Geophysical Abstracts 184 January-March 1961

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

GEOLOGICAL SURVEY BULLETIN 1146-A

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1961

UNITED STATES DEPARTMENT OF THE INTERIOR

STEWART L. UDALL, *Secretary*

GEOLOGICAL SURVEY

Thomas B. Nolan, *Director*

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C. Price 40 cents (single copy). Subscription price: $1.75 a year; 50 cents additional for foreign mailing. Use of funds for printing this publication has been approved by the Director of the Bureau of the Budget (June 23, 1960).

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INTRODUCTION

Extent of Coverage

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

Abstracts are prepared only of material that is believed to be generally available. Ordinarily abstracts are not published of material with limited circulations (such as dissertations, open-file reports, or 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 175 (October-December 1958, Bulletin 1086-D) have been compiled into a single list, which may be obtained by writing to the U. S. Geological Survey, Washington 25, D. C.

Supplements to this master list have been published in each issue since Geophysical Abstracts 175. The following is an additional supplement that lists references cited in Geophysical Abstracts 184 that have not been listed previously.

Arizona Geol. Soc. Digest—Arizona Geological Society Digest. Tucson, Arizona.

Geog. Rundschau—Geographische Rundschau [Geographical Review]. Georg Westerman Verlag. Braunschweig, German Federal Republic.

Geol. Gesell. Ber. —Berichte der Geologischen Gesellschaft in der deutschen demokratischen Republik für das gesamtgebiet der geologischen Wissenschaften [Reports of the geological society of the German Democratic Republic for the entire field of geological sciences]. Berlin, German Democratic Republic.

Hokkaido Univ. Faculty Sci. Jour. —Journal of the Faculty of Science, Hokkaido University. Sapporo, Japan.

Impact—Impact of science on society. United Nations Educational, Scientific and Cultural Organization. Paris, France.

Nat. Sci. and Mus. —Natural Science and Museums. National Science Museum. Tokyo, Japan.

Problemy Geokhimii—Problemy Geokhimii [Problems of Geochemistry]. L'vovskiy Gosudarstvennyy Universitet. L'vov, U. S. S. R.

Research Appl. Industry—Research Applied in Industry. Butterworths Scientific Publications. London, England.

Royal Geol. Soc. Cornwall Trans. —Transactions of the Royal Geological Society of Cornwall. Penzance, England.

Univ. Indonesia, Inst. Technology Bandung, Dept. Geology Contr. —Contributions from the Department of Geology, Institute of Technology Bandung, University of Indonesia. Bandung, Indonesia.

Yorkshire Geol. Soc. Proc. —Proceedings of the Yorkshire Geological Society. Hull, England.

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 H. Faul, A. J. Shneiderov, and J. H. Swartz, 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

184-1. Wetherill, G[eorge] W. Age of the base of the Cambrian: Nature, v. 187, no. 4731, p. 34-35, 1960.
Holmes, Arthur. Age of the base of the Cambrian: ibid, p. 35-36, 1960.

Wetherill draws attention to some problems existing in the determination of the base of the Cambrian and shows that the data used by Holmes in establishing the revised date of 600±20 million years, based on absite from pegmatites overlain by the Adelaide series in South Australia and on uraninite from Katanga do not yield a firm maximum age for the base of even the Middle Cambrian.

Holmes claims that Wetherill overrates some of the difficulties and exaggerates their geochronological consequences. The provisionally adopted figure of 600±20 million years was a reasonable estimate in the light of evidence then available; it should not be regarded as established fact. Disagreement over interpretation of inconclusive data is of minor significance in view of age determinations on Lower Cambrian and Upper Cambrian glauconites of some other areas. One particularly valuable set of results is from the relatively undisturbed Russian platform—recalculated using decay constants that correspond with American and British practice, the value obtained for the Lower Cambrian is 566×10^6 yr and that for the Upper Sinian, separated from it by only a slight unconformity, is $692\text{-}701 \times 10^6$ yr. — D. B. V.

184-2. Clark, David L. U-Pb age determination and Upper Devonian biostratigraphy: Geol. Soc. America Bull., v. 72, no. 1, p. 163-165, 1961.

Physical and biological evidence suggests that the minimum age of the Devonian-Mississippian boundary is about 335-340 million years. The figure of 350 million years of Cobb and Kulp (see Geophys. Abs. 181-28) is not a minimum but a maximum figure for this boundary. As 10-15 million years is within the range of reliability of the uranium-lead sample, this does not radically change the significance of the 350-million-year date; it simply emphasizes the importance of biostratigraphic understanding in the application of geochemical dates to the stratigraphic section. — D. B. V.

184-3. Tilton, G[eorge] R., and Davis, G. L. Geochronology, in Researches in geochemistry: New York, John Wiley and Sons, p. 190-216, 1959.

The accomplishments of geochronology with respect to geological problems are reviewed. The reliability of the isotopic methods of age determination is evaluated briefly, and some new investigations and their application are discussed. Particular attention is being given to tracing orogenic belts in time and space in order to evaluate the role of orogenies in the development of the continents. It is concluded that confidence in age determinations is justified when two different methods give the same result for a mineral or mineral assemblage; it is most satisfactory when agreement exists between the mica and the uranium-lead ages. For granites this agreement indicates time of crystallization of the granite as a whole. The frequent occurrence of unexpected results indicates that our knowledge of many phenomena concerning rocks and minerals needs improvement. — V. S. N.

184-4. Giletti, B[runo] J., and Lambert, R. St. J. Radioisotopes in the dating of geological and archaeological events: Research Appl. Industry, v. 12, no. 10/11, p. 368-373, 1959.

Methods for determining the age of geological and archeological events using radio isotopes are reviewed. The C^{14} method as applied to events up to 70,000 yr is described. The U-Th-Pb, K-Ar, and Rb-Sr decay schemes are discussed in terms of their use in dating geological events that are millions or thousands of millions of years old. The apparent ages of various parts of the crust are shown on a world map. — J. W. C.

Farley, Thomas A. Half-period of Th^{232}. See Geophys. Abs. 184-513.

184-5. Sobotovich, E. V. Vystupleniye E. V. Sobotovicha [Address of E. V. Sobotovich]: Akad. Nauk SSSR, Dom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 88-90, 1958 (1960).

A method for determining primary and radiogenic lead is proposed on the assumption that the magma contained lead in a single form during differentiation and solidification and that the lead remained isotopically identical in all the rock-making minerals, provided the time of solidification was small compared with the age of the rock. The following system of equations is proposed: $a+\gamma x=d$; $a'+x=d'$; and $a/a'=\lambda$, where d and d' are the measured quantities of any lead isotope except Pb^{204} in two minerals; a is the quantity of primary lead in the first mineral, x is the radiogenic isotope admixture, a' and x' are the same quantities in the second mineral, λ is the ratio of Pb^{204} in the first to that in the second mineral, and γ is the ratio of the quantity of radioactive element in the first mineral to that in the second. The primary isotopes sought in the first and the second minerals are then given by the equations: $a'=(d-\gamma d')/(\lambda-\gamma)$, and $a=\lambda a'$. — A. J. S.

184-6. Norbutt, K. I., Bespalova, I. D., Laputina, I. P., Kardakov, K. A., and Samoylov, G. P. Izotopicheskiy sostav rudnogo svintsa i vozrast mineralov, soderzhashchikh U, Th, i Pb po mass-spektrometricheskim i rentgeno-spektral'nym dannym [Isotopic composition of lead ore and the age of minerals containing U, Th, and Pb according to mass spectrometry and X-ray-spectrum methods]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 250-265, 1958 (1960).

