.

Books, Kenneth G. Remanent magnetism as a contributor to some aeromagnetic anomalies. See Geophys. Abs. 190-453.

- 190-477. Andreasen, G[ordon] E., Kane, M[artin] F., and Zietz, Isidore. Aeromagnetic and gravity studies of the Precambrian in northeastern New Mexico: Geophysics, v. 27, no. 3, p. 343-358, 1962.

A contour map of the Precambrian surface for a part of northeastern New Mexico (from the Colorado border south to lat 34° N., and from the foothills of the Sangre de Cristo Mountains east to long 104° W.) has been prepared from aeromagnetic, gravity, and drill-hole data. Thirty-seven depths to Precambrian rocks were computed from aeromagnetic anomalies. Regional gravity anomalies were generally not suitable for quantitative analysis, but the gravity highs correlate with known areas of basement highs, providing a basis for contouring in areas of meager depth control. Drill-hole data provided 61 depths to basement in and near the survey area. Contouring along the east edge of the Sangre de Cristo Mountains was guided by exposures of Precambrian rocks. A principal feature of the contour map is the Sierra Grande arch, a basement highland that extends southwest across the area to the northwest part of Guadalupe County. Major depressions occur west of Vegas Junction, northeast of Santa Rosa, and north and northeast of Las Vegas. The largest of these, the Las Vegas basin, occupies more than 1,000 sq mi and may be more than 10,000 feet deep.— D.B.V.

- 190-478. Irwin, William P., and Bath, Gordon D. Magnetic anomalies and ultramafic rock in northern California: Art. 25 in Geol. Survey Prof. Paper 450-B, p. B65-B67, 1962.

The relationship between areas of ultramafic rock and the large positive magnetic anomalies located during reconnaissance aeromagnetic surveys across the northern Coast Ranges, Great Valley, and Klamath Mountains of California (see Geophys. Abs. 183-490) is discussed. In the northern Coast Ranges and Klamath Mountains the large positive anomalies are chiefly over areas of ultramafic rocks, and collected samples of the rocks are found to be strongly magnetic. A great anomaly that extends more than 300 miles along nearly the entire length of the Great Valley is thought to be the expression of ultramafic rock buried below a considerable thickness of basement rock in addition to the late Mesozoic and Cenozoic strata. Locally, as shown by well cores, the ultramafic rock is part of the basement complex at or near the interface of the basement and the overlying strata. This may account for sharp local anomalies superimposed on the broad Great Valley anomaly.— V.S.N.

Lyons, Paul L. Geophysical background of Arkoma basin tectonics. See Geophys. Abs. 190-324.

Joesting, H[enry] R. Discussion of "Gravity and aeromagnetic exploration in the Paradox Basin." See Geophys. Abs. 190-325.

Byerly, P. Edward. Discussion of "Gravity and aeromagnetic exploration in the Paradox Basin." See Geophys. Abs. 190-325.

- 190-479. Agarwal, R. G. Interpretation of aeromagnetic data in west central Saskatchewan and east central Alberta: Saskatchewan Dept. Mineral Resources Rept., no. 63, 1960.

A structure map of the Precambrian surface beneath the sediments in west central Saskatchewan and east central Alberta has been prepared from aeromagnetic data and available ground control. The map suggests the probable thickness of the sediments at various points and throws light on some of the known sedimentary anomalies. It also indicates some of the local and regional high trends which may be of importance as controls for accumulation of petroleum and natural gas.— V.S.N.

- 190-480. Gregory, A[lan] F., Bower, Margaret E., and Morley, L. W. Geological interpretation of aerial magnetic and radiometric profiles, Arctic Archipelago, Northwest Territories: Canada Geol. Survey, Dept. Mines and Tech. Surveys, Bull., no. 73, 148 p., 1961.

This report differs from those published earlier (see Geophys. Abs. 185-479, 188-455, 189-468) only in the inclusion of 115 pages of geophysical profiles and interpretative notes.— V.S.N.

- 190-481. Bott, Martin Harold Phillips. Geological interpretation of magnetic anomalies over the Askrigg block: Geol. Soc. London Quart. Jour., v. 117, pt. 4, no. 468, p. 481-493, 1961.

A vertical field magnetic survey of the Askrigg block, which forms the southern half of the North Pennine rigid block of north England, discloses an east-west striking belt of magnetic basement rocks between Wensleydale and the Craven faults and terminated to the west by the Dent line. Gravity anomalies observed over the northern half of the block suggest a small granite intrusive mass (see also Geophys. Abs. 172-183) also elongated in an easterly direction. The granite has a slight magnetic effect, and two-dimensional models that are approximately consistent with the gravity and magnetic profiles have been constructed and are illustrated. The belt of magnetic basement rocks and the granite appear to form a resistant block that has controlled the subsequent structural history of the south half of the Askrigg block. The close correlation of the Dent and North Craven faults with the margin of the main anomaly and with the strike of the Ingletonian Lower Paleozoic boundary suggests that the belt of magnetic rocks has resisted major internal deformation but has yielded persistently along the weaker margins. It is notable that mineral veins are more common to the north and south of the belt; no clear connection exists between the distribution of mineral veins and the granite.— V.S.N.

- 190-482. Gantar, C., Morelli, C[arlo], Pisani, M., Segre, A. G., and Zampieri, L. Rilievo magnetico dell'Italia meridionale [The magnetic relief of southern Italy]: Boll. Geofisica Teor. ed Appl., v. 3, no. 12, p. 338-366, 1961.

A ground magnetic survey was made in Puglia (southern Italy) in 1955-56. The station coordinates and the values of the vertical component, Z, are tabulated. The vertical magnetic anomalies are correlated with local geologic structures and with gravimetric and seismic data.— A.J.S.

- 190-483. Gernik, V. V., and Potapov, V. G. Opyt raschleneniya vulkanogennoy tolshchi na Polyarnom Urale metodom magnitorazvedki [An attempt at differentiating volcanic layers in the Polar Urals by means of magnetic exploration]: Geofiz. Razvedka, no. 6, p. 59-72, 1961.

Magnetic anomalies clearly differentiate volcanic layers from Ordovician and Cambrian sedimentary rocks in the Polar Urals and also differentiate the volcanic layers themselves into characteristic rock units. The latter fact is of considerable importance in the search for copper in this region.— J.S.W.

- Bernstein [Bernshteyn], V. A. On magnetic investigations in vicinity of volcanoes. See Geophys. Abs. 190-622.

- 190-484. Nanda, S. N. A proposed mechanism of generation of microseisms: Bur. Central Seismol. Internat. Pubs., ser. A, Travaux Sci., no. 20, p. 193-197, 1959.

An all embracing cause for microseisms is suggested that involves winds, waves, and special orientation of winds that are either circular currents or winds that pile up or deplete water near a steep coast line. Such changes of sea level will pulsate with the auto-correlative periods, if any, in eddy viscosity near the surface of the sea which in turn depends on sea roughness. If there are standing waves, the roughness and therefore the eddy viscosity will have a period half that of waves. However, in this process standing waves are not necessary for generation of microseisms. In many cases it has been observed that prominent microseisms have a period less than half the period of prevailing sea waves. (See also Geophys. Abs. 181-403.)—V.S.N.

- 190-485. Bernard, Pierre. Sur la dualité d'origine des microsésismes d'après les enregistrements d'Abbadia (Basses-Pyrénées) [On the duality of the origin of microseisms according to the records at Abbadia (Basses-Pyrénées)]: Acad. Sci. [Paris] Comptes Rendus, v. 253, no. 23, p. 2732-2734, 1961.

Comparison of simultaneous observations made at Abbadia in southwestern France and at Parc-Saint-Maur, Paris, shows that a first maximum of microseismic activity originating from a low-pressure area over the sea reaches both stations, but that a second maximum is recorded only at Abbadia, being produced by the arrival at Cap Ferrat, the nearest point on the coast, of the swell coming from that depression. The periods of the microseisms due to the two different causes are the same or nearly so.—D.B.V.

- 190-486. Schneider, Götz. Mikroseismik-Ausbreitung in Nord- und Mitteleuropa [Propagation of microseisms in northern and central Europe (with English summary)]: Zeitschr. Geophysik, v. 27, no. 3, p. 118-135, 1961.

Three microseismic storms originating off the Norwegian coast, near the Farøe Islands, and in the Rockall region, respectively, were investigated using the records obtained at the Kew, Kiruna, Copenhagen, Pulkovo, Stuttgart, and Warsaw stations. The effect of the type of origin and region of origin is greater than that of distance or geologic environment of the station. Comparison with surface waves from near earthquakes shows that short-period microseisms are fundamental mode surface waves. Fourier analysis indicates that the short-period complex type of microseisms (Love and Rayleigh waves) is present during the whole storm.—D.B.V.

- 190-487. Zátópek, Alois. Neue Ergebnisse der Mikroseismenforschung in Prag [New results of microseism research in Prague]: Freiburger Forschungshefte, C 101, p. 35-48, 1961.

Microseisms observed at Prague in 1948-60 have been investigated as a whole, and period and amplitude curves have been constructed as a function of time. The general trend of the idealized amplitudes describes a curve with maximums in 1948-49 and 1956-57 and corresponds roughly to the course of solar activity. Idealized amplitude curves constructed for different stations, showing similar general trends, indicate that the eastern part of the North Atlantic frontal zone is the source of microseisms in central Europe and also the main source of microseisms in all of Europe. Regional characteristics can be explained as the effect of "second order" sources.

It is shown that the area west, southwest, and south of Iceland is the most important source for central Europe, whereas the area off the central and north coast of Norway is not as important a source with respect to central Europe as it is for Scandinavia and the Russian platform; the northern and central

parts of the Baltic Sea are fairly important. The main source areas in the North Atlantic lie mostly over depths of 1,000-3,000 m; statistically speaking therefore, depths of 2,000 m are most favorable for generation of microseisms. (See also Geophys. Abs. 173-317.)—D.B.V.

- 190-488. Vasil'yeva, T. L., Proskuryakova, T. A., Rykynov, L. N., and Savarenkiy, Ye. F. O vliyani rel'yefa zemnoy poverkhnosti na rasprostraneniye mikroseyzm [On the effect of the relief of the earth's surface on propagation of microseisms]: Moskov. Univ. Vestnik, no. 1, p. 3-12, 1961.

An attempt is made to evaluate quantitatively the effect of the relief of the earth's surface on propagation of microseisms for use in studies of the upper crust, for selection of station sites for studies of microseismic sources and determination of their coordinates, and for establishing areas of minimum microseismic interference. From the experiments by ultrasonic modeling it was found that the amplitudes of microseisms diminish substantially during their passage through mountainous terrains. Nonhomogeneity of the medium and vertical boundaries between rocks of different elastic properties also produce a damping effect on microseisms.—A.J.S.

- 190-489. Zapol'skiy, K. K. Izmereniya uroviya i spektral'nogo sostava krotkoperiodnykh mikroseyzm [Measurements of intensity and spectrum composition of short period microseisms]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177), p. 153-164, 1960.

Absolute measurements of intensity of microseisms of various frequencies within the range of 2-100 cycles per second using a frequency-selective vibrometric station on RC (resistance-capacitance) are described. The maximum effective amplification of the apparatus as a function of frequency is evaluated.—Author's abstract, A.J.S.

- 190-490. Saha, B. P. A preliminary note on short period microseisms recorded by Benioff seismograph at Shillong: Indian Jour. Meteorology and Geophysics, v. 13, no. 1, p. 81-90, 1962.

The occurrence of short period group microseisms of period close to one second recorded on some occasions by the short period vertical component Benioff seismograph at Shillong, India, is believed to be associated with the passage of cold fronts in association with the secondaries of the western disturbances which move from west to east during premonsoon months. The probable mechanism of generation of these microseisms is discussed.—V.S.N.

- 190-491. Anjaneyulu, T. S. S. Microseisms at Madras associated with disturbances in the Bay of Bengal: Indian Jour. Meteorology and Geophysics, v. 12, no. 4, p. 560-572, 1961.

Microseisms recorded at Madras that were associated with nearly all depressions and storms in the Bay of Bengal during the period 1955-59 are examined. Mean characteristics of microseisms in different months are described, and case histories of four microseismic storms are given. It is found that the maximum amplitude of a microseismic storm occurs long before the disturbance crosses the coast. An average depression can cause a perceptible increase in microseismic amplitude even at a distance of 500 miles; a cyclonic storm can cause a perceptible increase at a distance of 900 miles. The use of microseisms to forecast movement of meteorological systems at sea has many obstacles because microseismic energy is much modified by such complicated phenomena as refraction and diffraction due to topographic variations in the seabed.—V.S.N.

- 190-492. Okano, Kennosuke, and Kamo, Kosuke. Direction of approach of microseisms observed in Kyushu [in Japanese with English abstract]: Zisin, ser. 2, v. 14, no. 3, p. 131-137, 1961.

Vector seismographs were used to investigate the direction of approach of microseismic waves in Kyushu. It was found that no microseismic waves arrive from the west even when typhoons are present in the southwest. Arrivals are frequent, however, from the direction of the Hyuga Sea on the east where the continental margin is close to the coast. These results compared with results of observations at Abuyama Observatory on Honshu lead to the conclusion that the nearer the continental margin is to the coast, the more frequently microseismic waves are generated.— V.S.N.

- 190-493. Kishinouye, Fuyuhiko. Microseisms and subsoil conditions: World Conf. on Earthquake Eng., 2d, Tokyo and Kyoto 1960, Proc., v. 3, p. 1649-1653, 1960.

Microseisms, because of their long period, may provide information about subsoil conditions over a wider area than do earth tremors. Studies of microseisms in Japan show that the amplitude of microseisms is larger and the period longer on soft subsoil than on hard ground. Correlation of the amplitude of microseisms with the subsurface topography of the Shonai Plain shows that the thicker the alluvial deposits the larger the microseisms. In the area of the Tonankai earthquake, Shizuoka Prefecture, a positive correlation was found to exist between earthquake damage and the amplitude of microseisms.— V.S.N.

RADIOACTIVITY

- 190-494. Giannini, M., Prosperi, D., and Sciuti, S. Decay scheme of ^{212}Pb : *Nuovo Cimento*, v. 21, no. 3, p. 430, 1961.

Some experimental results concerning Pb-212 Bi-212 decay are reported. The investigation of the Pb-212 decay scheme is of some interest because until now it was not known whether the shell model holds in the lead region boundary. Coincidence spectra and γ, γ angular correlations have been employed in order to measure the intensities of the weakest transitions and to make spin assignments. A decay scheme has been proposed. Further, the doubtful existence of a 177 Kev γ -ray has been unambiguously demonstrated.— R.M.G.

- 190-495. Barkan, S. Branching ratio of α and β emissions from ^{212}Bi (ThC): *Nuovo Cimento*, v. 20, no. 3, p. 450-453, 1961.

Semiconductor counters were used to measure the branching ratio of Bi-212 with increased precision. The average of 8 runs gave a value of $\alpha/(\alpha+\beta)=0.358\pm 0.001$.— D.B.V.

- 190-496. Ogilvie, K. W. The half-value period of radium C': *Phys. Soc. [London] Proc.*, v. 76, pt. 2, p. 299-301, 1960.

An experiment is described that was performed by the integral method in order to find out whether the discrepancy between von Dardel's value for the half life of RaC' and other published values could be due to a small systematic error in the order determinations. The results confirm von Dardel's value of $163.7\pm 0.1 \mu$ sec.— D.B.V.

- 190-497. Rama, and Honda, Masatake. Cosmic-ray-induced radioactivity in terrestrial materials: *Jour. Geophys. Research*, v. 66, no. 10, p. 3533-3539, 1961.

Cosmic-ray-induced activities have been detected in a few laboratory materials both at sea level and at mountain altitude. The measured amounts are found to be consistent with those expected to be produced from known flux of cosmic-ray neutrons and negative muons.— Authors' abstract

- 190-498. Prouvost, Jean. Répartition de la radioactivité dans les roches granitiques de la région d'Avallon [Distribution of radioactivity

in the granitic rocks of the Avallon region]: Soc. Savantes Cong., Dijon 1959, Sec. Sci., Comptes Rendus, p. 297-301, 1960.

Beta-radioactivity measurements were made on 4 pulverized samples of granite from different places in the north part of the Lormes batholith in the vicinity of Avallon, France. Activity was very weak, ranging from 50 to 112 counts per 5 min, and uniformly distributed. Petrographically and chemically the granite is also quite uniform, although in the field it presents different facies. As this massif may represent only the roof area of a larger batholith, the uniformity of distribution of radioactivity does not necessarily contradict the frequently observed fact that radioactivity increases toward the periphery of a batholith.— D.B.V.

- 190-499. Balyasnyy, N. D., Kogan, R. M., Renne, O. S., and Fridman, Sh. D. Opyt opredeleniya soderzhaniya RaC', ThC'' i I-40 v odnorodnykh granitoidakh po energeticheskomu sostavu γ -luchey [An experiment in determining the concentrations of RaC', ThC'', and K-40 in homogeneous granites according to the energy composition of γ -rays]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 664-676, 1962.

Using a scintillation spectrometer the gamma-ray spectrum was measured at the surface of homogeneous biotite granites over an area of 10,000 m² (85 observation points), and the distribution of RaC', ThC'', and K-40 was determined. A zonality was found in the distribution of RaC' and ThC''; the linear dimensions of the zones are measured in tens of meters, and the differences in average concentration in the zones are within 20 percent. The statistical distribution of RaC', ThC'', and K-40 in the biotite granites satisfies the normal law. The energy composition of the gamma radiation at the surface of the granites was calculated.— Authors' abstract, J.W.C.

- 190-500. Starik, I. Ye., Nikolayev, D. S., Kuznetsov, Yu. V., and Legin, V. K. Radioaktivnost' osadkov Chernogo morya [Radioactivity of Black Sea sediments]: Akad. Nauk SSSR Doklady, v. 139, no. 6, p. 1456-1459, 1961.

The vertical distribution of uranium, thorium, ionium (Th-230), and radium and of the Th/U, Ra/U, and Ra/Io ratios in Black Sea sediments at three different stations (from core samples 289, 281, and 516 cm long, respectively) is presented. A deficiency in radium suggests that the sediments are young, in other words, sedimentation is very rapid. The rate of deposition calculated from two of the cores is more than 36 cm per 1,000 yr, and from the third core at least 50-60 cm per 1,000 yr. The absolute time of sedimentation, calculated for one core, is 1,500 yr.— D.B.V.

- 190-501. Vachnadze, Yu. A. K voprosu o radiometricheskom analize gornyykh porod [On the problem of radiometric analysis of rocks]: Akad. Nauk Gruzin. SSR Soobshch., v. 24, no. 4, p. 405-407, 1961.

Radiometric analysis for U, Th, and K in rock samples from the Dzirul' crystalline massive by the method proposed by Nazarov and others in 1957 and 1958 shows that this method is qualitative but not quantitative.— A.J.S.

- 190-502. Khitrov, L. M., and Kotlyarov, K. A. Glubokovodnyy gamma-radiometr i izmereniye radioaktivnosti glubinykh sloyer vody Indiy-skogo okeana [Deep-water gamma radiometer and measurement of the radioactivity of the deep layers of the water of the Indian Ocean]: Okeanologiya, v. 2, no. 2, p. 334-345, 1962.

A deep-water radiometer was constructed that meets the requirements of resistance to heat, moisture, corrosion, and shock and of being stable for periods of at least five hours. A picture of the instrument and a block diagram

of the circuit are given. A NaI crystal is used. Extensive measurements were made to depths of 4,000 m in the Pacific Ocean. Activity drops off sharply to a depth of about 10 m and then becomes constant for the remaining part of the interval measured.—J.W.C.

- 190-503. Rama, and Honda, M[asatake]. Natural radioactivity in the atmosphere: *Jour. Geophys. Research*, v. 66, no. 10, p. 3227-3231, 1961.

The activities of cosmic-ray-produced radioisotopes P-32, P-33, and Be-7, and of Pb-210, which arise from the decay of radon, have been measured in samples of dust filtered from stratospheric and tropospheric air. The short-lived activities appear to be in secular equilibrium with the respective local productions in various regions of the upper stratosphere. The activities of Pb-210, on the other hand, are found to be uniform throughout the stratosphere. The implications of these and the tropospheric observations are discussed.—Authors' abstract

- 190-504. Machta, Lester, and Lucas, Henry F., Jr. Radon in the upper atmosphere: *Science*, v. 135, no. 3500, p. 296-299, 1962.

Radon-222 concentrations in samples of air from high altitudes were measured over northeast Alaska and southwest of Hawaii to ascertain their usefulness for investigating exchange across the tropopause and in the stratosphere. The radon in 500- to 1,000-liter samples of air was concentrated on activated coconut charcoal at solid CO₂ temperature and transferred to an alpha scintillation counter having a sensitivity of 5.45 counts per min per 10⁻¹² curie and a background of about 0.1 count per min. Reduced to standard conditions, the concentrations of radon in 25 upper atmosphere samples ranged from less than 1×10⁻¹⁶ to 8×10⁻¹⁵ curie per liter, compared with a mean hemispheric ground-level concentration in the probable range 1×10⁻¹⁴ to 1×10⁻¹³ curie per liter. In the series of measurements over Alaska, radon concentrations were much greater at 25,000 feet, below the tropopause, than anywhere above; they were small at 40,000 feet, above the tropopause, increased at the 50,000-foot and 60,000-foot levels, and decreased again at 65,000 feet. It is inferred from the data, and because of the short half-life of radon and the absence of radon sources in the stratosphere, that separate layers existed in the stratosphere whose transit time from the troposphere was between about 2 weeks and 2.5 days. The mechanism of the inferred exchange between troposphere and stratosphere was not resolved. Samples taken southwest of Hawaii on June 6, 8, 15, and 20 at 50, 60, and 65,000 feet contained radon in a much smaller range of concentration, less than 1×10⁻¹⁶ to 2.2×10⁻¹⁵ curie per liter, even though the samples straddled the tropopause on at least one day. Slowly rising currents through the tropopause to at least 65,000 feet are thought to have dominated turbulent interchange.—A.B.T.

- 190-505. Kapitanov, Yu. T., Serdyukova, A. S., and Korenkov, A. P. Ekspressnyy metod opredeleniya kontsentratsii radiya A i sootnosheniy mezhdru produktami raspada radona v vozdukhe [Express method of concentration determination of radium A and correlation between the decay products of radon in the air]: *Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka*, no. 11, p. 106-114, 1961.

A method which permits determination of the RaA concentration and ratios of RaA:RaB:RaC in the air within 13 minutes and with an accuracy ±10 percent at 1-10⁻¹⁰ curie/l is discussed. Two variants of the process are described, and the accuracy of the method is evaluated and compared with determinations by other methods.—A.J.S.

RADIOACTIVITY SURVEYING AND LOGGING

- 190-506. Bates, Robert G. Airborne radioactivity surveys—A geologic exploration tool: *Southeastern Geology*, v. 3, no. 4, p. 221-230, 1962.

Airborne radioactivity surveys provide geologic information on large areas in a short period of time. Preliminary study of the aeroradioactivity data outlines areas of differing geology and indicates the relative complexity of each, thus distinguishing areas of initial interest for subsequent ground surveys. Rapid compilation of a provisional geologic map is possible using aeroradioactivity data to provide continuity between widely-spaced ground traverses. Aeroradioactivity surveys of glaciated regions and those containing extensive alluvial deposits provide little bedrock information. Best results are obtained in areas of varied lithologies, tilted strata, and extensive outcrops or residual soil.— Author's abstract

190-507. Langford, Gerald T. Radiation surveys aid oil search: *World Oil*, v. 154, no. 5, p. 114-119, 1962.

In areas of subsurface petroleum accumulation, there is also an increase in the methane content, some of which migrates vertically to the surface. The methane molecules act as carriers of radioactive decay products. When these molecules rise above the water table, they dry out and break down, emitting low-energy gamma rays and Bi-214. These soft rays are the only radiation directly associated with petroleum pools. The sensitivity of the instrument used to detect this characteristic radiation is increased greatly by using two 7-inch thallium-activated NaI crystals. A cosmic ray burst creates a sudden surge of current, such bursts are removed by inserting a gate circuit in the instrument to absorb these surges. The background of hard radiation is reduced by a gate circuit which "clips off" the top two-thirds of the pulse count of the hard rays. As an oil pool is approached, the soft rays increase in number while the hard rays remain constant.— J.W.C.

190-508. Merritt, J. W. Geochemistry and radiation surveying for oil and gas: *Internat. Geol. Cong., 20th, Mexico City, 1956, Symposium de Exploración Geoquímica*, v. 2, p. 283-302, 1959.

The operational history of and problems connected with the use of soil chemistry and soil radiation in exploring for oil and gas are reviewed briefly. Examples are given where gamma radiation of surface samples over oilfields with one producing horizon is at a maximum at the margins of the field. For other simple oilfields, corrections are needed to the raw gamma radiation data. The soil radiation method is rarely applicable to complex oilfields with several producing horizons.— B.R.D.

190-509. Grumbkov, A. P., Matveyev, V. V., Semenov, G. S., and Sokolov, A. D. *Primeneniye stsintilyatsionnoy apparatury dlya poiskov zalezhey nefi i gaza* [Use of scintillation apparatus for exploration for oil and gas pools]: *Geologiya Nefti i Gaza*, no. 3, p. 33-37, 1960.

Differentiation of the components of radioactive radiation enhances greatly the value of radioactivity surveying in oil exploration. The Avtografs radiometer, designed for this purpose, is described. It consists of a counting head, two discriminator-amplifier channels, and a recording block. It is possible to vary the threshold of discrimination in a range corresponding to 100-500 Kev in the first channel and 1.5-2.6 Mev in the second. In field tests the gamma activity was found to be related directly to the type of rock at the surface.— J.W.C.

190-510. Polyakov, A. K. *Geologo-geofizicheskiye metody obsluzhivaniya na rudnikakh tsvetnykh metallov* [Geologic-geophysical methods of servicing nonferrous mines]: *Sovetskaya Geologiya*, no. 7, p. 160-161, 1961.

The application of the gamma-gamma method for testing nonferrous ores in the field for their metal content is discussed briefly. Mercury-203, selenium-75, cesium-137, and cobalt-60 isotopes were used.— A.J.S.

- 190-511. Savinskiy, D. Nekotoryye analiticheskiye i statisticheskiye zakonmernosti pri gamma-oprobovani mestorozhdeniy radioaktivnykh elementov v yestestvennom zalegani i gamma-karotazhe [Certain analytic and statistical regularities in gamma surveying of deposits of radioactive elements in natural occurrence and in gamma logging]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 659-663, 1962.

A mathematical method is proposed for reducing the effect of nonuniform distribution of radioactive elements when the mean content of these elements is being determined.—A.J.S.

- 190-512. Voskoboynikov, G. M. O nekotorykh voprosakh teorii radiometricheskikh metodov razvedki [On some problems of the theory of radiometric prospecting methods]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 114-119, 1961.

This is a criticism of Filippov's papers on radioactive logging by the gamma and gamma-gamma methods (see Geophys. Abs. 177-332, 178-346). According to Voskoboynikov the papers are carelessly written and edited and contain gross errors.—A.J.S.

- 190-513. Nishimura, Susumu. Variation in radioactivity across igneous contacts. III: Kyoto Univ. Coll. Sci. Mem., ser. B, v. 28, no. 2, p. 255-264, 1961.

Beta-gamma radioactivity profile measurements using a Lauritsen electroscop were made across 53 contacts. The activity was so weak that definite conclusions could not be reached with the exception that peaks in the profile at the contact suggested a concentration of Th, U, K-40, as well as Rb-87.—F.E.S.

- 190-514. 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.

Beta radioactivity and semi-quantitative spectrographic profiles across three contacts are shown graphically. A detailed discussion and analysis of the cause of the observed variations is given. Data suggest the profiles are related to temperature variations across the contacts and to fractional crystallization. (See also Geophys. Abs. 187-530.)—F.E.S.

- 190-515. Alekseyev, F. A. Radiometric method of direct exploration for oil and gas [in Chinese with Russian summary]: Acta Geophys. Sinica, v. 9, no. 1, p. 47-64, 1960.

The theory of the radiometric method of exploration, the principles of interpretation of the data, and recommended procedures are examined. The anomalous behavior of the natural gamma field in regions of oilfields is explained by a drop in the clark of the radioactive elements in the entire section above the pools. A similar anomalistic behavior characterizes the disseminated stable elements, particularly the heavy elements—Mn, V, Ni, Cr, Co, and others. The distribution of both the radioactive and disseminated stable elements is governed by ion exchange.—J.W.C.

- 190-516. Grumbkov, A. P. Methods, apparatus, and treatment of data in radioactivity prospecting for petroleum [in Chinese]: Acta Geophys. Sinica, v. 9, no. 2, p. 169-175, 1960.

This is a brief review of gamma-ray methods, techniques, and apparatus that have been developed for petroleum prospecting at the Institut Geologii i Razrabotki Goryuchikh Iskopyemykh of the Academy of Sciences of the U.S.S.R.