The X-ray-spectrum method of absolute age determination of uranium and thorium minerals can be used successfully for monazite and uraninite, but cannot be applied to pitchblende, brannerite, and samarskite unless mass spectroscopic analysis of the lead is made independently. The absolute ages of a large group of minerals from various regions of the U. S. S. R. obtained by the X-ray spectrum and of some minerals by the lead-isotope method are given. — A. J. S.

184-7. Fanale, Fraser, and Kulp, J. L[aurence]. Helium in limestone and marble: Am. Mineralogist, v. 46, no. 1-2, p. 155-167, 1961.

The helium and uranium contents of a number of specimens of marble, Iceland spar, and fossil shell of known age have been determined. The gross helium retentivity in calcite is small and highly variable, indicating that most of the uranium is external to the lattice. An excess of helium in the marbles over the amount calculated from the age and alpha activity is attributed to fluid inclusions containing gases present in the metamorphic environment. It is concluded that the helium method is not a practical geochronometer for carbonates. — D. B. V.

184-8. Hurley, P[atrick] M., Cormier, R. F., Hower, J., Fairbairn, H[arold] W., and Pinson, W[illiam] H., Jr. Reliability of glauconite for age measurement by K-Ar and Rb-Sr methods: Am. Assoc. Petroleum Geologists Bull., v. 44, no. 11, p. 1793-1808, 1960.

Age measurements on 38 glauconites by the K-Ar and Rb-Sr methods show a consistent variation with geologic age with a small scatter. The results appear to fall 10-20 percent short of ages measured on micas of associated dated igneous rocks. The K-Ar and Rb-Sr ages are closely concordant in the majority of samples.

It is concluded that there is some consistent mechanism acting to lower the age of glauconites. This mechanism may be related to diagenetic modifications in the structure of the glauconitic material, and this process may continue with time. Superimposed on this rather uniform process is a variability due in part to occluded detrital grains of muscovite, or to argon loss by diffusion in samples deeply buried in folded sedimentary sections.

The factors influencing glauconite ages may be universally constant enough to permit the use of an empirical glauconite time scale for limited purposes. — D. B. V.

184-9. Polevaya, N. I., Kazakov, G. A., and Murina, G. A. Glaukonity kak indikator geologicheskogo vremeni [Glauconites as an indicator of geologic time]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 419-429, 1958 (1960).

Results of argon age determinations on 40 glauconite-bearing rocks from the U. S. S. R. and Czechoslovakia are reported. The various methods of separation of glauconite into monomineralic fractions have different effects on the argon and potassium in the sample. Mechanical and magnetic means are preferred rather than use of heavy liquids that contain potassium or thallium. — A. J. S.

184-10. Amirkhanov, Kh. I., Brandt, S. B., Bartnitskiy, Ye. N., Gurvich, V. S., and Gasanov, S. A. K voprosu o sokhrannosti radiogennogo argona v glaukonitakh [Problem of retention of radiogenic argon in

glauconites]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 202-207, 1957 (1960).

This is the same as the paper previously published in Akad. Nauk SSSR Doklady, v. 118, no. 2, p. 328-330, 1958 (see Geophys. Abs. 172-12). — J. W. C.

184-11. Damon, Paul E., Hedge, Carl E., Taylor, Omer J., and Halva, Carroll. Radiometric determination of potassium in silicates: Arizona Geol. Soc. Digest, v. 3, p. 75-80, 1960.

A radiometric method for potassium analysis which requires no chemical preparation is described. The method, developed at Columbia University and further tested in the geochronology laboratories of the University of Arizona, involves alpha- and beta-counting of a powdered sample. The beta count, which may be taken with or without a 5 mil aluminum absorber to eliminate soft beta particles from Rb^{87}, is reduced by an empirical correction for the betas resulting from the uranium and thorium series. The alpha count, due only to the uranium and thorium series, determines the magnitude of this correction. The resulting beta count is compared with a standard sample of potassium to determine the potassium content.

The average difference of the radiometric values from other methods for samples containing > 1.5 percent potassium is approximately 2.7 percent; this is about equal to the average standard deviation computed from statistical considerations. The error rises rapidly for samples containing < 1.5 percent. It is concluded that the alpha-beta radiometric method for determining potassium is very reliable and is apparently as precise as the methods used for comparison. — V. S. N.

184-12. Vorsin, A. N. Radiochastotnyy mass-spektrometr dlya opredeleniya absolyutnogo vozrasta gornykh porod po kaliy-argonovomu metodu [Radiofrequency mass spectrometer for determination of absolute age of rocks by the potassium-argon method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 265-267, 1957 (1960).

A new radiofrequency mass spectrometer of the Bennett type for determination of argon isotopes in rocks is described. The resolving power is about 30. Another such instrument with a resolving power of 100 is being designed. — A. J. S.

184-13. Amirkhanov, Kh. I., Brandt, S. B., Ivanov, V. S., and Truzhnikov, M. S. O metodike mass-spektrometricheskogo opredeleniya radiogennogo argona v gornykh porodakh [On the method of mass-spectroscopic determination of radiogenic argon in rocks]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 287-293, 1957 (1960).

Experience in using the MC-2M mass spectrometer for age measurements on sedimentary and igneous rocks by the potassium-argon method is discussed. The spectrometer contains more than 100 electronic tubes and a high vacuum apparatus. Damage that occurred during the 3-year operation (more than 1,000 determinations) of MC-2M is analyzed and improvements are suggested. The accuracy of the method ranges within 6-12 percent error depending on the age of the rock. — A. J. S.

184-14. Krylov, A. Ya., and Silin, Yu. I. Znacheniye argon-kaliyevogo otnosheniya v osadochnykh i metamorficheskikh porodakh [The meaning of the argon-potassium ratio in sedimentary and metamorphic rocks]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 292-311, 1958 (1960).

This is virtually the same as the paper published in Akad. Nauk SSSR, Izv. Ser. Geol., no. 1, p. 56-66, 1960 (see Geophys. Abs. 182-12). — A. J. S.

184-15. Murina, G. A., and Sprintsson, V. D. K voprosu o migratsionnoy sposobnosti kaliya i argona [Problem of migratory capability of potassium and argon]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 343-349, 1958 (1960).

Migration of potassium and argon in feldspars and micas was studied. The Ar^{40} content in the minerals investigated decreased at a slower rate than that of K^{40}. The Ar^{40}/K^{40} ratio was found to change by 2.5-3.0 percent in micas, and by 8-30 percent in feldspars. — A. J. S.

184-16. Amirkhanov, Kh. I., Brandt, S. B., Bartnitskiy, Ye. N., Gasanov, S. A., and Gurvich, V. S. O mekhanizme poter' radiogennogo argona v slyudakh [On the loss mechanism of radiogenic argon in micas]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 350-356, 1958 (1960).

This is the same as the paper previously published in Akad. Nauk SSSR, Izv. Ser. Geol., no. 3, p. 104-107, 1959 (see Geophys. Abs. 177-15). — A. J. S.

184-17. Amirkhanov, Kh. I., Brandt, S. B., and Bartnitskiy, Ye. N. K opredeleniyu absolyutnogo vozrasta kaliyevykh polevykh shpatov argonovym metodom [Determination of the absolute age of potassium feldspars by the argon method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 357-360, 1958 (1960).

This is the same as the paper previously published in Akad. Nauk SSSR, Izv. Ser. Geol., no. 11, p. 110-112, 1958 (see Geophys. Abs. 176-10). — A. J. S.

184-18. Rubinshteyn, M. M. K voprosu poter' argona kaliyevymi polevymi shpatami i o geologicheskom znachenii etogo metoda [On the problem of argon loss in potassium feldspars and on the geological significance of this phenomenon]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 361-369, 1958 (1960).