The ASGM-25 and "AVIAGRAS" apparatus are used for airborne surveys, the AGR-3 and multichannel AGR-SS for carborne use, and the LS-1 model is very convenient for measuring intensive radiation from rock samples. Methods of determining the relative proportions of different elements contributing to the radioactivity measured are also discussed.—D.B.V.

Shibato, Kihei; Iida, Kumizi; and Sano, Shun-Ichi. Geophysical prospecting studies of uranium resources at Hirase Mine, Gifu, Prefecture. See *Geophys. Abs.* 190-213.

190-517. Grammakov, A. G., Ovchinnikov, A. K., Lyubavin, Yu. P., Ovchinnikov, V. M., and Sazonov, A. M. Vliyaniye vesa uranovykh rud i tolshchiny sloya zheleznogo poglotitelya na stsintillyatsionnyy spectr ikh gamma-izlucheniya [The effect of the weight of uranium ores and of the thickness of the layer of the iron absorber on the scintillation spectrums of their gamma radiation]: *Atomnaya Energiya*, v. 11, no. 1, p. 69-71, 1961.

The gamma energy spectrum of uranium was studied on six models of ore bodies weighing from 14.2 to 2,920 km. The models consisted of iron tanks filled with ore and having an axial hole to imitate a borehole. Gamma-radiation spectrums and impulse rates are compared on graphs for the different models. (See also *Geophys. Abs.* 185-510.)—A.J.S.

190-518. Kukharenko, N. K., and Basin, Ya. N. K voprosu opredeleniya poristosti plastov po dannym neytronnogo gamma-karotazha [On the problem of porosity determination of strata from neutron gamma logging data]: *Vses. Neftegaz. Nauchno-Issled. Inst. Trudy*, v. 29, p. 195-206, 1960.

Geophysical methods of porosity determination are discussed, and ways for improving neutron-gamma logging are suggested. Increasing the thickness of the screen between the neutron source and the counter, and surrounding the latter by cadmium increase the relative differentiation of strata by 35 to 50 percent.—A.J.S.

190-519. Larionov, V. V. Otsenka poristosti kollektorov i ikh glinistosti po dannym radiometrii skvazhin [Evaluation of porosity of reservoirs and their clay content from the data of borehole radiometry]: *Vses. Neftegaz. Nauchno-Issled. Inst. Trudy*, no. 29, p. 218-228, 1960.

Determination of the porosity of reservoir rocks by the neutron-gamma method is discussed, and the characteristics of the neutron-gamma count as a function of porosity is investigated in terms of the salinity of the water in the pores and of the water of hydration.—A.J.S.

190-520. Shapiro, D. A. Kontrol' tekhnicheskogo sostoyaniya skvazhin metodom NGK [Control of boreholes condition by the neutron-gamma logging method]: *Razvedochnaya i Promyslovaya Geofizika*, no. 40, p. 68-71, 1961.

It is proposed that the isotope method of monitoring conditions in boreholes be replaced by neutron-gamma logging. This method does not require the safety measures necessary with the isotope method and does not prevent radioactivity logging of water-oil contacts.—A.J.S.

190-521. Kozachok, I. A. Do pytannya pro spovil'nennya v poglyayuchomu seredovyshchi [On the slowing down of neutrons in an absorbing medium]: *Akad. Nauk Ukrayin. RSR Dopovidí*, no. 9, p. 1156-1160, 1961.

The slowing down and resonance capture of neutrons in a homogeneous absorbing medium are discussed, and the usually complex mathematical treat-

ment of the problem is reduced to a simpler form. The problem can then be solved by the method of spherical harmonics, since the function of phase distribution can be represented by an integral-differential equation soluble for the case of narrow resonances and absorption by nuclei of heavy elements.— A.J.S.

SEISMIC EXPLORATION

- 190-522. Kats, S. A. Printsip ekvivalentnosti interferentsionnykh sistem [The equivalence principle of interference systems]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1624-1632, 1961.

The effect of grouping shot points and receivers is considered. It is shown that the directional characteristics thus generated are equivalent to the directional characteristics of grouped receivers with a single shot point. This permits determination of the optimum array of groups of receivers and shot points when used simultaneously.— Author's abstract, A. J. S.

- 190-523. Gol'tsman, F. M. Ob eksperimental'nom analize pomekh i nadezhnosti rezul'tatov gruppirovaniya signalov [On the experimental analysis of interferences and the reliability of the results of grouping of signals]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1707-1716, 1960.

The oscillations recorded on a seismogram are a function $f(x;t)$ of two variables: the direction x along which the signals are received, and the time t . The function $f(x;t)$ can be considered either as a set of the function x for constant values of t , or as a set of t for constant x . These two, the x -concept $f(x)_t$ and the t -concept $f(t)_x$ of the signal $f(x;t)$, are investigated for their basic properties of signal and interference. An experimental analysis of the interferences shows that the grouping of signals is reliable only when the spectrums of x -concepts of the useful signal and the accompanying interference are separated. The cophasal axes are discussed as qualitative criteria where the length of the axis is several times greater than the base of the group.— A.J.S.

- 190-524. Gol'tsman, F. M. Statisticheskaya otsenka nadezhnosti rezul'tatov gruppirovaniya signalov [Statistical evaluation of the reliability of the results of grouping of signals]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1717-1727, 1960.

A reliability criterion proposed here consists of determination of the probability that the cophasal axes observed could have been obtained from a smoothing of incidental noises by grouping. It was found that reliability increases when the number of determined values of cophasal axes increases and the correlation between them decreases. In general, the numerical value of reliability should be not less than 3-4 units of information before a separated cophasal axis can be used in the interpretation of a signal.— A.J.S.

- 190-525. Timoshin, Yu. V. K teorii grupirovaniya [On the theory of grouping]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1728-1739, 1960.

The theory of grouping of impulse oscillations (seismic waves) is analyzed mathematically, and analytic formulas for impulse characteristics of directional sensitivity for various grouping configurations and impulse forms are derived on the basis of Laplace transformation. Methods for selection of grouping parameters for a given signal to noise ratio before and after grouping are discussed. It was found that the impulse characteristics of directional sensitivity are similar to the characteristics of harmonic oscillations. The suppression coefficient of heterogeneous distributions was found to drop as the damping rate of impulses increases; this makes the homogeneous groups more effective. A method for experimental construction of impulse characteristics of directional sensitivity is proposed.— A.J.S.

- 190-526. Napalkov, Yu. V. O teorii grupirovaniya seysmopriyemnikov [On the theory of grouping of seismic receivers]: *Prikladnaya Geofizika*, no. 27, p. 12-34, 1960.

Seismic receiver arrays are discussed with regard to oriented sensitivity characteristics, and a more rigorous treatment of the frequency theory of oriented reception sensitivity of arrays is proposed.—A.J.S.

- 190-527. Vasil'yev, Yu. I., and Ivanova, T. G. O fil'truyushchikh svoystvakh tonkikh sloyev [On filtering properties of thin layers]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 10, p. 1475-1487, 1961.

The relationship between the transmission coefficients of longitudinal and transverse sinusoidal waves through a thin layer is analyzed in terms of vibration frequencies and different angles of incidence on layers of lower and higher velocities (the case of solid mediums is considered). The effective attenuation coefficients of elastic waves propagating in a perfectly elastic medium consisting of thin layers are calculated. The effective attenuation coefficients of longitudinal and transverse waves are compared with each other and with actual attenuation coefficients known for the case of imperfectly elastic mediums. Experimental data are presented.—Authors' abstract, A.J.S.

- 190-528. Lyuke, Ye. I. Ob eksperimental'noy zavisimosti energii seysmicheskikh voln ot usloviy vzryva [On the experimental relationship of the energy of seismic waves to the conditions of the explosion]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 12, p. 1782-1790, 1960.

Experimental shots were made in the air at heights 0-9 m over a water basin 4 m deep and 30 m in diameter using charges of 2.6-59.8 kg. The methods of the experiments and the conditions under which they were performed are described. Longitudinal and surface waves were measured, and their seismic records are illustrated. The trajectories of particle motion in the waves were determined to have an elliptical shape extended along the X-axis, and the waves exhibit a clearly expressed normal dispersion. A method of energy determination of seismic waves is given.—A.J.S.

- 190-529. Okada, Hiroshi, and Tazime, Kyozi. Love-waves in stratified three layers: *Hokkaido Univ. Fac. Sci. Jour.*, ser. 7, v. 1, no. 2, p. 115-138, 1958; continued in *ibid.*, no. 3, p. 139-161, 1959, (2d part only) reprinted in *Jour. Physics Earth [Tokyo]*, v. 7, no. 1, 1959.

The basic properties of Love waves are investigated by calculation of examples of the dispersion curve, the amplitude function, and the amplitude distribution for zeroth and first order Love waves. In order to obtain concrete results, rather large rigidity ratios are assumed in the numerical calculations regardless of the actual conditions of the earth. Such ratios are found only near the surface of the earth in seismic prospecting. Results are illustrated and it is concluded that the first boundary which has a large velocity contrast under the source plays the most important role in growth of Love waves; that is, the first boundary alone will be found by observation of Love waves.—V.S.N.

- 190-530. Zav'yalov, V. D. Interpretatsiya seysmogramm v zonakh interferentsii [Interpretation of seismograms in zones of interference]: *Prikladnaya Geofizika*, no. 24, p. 26-53, 1960.

Interpretation of seismograms in regions of interference is discussed, and an attempt is made to counteract the break-up of phase correlation waves caused by interference.—A.J.S.

- 190-531. Andreyev, B. A., Boronin, V. P., and Krylov, S. V. Geofizicheskiye osobennosti neftenosnykh struktur Volgo-Ural'skoy provintsi

[Geophysical characteristics of oil-bearing structures of the Volga-Ural province]: *Sovetskaya Geologiya*, no. 7, p. 95-106, 1961.

The intensity of fracturing in sedimentary rocks varies with the degree of bending of the strata; this results in "velocity anomalies" for seismic waves and produces a greater effect on the gravity field than does the local topography. These effects are found to be especially pronounced in the Volga-Ural province of the Russian platform. Methods for taking velocity anomalies into account in seismic and gravity prospecting are given.— A.J.S.

- 190-532. Oliveira, Geraldo de. Determinação analítica e gráfica do horizonte refrator pelas parábolas envoltórias [Analytic and graphic determination of the refracting horizon by means of envelope parabolas]: *Bol. Tecn. Petrobrás*, v. 3, no. 1, p. 5-19, 1960.

The analytic treatment of refraction equations and construction of graphs is simplified if it is considered that the intersection of the plane of incidence of the seismic waves with a refracting horizon is tangent to a parabola formed by the envelope of the refracting horizons compatible with the data obtained when a refraction profile is shot in one direction.— D.B.V.

- 190-533. Finn, R. S., and Heap, W. O. How vibratory seismic systems are performing: *World Oil*, v. 154, no. 5, p. 108-111, 1962.

The servo-hydraulic vibrator is capable of delivering a 10,000 pound peak force per cycle while sweeping a continuous frequency spectrum. The vibrations are controlled by an input signal recorded on a magnetic tape which begins at a selected frequency and sweeps to a higher or lower selected frequency for a given time period in such a manner that no portion is repetitive. The seismic energy that is returned to the surface is recorded on the same magnetic tape on which the predetermined input signal is recorded. By cross-correlating received signals with input signals, a seismic record is obtained on which events are represented correctly in phase, amplitude, and time. The correlation of the received signals with the master input signal can also be looked upon as a highly discriminating filter which rejects energies that do not have the same duration (frequencies) and which preserves the relative amplitudes of the component frequencies present. The truck-mounted vibrators permit maximum flexibility in choice of arrays.— J.W.C.

- 190-534. Ginzburg, Avihu, and Meidav, Tsvi. Compute seismic wave lengths via nomogram: *World Oil*, v. 154, no. 9, p. 111-114, 1962.

Linear shooting combined with a parallel linear geophone array may result in a higher signal-to-noise ratio. In general, the energy returns from deeper beds, and in some cases can provide satisfactory coverage of areas where no records were previously obtainable. A nomogram of general applicability is presented to provide quick determination of maximum allowable geophone array length and the apparent wave length of the signal. This chart also allows conversion from period to frequency and determination of noise wave lengths if desired.— J.W.C.

- 190-535. Mooney, Harold M., and Kaasa, Robert A. Air waves in engineering seismology: *Geophys. Prosp.*, v. 10, no. 1, p. 84-92, 1962.

Certain traveltimes readings in shallow engineering seismology can be attributed to a seismic wave which has propagated through the air, but in which the energy has been transmitted into the ground before reaching the detector. Waveform evidence for this conclusion is presented, based upon the effects of altering the source conditions to delay the direct wave and of embedding the geophone in sound-absorbent material. Erroneously large depths may be computed if these air wave readings are interpreted as readings produced by direct

waves through the ground. Potential difficulty exists only if velocity in the near-surface material is less than 330 m per sec (1,100 fps).— Authors' abstract

- 190-536. Nagumo, Shozaburo; Kamata, Seikichi; and Kawashima, Takeshi. A new method of continuous profiling with off-set L-spread [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 12, no. 11, p. 831-838, 1961.

A new geophone spread system for seismic reflection surveying, known as the off-set L-spread, is discussed and illustrated in diagrams. The system makes it possible to obtain both continuous profile and continuous strike-dip control. Computation procedures are given, and a field example is discussed.— V.S.N.

- 190-537. Giorgio, A. Influenza del piano di riferimento nella sismica a riflessione [Effect of the reference plane on seismic reflection]: Boll. Geofisica Teor. ed Appl., v. 3, no. 12, p. 288-293, 1961.

The choice of a reference plane gives rise to error in the difference of the first arrival time of elastic waves reflected from the bottom and the top of a geologic stratum. Criteria for selection of a reference plane are suggested, and formulas for correction of seismic wave velocities for this reference plane under different topographic conditions are given.— A.J.S.

- 190-538. Klugman, I. Yu., and Lerner, B. L. Programmirovaniye kinematicheskikh popravok v mashinakh dlya avtomaticheskogo postroyeniya razrezov po dannym seysmorazvedki MOV [Programming of kinematic corrections in the apparatus for automatic seismic profiling from the data of seismic prospecting MOV]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1502-1509, 1961.

Problems in seismic reflection surveying that can be solved by automatic profiling machines are considered. The existence of the two types of machines that are different in principle is justified. The problem of programming the machines' operation in regions with predominantly flat-lying structures is investigated. A simplified method of programming that secures the required accuracy of performance of these machines is proposed.— Authors' abstract, A.J.S.