The problem of loss of Ar and K by feldspars during geologic time, and the variation of such losses in individual rocks is discussed and analyzed. It was established by several investigators that such losses of Ar and K in feldspar result in an apparent age that is 10-40 percent younger than that of associated micas determined from the Ar^{40}/K^{40} ratio, and that the degree of such a change has little or no correlation with the absolute age of the rock investigated. — A. J. S.

184-19. Shukolyukov, Yu. A. Nomogramma i vychislitel'naya lineyka dlya rascheta vozrasta gornykh porod i mineralov po dannym argonovogo metoda [A nomogram and a slide rule for age computation of rocks and minerals according to data of the argon method]: Vses. Nauchno-Issled. Geol. Inst. Inf. Sbornik, v. 1, p. 142-145, 1955.

A special nomogram and slide rule for mathematical treatment of experimental data of the argon method are described and discussed. Both nomogram and slide rule give the absolute age of the sample within 2 percent error. Less than one minute is required to make the calculation. — A. J. S.

184-20. Polevaya, N. I., Titov, N. Ye., and Sprintsson, V. D. Opyt primeneniya kal'tsiyevogo metoda dlya opredeleniya absolyutnogo vozrasta sil'vinov [Experiment in the use of the calcium method for the determination of the absolute age of sylvites]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 411-418, 1958 (1960).

This is the same as the paper previously published in Geokhimiya, no. 8, p. 718-726, 1958 (see Geophys. Abs. 177-21). — J. W. C.

184-21. Mann, W. B., Seliger, H. H., Marlow, W. F., and Medlock, R. W. Redetermination of the national carbon-14 standard: U. S. Nat. Bur. Standards Tech. News Bull., v. 44, no. 11, p. 182-183, 1960.

The value of the national sodium carbonate-C^{14} standard has been revised to 1.250±1.5 percent disintegrations per sec per g of solution as compared with the old value of 1,280±10 percent disintegrations per sec per ml of solution. The redetermined value is useful to research in chemical, biochemical, and industrial processes as well as in geological and archeological dating. —V. S. N.

184-22. Libby, W[illard] F. Radiocarbon dating: Science, v. 133, no. 3453, p. 621-629, 1961.

This is a review of the radiocarbon dating method. The formation of radiocarbon in the atmosphere, and counting and dating techniques are described. A curve of radiocarbon content versus age for samples of known age is presented. Prior to 1870 the radiocarbon content of living matter appears to have varied by only 1 percent or less. From 1870 to 1954 carbon dioxide from combustion of fossil fuels diluted the biosphere and reduced the radiocarbon content; the trend was reversed when atomic explosions began to introduce carbon-14 into the atmosphere. These recent perturbations are of no great concern for present dating work but could possibly create difficulties in the future, if the method continues to be used.

The important date of the last glacial maximum is now well established as 11,400±200 yr ago. The uses of radiocarbon dating in geology, oceanography, meteorology, and particularly in archeology, and the accuracy of the results, are discussed briefly. — D. B. V.

184-23. de Vries, Hessel. Measurement and use of natural radiocarbon, in Researches in geochemistry: New York, John Wiley and Sons, p. 169-189, 1959.

Recent improvements in methods of radiocarbon dating techniques are described, highlights of some older chronology in North America and Europe

(early Wisconsin and early Würm, respectively) are reviewed, and some new measurements of the variation of radiocarbon with time and location on earth are discussed. — V. S. N.

184-24. Bolin, Bert, and Eriksson, Erik. Changes in the carbon dioxide content of the atmosphere and sea due to fossil fuel combustion, in The atmosphere and the sea in motion (Rossby memorial volume): New York and Cambridge, Rockefeller Inst. Press and Oxford Univ. Press, p. 130-142, 1959; also in Woods Hole Oceanographic Inst. Collected Repr. 1959, Contr. no. 1025, 12 p., 1960.

The dissociation equilibrium of carbon dioxide in the sea is discussed with particular emphasis on the buffering effect of sea water when changes of the partial pressure of CO_2 in the gas phase take place. The results are used in a study of the changes of the carbon dioxide content of the atmosphere and the sea that occur as a result of release of CO_2 to the atmosphere by fossil fuel combustion. The 10 percent increase of the CO_2 content of the atmosphere reported by Callendar may be compatible with a Suess effect of only a few percent. Because of the small buffering effect of the sea, the biosphere on land may play a more important role for changes actually occurring in the atmosphere due to release of CO_2 by combustion than previously believed. — V. S. N.

184-25. Tilton, G[eorge] R., Wetherill, G[eorge] W., Davis, G. L., and Bass, M. N. 1000-million-year-old minerals from the eastern United States and Canada: Jour. Geophys. Research, v. 65, no. 12, p. 4173-4179, 1960.

Measurements on muscovite, biotite, microcline, uraninite, and zircon by the K-Ar, Rb-Sr, and lead isotope methods give ages ranging from 900 to 1,150 million years for rocks in Ontario, along the Appalachians from New York to North Carolina, and beneath the sedimentary cover in Michigan, Ohio, and West Virginia. The whole region is believed to be part of a belt, roughly parallel to the more recent Appalachian orogenic belt, in which igneous intrusion and metamorphism accompained a major orogeny $1{,}000 \times 10^6$ yr ago. — D. B. V.

184-26. Tilton, G[eorge] R., Davis, G. L., Wetherill, G[eorge] W., Aldrich, L. T[homas], and Jäger, Emilie. The ages of rocks and minerals: Carnegie Inst. Washington Year Book 58, July 1, 1958-June 30, 1959, p. 170-178, 1959; reprinted in Carnegie Inst. Washington Geophysical Lab. Ann. Rept. of Director for 1958-59, 1959.

The mineral age measurements program of the Geophysical Laboratory is carried out in cooperation with the Department of Terrestrial Magnetism. The ages reported here for the Maryland Piedmont and the Southern Appalachians and for the pegmatites and granites of the Cutler batholith, Cutler, Ontario, are approximately the same as those reported in the Annual Report of the Director for 1958-59, Department of Terrestrial Magnetism (see Geophys. Abs. 184-27).

A report is also made of a preliminary study of the age relationships of some Alpine rocks. Indications are that in favorable cases the young age of the Alps will not prevent the application of the Rb/Sr and K/A methods to rocks of Alpine age. — V. S. N.

184-27. Aldrich, L. T[homas], Wetherill, G[eorge] W., Bass, M[anuel] N., Compston, W., Davis, G. L., and Tilton, G[eorge] R. Mineral age measurements: Carnegie Inst. Washington Year Book 58, July 1, 1958-June 30, 1959, p. 237-250, 1959; reprinted in Carnegie Inst. Washington Dept. Terrestrial Magnetism Ann. Rept. of Director for 1958-59, 1959.

Age determinations directed toward the location in time and space of the great Precambrian mountain chains or orogenic belts are reported for the following areas: the Appalachian orogenic belt from New York to North Carolina and Tennessee; the southern Canadian shield in Ontario, Michigan, and Wisconsin; igneous rocks of southern Missouri and the Arbuckle and Wichita Mountains of Oklahoma; Death Valley, Calif.; and other countries including Finland, Saudi Arabia, Australia, and Venezula. — V. S. N.

184-28. Bass, Manuel N. Grenville boundary in Ohio: Jour. Geology, v. 68, no. 6, p. 673-677, 1960.

Basement rocks penetrated by deep wells in Ohio can be sharply divided by a boundary trending slightly west of north into high grade metamorphic rocks on the east and unmetamorphosed igneous and sedimentary rocks on the west. Micas from the metamorphics give rubidium-strontium ages between 900 and 1,000 million years, indicating they are part of the Grenville orogenic belt. The sharp lithologic contrast across the boundary suggests that it is truly the Grenville boundary. The unmetamorphosed igneous rocks west of the boundary are similar to those from basement wells in Illinois and Indiana and from outcrops in southern Wisconsin, the St. Francis Mountains, and the Arbuckle Mountains. Micas and feldspars from the outcropping rocks give rubidium-strontium ages of 1,350-1,450 million years. The writer thinks that all these rocks west of the boundary comprise a nonorogenic igneous province, and therefore the rocks west of the boundary in Ohio will prove to be older than the rocks of the Grenville orogenic belt. — Author's abstract

184-29. Adams, J[ohn] A. S., Osmond, J. K., Edwards, G[eorge], and Henle, W. Absolute dating of the Middle Ordovician: Nature, v. 188, no. 4751, p. 636-638, 1960.

Zircons from four Middle Ordovician bentonites of well established stratigraphic position from Tennessee have been dated on the basis of isotope measurements of the lead; the uranium and lead concentrations were determined by isotopic dilution. Using decay constants of $1.537 \times 10^{-10} yr^{-1}$ for U^{238} and $9.72 \times 10^{-10} yr^{-1}$ for U^{235}, the U^{238}/Pb^{206} and U^{235}/Pb^{207} ages were calculated; results are tabulated. Previously unpublished determinations by Faul and Tilton on zircon and biotite from an Alabama bentonite of similar age are also reported; in all respects their measurements are corroborative. The average of the consistent U^{238}/Pb^{206} ages, $447 \pm 10 \times 10^6$ yr, is considered to be most reliable for Middle Ordovician time in Tennessee and Alabama. — D. B. V.

184-30. McFarlan, E., Jr. Radiocarbon dating of Late Quaternary deposits, south Louisiana: Geol. Soc. America Bull., v. 72, no. 1, p. 129-158, 1961.

Broecker, Wallace [S.]. A discussion of the above paper: ibid, p. 159-161, 1961.

A complete cycle of sea level fluctuation associated with major changes in continental glaciation since the beginning of the last glacial stage, recorded in the Late Quaternary deposits of southern and offshore Louisiana, has been dated by radiocarbon analysis of 122 surface and subsurface samples. The eustatic curve obtained implies that the last major glacial stage reached its maximum and had begun to retreat before 35,000 yr ago, and that the final retreat began 18,500 yr ago and ended 5,000 yr ago. No general agreement exists between the eustatic data and other estimates on the age of maximum glaciation and beginning of ice retreat.

Broecker states that McFarlan's conclusions as to the time of the last glacial maximum and retreat do not seem justified on the basis of the data presented. An acceleration in sea level rise just prior to 11,000 yr ago is not ruled out. — D. B. V.

184-31. Hayden, Richard J., and Wehrenberg, John P. A^{40}-K^{40} dating of igneous and metamorphic rock of western Montana: Jour. Geology, v. 68, no. 1, p. 94-97, 1960.

Potassium-argon age determinations on samples of biotite, feldspar, and hornblende from igneous and metamorphic rocks in western Montana are reported in a table. — V. S. N.

184-32. Hester, Jim J. Late Pleistocene extinction and radiocarbon dating: Am. Antiquity, v. 26, no. 1, p. 58-77, 1960.

All radiocarbon dates from North America that are associated with extinct Late Pleistocene mammals, those from levels stratigraphically later than levels with extinct forms, and those associated with recent fauna are tabulated alphabetically by site. Dates considered invalid are tabulated but are not used in formulating conclusions.

Conclusions are than drawn concerning the time range of certain herding mammals, the mammoth, the mastodon, the super bison, and the ground sloth. Partial contemporaneity of the Clovis elephant hunters and the Folsom bison hunters is indicated. — D. B. V.

184-33. Smith, D. G. W., Baadsgaard, H., Folinsbee, R. E., and Lipson, J[oseph]. K/Ar age of Lower Devonian bentonites of Gaspé, Quebec, Canada: Geol. Soc. America Bull., v. 72, no. 1, p. 171-173, 1961.

Seven samples of Lower Devonian bentonites from the Gaspé Peninsula were dated by the potassium-argon method, using the constants $\lambda_e = 0.589 \times 10^{-10}$/yr and $\lambda\beta = 4.76 \times 10^{-10}$/yr. The suggested age of $385 \pm 15 \times 10^6$ yr is in accord with Holmes' revised time scale and is supported by a number of dates obtained by Hurley and others (1958) for intrusions cutting Lower Devonian sediments in New England and Acadian areas. — D. B. V.

184-34. Semenenko, N. P. Voprosy geokhronologii dokembriya Afriki [Problems of geochronology of the Precambrian of Africa]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 139-145, 1957 (1960).

A review of geochronological determinations of African Precambrian rocks is given. The absolute ages obtained by the uranium-thorium-lead, lead isotope, rubidium-strontium, and to some extent, potassium-argon methods on

uraninite, monazite, samarskite, euxinite, betafite, pyrochlore, brannerite, columbite, and zircon from African Precambrian rocks are compared with Precambrian ages from the U. S. S. R. The Precambrian is subdivided into Precambrians IV (630-1,200 million years), III (1,200-1,850 million years), II (2,000-2,900 million years), and I (3,000-3,800 million years). — A. J. S.

184-35. Nicolaysen, L. O., de Villiers, J. W. L., Burger, A. J., and Strelow, F. W. E. New measurements relating to the absolute age of the Transvaal system and of the Bushveld igneous complex: South Africa Geol. Soc. Trans. and Proc. for 1958, v. 61, p. 137-163, (1960).

Reliable data relative to the absolute age of the Transvaal system are crucial to the delineation of a quantitative time scale for South African stratigraphy. Since 1954 the following investigations have been carried out: rubidium-strontium age determinations on micas from four Bushveld igneous rocks; uranium-lead and thorium-lead age determinations on six monazites from Houtenbek 392, Moos River district; uranium-lead age determinations on three zircon concentrates from a granite near Ottensville, Central Bushveld; and a study of lead isotopic compositions of galenas deposited within sediments of the Transvaal system. It is concluded that an age of 1,950±150 million years can be assigned to the intrusion of the Bushveld igneous complex and, therefore, the Transvaal system was deposited at a time greater than 1,950±150 million years ago. It appears that existing chronologies of South African strata need revision. — V. S. N.

184-36. Schreiner, G. D. L., and Niekerk, C. B. van. The age of a Pilansberg dyke from the central Witwatersrand: South Africa Geol. Soc. Trans. and Proc. for 1958, v. 61, p. 197-203, (1960).

The age of the Robinson dike, one of a system of dikes radiating in a south to southeast direction from the Pilansberg intrusive in the Transvaal, has been determined by the rubidium-strontium method. It is concluded that the age determined, 1,290±180 million years, may be extended to the rest of the dike system and, therefore, to the Pilansberg intrusive itself. This means that the Waterberg system is older than 1,300 million years and, if its correlation with the Matsap is valid, rules out the possibility of the correlation of the latter with the Table Mountain sandstone (see also Geophys. Abs. 173-11). — V. S. N.

184-37. Durand, Georges [L.], and Lay, Claude. Détermination de l'âge de quelques galènes de la vallée du Niari (Moyen Congo) [Determination of the age of some galenas from the Niari valley (Moyen Congo)]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 5, p. 750-751, 1960.

The lead isotope ages of 6 galenas and 1 cerussite from the Niari valley in Moyen Congo are tabulated. The techniques and material used were described in an earlier note (see Geophys. Abs. 183-27). Four of the galenas are apparently from the same Precambrian epoch ($630\text{-}650\times10^6$ yr), and the cerussite is slightly younger (580×10^6 yr); these values confirm Bigotte's conclusions (1959). A value of 510×10^6 yr for the N'Zala galena is explained by secondary mineralization, and a still lower value of 420×10^6 yr for the Djenguilé galena is explained by the presence of radiogenic lead from uranium mineralization in the vicinity. — D. B. V.