- 190-539. Bespyatov, B. I., and Khramoy, A. I. Opyt primeneniya seysmostantsiy s magnitnoy zapis'yu [Experience in the use of seismic stations with magnetic recording]: Geologiya Nefti i Gaza, no. 3, p. 37-42, 1960.

Case histories are presented to show how magnetic recording is used in seismic surveying to solve problems connected with the wave picture. Filters were used successfully to suppress interferences and thereby to reveal reflecting horizons that had previously been obscured.— J.W.C.

- 190-540. Glotov, O. K. Postroyeniye otrazhayushchikh gorizontov, sposobom sredinnykh tochek [Construction of reflecting horizons by the method of middle points]: Prikladnaya Geofizika, no. 27, p. 35-49, 1960.

A method is proposed for determining the depth to a reflecting boundary under a certain point of a shot area, where the depth of the boundary under another point of the shot area and the difference of traveltimes of reflected waves according to the counter traveltimes curves between the two points are known. The errors due to deflection of seismic rays because of a low velocity zone (upper ground and soil) and due to vertical and horizontal velocity gradi-

ents when the inclination angle of the reflecting boundary is small are discussed. A practical procedure is proposed for construction of profiles by this method.—A.J.S.

- 190-541. Kozlov, E. A. O tochnosti opredeleniya effektivnoy skorosti po "svodnym" godografam otrazhennykh voln [On the accuracy of determining the effective velocity by combined traveltimes of reflected waves]: *Prikladnaya Geofizika*, no. 27, p. 50-56, 1960.

This paper analyzes mathematically and rejects the method of determining the effective velocity of reflected waves by the combined treatment of their traveltimes for the same horizon from adjacent shot points. The analysis shows no gain in accuracy by this method.—A.J.S.

- 190-542. Krylov, S. V. Ob opredelenii gorizontallykh izmeneniy skorosti po godografam otrazhennykh voln [On determination of horizontal variations of velocity from traveltimes of reflected waves]: *Prikladnaya Geofizika*, no. 30, p. 3-24, 1961.

The method of combined analytical averaging of a system of traveltimes of reflected waves, applied successfully by Puzyrev to problems of seismic velocity determination and regional velocity variations (see *Geophys. Abs.* 172-227), is applied to investigation of local velocity variations. Integral transformations of traveltimes of reflected waves, the statistical process of averaging a system of such curves, and the accuracy of effective velocities determined by the method are discussed.—A.J.S.

- 190-543. Bol'shikh, S. F., Gorbatova, V. P., and Davydova, L. N. Izucheniye kinematischeskikh i dinamicheskikh kharakteristik otrazhennykh i golovnykh voln na modelyakh sloistoy sredy [A study of kinematic and dynamic characteristics of reflected and head waves on models of a layered medium]: *Prikladnaya Geofizika*, no. 30, p. 25-49, 1961.

The kinematic and dynamic characteristics of reflected and head seismic waves are discussed on the basis of investigations by Malinovskaya and others (see *Geophys. Abs.* 170-77, 179-119). The results of theoretical calculations and model experiments within the range where the head and refracted waves are recorded together are presented for one, two, and three layer elastic mediums immersed in water. Head waves can be observed when they are formed on thick refracting layers at distances in which the head waves become first arrival waves and when the velocity in the refracting layer is greater than in the cap layer.—A.J.S.

- 190-544. Gol'din, S. V. Ob izuchenii izmeneniya sredney skorosti do opornogo otrazhayushchego gorizonta [On the study of mean velocity variation down to a marker reflecting horizon]: *Prikladnaya Geofizika*, no. 30, p. 50-62, 1961.

The mean seismic wave velocity, \bar{v} , used in interpretation of reflection data on platform structures is analyzed, and the problem of selection of an appropriate velocity function $\bar{v}(M)$ at a point $M(x, y)$ from the available data on effective velocities is discussed. The feasibility of using the functional relationship, $\bar{v}_{ef}(t_0)$, constructed according to the times of wave reflection from a marker horizon, is evaluated as a method of determination of depth.—A.J.S.

- 190-545. Kolmakov, M. V. Integral'noye opredeleniye effektivnykh skorostey v metode otrazhennykh voln [Integral determination of effective velocities in the method of reflected waves]: *Geofiz. Razvedka*, no. 3, p. 11-32, 1961.

The possibility of obtaining direct formulas for determining the propagation velocity of elastic oscillations when their traveltime curves are integrated is analyzed. This is the areal integration method which increases the effectiveness of MOV (method of reflected waves) several times, and reduces considerably the accidental error.—A.J.S.

- 190-546. Glogovskiy, V. M. O sovместnom uravnenii sistemy godografov otrazhennykh voln [On the joint smoothing of a system of travel-time curves of reflected waves]: *Geofiz. Razvedka*, no. 3, p. 32-39, 1961.

A method is proposed for simultaneous treatment of traveltime curves of reflected waves of individual shots by shifting the plotted points in such a way as to make possible an approximation of the curves so that the sum of deviation squares of the experimental points from the specified curve will be a minimum. The method reduces the accidental error of experimental observations.—A.J.S.

- 190-547. Bespyatov, B. I. Opyt primeneniya grupirovaniya v Saratovskom i Stalingradskom Povolzh'ye [An experience in the use of grouping in the Saratov and Stalingrad district of the Volga region]: *Geofiz. Razvedka*, no. 3, p. 40-54, 1961.

A general method of quantitative evaluation of the directivity and statistical effect in a pulse regime of oscillations in various interference systems including grouping is developed. The directivity coefficients for many variants of linear and area grouping of seismic devices are determined for groups up to 10 devices, and a working scheme for determination of the optimum parameters of grouping is given.—A.J.S.

- 190-548. Kiselev, M. I. Sposob isklucheniya zapisi vozduшной volny pri vzbuzhdenii uprugikh kolebaniy vozdušnymi vzryvami [Method of eliminating the record of an air wave in generating elastic oscillations by air shots]: *Geofiz. Razvedka*, no. 3, p. 109-110, 1961.

One geophone is placed in a shallow hole and another is suspended elastically (spring, rubber band) in the air above it. Opposite poles of both geophones are connected to the same ends of the cable. Assuming that the air-wave effects on both geophones are approximately equal, the air-wave record will be reduced.—A.J.S.

- 190-549. Yurchenko, B. I. Korrelatsiya otrazheniy v zone razmyva i vyklinivaniya plastov [Correlation of reflections in a zone of erosion and pinch out of strata]: *Geofiz. Razvedka*, no. 2, p. 1-16, 1960.

Problems of correlation of seismic reflections in the region of the Karpinskiy buried ridge are discussed. Utilization of apparent velocities at reciprocal points of the traveltime curves of reflected waves is suggested for checking the accuracy of the correlation.—A.J.S.

- 190-550. Teplitkiy, V. A. Opyt primeneniya seysmicheskogo metoda ploskogo fronta v Vostochnoy Turkmenii [Experience in the use of the seismic method of the plane front in Eastern Turkmenia]: *Razvedochnaya i Promyslovaya Geofizika*, no. 40, p. 3-7, 1961.

The effectiveness of seismic investigations in east Turkmen S.S.R. by the method of reflected waves [MOV] is compared with the method of the plane front [MPF], which was devised by the Ukrgeofizika Trust. The latter method is based on simultaneous shots in three or four holes 200 or 180 m apart in line with a group of nine geophones placed 5 m apart and moved in steps of 20

m. It was found that MPF produces better defined seismograms as compared with MOV. The inability of MPF to determine the values of effective velocities is its drawback.— A.J.S.

- 190-551. Koryagin, V. V., and Sokolov, A. F. O poperechnom profilirovani v metode otrazhennykh voln [On cross-profiling in the method of reflected waves]: *Razvedochnaya i Promyslovaya Geofizika*, no. 40, p. 8-17, 1961.

The results are presented of longitudinal-transverse seismic profiling for finding methods of reducing errors in interpreting reflected waves from several thin layers. The superposition of the reflected and of the various interference waves of high apparent velocity makes the seismograms practically illegible. The experimental data were compared with synthetic seismograms constructed for the longitudinal and transverse waves. It was found that the transverse traveltimes yield structural information that is lacking in the longitudinal traveltimes curves. The procedure is given for constructing the transverse traveltimes curves, for determination of effective velocities using these curves, and for construction of the profiles.— A.J.S.

- 190-552. Bo, Guan'-Khon. Shallow-water marine seismic surveying [in Chinese with Russian summary]: *Acta Geophys. Sinica*, v. 9, no. 1, p. 65-68, 1960.

The first experimental work on shallow-water seismic surveying in China is discussed, and the methods and apparatus are described. In the region of the operation, cophasal axes were obtained in the limits 0.4-1.7 sec, frequency characteristic of the sediments was higher, and the period of vibrations was from 0.01 to 0.013 sec. The wave interference was low frequency. The apparatus proved successful for the area of the tests.— Author's abstract, J.W.C.

- 190-553. Mu, Iyun'-Guan'. Integration of the calculation of effective velocity [in Chinese with Russian abstract]: *Acta Geophys. Sinica*, v. 9, no. 1, p. 69-73, 1960.

A new method of calculating effective velocity is presented. It is based on the integration of reflecting traveltimes curves and has a high precision.— Author's abstract, J.W.C.

- Brundage, Harrison T. Productivity in exploration. See *Geophys. Abs.* 190-256.

Carabelli, Edmondo. Glacier surveys and glaciological studies on the occasion of the International Geophysical Year (Miage Glacier)—geophysical exploration. See *Geophys. Abs.* 190-294.

- 190-554. Cassinis, R[oberto]. La sismica di rifrazione nella ricerca delle strutture profonde [Refraction seismic surveying in the study of deep structure (with English summary)]: *Quaderni di Geofisica Appl.*, v. 18-19, p. 20-69, 1957-58.

The limiting factors to the application of refraction are discussed, particularly in the case of the exploration for deep structures, where long range shots and very low frequency are involved. Errors coming either from shallow or deep effects are analyzed. Different field techniques are described and compared, as well as interpretation procedures. Particular attention is given to the problems involved in the determination of horizontal displacement and depth when the velocity in the overburden is a function of depth or when it is subjected to lateral changes. The possible velocity distributions in the overburden are examined according to the different geological pictures. Comparisons are made between depth sections computed assuming straight or curved

ray paths. Discussion is made about the possibility of determining faults through diffraction; an experiment on a seismic model is presented. An analytical method of taking into account the effect of dip in the determination of the shape of structures is suggested.— Author's summary

- 190-555. Yepinat'yeva, A. M., Ivanova, L. A., Kun, V. V., and Shport, L. P. Nekotoryye voprosy metodiki seysmicheskoy razvedki paleozoy-skogo fundamenta v Zapadnoy Sibiri [Some problems in the method of seismic exploration of the Paleozoic basement in western Siberia]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 12(179), p. 3-67, 1960.

The results of experimental refraction work designed to study the structure of the Paleozoic basement in some regions of western Siberia are reported. Special consideration was given to vertical and inclined surfaces of the basement, wedge-shaped layers, and local, almost horizontal interfaces within the basement. Criteria based on kinematic characteristics of waves are formulated for determining the nature of certain late arrivals.— A.J.S.

- 190-556. Yepinat'yeva, A. M., and Kondrat'yev, O. K. Opyt primeneniya vysokochastotnoy apparatury pri izuchenii paleozoy-skogo fundamenta v Zapadnoy Sibiri [Experience in the application of high-frequency apparatus in study of the Paleozoic basement in western Siberia]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 12(179), p. 68-84, 1960.

Results of experimental applications of high frequency seismic apparatus to study of the structure of the Paleozoic basement of western Siberia to a depth of 500-700 m is reported. It was possible to record refracted waves from depths of the order of 500 m using a frequency band of 80-120 cycles per second. Better resolution can be obtained with high frequency than with middle frequency apparatus.— A.J.S.

- 190-557. Abdulayev, R. A. Sostavleniye normal'nykh godografov i opredeleniye sredney skorosti do prelomlyayushchikh granits pri pomoshchi nomogram [Composition of normal travelttime curves and determination of mean velocity to refracting boundaries with the aid of nomograms]: Razvedochnaya i Promyslovaya Geofizika, no. 40, p. 18-22, 1961.

The construction of normal travelttime curves from a number of transverse travelttime curves is discussed. A master chart proposed for this operation eliminates the calculation of a travelttime curve for each perpendicular distance, R , from the shot point to the profile, when the boundary velocity, v_g , varies. A nomogram is constructed for determination of mean seismic velocities to refracting boundaries.— A.J.S.

- 190-558. Kravets', V. V., and Kharchenko, F. M. Pro nestatsionarni protsesy v seysmitsi zlomlenykh khvil' [On nonstationary processes in the seismics of refracted waves]: Akad. Nauk Ukrain. RSR Dopovidi, no. 11, p. 1466-1470, 1961.

The recurrent method of mathematical analysis is applied to the amplitude values obtained by the method of correlated refracted waves over vertically layered structures. A study is made of the possibility of determining displacement velocities of the particles in the medium from values measured on the laminar structure by excluding the transient processes taking place in the medium and in the seismic channel.— A.J.S.

- 190-559. Yepinat'yeva, A. M. Present status of KMPV [in Chinese with Russian abstract]: Acta Geophys. Sinica, v. 8, no. 1, p. 55-59, 1959.

The present status of the correlation method of refracted waves (KMPV) is reviewed. Theoretical calculations and experimental data presented here indicate the possibilities of solving geological problems by widening the range of use of the refraction method, by clarifying the types of mediums that can be studied, by using dynamic characteristics of waves, and by employing a new class of waves. It is pointed out in conclusion that the tasks now before seismic surveying in China require use of the dynamic characteristics of waves.— Author's abstract, J.W.C.

190-560. Foster, M[anus] R., Hicks, W[arren] G., and Nipper, J. T. Optimum inverse filters which shorten the spacing of velocity logs: *Geophysics*, v. 27, no. 3, p. 317-326, 1962.

A long-spacing velocity log contains almost the same information as an ideal short-spacing log, but in a distorted form with added noise. The distortion can be thought of as a moving average or smoothing filter. Its inverse, called a "sharpening" filter by astronomers, amplifies noise. To be useful, the inverse must be designed with a balance between errors due to noise amplification and those due to incomplete sharpening. The Wiener optimum filter theory gives a prescription for achieving this balance. Finite-memory optimum inverse filters have been calculated using the IBM 704, and have been applied to actual data, digitized in the field, to produce synthetic short-spacing velocity logs. In comparison with their field counterparts, these synthetic logs have less calibration error and are free from noise spikes; general agreement is good.— D.B.V.