184-38. Galanopoulos, A. G. Zur Bestimmung des Alters der Santorin—Kaldera [Determination of the age of the Santorin caldera (with English abstract)]: Annales Geol. des Pays Helléniques, 1st ser., v. 9, p. 184-185, 1958.

This is virtually the same as the paper published in Neues Jahrb. Geologie u. Paläontologie Monatsh. Jahrg. 1957, Heft 9, p. 419-420 (see Geophys. Abs. 171-17). — J. W. C.

184-39. Šmejkal, Václav. Absolutní stáří některých granitoidů a metamorfitů Českého masivu stanovené kalium-argonovou metodou [Absolute age of some granitic and metamorphic rocks of the Czech massif determined by the potassium-argon method (with Russian summary)]: (Czechoslovakia) Ústřed. Ústav. Geol. Věstník, v. 35, no. 6, p. 441-449, 1960.

The potassium-argon ages of 35 granitic and metamorphic rocks from different parts of Czechoslovakia have been determined using the decay constants $\lambda_K = 0.557 \times 10^{-10} yr^{-1}$ and $\lambda_\beta = 4.72 \times 10^{-10} yr^{-1}$; results are tabulated, along with 10 determinations made in the U. S. S. R. recalculated using the same constants. Two intrusive cycles are indicated, corresponding closely with those established by Vinogradov and others for Saxony (see Geophys. Abs. 182-44). A young Variscan cycle, to which the tin, tungsten, and molybdenum mineralization of the Erzgebirge is related, occurred 260 million years ago in Early Permian or at the Stephanian-Permian boundary according to Kulp's time scale. An older Variscan cycle, in the Erzgebirge and in the plutons of central Bohemia, apparently occurred about 360-370 million years ago in Early Devonian; however, a correction for nonradiogenic argon probably would place this cycle at the Devonian-Carboniferous boundary, or somewhat younger. — D. B. V.

184-40. Kantor, Ján. Príspevok k poznaniu Veporidných granitov podl'a A/K^{40} metódy [Contribution to the understanding of the Veporide granites by the K/Ar method (with German summary)]: Slovenská Akad. Vied Geol. Práce, v. 16, p. 5-10, 1959.

The Hrončok granite is part of the highly metamorphosed belt of the west central Carpathians, the so-called Tatra Veporides of unknown stratigraphic age. Volumetric potassium-argon age determinations (without correction for atmospheric argon contamination) give 110 million years for potassium feldspar and 115 million years for biotite, calculated with the K-capture and beta-decay time constants of $6.02 \times 10^{-11} yr^{-1}$ and $49 \times 10^{-11} yr^{-1}$, respectively. — H. F.

184-41. Kantor, Ján. Kriedové orogenetické procesy v svelte geochronologického výskumu Veporidného kryštalinika (Kohútske pásmo) [Cretaceous orogenic processes in the light of geochronological studies of the Veporide crystalline rocks of the Kohút belt (with German and English summaries)]: Slovenská Akad. Vied Geol. Pracé, v. 19, p. 5-26, 1960.

Age measurements on biotite concentrates from five Veporide crystalline rocks from central Slovakia give 75-107 million years by the potassium-argon method (no air-argon correction), using the K-capture and beta-decay constants of $6.02 \times 10^{-11} yr^{-1}$ and $49 \times 10^{-11} yr^{-1}$, respectively. Glauconite from

an Albian limestone near Wielka Rówien in the Polish High Tatra Mountains gives 88 million years. Location of the samples is shown on a geologic sketch map of Slovakia. It is concluded that the ages indicate an intensive orogeny 75 to 80 million years ago, belonging to the "sub-Hercynian Alpine phase." The later Laramide orogeny apparently was of much lower intensity in the Veporides. — H. F.

184-42. Kantor, Ján. Príspevok ku geochronológii nízkotatranských granitoidov [Geochronology of the granitic rocks of the Low Tatra]: Slovenská Akad. Vied Geol. Práce, no. 55, p. 159-169, 1959.

Ages of the Dunbier and Prašivá granites from the central massif of the Low Tatra in central Slovakia, heretofore usually regarded as Precambrian, were measured by the volumetric potassium-argon method on biotite, muscovite, and feldspar. Major-constituent chemical and trace-element spectrochemical analyses are reported for most samples. Six of the nine samples, uncorrected for atmospheric argon contamination, give ages from 270 to 360 million years with feldspar giving the lowest ages. Three mica samples analyzed in the laboratory of I. E. Starik (Leningrad) with correction for atmospheric argon contamination give 300, 305, and 330 million years, respectively. All ages are computed with the decay constants for K-capture and beta-decay of $6.02 \times 10^{-11} yr^{-1}$ and $49 \times 10^{-11} yr^{-1}$, respectively. — H. F.

184-43. Vinogradov, A. P., Tugarinov, A. I., Zykov, S. I., and Stupnikova, N. I. O vozraste gornykh porod Aldanskogo shchita [On the age of the rocks of the Aldan shield (with English summary)]: Geokhimiya, no. 7, p. 563-569, 1960.

The results of 18 absolute age determinations on uranium-thorium minerals from the Aldan shield are tabulated. Ancient intrusives in the core of the shield are 2,200-2,700 million years old. Intensive volcanism in and around the periphery of the shield took place 1,140±50 and 650±50 million years ago. The effect of later Paleozoic and Mesozoic metamorphism is detected in some minerals in the form of a sharp decrease in Pb/U and Pb/Th age values. — D. B. V.

184-44. Semenenko, N. P., Burkser, Ye. S., and Ivantishin, M. N. Sravnitel'naya kharakteristika vozrasta gornykh porod ukrainskogo kristallicheskogo massiva [Comparative study of the age of rocks of the Ukrainian crystalline massif]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 5th sess., p. 86-110, 1958.

In an attempt to study the migration of radiogenic elements and the absolute age of Precambrian rocks, parallel age determinations were made on minerals from the same rocks by four different laboratories. Samples from seven localities in the Ukraine massif were investigated by the argon method (for biotite and feldspar) and by the lead method (for accessory minerals such as allanite, sphene, and monazite). The rubidium age was also determined for several micas. Results are given for each locality. A divergence in the absolute ages as determined by the different methods (1,200, 1,400, and 1,900 million years for the same specimen) leads to the conclusion that the age data obtained must be checked against rubidium-strontium data. — A. J. S.

184-45. Ovchinnikov, L. N., Shur, A. S., and Panova, M. V. Nekotoryye resul'taty primeneniya kaliy-argonovogo metoda dlya opredeleniya

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absolyutnogo vozrasta mineralov i gornykh porod Urala [Some results of application of the potassium-argon method for determination of the absolute age of minerals and rocks of the Urals]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 8-26, 1957 (1960).

The results of more than 50 age determinations made by the Urals branch of the Academy of Sciences, U. S. S. R., are reported, and the methods of calculation are discussed. (See also Geophys. Abs. 172-17.) — A. J. S.

184-46. Garris, M. A. Pervyye rezul'taty opredeleniya kaliy-argonovym metodom absolyutnogo vozrasta gornykh porod vostochnoy okrainy Russkoy platformy i Yuzhnogo Urala [The first results of absolute age determinations of rocks in the eastern borderland of the Russian platform and southern Urals by the potassium-argon method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 27-39, 1957 (1960).

Age determinations are reported for rocks of the crystalline basement of the Bashkir A. S. S. R. recovered from deep drill holes. The granitic gneisses range in age from 1,380 to 1,620 million years, and the gabbro diabases from 1,010 to 1,140 million years. Pegmatites from the eastern flank of the Ural Mountains yield ages of 210-270 million years. — J. W. C.

184-47. Amirkhanov, Kh. I., and Magatayev, K. S. Ob itogakh ustanovleniya absolyutnogo geologicheskogo vozrasta osadochykh obrazovaniy neftenosnoy provintsii Dagestana [On the results of establishing the absolute geological age of sedimentary deposits in the oil-bearing region of Dagestan]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 48-53, 1957 (1960).

Age determinations on 26 glauconites from sediments of Silurian, Jurassic, Cretaceous, and Tertiary age of Dagestan are reported. (See also Geophys. Abs. 179-13). — J. W. C.

184-48. Polevaya, N. I., and Chernova, N. N. Vozrast porod Zabaykal'ya po dannym argonovogo metoda [Age of rocks of the Transbaikal area according to data of the argon method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 69-82, 1957 (1960).

Absolute ages were determined for various igneous rocks of the Transbaikal area. The intrusives of the Caledonian magmatic cycle were dated at 250-435 million years, the plutons of the Hercynian magmatic cycle at 205-235 million years, and the Jurassic intrusions at 110-155 million years. A group of effusive rocks was dated at 125-245 million years. — A. J. S.

184-49. Polevaya, N. I., Sprintsson, V. D., and Chernova, N. N. Vozrast magmaticheskikh porod yuga Dal'nego Vostoka [Age of magmatic rocks of the south of the Far East]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 83-106, 1957 (1960).

Argon ages of igneous rocks of the south part of the Far Eastern Region are reported. Silicic extrusive rocks yield ages of 30-105 million years. The ages of several Jurassic granitic intrusives of Sikhote-Alin were determined at 120-175 million years; the Meso-Cenozoic intrusives of north Sikhote-Alin and of the left bank area of the lower course of the Amur River, 70-120 million years; the intrusives of the tectonic zone of the Khor and Anyuy Rivers, 75-95 million years; the intrusive rocks of the lower Amur basin, 65-120 million years; the Paleozoic intrusives of Maloye Khingan, 180-365 million years; the Mesozoic intrusives of Maloye Khingan, 85-180 million years; the Varissian intrusive complex in the basin of the Zeya and Bureya Rivers, 140-265 million years; and the igneous rocks of the Kur-Umra region, 100-155 million years. Some of the argon ages do not agree with the geologic ages of the rocks. — A. J. S.

184-50. Afanas'yev, G. D. O primenenii kaliy-argonovogo metoda dlya tseley geologii v svete rezul'tatov issledovaniy gornykh porod i mineralov Kavkaza [On application of the potassium-argon method for geological purposes in the light of results of investigations of rocks and minerals of the Caucasus]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 107-118, 1957 (1960).

The suitability of potassium-sodium feldspars for potassium-argon age determinations is discussed. On the basis of argon ages on muscovites, microclines, and other minerals in the Caucasus, and by comparing the argon ages with lead isotope ages, data that are in a satisfactory agreement with geologic ages are obtained. — A. J. S.

184-51. Komlev, L. V., Gerling, E. K., and Zhirov, K. K. O vozraste redkometal'noy granitnoy intrusii Akchatau po dannym geliyevogo metoda dlya monatsitov [On the age of the rare-metal granite intrusion of Akchatau according to data of the helium method for monazites]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 129-132, 1957 (1960).

Utilization of monazites for helium age determinations is discussed. Three samples of monazite from the Akchatau granite were dated at 324±16, 272±14, and 275 million years; the average is 290 million years. These data were regarded with uncertainty. A later determination on an additional monazite from Akchatau, however, has yielded an age of 284 million years. — A. J. S.

184-52. Semenenko, N. P., Ivantishin, M. N., and Burkser, Ye. S. Osnovnyye dannyye po geokhronologii Ukrainskogo kristallicheskogo massiva [Basic data on the geochronology of the Ukrainian crystalline massif]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 146-166, 1957 (1960).

Detailed examination of the stratigraphy of the Ukrainian crystalline massif indicates that the oldest units studied have an age of 2,300-2,600 million years and more. The age of the main lower stage of folding of the massif is 1,950-2,150 million years; this is the Bug stage. The second structural stage is the Saksagan. It occupies the central part of the massif and has an age of 1,700-1,920 million years. The third structural stage is represented by the Volyn folding and has an age of 1,400-1,600 million years. Next follows a group of granites of the age group 1,150-1,250 million years. The final Precambrian cycle consists of granites of the age group 500-900 million years. — J. W. C.

184-53. Polovinkina, Yu. Ir., Polevaya, N. I., and Murina, G. A. Absolyutnyy vozrast granitov Ukrainy [Absolute age of granites of the Ukraine]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 167-181, 1957 (1960).

A number of granites and their pegmatites from the Ukrainian crystalline massif were dated by the potassium-argon method, and the results are compared with data obtained by other authors by the argon and lead methods. On the basis of this analysis the age of the Lower Archean plagioclase granites ranges from 1,890 to 2,000 million years. The highest age obtained for the Dnieper region amphibolites is 2,000-2,500 million years, but some determination on these same rocks gave a much lower value of 1,300 million years. The reason for such great divergence for the same rock is unknown. — A. J. S.

184-54. Komlev, L. V., Danilevich, S. I., Ivanova, K. S., Mikhalevskaya, A. D., Savonenkov, V. G., and Filippov, M. S. O vozraste geologicheskikh formatsii yugo-zapadnoy chasti Ukrainskogo dokembriya [Age of geologic formations of the southwest part of the Ukrainian Precambrian]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 182-192, 1957 (1960).

This is the same as the paper previously published in Geokhimiya, no. 7, p. 566-572, 1957 (see Geophys. Abs. 180-6). — J. W. C.

184-55. Krylov, A.Ya., Baranovskaya, N. V., and Silin, Yu. I. Primeneniye argonovogo metoda opredeleniya vozrasta k resheniyu nekotorykh geologicheskikh voprosov [Application of the argon method of age determination to solution of some geological problems]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 208-213, 1957 (1960).

The potassium-argon method can be used for determination of the age of source material of detrital rocks, the age of metamorphism of pelitic rocks, and the age of formation of new potassium minerals during metamorphism. The ages of several Carboniferous sandstones of the northern Tien Shan proved to be on the same order as that of their parent granite. Schists and gneisses from the Malnyy Kebin River region yielded ages from 370 to 430 million years, which correspond to the main Caledonian orogeny. The age of hornfels is either close to that of the granite with which it is in contact or is somewhat higher. — J. W. C.

184-56. Shcherbakov, D. I. Napravleniye rabot po opredeleniyu absolyutnogo vozrasta geologicheskikh formatsiy [Direction of research in determination of the absolute age of geologic formations]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 7-12, 1958 (1960).

The principal areas of geochronological research in the U. S. S. R. are as follows: 1) age correlation by residual isotopes or by natural radioactive elements in rocks; 2) absolute age of Precambrian formations; 3) absolute age of tectono-magmatic processes in the development of geosynclinal zones; 4) variations in absolute age of the minerals of igneous rocks; and 5) determination of metallogenic epochs from absolute ages of ore deposits. — A. J. S.

184-57. Polkanov, A. A., and Gerling, E. K. Problema absolyutnogo vozrasta dokembriya Baltiyskogo shchita [The absolute age problem of the Precambrian Baltic shield]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 13-45, 1958 (1960).