190-561. Geertsma, J. On Tuman's paper on "Refraction and reflection of sonic energy in velocity logging" (*Geophysics*, October, 1961, p. 588): *Geophysics*, v. 27, no. 2, p. 275-276, 1962.

A more suitable calculation of curved path behavior may be obtained by replacing the radial stress used by Tuman (see *Geophys. Abs.* 188-541) by the normal stress in the direction of the wave path. This approach requires that both vertical and radial stress must be known as a function of distance from the well bore. A significantly curved path along which an acoustic wave travels fast enough to be detected as a first arrival will be found mainly in cases where there is an important vertical stress relief around the borehole. It is also suggested that a value of 0.3 for Poisson's ratio would be more realistic than the 0.5 used in Tuman's calculations.— D.B.V.

190-562. Karus, Ye. V., and Saks, M. V. Impul'snyy ultrazvukovoy karotazh [Impulse ultrasonic logging]: *Akad. Nauk SSSR Vestnik*, no. 5, p. 70-74, 1961.

The acoustical logging method is reviewed. Such logs furnish information on the velocities of longitudinal and transverse waves, their ratio V_p/V_s , Poisson's ratio, predominant frequencies of longitudinal and transverse waves, and attenuation of amplitudes of longitudinal and transverse waves. Illustrations are given.— A.J.S.

190-563. Khalevin, N. I., and Barykin, D. D. Ustanovka dlya akusticheskikh issledovaniy v burovykh skvazhinakh [An apparatus for acoustic investigations in boreholes]: *Akad. Nauk SSSR Izv. Ser. Geophys.*, no. 1, p. 69-78, 1961.

A description is given of a pickup, receiver, and control panel for impulse ultrasonic waves generated by an electromagnetic converter of TA-4 type powered by an a-c supersonic generator of 85 and 2,000 cycles per second fixed frequency. Examples of borehole observations are given. Differentiation of the geologic section is better when the higher frequency is used.— A.J.S.

- 190-564. Khramoy, A. I. Metodika obrabotki seismokarotazhnykh nablyudeniy [Method of processing of seismic logging observations]: Geofiz. Razvedka, no. 2, p. 3-11, 1960.

An analytical approach is proposed for determining layer velocities of seismic waves by applying the least squares method to deviations of observed points from the straight-line section of the traveltime curve. A higher accuracy is claimed for this method in comparison with the graphic method ordinarily used. The approach is illustrated by the analytical processing of a vertical traveltime curve. The processing and synthesis of seismic logging data are discussed.—A.J.S.

- 190-565. Rekunov, N. A., Mikhaylov, A. D., Domokurov, I. A., Nazmutdinov, R. Sh., and Igushkin, I. A. Seismokarotazhnaya stantsiya SKS-8-59K [Seismic logging station SKS-8-59K]: Geofiz. Razvedka, no. 3, p. 104-109, 1961.

A description is given of the seismic logging station SKS-8-59K, which was constructed of parts of discarded stations CC-26-51D and CC-30-60. This combination model is used for seismic logging of deep and structural boreholes. It consists of 8 amplifiers, an oscillograph with 9 galvanometers, a communication unit, a tuning-fork generator, and a measurement and control panel. The apparatus is reported to perform satisfactorily.—A.J.S.

- 190-566. Petkevich, G. I. Seismokarotazhni doslidzhennya v Perekarpats'komu progyui [Seismic logging study in the Cis-Carpathian depression]: Kiev, Akad. Nauk Ukrainy. RSR, 99 p., 1960.

This book is devoted to the theory, methods, and interpretation of seismic logging data in the Cis-Carpathian depression and to synthesis of data of mean velocity of elastic waves. Chapter 1 gives a review of parametric methods of seismic investigation in boreholes; chapter 2 discusses the geological-geophysical characteristics of the depression; in chapter 3 problems of processing and interpreting logging data are considered; and in chapter 4 a summary is given of the results of seismic logging in the depression and data of analysis of variations and seismic waves velocities. Chapter 5 concludes with a discussion on systematic variations of elastic waves in the depression. Criteria are proposed for selecting mean velocity curves.—A.J.S.

- 190-567. Khramoy, A. I. O seismogeologicheskom rayonirovanii [On seismogeologic regionalization]: Geologiya Nefti i Gaza, no. 4, p. 22-24, 1960.

The proposal is made that small experimental seismic survey parties make reconnaissance studies of all areas where regular, large seismic parties are to operate later. These preliminary studies would be designed to determine the most suitable methods for use in each particular area.—J.W.C.

- 190-568. Kundorf, Woldemar, and Rotter, Dietrich. Eine Untersuchung über die Anwendung der Methode natürlicher hochfrequenter seismischer Felder (Eigenimpulsmethode) im Steinkohlen- und Erzbergbau [An investigation of the application of the method of natural high-frequency seismic fields (self-impulse method) in coal and ore mining]: Freiburger Forschungshefte, C 120, 76 p., 1961.

The apparatus, procedure, and evaluation of results of the self-impulse method are discussed. Then the application of seismoacoustic methods in various mines and the apparatus used are described. The results show that the strain conditions in rocks and the effect of overburden pressure underground in mines can best be investigated by a combination of geophysical methods (self-impulse or outside impulse, thermal, and electromagnetic methods). A 76-entry bibliography is given.—D.B.V.

- 190-569. World Oil. Gas-gun marine surveys run off U.S. west coast: World Oil, v. 154, no. 7, p. 86, 1962.

The gas exploder is being used extensively for rapid seismic coverage of sedimentary areas offshore from Oregon and Washington. The device used is a 20-ft length of 6-in pipe, closed at the top and suspended by an A-frame over the stern. The open end of the tube is held about 4 feet below the surface of the water. A propane-oxygen mixture is fed into the tube and fired automatically by a spark plug at 3-sec intervals. As many as 21 hydrophones trailing behind the ship record the returning energy. Although earth penetrations to 4,000-5,000 feet are reported, the explosions are almost inaudible only 100 feet from the vessel.— J.W.C.

- 190-570. Oilweek. Greater penetration for marine seismic method: Oilweek, v. 13, no. 17, p. 37, 1962.

A 2 1/2 times increase in depth penetration has been announced for the Gas Exploder system of continuous seismic profiling. The new system has recorded penetration of underwater sub-bottom strata to 14,000 feet.— V.S.N.

- 190-571. Khomenyuk, Yu. V. O ratsionnal'nom analizatore dlya sistemy s nakopleniyem i preobrazovaniyem chastoty [On an efficient analyzer for a system with accumulation and transformation of frequency]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 3, p. 433-437, 1961.

A system is discussed for accumulation of periodically repeated signals used for determination of weak signals on a background of interferences. A mathematical treatment is given for an ideal analyzer and also for available analyzers. It was found that the ideal analyzer separates signals from noise better than inductance-capacitance circuits.— A.J.S.

- 190-572. Vasil'yev, Yu. I., and Shcherbo, M. N. O sobstvennykh kolebaniyakh v sisteme gorizontallyy seysmograf-pochva [On characteristic oscillations in the system, horizontal seismograph-ground]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1614-1623, 1961.

The difference in the vertical and horizontal components of natural oscillations in the systems of vertical seismograph-ground and horizontal seismograph-ground is discussed on the basis of nearly one hundred experiments performed with types SEDS-52 (mostly), SPM-16, NS-3, and RSK-49 seismic pickups. These weigh from 0.4 to 4.5 kg and have natural frequencies from 3.5 to 32 cycles per second. It was found that the resilience of the system seismograph-elastic ground is different for vertical and horizontal displacements.— A.J.S.

- 190-573. Polshkov, M. K. Ustanavlivayushchiyessa protsessy v seysmicheskoy usilitele s π -obraznymi fil'trami verkhnikh i nizhnikh chastot [The quasi-steady processes in a seismic amplifier having π -shaped filters in the upper and lower frequencies]: Prikladnaya Geofizika, no. 30, p. 63-71, 1961.

A theoretical evaluation of quasi-steady phenomena in a seismic amplifier having π -shaped filters of FVCh and FNCh types is given. By comparing the characteristics of the minimum and optimum frequency curves, it was shown that the duration of the quasi-steady state in the amplifier increases with an increase in the steepness of the frequency characteristic.— A.J.S.

- 190-574. Polshkov, M. K. Ustanavlivayushchiyessa protsessy v seysmicheskoy usilitele s T-obraznymi fil'trami verkhnikh i nizhnikh chastot [The quasi-steady processes in a seismic amplifier having T-shaped filters in the upper and lower frequencies]: Prikladnaya Geofizika, no. 30, p. 72-78, 1961.

Quasi-steady processes in a seismic amplifier having T-shaped filters of FVCh and FNCh types are described. The curves of the processes in terms of E_3 versus ω and t (E_3 =emf at the amplifier output, ω =frequency, t =time) are obtained. Comparing the curves of minimum and optimum frequency characteristics it was found that the quasi-periodicity of the processes increases as the steepness of the frequency characteristic increases, and as the ratio of the limiting frequencies ω_2 and ω_1 decreases.— A.J.S.

- 190-575. Polshkov, M. K. Ustanavlivayushchiesya processy v seismicheskom usilitele reostatnogo tipa s simmetrichnym T-obraznym vzenom fil'tra verkhnykh chastot [Transient-to-steady processes in a seismic amplifier of rheostat type, having a symmetrical T-shape link of the high frequency filter]: Geofiz. Razvedka, no. 3, p. 3-11, 1961.

The transient-to-steady processes in the intermediate cascade of a low frequency rheostat seismic amplifier with a T-shape link of the filter of higher frequencies are analyzed and discussed. Curves of e.m.f. as a function of time vs. $\omega_0(t)$ of the transition from transient to steady state were obtained and compared, indicating that the processes investigated have a quasi-periodic shape, cross the time axis seven times, and attenuate very slowly.— A.J.S.

- 190-576. Azimi, Sh. A., and Ogil'vi, A. A. Opyt primeneniya odnokanal'noy seismicheskoy ustanovki pri inzhenerno-geologicheskikh issledovaniyakh [Experiment in application of a single channel seismic apparatus for engineering-geological investigations]: Razvedka i Okhrana Nedr, no. 4, p. 34-40, 1962.

The construction and operation of a one-channel microseismic apparatus weighing about 20 kg are described, and the results of field testing on 112 seismic profiles each an average of 80 m in length are discussed. This method is satisfactory for geological investigations to depths of a few tens of meters.— A.J.S.

- 190-577. Khomenyuk, Yu. V. Poluprovodnikovyye preobrazovateli napryazheniya dlya pitaniya seymostantsiy ot akkumulyatorov [Semiconductor voltage transformers for power supply of seismic stations from storage batteries]: Razvedochnaya i Promyslovaya Geofizika, no. 40, p. 23-26, 1961.

Voltage transformer circuits using the semiconductor triodes PN-1, PN-2, and PN-3 instead of anode batteries in the seismic stations PSS-30/60, SS-26-51D, and SSM-57, respectively, are described and illustrated with schematic diagrams.— A.J.S.

- 190-578. Fedin, A. A. Usovershenstvovaniye skhemy otmetki momenta vzryva po radio [Improvement of the circuit for the shot-time mark by radio]: Geofiz. Razvedka, no. 2, p. 119-120, 1960.

A modification is suggested for the circuit of the "Urozhay" radio sender used for checking shot time. The introduction of an additional condenser makes it possible to record the radio signal of the explosion on a frequency of 200 cycles per second up to a distance of 20-30 km.— A.J.S.

- 190-579. Birch, William B., and Dietz, Frank T. Seismic refraction investigations in selected areas of Narragansett Bay, Rhode Island: Jour. Geophys. Research, v. 67, no. 7, p. 2813-2821, 1962.

Seven reversed refraction profiles were made in four shallow-water areas in Narragansett Bay, R. I., and the results are presented in the form of reversed travelttime graphs and cross-sections of the strata. Seismic velocities

and layer depths are tabulated. Three velocity ranges were obtained: (1) 1.54-1.77 km/s (sediments); (2) 4.16-5.11 km/s (Rhode Island formation); and (3) 5.54-6.46 km/s (crystalline rocks). The thickness of the sediment layer ranges from about 14 to 52 m, generally being thicker in the northernmost area. The boundary between the sediment and the intermediate layer varies from 23 to 45 m below mean low water, and the intermediate layer ranges in thickness from approximately 200 m at the northern end of the bay to 58 m toward the south. The boundary between the intermediate and the crystalline layer varies from 85 to 340 m below mean low water.— D.B.V.

Kovach, Robert L., Allen, Clarence R., and Press, Frank. Geophysical investigations in the Colorado delta region. See *Geophys. Abs.* 190-327.

190-580. Donath, Fred A., and Kuo, John T. Seismic-refraction study of block faulting, south-central Oregon: *Geol. Soc. America Bull.*, v. 73, no. 4, p. 429-434, 1962.

A 7,100-ft seismic refraction profile run across the floor of a former lake basin in south-central Oregon reveals fault blocks beneath the lake sediments. Data were interpreted by a wave-front solution. The reversed profile crosses four faults whose spacing, dips, and vertical displacements conform remarkably to observations of faults exposed elsewhere in the region. The seismic interpretation indicates that the faults are very steep with vertical slip ranging from 200 to about 800 feet.— Authors' abstract

190-581. Savit, Carl H., Blue, Donald M., and Smith, Jennings G. Exploration seismic techniques applied to oceanic crustal studies: *Jour. Geophys. Research*, v. 67, no. 5, p. 1919-1931, 1962.

A 33-km unreversed seismic refraction profile was made northeast of the Bahama Islands to demonstrate and evaluate the feasibility of using conventional shallow water seismic exploration techniques and equipment for oceanic crustal studies. The recording boat, towing a mile-long, 24-hydrophone-group cable, moves away from a shooting boat in fixed position; charges are detonated electrically each time the towed cable traverses its own length, and seismic velocities can be identified with a single shot at a relatively short distance by observing arrivals over the known length of cable. Dip determination from a reflection profile permitted an unambiguous refraction interpretation. Observed compressional wave velocities of 2.18, 4.98, 5.74, and 7.04 km/s are tentatively interpreted, respectively, as a semiconsolidated sedimentary layer 1.67 km thick, a consolidated sedimentary rock or crustal layer 1.14 km thick, a granitic layer 1.85 km thick, and an underlying layer of undetermined thickness of gabbro or oceanic crust.— D.B.V.

190-582. Ewing, John I., Worzel, J. Lamar, and Ewing, Maurice. Sediments and oceanic structural history of the Gulf of Mexico: *Jour. Geophys. Research*, v. 67, no. 6, p. 2509-2527, 1962.