The Precambrian geology of the Baltic shield is reviewed in detail on the basis of about 230 age determinations. An argon age of 6,000 million years has been determined for beryl from the Kola Peninsula, which finds a parallel in the 4,000-5,000 million years yielded by beryl from Beryl Mountain, N. H. (see Geophys. Abs. 172-16). Age data on Precambrian rocks from the Scandinavian Peninsula, Finland, Karelia, and the Kola Peninsula are given in extensive tables, which contain information on the orogens, the geographic locations of the rocks dated, the geologic formations, and the ages determined with the old and the new constants of K^{40}. — A. J. S.

184-58. Semenenko, N. P. Geokhronologiya v absolyutnom letoschislenii i voprosy geologicheskoy istorii dokembriya [Geochronology in absolute age and the problem of Precambrian geologic history]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 48-78, 1958 (1960).

Absolute ages of Precambrian geologic formations of Europe, Siberia, North America, and Africa are reviewed on the basis of determinations of the last 10 years. The Precambrian of the Ukrainian crystalline massif is dated from 900 to 3,000 million years; that of the Baltic shield—from 880 to 3,500 million years; the Urals—from 400 to 2,350 million years; the Russian platform—566 to more than 1,740 million years; Siberia—250-1,900 million years; the Canadian shield—200-2,600 million years; and the African platform—630-3,800 million years. A geochronological chart is given in which the Precambrian is divided into 10 cycles of mineralization and orogenesis. — A. J. S.

184-59. Komlev, L. V., Danilevich, S. I., Ivanova, K. S., Kuchina, G. N., Savonenkov, V. G., and Filippov, M. S. Absolyutnyy vozrast kirovogradskikh i trakhitoidnykh granitov ukrainskogo dokembriya po dannym svintsovo-izotopnogo i argonovogo metodov [Absolute age of Kirovograd and trachytoid granites of the Ukrainian Precambrian according to the lead isotope and the argon methods]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 91-111, 1958 (1960).

The porphyritic granites of the Kirovograd type in the Ukraine S. S. R. yield a lead isotope age of 1,970±60 million years and an argon age of 1,960±50 million years. The trachitoid red granites of this same region give a lead-isotope age of 1,900±30 million years and an argon age of 1,930±50 million years. The similarity in age and the geochemical data both indicate that these igneous rocks belong to a single comagmatic series. — J. W. C.

184-60. Komlev, L. V., Filippov, M. S., Danilevich, S. I., Ivanova, K. S., and Savonenkov, V. G. Absolyutnyy vozrast monatsitov iz nekotorykh krasnykh aplitoidnykh granitov i pegmatitov ukrainskogo dokembriya [Absolute age of monazites from some red aplitic granites and pegmatites of the Ukrainian Precambrian]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 112-122, 1958 (1960).

Age determinations are reported on 17 monazites from red aplitic granites and pegmatites of the Ukraine S. S. R. The lead isotope ages range from 1,500 to 2,100 million years and correspond to the time of formation of the principal magmatic complexes of the Ukrainian Precambrian. The absolute age of some granites of the area, determined by the argon method, is 1,700-1,800 million years. — A. J. S.

184-61. Komlev, L. V., Filippov, M. S., Danilevich, S. I., Ivanova, K. S., Kryukova, N. F., Kuchina, G. N., and Mikhalevskaya, A D. Vozrastnyye dannyye argonovogo i svintsovoizotopnogo metodov dlya nekotorykh granitov i pegmatitov Srednego Pridneprov'ya [Age data of the argon and lead isotope methods for some granites and pegmatites of the middle Dnieper area]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 123-130, 1958 (1960).

This is virtually the same paper as previously published in Geokhimiya, no. 2, p. 110-115, 1959 (see Geophys. Abs. 179-15). — A. J. S.

184-62. Semenenko, N. P. Vystupleniye N. P. Semenenko [Address of N. P. Semenenko]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 131-134, 1958 (1960).

The absolute ages of Ukrainian Precambrian rocks determined by the Ukrainian Academy of Sciences and those presented by Komlev (see Geophys. Abs. 184-59, -60, -61) are summarized. On the basis of the uranium-thorium-lead method, the Ukrainian crystalline massif formed during the time between 3,000 and 1,100 million years ago. — A. J. S.

184-63. Zhirov, K. K., Artemov, Yu. M., Volobuyev, M. I., Zhirova, V. V., Knorre, K. G., Stupnikova, N. I., Sten'ko, V. A., Tikhonov, V. Ye., and Arakelyan, V. A. O vozraste Tarakskoy intruzii Yeniseyskogo kryazha [On the age of the Tarak intrusion of the Yenisei range]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 135-142, 1958 (1960).

The absolute ages of various geological units of the Yenisei range in Siberia are reported. The investigation consisted of dating by the lead, argon, and strontium methods, determination of the isotope composition of the lead, and study of the distribution of radioactive and other elements that could provide geochemical criteria for following changes that have occurred in the rocks. The lead method yielded ages of 570-2,030 million years, and the ages obtained on other samples by the argon method were found to be 170-1,200 million years. — A. J. S.

184-64. Ovchinnikov, L. N. Absolyutnyy vozrast rudnykh mestorozhdeniy Urala po dannym argonovogo metoda [Absolute age of ore deposits of the Urals according to data of the argon method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 143-151, 1958 (1960).

The results of argon age determinations on Ural ore deposits are reported. In the Early Paleozoic stage of metalogenesis, chalcopyrite deposits are dated at 420-460 million years and the associated igneous rocks at 455 million years.

In the Middle Paleozoic stage the contact-metasomatic rocks, the chalcopyrite deposits, and the pegmatites are dated at 330-365, 305-375, and 310-340 million years, respectively. In the Late Paleozoic stage the contact metasomatic rocks, the chalcopyrite deposits, the gold ores, and the pegmatites were dated at 240-245, 240-265, 270, and 260-275 million years, respectively. — A. J. S.

184-65. Ovchinnikov, L. N., Shur, A. S., and Dunayev, V. A. Ob absolyutnom vozraste geologicheskikh obrazovaniy Urala [On the absolute age of geological formations of the Urals]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 152-164, 1958 (1960).

Argon ages of 46 igneous and metamorphic rocks of the Urals are reported. The Precambrian units are dated at 1,155-1,940 million years. The Early Paleozoic igneous rocks yield dates of 440-500 million years, and the Middle Paleozoic rocks give 280-390 million years. Metamorphic rocks related to copper-bearing areas are dated at 240-460 million years. The conglomerates between the Proterozoic and Cambrian formations give dates of 240-390 million years. — A. J. S.

184-66. Garris, M. A., Shanin, L. L., Ustyuzhanin, L. S., Dyadin, N. N., and Soldatenkov, S. S. Absolyutnyy vozrast granitoidov yuzhnogo Urala i Mugodzhar po dannym kaliy-argonovogo metoda [Absolute age of granites of the south Urals and Mugodzhar according to the potassium-argon method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 166-187, 1958 (1960).

Age determinations on granitic intrusives of the south Urals and the Mugodzhar region in Bashkir A. S. S. R., are reported. Most of these determinations were made by the potassium-argon method on potassium feldspars; some were on muscovite. On a basis of 58 samples the Carboniferous granites were dated at 180-297 million years, and the Silurian granites at 335-345 million years. The Carboniferous metamorphic rocks, dated by the anorthoclase from the Mugodzhar augen gneiss at 212±7 million years, were thus shown to belong to the Upper Carboniferous instead of to the Archean. — A. J. S.

184-67. Knorre, K. G., Studenikova, Z. V., and Lebedev, V. I. Opredeleniye absolyutnogo vozrasta porod severnogo Kavkaza kaliy-argonovym metodom [Determination of absolute age of the rocks of the north Caucasus by the potassium-argon method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 188-194, 1958 (1960).