Data obtained in the Gulf of Mexico by a new technique for underway marine seismic reflection measurements are interpreted as follows: the Sigsbee knolls and related structures are interpreted as salt domes. Refraction horizon (5) marks the top of the beds of evaporites from which these domes arise; these beds are an extension of the Louann salt (Jurassic-Permian) that has supplied the Gulf Coast salt domes. Between horizon (5) and the oceanic layer there are, in addition to the evaporites, Paleozoic and perhaps even older sediments and the intermediate layer, typical of ocean basins, which have not been resolved by the seismic measurements. The sediments of the Sigsbee deep have been deposited on a typical oceanic crust and are therefore in water roughly 5 km deep. The implications of this interpretation, particularly the possibility of deposition of evaporites in a large deep basin, are serious.— D.B.V.

- 190-583. Hobson, George D. Vaudreuil map-area, Quebec, Part II. The seismic method applied to a bedrock channel problem: Canada Geol. Survey, Dept. of Mines and Tech. Survey, Paper 61-20, p. 15-18, 1962.

A seismic refraction survey of the Vaudreuil map-area, Quebec, immediately west of the confluence of the Ottawa and St. Lawrence Rivers, successfully located buried valleys some of which are good sources of ground water. The seismic velocities within both the overburden and the bedrock are unusually consistent, and the quality of the refraction arrivals and the time-distance graphs derived from the arrivals are exceptionally definitive. The contoured bed-rock data on the accompanying depth-to-bedrock map indicate that seismic and drilling data are compatible in the area. Reflection data compiled in the south-central part of the area suggest that the depth to the Precambrian rocks is of the order of 1,500 feet.— V.S.N.

- 190-584. Bystritskaya, P. M. Rezul'taty i zadachi seismicheskikh rabot na territorii Saratovskoy oblasti [Results and problems of seismic work in the territory of Saratov]: Vses. Neftegaz. Nauchno-Issled. Inst. Trudy, no. 22, p. 83-94, 1959.

Results of seismic exploration for orientation of deep prospecting boreholes in the Karamysh depression, the zone of the Saratov dislocations, and the neighboring Saratov Trans-Volga area are discussed. Logging data have confirmed the seismic interpretations.— A.J.S.

- 190-585. Khat'yanov, F. I., Amirova, A. V., and Ivanova, Z. S. Posloynnaya zonal'nost' skorosti seismicheskikh voln v predelakh nekotorykh neftenosnykh platformennykh struktur Bashkirii [Layer zonality of seismic wave velocity within several oil-bearing platform structures of Bashkiria]: Sovetskaya Geologiya, no. 3, p. 97-105, 1961.

Anomalous seismic wave velocities are recorded in many large structural units of the Bashkir A.S.S.R. due to variations in the density and porosity of individual sedimentary layers. A direct relationship has been established in this area between change in average wave velocity and thickness of the Lower Carboniferous and Upper Devonian terrigenous deposits. Small variations in average wave velocity (100-150 m per sec) in carbonate strata can lead to incorrect conclusions as to the form of structural units.— J.W.C.

- 190-586. Chirvinskaya, M. V. Opyt kompleksirovaniya seysmorazvedochnykh i burovnykh rabot [Experiment in combining seismic surveying and drilling operations]: Geologiya Nefti i Gaza, no. 3, p. 31-33, 1960.

Coordinated use of seismic surveying and drilling in the Dnieper-Donets downwarp of the cis-Carpathians is described. Such coordination reduced exploration costs drastically.— J.W.C.

- 190-587. Vol'vovskiy, I. S., Ryaboy, V. Z., and Shraybman, V. I. Glubinnoye geologicheskoye stroyeniye Ferganskoy vpadiny po geofizicheskim dannym [Subsurface geology of the Fergana depression according to geophysical data]: Sovetskaya Geologiya, no. 1, p. 156-160, 1962.

Regional seismic studies were made in the Fergana depression in 1958-59, as a result of which the structure of the crust to depths of 50-60 km has been determined. The seismic data are helpful in solving problems on the nature of the large gravity minimum which coincides with the depression. The several structural interfaces within the crust in this area are practically conformable in regional plan and show the presence of a clearly expressed syncline. The most pronounced interfaces are the top of the folded basement and

the M-discontinuity; at both of these there is a sudden increase in formation velocity of 1.2-1.5 km/s. The observed gravity field cannot be explained entirely by the structure of the crust; therefore, the density of the covering sediments can be assumed to be nonuniform.— J.W.C.

- 190-588. Vol'vovskiy, B. S., Vol'vovskiy, I. S., and Tal'-Virskiy, B. B. *Primeneniye seymorazvedki dlya poiskov mestorozhdeniy nefi i gaza v Ferganskoy doline* [Use of seismic surveying for exploration for oil and gas fields in the Fergana valley]: *Geologiya Nefi i Gaza*, no. 1, p. 18-25, 1960.

Extensive reflection and refraction surveys were made in the Fergana depression, an area of relatively recent subsidence where the shallow-water marine Paleogene occurs at depths of 7.5-8.5 km. An excellent, persistent reflecting marker horizon is traced throughout the area; it is generally tied to the top of the Upper Cretaceous but deviates from this stratigraphic position by as much as 200 m in some places. Several seismic profiles and structure contour maps are presented.— J.W.C.

- 190-589. Ayzberg, R. Ye., Germanyuk, M. M., and Kamyshev, N. N. *O napravlenii geologo-geofizicheskikh rabot na nefi i gaz v Gaurdak-Kerkinskom rayone* [Direction of geological-geophysical work for oil and gas in the Gaurdak-Kerki region]: *Geologiya Nefi i Gaza*, no. 4, p. 13-15, 1960.

Two types of uplifts are distinguished in the Gaurdak-Kerki region of the Turkmen S.S.R.: salt domes of the Donguz-Syrt type and normal anticlines of the Kara-Tepe type. The salt domes are studied by gravity and seismic surveying, whereas the normal anticlines are investigated by drilling and seismic surveying.— J.W.C.

- 190-590. Mil'shteyn, D. M. *Primeneniye seymorazvedki dlya izucheniya glubinnogo stroyeniya yugo-vostochnogo Turkmenistana* [Use of seismic surveying for study of the subsurface of southeast Turkmenistan]: *Geologiya Nefi i Gaza*, no. 4, p. 16-20, 1960.

On a basis of 4,700 km of profiles, largely reflection, made during 1956-59, a synthesis is presented for the subsurface structure of the southeast part of the Turkmen S.S.R. Structure maps are given for the top of the Bukhara stage (Paleogene) and for the top of the Jurassic system.— J.W.C.

- 190-591. Dorman, M. I., and Nikolayevskiy, A. A. *Novyye dannyye o geologicheskoy stroyeni Vilyuyskoy sineklizy po materialam geofizicheskikh issledovaniy* [New data on the geology of the Vilyuy syncline according to data of geophysical investigations]: *Geologiya Nefi i Gaza*, no. 1, p. 13-18, 1960.

Seismic reflection surveys were made in the Vilyuy River region of eastern Siberia for elucidating the subsurface structure of this little studied area. A large number of reflections (15-18 horizons) were registered, and the depth of the reflections was as much as 4,500 m; however, none of the reflectors could be traced throughout the entire area. Structure contour maps based on the seismic data are presented for the surface of the Jurassic and the surface of the Cambrian.— J.W.C.

- 190-592. Hawkins, L. V. *The application of the seismic method and seismic timers to the investigation of the depth and quality of magnesite deposits near Young, N.S.W.*: *Australasian Inst. Mining and Metallurgy Proc.*, no. 201, p. 1-13, 1962.

The magnesite deposits near Young, New South Wales, occur in decomposed serpentine below a soil and alluvial cover. The seismic refraction techniques

used to conduct detailed and reconnaissance depth and velocity analyses of the serpentine-magnesite refractor are described. Measured seismic velocities may be used as an index of the presence and quality of magnesite.— V.S.N.

- 190-593. Ishida, Tamotsu. Seismic observations of the Yamato Mountains traversing trip [in Japanese with English abstract]; Antarctic Rec., no. 14, p. 36-43, 1962.

Refraction seismic studies were conducted at four stations (approximately from lat 42° E., long 70°30' S. to lat 36° E., long 71°15' S.) during a traverse from Syowa Base to and across the Yamato Mountains, Antarctica. The equipment used and techniques employed are discussed. The density variation with depth in névé was calculated from the variation of the P-wave velocity with depth; it was found that the rate of increase of density with depth is greater in this area than on the Ross Shelf or in Queen Maud Land. Reflection shooting was carried out at intervals of 10 km over a total of 270 km, and the resulting profile of ice thickness shows three deep valleys (approximately 1,600 to 2,000 m deep) in the bedrock that may be the sources of the Shirase Glacier. (See also Geophys. Abs. 188-565.)— V. S. N.

STRENGTH AND PLASTICITY

- 190-594. Varnes, David J. Analysis of plastic deformation according to Von Mises' theory, with application to the South Silverton area, San Juan County, Colorado: U.S. Geol. Survey Prof. Paper 378-B, 49 p., 1962.

The patterns of faults in the South Silverton mining area are analyzed according to Von Mises' theory of plasticity in plane strain. Initial sections are devoted to standard derivations of basic equations concerning stress, to criteria of failure, and to plastic stress-strain relations in plane strain. Generalized differential equations are derived for slip lines in polar coordinates and applied in the later sections of the report to the two basic problems presented by the Silverton district. The two problems are (1) that of determining the slip-line pattern to be expected if a wedge is compressed in plane strain so that material flows toward the large end, and (2) that of constructing the slip-line field generated by radial stresses, in plane strain, within a segment of a ring around the southeast border of the subsided block of the Silverton caldera.— V.S.N.

- 190-595. Panek, Louis A. Methods for determining rock pressure, in Fourth symposium on rock mechanics, 1961, Proc.: Pennsylvania State Univ. Mineral Industries Expt. Sta. Bull., no. 76, p. 181-184, 1961.

Methods of employing sensing devices having various load-deformation response characteristics to detect changes of stress or deformation in rock are discussed. Illustrations are chosen from equipment and methods employed by the U.S. Bureau of Mines. The following devices to determine change of rock stress are discussed: one that responds to deformation only, one that has a modulus matched to the rock modulus, and one that responds to rock deformation and stress in an arbitrary manner.— V.S.N.

- 190-596. Terzaghi, Karl. Measurement of stresses in rock [with French abstract]: Géotechnique, v. 12, no. 2, p. 105-124, 1962.

The procedures used by Hast (see Geophys. Abs. 185-582) to measure the initial state of stress in rock surrounding an excavated space by measuring the stresses located beyond the distance to which the rock was damaged by blasting are described. The benefits which can be derived from using this method of measurement in connection with the design of permanent linings for rock tunnels and caverns are discussed.— V.S.N.

- 190-597. Obert, Leonard, Merrill, Robert H., and Morgan, Thomas A. Borehole deformation gage for determining the stress in mine rock: U.S. Bur. of Mines Rept. Inv., RI5978, 11 p., 1962.

This report describes a gage which, when used with any procedure for producing strain relief, will measure the resulting borehole deformation. From the borehole deformation the magnitude and direction of the principal stresses in a plane normal to the axis of the borehole can be calculated. The design considerations, mechanical construction, sensitivity, and stability of the gage are discussed.— Authors' abstract

- 190-598. Vinogradov, S. D. Über die energetische Verteilung von Brüchen bei der Gesteinszerstörung [On the distribution of energy from fractures during rock disruption]: Freiburger Forschungshefte, C 116, p. 35-40, 1961.

The distribution of energy released upon destruction of rock under unilateral pressure and constant rate of deformation was investigated in the laboratory (on basalt, granite, marble, quartzite, and rock salt) and in place in mine workings (in the Krivoy Rog iron district and Kizil coal district), using the ultrasonic impulse method. The results show that there is a linear relationship between the number of impulses (or number of fractures arising during disruption of the rock) and their energy in the double logarithmic coordinate system. The slope of the line depends on the mechanical properties of the rock. For basalt, granite, marble, and rock salt the dependence was established empirically as $\gamma = A(G/\tau)^{\frac{1}{2}}$, where γ =slope of the line, A =a dimensionless coefficient, G =shear modulus, and τ =compressive strength. Under the conditions of the investigation, A is practically a constant.— D.B.V.

- 190-599. Tomashevskaya, I. S. Issledovaniye modulya sdviga u obraztsov gornykh porod pri vysokikh vsestoronnikh davleniyakh metodom krucheniya [Investigation of the shear modulus for rock samples under high confining pressures by the torsion method]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 3, p. 438-442, 1961.

Specimens of gabbro, diorite, diabase, basalt, serpentine, syenite, and marble were tested for the shear modulus by torsion under a confining pressure up to 3,000 kg per sq cm. Graphs of the modulus G versus pressure obtained by the tests show higher values of G than those calculated from dynamic measurements of elastic wave velocities. This is explained by strengthening of the rocks by repeated calibrating torsions prior to the metering test by the first method. The data obtained can be used in the studies of tectonophysical processes.— A.J.S.

- 190-600. Nakaya, Ukichiro, and Muguruma, Jiro. Physical properties of the ice of Fletcher's Ice Island (T-3): Arctic Inst. North America Research Paper, no. 20, 34 p., 1962.

The visco-elastic properties of samples of land and old sea ice from 12 sites on Fletcher's Ice Island were studied from September 1959 to February 1960. Crystallographic investigations were also made using a polarizing microscope. Results are given of measurements of the vertical distribution of Young's modulus, viscosity, and density; of the chlorine content of sea-ice; and of Young's modulus as a function of temperature. The viscous nature and the activation energy of land and sea ice are discussed.— V.S.N.

SUBMARINE GEOLOGY

- 190-601. Northrop, J[ohn], Frosch, R[obert] A., and Frassetto, R[oberto]. Bermuda-New England Seamount Arc: Geol. Soc. America Bull., v. 73, no. 5, p. 587-594, 1962.

The seamounts that are known to exist along the 1,000-mile arc between Bermuda and Georges Banks are believed to be extinct volcanoes that erupted on the ocean floor prior to Cretaceous time. They are classified into single-peaked and multiple-peaked mounts. The former are generally smaller and lie on the New England end of the arc. Gravity anomalies are associated with two of these seamounts. The largest seamount occurs where the trend of the arc changes from northeasterly out of Bermuda to northwesterly toward Cape Cod. The abrupt angle that the seamounts' flanks make with the surrounding abyssal plain suggests that sediment has filled up the intermount areas and lapped up on the flanks. The sediment is thought to be transported to the area by turbidity currents flowing down the canyons in the continental shelf.—D.B.V.

- 190-602. Leenhardt, Olivier. Dépouillement d'un profil sismique par la méthode de refraction tiré au large de la côte vanoise [Analysis of a seismic profile drawn by the refraction method off of the Vanoise coast]: Soc. Géol. France Comptes Rendus, no. 4, p. 125-127, 1962.

The results are discussed of an analysis of a seismic refraction profile made by the Woods Hole Oceanographic Institution in cooperation with the Oceanographic Museum of Monaco for 20 km along the border (lat 42°51' N., long 07°07' E. to lat 42°59' N., long 07°10' E.) of the abyssal plain of the Mediterranean Sea. The profile indicates that at the foot of the continental slope a thin layer of unconsolidated sediments ($V=2.0$ kmps; $H=0.5$ km) overlies semiconsolidated sediments ($V=2.8$ kmps; $H=1.3$ km) which in turn overlie consolidated sediments ($V=4.5$ kmps). The presence of sediments with a velocity of 4.5 kmps does not indicate that the zone studied is typical of the oceanic crust as it has been defined in the Atlantic and Pacific Oceans. It is impossible to be sure, however, without a grid of longer profiles.—V.S.N.

- 190-603. Goldberg, E. D., and Koide, Minoru. Geochronological studies of deep sea sediments by the ionium/thorium method: Geochim. et Cosmochim. Acta, v. 26, p. 417-450, 1962.

The ionium-thorium method for determining the rate of accumulation of marine sediments was applied to a group of deposits from the Pacific, Atlantic, and Indian Oceans. The thorium isotopes accommodated in authigenic minerals, presumably derived from sea water, were measured by alpha spectroscopy. The samples were leached with hot concentrated hydrochloric acid to isolate thorium accommodated on sorption sites or located in authigenic minerals, but not to include thorium from detrital phases. Corrections for the uranium-supported ionium were not deemed necessary to establish rates of deposition in the areas studied.

Sediments in the South Pacific have rather uniform and low rates of deposition ($0.3-0.6$ mm/ 10^3 yr), whereas the North Pacific values in general are at least several times higher. These results are in accord with a much greater contribution of sedimentary components from the continents in the northern area. South Atlantic depositional rates were of the same order, millimeters per thousand years, as the North Pacific, whereas two adjacent Indian Ocean cores gave widely contrasting values.

Surface values of the ionium-thorium ratio, and to a lesser extent the hydrochloric acid leachable thorium concentrations, show a marked geographical dependence which is attributed to the relative amounts of continental run-off an oceanic area receives.—J.N.R.

- 190-604. Zumberge, James H. A new shipboard coring technique: Jour. Geophys. Research, v. 67, no. 6, p. 2529-2536, 1962.

A modified piston coring technique developed on Lake Superior in 1961 to permit coring of continuous soft lacustrine material is described. The wire line normally used to suspend a piston coring device was replaced by rigid drill pipe. A 28-ft core could be taken from any part of the upper 50 or 60 feet

of soft sediments. Other modifications permitted using the inner core barrel techniques for punch coring in the deeper sediments of compact clay and glacial till. After complete penetration of the uncemented sediments, bedrock was cored by ordinary rotary techniques. All drilling sites were in water 500 feet or deeper. — D.B.V.

Ewing, John I., Worzel, J. Lamar, and Ewing, Maurice. Sediments and oceanic structural history of the Gulf of Mexico. See *Geophys. Abs.* 190-582.

VOLCANOLOGY

190-605. Brouwer, H. A. *Vulcanism and tectonics*: Koninkl. Nederlandse. Akad. Wetensch. Proc., ser. B, v. 64, no. 5, p. 706-712, 1961.

The structural changes that influence the birth and lifetime of volcanoes are so extremely variable that the structures associated with volcanic activity have been studied in some detail without solving the problem of the nature of the movements that formed these structures. If the origin of the structures is not yet understood, it is not to be expected that simple tectonic controls of extrusive volcanism can be found, but some examples are given to show that the distribution of volcanic activity can throw light on the nature of earth movements. Steep fractures and faults under tensile stress favor the rise and escape of magmas. It is also becoming more and more evident that horizontal shifting along shear planes, developed by rotational stress acting in a horizontal plane, plays an important part in structural geology; if the fault planes are not tightly closed and reach the magma at depth, volcanic activity may be connected with them.

The lack of young volcanism in the Andean chain in north and central Peru is attributed to the influence of the Brazilian mass, which prevents the appearance of fractures, whereas in parts of the chain where tension can be expected (as in southern Peru) there is strong volcanism. Several other examples are given of where volcanic activity is related to tension in the crust. — D.B.V.

190-606. Bullard, Fred M. *Volcanoes—in history, in theory, in eruption*: Austin, Texas, Univ. of Texas Press, 441 p., 1962.

Present knowledge of volcanoes is summarized in nontechnical language, and some of the important volcanoes and volcanic regions of the earth are described as examples of the various types of volcanoes. The text is divided into three parts—facts and fiction about volcanoes; types of volcanic eruptions; and theory, cycles, and utilization of volcanoes. The book is well illustrated and includes a glossary of terms and a bibliography of approximately 150 entries. — V.S.N.

190-607. Gorshkov, G. S. Determination of the explosion energy in some volcanoes according to barograms: *Bull. Volcanol.*, v. 23, p. 141-144, 1960.

The most convenient and perhaps most precise method of determining the energy of explosive volcanic eruptions, that based on barograph records, is described briefly and some examples of its application are given. It is recommended that all volcanological stations and observatories be equipped with barographs and microbarographs, the former to record the air waves from violent local explosions and the latter to record weak local and violent remote ones. — D.B.V.

190-608. Richter, Donald H., Moore, James G., and Haugen, Robert T. Recent growth of Halemaumau, Kilauea Volcano, Hawaii: *Art. 20, in U.S. Geol. Survey Prof. Paper 450-B*, p. B53-B-56, 1962.

Halemaumau, a circular crater in the summit caldera of Kilauea Volcano, is the principal site of Kilauea's summit activity and is believed to overlie the

main magma conduit to the summit. A study of the crater's growth during the period 1928 to 1961 by slides and rockfalls off its precipitous and highly fractured walls is presented, based on mapping and measurement of the cracks around Halemaumau's rim. Long line measurements on the rim indicate that the opening of peripheral cracks, and hence growth of the crater, accelerates during detumescence of the volcanic dome. It is quite likely that the withdrawal of magma from beneath the summit area, resulting in removal of vertical support, may also substantially reduce lateral support at the base of the crater and initiate crack opening. Strong local earthquake activity accompanying detumescence is another factor that may be important.— V.S.N.

- 190-609. Ault, Wayne U., Richter, Donald H., and Stewart, David B. A temperature measurement probe into the melt of the Kilauea Iki lava lake in Hawaii: *Jour. Geophys. Research*, v. 67, no. 7, p. 2809-2812, 1962.

In October 1961 a hole was drilled through the 35-ft crust on Kilauea Iki lava lake, and a hollow stainless steel-mullite probe containing a thermocouple was forced 4 feet into the underlying melt. Observations made during emplacement of the probe permit the base of the crust to be identified as the 1,065°C isotherm. The maximum temperature measured in the molten lava was 1,106°C. The thermal gradient in the liquid was 5°C per ft, and the cooling rate for a 22-day period was 0.5°C per day at a depth of 39.2 feet. After the first 8.1 months, the average rate of crustal thickening for a 13.3-month period was 0.94 ft per month.— Authors' abstract

- 190-610. Macdonald, Gordon A. Prediction of eruption of Hawaiian volcanoes: *Bull. Volcanol.*, v. 23, p. 211, 1960.

Prediction of Hawaiian eruptions is based primarily on the interpretation of seismic and ground tilt records. If the volcano is in swollen condition and continues to swell, a large number of shallow earthquakes is highly suggestive, if not definitely indicative, of imminent eruption. The focus of the shocks indicates the location of the eruption, sometimes very closely. The time of outbreak still cannot be predicted except in a rather general manner, but sometimes can be predicted within a few days. Summit eruptions of Mauna Loa and Kilauea are preceded by a less definite pattern of earthquakes than are flank eruptions, and are thus harder to predict. No regular cycle of activity has been recognized in Hawaii, nor can any definite correlation be found with astronomical and tidal cycles.— D.B.V.

- 190-611. Ives, Ronald L. Dating of the 1746 eruption of Tres Virgenes volcano, Baja California del Sur, Mexico: *Geol. Soc. America Bull.*, v. 73, no. 5, p. 647-648, 1962.

The most recent eruption of Tres Virgenes Volcano, Baja California del Sur, Mexico, is dated as late May or early June 1746, by the contemporary map and itineraries of Ferdinando Consag, S. J. Probable existence and locations of other confirmatory documents are indicated.— Author's abstract

- 190-612. Richards, Adrian F. Geology of the Islas Revillagigedo, Mexico. 1. Birth and development of Volcano Bárcena, Isla San Benedicto: *Bull. Volcanol.*, v. 22, p. 73-123, 1959.

On August 1, 1952, the volcano Bárcena was born on San Benedicto Island, about 300 nautical miles off the west coast of Mexico. A pyroclastic cone nearly 1,100 feet above sea level was formed by August 2. By mid-September cone formation had ceased and a lava plug capped the magma conduit in the crater. Early in November activity was resumed and blocky, soda trachyte lava formed two domes in the crater. On December 8 lava flowed through the base of the volcano and formed a delta nearly half a mile out to sea by the end of February

1953. All activity except solfataric steaming stopped by that time.

During the period of cone formation, glowing clouds (volcanic density flows) descended the cone. As the expulsion of ash and steam decreased in early September 1952, the exterior of the cone is believed to have been furrowed by these avalanches. The index of explosiveness of Bárcena is 90 percent, the highest of any known oceanic volcano in the eastern Pacific. About 10,500 million cubic feet (300 million m^3) of tephra and lava were erupted during the activity (see also Geophys. Abs. 168-323).— D.B.V.

190-613. Jolivet, J. Surveillance géophysique des volcans des Antilles Françaises. Possibilités de prévision et de contrôle des éruptions [Geophysical surveillance of the volcanoes of the French Antilles. Possibilities of prediction and control of eruptions]: Bull. Volcanol., v. 23, p. 31-44, 1960.

Plans for geophysical surveillance of the volcanoes on Martinique and Guadeloupe are described. The seismograph will be the basic tool; each station will be equipped with three three-component systems of different periods and magnifications (1-sec period with maximum magnification of 20,000; several-sec period with maximum magnification of 2,000; and long-period with maximum magnification of 200). In normal periods the maximum magnification will be used, but in periods of alert the magnification will be reduced and the recording speed stepped up.

Geochemical surveys of fumarole gases will supplement the seismograph observations. At present there are no plans for magnetic or gravity surveys. It is hoped that eventually it will be possible to predict glowing cloud eruptions several days in advance; the determination of their direction, however, will be a much more difficult matter.— D.B.V.

190-614. Thorarinnsson, Sigurdur. On the predicting of volcanic eruptions in Iceland: Bull. Volcanol., v. 23, p. 45-52, 1960.

Two lines of investigation are being pursued in Iceland in an attempt to predict volcanic eruptions. The past behavior of individual volcanoes is being studied on the basis of historical records and of tephrochronological and other geological evidence. Geophysical methods, the more reliable way, are beginning to be used but resources are still limited.— D.B.V.

190-615. Machado, Frederico. Secular variation of seismo-volcanic phenomena in the Azores: Bull. Volcanol., v. 23, p. 101-108, 1960.

Some correlation is found between the past behavior of volcanoes in the Azores, sunspots, and earth tides that might aid in predicting eruptions. There also is evidence that buckling of the thin roof of magma chambers may be the mechanism responsible for eruptions and their accompanying earthquake swarms; in that case, geodetic control of adjacent regions probably will be decisive in forecasting volcanic activity.— D.B.V.

190-616. Nature. Royal Society Expedition to Tristan da Cunha—preliminary report: Nature, v. 194, no. 4834, p. 1119-1122, 1962.

A Royal Society expedition was sent to Tristan da Cunha to examine the new volcano, to make a geologic survey of the Tristan da Cunha group, and to investigate the effect of the present volcanic activity on the flora and fauna of the island. The eruption occurred on the settlement plateau near the foot of the volcano, centered about 300 yards east of the settlement. It was preceded by a series of tremors beginning on August 6, 1961, sometimes of about force 5 or 6 and highly localized. On October 9 rifts 200 yards long and 2 yards apart opened up parallel to the coastline, with the seaward side uplifted about 30 feet. At about 2 a.m. that night a red glow was observed, and the next morning a mound of solid incandescent lava appeared; in four days this dome reached a

height of 250 feet, began to expand northward, and emitted a stream of lava that carried away the seaward wall of the dome. Within the horseshoe-shaped crater thus formed, a central cone was built up by pyroclastic activity and a lava stream poured northward to the sea. The seaward front of the lava field was about 1,300 yards long, 900 yards from the source, and in places as much as 500 yards beyond the former coastline; the lava was up to 80 feet thick.

The emission of lava had ceased when the expedition arrived on January 27; by the end of February the red glow from the central cone and from cracks in the congealed lava had also died out. After January the chief change was extrusion of a large dome of solid lava about 260 yards long and more than 100 yards wide, to 100 feet above the surrounding lava. By mid-March this up-doming had ceased and emission of vapor was greatly reduced. Intensive erosion of the seaward edge of the lava field had already occurred.— D.B.V.

- 190-617. Ferreira, H. Amorim. Notice sur deux manifestations récentes d'activité volcanique dans le territoire de Portugal [Report on two recent manifestations of volcanic activity in Portuguese territory]: Bull. Volcanol., v. 23, p. 73-75, 1960.

The eruption on Fogo in the Cape Verde Islands that began in June 1951 and that of Capelinhos on Fayal in the Azores are reported briefly, and a list of references so far published is given for each.— D.B.V.

- 190-618. Zbyszewski, G. L'éruption du volcan de Capelinhos (Île de Faial, Açores) [The eruption of Capelinhos Volcano Fayal Island, Azores]: Bull. Volcanol., v. 23, p. 77-100, 1960.

This is essentially the same as the paper published in the Internat. Geol. Cong., 21st, Copenhagen 1960, Proc., pt. 26, p. 108-115, 1961 (see Geophys. Abs. 189-618). The latter, written a year later, contains additional remarks. This version includes a folded insert graph showing day-to-day intensity of activity from October 1957 through the end of activity in October 1958.— D.B.V.

- 190-619. Berg, E., and Janssen, T. Microséismes et séismes précédant l'éruption du Nyamuragira-Kitzimbanyi (Afrique centrale) 1958 [Microseisms and earthquakes preceding the Nyamuragira-Kitzimbanyi eruption (central Africa) in 1958 (with English abstract)]: Bull. Volcanol., v. 23, p. 63-68, 1960.

Microseismic and seismic activity in the three months prior to the 1958 eruption in the Virunga volcanoes in the Western Rift Valley of Africa has been analyzed. It is believed that it would have been possible to predict the eruption about 30 hours beforehand with a precision of 10 percent in time on the basis of two series of small earthquakes that began some 50 hours before the two outbreaks, if the law governing the exponential decay of the total number of shocks had been known. This conclusion is valid only for the 1958 eruption and should be tested in other cases.— D.B.V.

- 190-620. Gèze, Bernard. L'utilisation des volcans pour accroître la pluviosité dans le Sahara est-elle utopique? [Is the use of volcanoes to increase the rainfall in the Sahara utopian?]: Bull. Volcanol., v. 23, p. 213-217, 1960.

Volcanic eruptions introduce substantial amounts of water vapor into the atmosphere; the decline in volcanism in the Sahara region is thus related to the general decrease in humidity. The idea of activating dormant volcanoes (such as the Tousside of the Tibesti group) by means of nuclear explosions in order to increase rainfall might not be too fantastic.— D.B.V.

- 190-621. Imbò, G[iuseppe]. Quelques phénomènes accompagnant les phases préliminaires de manifestations éruptives du Vésuve et les rela-

tives possibilités de prévisions [Some phenomena accompanying the preliminary phases of eruptive manifestations of Vesuvius and the relative possibilities of predictions]: *Bull. Volcanol.*, v. 23, p. 55-61, 1960.

The paroxysms of Vesuvius are divided into two categories, those preceded and those not preceded by oscillations in ground inclination at the Vesuvius observatory. Mareographic oscillations of about the same period registered at Ischia, Naples, and Civitavecchia during the 1900, 1906, and 1944 eruptions suggest a common cause. Oscillations of magma in the reservoir, having a period of about 90 min, can explain all the phenomena observed.— D.B.V.

190-622. Bernstein [Bernshteyn], V. A. On magnetometric investigations in vicinity of volcanoes: *Bull. Volcanol.*, v. 23, p. 129-133, 1960.

This summarizes the results of magnetic studies on Klyuchevskaya and Zavaritskiy volcanoes in Kamchatka, previously published in Russian in *Akad. Nauk SSSR Lab. Vulkanologii Byull. Vulkanol. Sta. no. 28*, p. 58-78, 1959, and no. 30, p. 69-74, 1960 (see *Geophys. Abs.* 182-432, 186-529).— D.B.V.

190-623. Naboko, S. I. Change in the fumarole regime of Klyuchevsky volcano: *Bull. Volcanol.*, v. 23, p. 135-140, 1960.

The relation of fumarolic activity in lateral craters to eruptions of Klyuchevskaya has been investigated on the basis of systematic observations on cinder cones, lava flows, and lateral craters formed in seven eruptions from 1932 to 1956, including some 300 gas analyses. Gases emanating from fresh lava at the surface are enriched in HCl and HF; those emanating from explosion craters where lava does not reach the surface are largely sulfuric-carbonic. The composition of the gases changes with time from haloid through sulfuric to carbonic, or from sulfuric to carbonic in the latter case.

Increases of temperature and gas concentration in old fumaroles in lateral craters often coincided with increased activity in the main crater or with the formation of new lateral craters, but in other cases the fumarolic regime did not reflect increased volcanic activity. Changes in fumarolic activity appear to be caused by seismic activity (landslides and fissuring of the lateral cones facilitates the emanation of gases and oxidation reactions); however, not all of the seismic activity in the area is related to eruptions.— D.B.V.

190-624. Vlodavetz [Vlodavets], V. I. Principes de la division régionale volcanique en U.S.S.R. [Principles of the volcanic regionalization in the U.S.S.R.]: *Bull. Volcanol.*, v. 23, p. 145-149, 1960.

A program of volcanic regionalization is in progress in the U.S.S.R., to define zones near active volcanoes that are quite dangerous or relatively dangerous to life and property. The factors taken into consideration are: (1) category of the volcano (known to be active, or doubtful); (2) its present state; (3) structure of the volcano and nature of the rocks forming it; (4) nature of past activity; (5) geophysical data; (6) relief of the volcano and its environs; and (7) climatic conditions. Maps based on these considerations should show not only the dangerous areas, but also possible routes of lava flows, agglomerate flows, glowing clouds, or mud flows, and evacuation routes from populated areas.— D.B.V.

190-625. Naboko, S. I. U podnozh'ya ognedyshashchikh gor [At the foot of volcanoes]: *Priroda*, no. 11, p. 61-69, 1959.

A popular account is given of the establishment, organization, and activities of the Kamchatka Volcanological Station (1935-60). Eruptions of Klyuchevskaya, Sheveluch, Avacha, and Bezymyanny volcanoes are briefly described. Seismic surveys indicate a lens-like body of magma 50-60 km beneath Klyu-

chevskaya Volcano. The lens is 10-12 km thick and 30 km in diameter, having a volume of 3,000-5,000 sq km. The negative magnetic anomaly extending from the top to the foot of Klyuchevskaya Volcano can be explained by the presence of magma in crevices through magnetic rocks. The rocks heated by the magma above the Curie point lose their magnetism and form the observed negative anomaly. The applied research of the station is directed toward prediction of volcanic eruptions and utilization of superheated thermal springs for generation of power.—A.J.S.

- 190-626. Yoshikawa, Keizo. On the crustal movement accompanying with the recent activity of the Volcano Sakurajima (pt. 2): Kyoto Univ. Disaster Prevention Research Inst. Bull., no. 50, 26 p., 1962.

Routine observations of Sakurajima Volcano by tiltmeter and extensometer at Hakamagoshi Observatory, 5.6 km WNW of the crater, and at Hi Yamizu Observatory in Kagoshima City, 11 km WNW of the crater, are discussed. The results are compared with the precise leveling results reported previously (see Geophys. Abs. 189-621). It was found that the variation of discharge of volcanic energy during this active period increased with time and the harmonic variation of crustal deformation at Hakamagoshi is related to the variation in permeation of sea water with the ocean tide. Observations on crustal movements of the volcano are observed more accurately at Hi Yamizu because the movements of the active fault on which Hakamagoshi is located become so predominant at times that the overall movements of the volcano are unrecognizable. Abnormal tilt in a particular direction and abnormal contraction in a vertical direction are usually observed several days before an eruption and, therefore, may be considered as clues to an eruption.—V.S.N.

- 190 627. Morimoto, R[yohei]. Submarine eruption of Myojin Reef: Bull. Volcanol., v. 23, p. 151-160, 1960.

This is a description of the submarine eruption of Myojin Reef, 420 km south of Tokyo in 1952-53, and of the dacite found embedded in wreckage of the No. 5 Kaiyo-maru, the observation vessel that was destroyed with all aboard by an explosion of the volcano on September 24, 1952. (See also Geophys. Abs. 165-384, 168-315, 183-595.)—D.B.V.

- 190-628. Alcaraz, Arturo. Tilt measurements in Philippine volcanic areas: Bull. Volcanol., v. 23, p. 161-179, 1960.

This paper presents the results obtained in the first year of a program of tilt measurements that was initiated in the vicinity of Mayon and Hibok-Hibok volcanoes in the Philippines in 1957. As there was no unusual activity at either volcano in the period in question, the data do not warrant drawing any new inferences concerning the relation of ground tilt to volcanic activity.—D.B.V.

- 190-629. Neumann van Padang, M. Measures taken by the authorities of the Vulcanological Survey to safeguard the population from the consequences of volcanic outbursts: Bull. Volcanol., v. 23, p. 181-192, 1960.

The Vulcanological Survey in the former Dutch East Indies had its inception after the eruption of Kelud in 1919. Seven volcanoes were guarded continuously, five that had caused catastrophes and two that were visited by many tourists. Maps were drawn for each volcano showing regions that would be in greatest danger in case of an eruption, and warning systems were set up for individual volcanoes. At Kelud, where mud flows due to displacement of water in the crater lake had killed thousands as a result of eruptions that in themselves were minor and lasted only a few hours, the crater was pierced and drained of most of its water; the 1951 eruption proved that the drainage tunnel served its purpose, as damage was caused chiefly by ejected material and limited to the vicinity of the crater.—D.B.V.

- 190-630. Healy, J[ames], and Tazieff, H[aroun]. Surveillance des volcans actifs du Nouvelle-Zélande [Surveillance of the active volcanoes of New Zealand]: Bull. Volcanol., v. 23, p. 193-195, 1960.

North Island of New Zealand has a rift zone in which are located several active volcanoes and other areas where volcanic activity, although not recorded in history, has occurred in comparatively recent times. The city of Auckland is in an area of scattered basalt cones that range in age from 30,000 to only 750 yr. The last eruption of Mount Egmont in the heart of the New Plymouth district has been dated as 360 yr ago, and rumbling noises were heard in the vicinity twice in recent years. Seismographs have been or are being installed in the vicinity of the active volcanoes in Tongariro National Park, but in general the volcano surveillance program is yet to be developed.—D.B.V.

- 190-631. Aubert de la Rüe, E. Les manifestations actuelles du volcanisme aux Nouvelles Hébridés (Mélanésie) [The present manifestations of volcanism in the New Hebrides (Melanesia)]: Bull. Volcanol., v. 23, p. 197-205, 1960.

About 10 of the 60 or so principal volcanoes of the New Hebrides Archipelago have shown signs of activity since the discovery of the islands in 1774, not counting submarine volcanoes. Masum on Ambrym island is the most imposing volcano in the group; it resembles Etna in its activity, with strombolian explosions in the central crater that sometimes become vulcanian in intensity, occasionally emitting lava from peripheral fissures. Intensive explosions occurred in 1951, 1952, and 1953. Iahue Volcano on Tanna island is noted for incessant and regular strombolian activity, and does not appear to pose a threat to the immediate vicinity. Lopevi is an island cone that shows intermittent strombolian activity, with moderate explosions and occasional lava flows from the central crater and radial fissures. Eruptions occurred in 1864, 1874, 1893, 1902, and 1939. Vanua Lava and Aoba islands show solfataric activity, and there are hydrothermal manifestations on Lacona and Tongoa. In addition, 5 or 6 submarine volcanoes have erupted intermittently.—D.B.V.

- 190-632. Blot, C., Chaigneau, M., and Tazieff, H[aroun]. Nouvelles Hébridés (mars-mai 1959) [New Hebrides (March-May 1959)]: Bull. Volcanol., v. 23, p. 207-209, 1960.

An expedition to the New Hebrides volcanoes collected gas samples on Ambrym island and made a magnetic profile across the volcano on Tanna island and also obtained some seismic records there. Although the hostility of the natives interfered with much of the work, the results are encouraging and it is hoped that permanent seismic observatories will be installed at the New Hebrides volcanoes.—D.B.V.

- 190-633. Ducrot, M[arcel]. Le volcan actif de l'Île de la Réunion. Surveillance et étude de l'activité. Possibilités d'utilisation de l'énergie émise [The active volcano of Reunion Island. Surveillance and study of the activity. Possibilities of utilization of the energy released]: Bull. Volcanol., v. 23, p. 109-120, 1960.

Activity of Piton de la Fournaise, an active volcano that occupies one third of the area of Reunion Island, has generally been strombolian in character, possibly was hawaiian at times in the past, and in 1766, 1812, and 1860 was ultravulcanian. The duration of eruptions has varied from a few hours to six months, with an average of two months. Intensity has likewise varied; in the second 1953 eruption, 1,000,000 m³ of material were ejected to heights of as much as 500 m and 15,000,000 m³ of lava flowed at a rate of 26,250 m³ per hr.

In 1956 a program of systematic surveillance of the volcano was initiated to protect the population. So far this consists mainly of watching for changes

in the rate, character, or location of emissions during periods of quiescence, and very detailed observations during periods of paroxysmal activity. The possibilities of using volcanic gases as sources of energy, at least in isolated places, is discussed (see also Geophys. Abs. 176-368).—D.B.V.

- 190-634. Gorshkov, G. S. Some results of seismometric investigations at the Kamchatka Volcanological Station: *Bull. Volcanol.*, v. 23, p. 121-128, 1960.

The formation of new lateral craters on Klyuchevskaya Volcano in Kamchatka is preceded by a swarm of volcanic earthquakes. In 1948, however, no eruption followed an intensive swarm. Usually the force of these earthquakes is proportional to the intensity of the subsequent eruption, and their epicenter lies where the new crater subsequently forms. Data are as yet insufficient to determine whether summit eruptions can also be predicted from the seismic records.—D.B.V.

- 190-635. Kamo, Kosuke. Nature of the volcanic micro-tremors at the Volcano Aso, part 1. Observation of a new type of long-period micro-tremors by long-period seismograph: *Kyoto Univ. Disaster Prevention Research Inst. Bull.*, no. 54, 16 p., 1962.

A new type of volcanic microtremor with a period of 40-55 sec has been detected at Aso Volcano with a long-period seismograph. This tremor is closely related to volcanic activity and, in this respect, is similar to the tremor of 3.5-7.0 sec identified by Sassa (1936). It begins to appear when the amplitude of the 3.5-7.0 sec tremor is large and decreases before an eruption as do all types of volcanic microtremors identified at Aso.—V.S.N.

- 190-636. Kamo, Kosuke. Nature of the volcanic micro-tremors at the Volcano Aso, part 2. Some natures of the volcanic microtremors of the 1st kind at the Volcano Aso: *Kyoto Univ. Disaster Prevention Research Inst. Bull.*, no. 55, 13 p., 1962.

Tripartite observations were made at Aso Volcano with horizontal seismographs to determine the velocity and direction of propagation of Sassa's (1935) 1st kind of microtremors. Observations were made also with three component seismographs to examine the oscillatory modes of the tremors. It is confirmed that this type of tremor is generated near or at the crater. The period is predominantly in the 0.8-2.0 sec range and the propagation speed (phase velocity) is about 1.2-1.35 km/s. The distribution of oscillatory modes in the caldera is compatible with the mechanism suggested by Sassa; a close relation exists between the oscillatory mode and the trend of a valley or cliff near an observing station, that is, the long axis predominates along the trend of valley or cliff.—V.S.N.

Nekhoroshev, A. S. To the problem of the methods for determining the presence of volcanic vapours at depth. See *Geophys. Abs.* 190-336.

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