On a basis of recent absolute age determinations four intrusive granite complexes of the north Caucasus are discussed. The granite of the main ridge is dated at 270-470 million years, the complex of northern (Paleozoic and Triassic) granites at 175-230 million years; the complex of Mesozoic granites at 80-150 million years, and the Cenozoic complex of granites at 15-50 million years. No Precambrian intrusive rocks were found. The youngest age, determined by the U^{238}/Pb^{206} ratio, yielded 20 million years, as compared with 15 million years obtained by the potassium-argon method. — A. J. S.

184-68. Komlev, L. V., Filippov, M. S., Danilevich, S. I., Kryukova, N. F., Kuchina, G. N., and Mikhalevskaya, A. D. Absolyutnyy vo-

zrast gruppy gertsinskikh granitnykh plutonov Tsentral'nogo Kazakhstana [Absolute age of the group of Hercynian granitic plutons of central Kazakhstan]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 205-215, 1958 (1960).

Argon ages were determined for biotite from granites, and lead ages for monazites from granites and pegmatites; all from rare-metal intrusions of alaskitic granites of central Kazakh S. S. R. The argon ages range from 260 to 360 million years, and the lead ages from 248 to 292 million years. The ages obtained do not agree with the Holmes time scale for the Paleozoic if the rare-metal alaskitic granites are considered as Late Carboniferous and Permian. — A. J. S.

184-69. Komlev, L. V., Filippov, M. S., Danilevich, S. I., Kryukova, N. F., Kuchina, G. N., Mikhalevskaya, A. D., and Savonenkov, V. G. Vozrast granitnoy intruzii Bektau-Ata v Severnom Pribalkhashye (Tsentral'nyy Kazakhstan) [The age of the Bektau-Ata granite intrusion in the northern Balkhash region (central Kazakhstan)]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 216-232, 1958 (1960).

Argon dating of the Bektau-Ata granite indicates persuasively that this mass has the same age as the rare metal granite intrusions of central Kazakh S.S.R. (see Geophys. Abs. 184-68). The most reliable age for these granites using the new K^{40} constant lies in the interval 280-320 million years, and the average value is 295±15 million years. The average value based on three isotope ratios and on total radiogenic lead is 295±5 million years. — J. W. C.

184-70. Komlev, L. V., Filippov, M. S., Kuchina, G. N., and Kryukova, N. F. Absolyutnyy vozrast granitnykh intruziy Kokchetavskogo podnyatiya v Severnom Kazakhstane [Absolute age of granite intrusion of the Kokchetavok uplift in northern Kazakhstan]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 233-240, 1959 (1960).

Potassium-argon ages are reported for the granites of the Zerendinskaya, Borovskaya, Zolotonoshenskaya, Konstantinovskaya, and Orlinogorskaya intrusions of the Kokchetavok anticlinorium in north Kazakh S.S.R; the new K^{40} constant was used. An early group of granites and less silicic granitic rocks is dated at 400-480 million years, a middle group of granites at 350-380 million years, and a later group of leucocratic rare-metal granites at 260-300 million years. — A. J. S.

184-71. Semenova, T. P. Absolyutnyy vozrast intruzivnykh porod rayona Kendyktasskikh gor Kazakhstana po dannym argono-kaliyevogo metoda [Absolute age of intrusive rocks of Kendyktas mountains of Kazakhstan according to data of the argon-potassium method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 242-249, 1958 (1960).

Absolute age determinations were made on igneous rocks of the northwestern side of the Kendyktas mountains in the Kazakh S. S. R.; it was concluded that the various types represent a comagmatic series. The potassium-argon method was used to date 14 rock samples, 4 quartz-feldspar fractions, and 2 biotite fractions. Fifteen of these samples yielded reliable data. The ages range from 355 to 480 million years. — A. J. S.

184-72. Bagdasaryan, G. P. O vozraste nekotorykh intrusiy Armenii po dannym geologicheskikh issledovaniy i radiologicheskikh opredeleniy (argonovym metodom) [On the age of certain intrusions of Armenia according to geologic investigations and radiologic determinations (by the argon method)]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 266-273, 1958 (1960).

Problems of absolute age determinations in Armenia are discussed, and the dates on 45 samples of rocks and minerals from Armenian intrusions are reported. The Ar^{40}/K^{40} ratio of the samples ranges from 0.93 to 4.6, corresponding to absolute ages of 28-131 million years. These results are in agreement with the geologic ages of the intrusions according to the Marble scale. — A. J. S.

184-73. Yordanov, N. Issledovaniya ortita v svyazi s opredeleniyem absolyutnogo geologicheskogo vozrasta plutonov Plany [Investigations of orthite in connection with the absolute geologic age determination of the Plana pluton]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 274-282, 1958 (1960).

The absolute age was determined for plutonic rocks by the helium, lead, and argon methods, and a systematic study was made of the suitability of allanite (orthite) for geochronology. The most probable absolute age of the Plana plutons is 80 million years. The emanating properties of allanite indicate its good capacity to preserve the products of nuclear transformations. Due to the crystal structure, however, lead can easily be lost by diffusion during metamorphic processes or acquired during hydrothermal activity. The ratios of Pb/U and Pb/Th in the interior of the allanite crystals investigated are different from those in the exterior portion; the interior parts of the crystals, therefore, are recommended for analysis. — A. J. S.

184-74. Krylov, A. Ya., Silin, Yu. I., and Lovtsyus, A. V. Argon-kaliyevoye otnosheniye v razlichnykh chastiyak granitnyk intruziy [The argon-potassium ratio in different parts of granite intrusions]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 283-291, 1958 (1960).

A study was made to detect "excess argon"—the argon assimilated by a crystallizing magma to produce an exaggerated absolute age. Ar^{40}/K^{40} analyses were performed on four single-phase intrusions of the central Tien Shan: Dzhety-Oguz (16 samples), Sary-Bulak (14 samples), Sary-Maynak (10 samples), and Kok-Mayhak (8 samples); these yielded absolute ages of 300-390, 285-415, 340-385, and 240-330 million years, respectively. No "excess argon" caused by an exogene contact effect was established. — A. J. S.

184-75. Gerling, E. K., Yashchenko, M. L., Levskiy, L. K., and Ovchinnikova, G. V. Opredeleniye vozrasta nekotorykh slyud po rubidiy-strontsiyevony metody [Determination of the age of several micas by the rubidium-strontium method]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 326-342, 1958 (1960).

Absolute age determinations on micas from Proterozoic and Archean rocks by the rubidium-strontium method are reported. Using the 1.39×10^{-11} per yr

β-decay constant of Rb^{87} (see Geophys. Abs. 167-231), several samples of mica from the Kola Peninsula, Siberia, and the Murmansk region were dated. The ages range from 2,600±200 to 1,800±150 million years for the Kola Peninsula and Murmansk micas, and 420±55 million years for those from the Mamsk region in Siberia. These ages are in general agreement with Ar^{40}/K^{40} determinations; however, the muscovite rocks from the Mamsk region are considered to belong geologically to the Upper Archean and Lower Proterozoic. — A. J. S.

184-76. Usenko, I. S., Bernads'ka, L. H., and Kotlovs'ka, F. I. Novī danī vyznachennya vīky postproterozhoys'kykh absolyutnoho efuzhyvnykh porīd [New data on the determination of the absolute age of post-Proterozoic effusive rocks]: Akad. Nauk Ukrayin. RSR Heol. Zhur., v. 18, no. 5, p. 83-88, 1958.

The results of potassium-argon age determinations on post-Proterozoic effusive rocks from the Ukraine are presented. Three age groups can be distinguished. The oldest is represented by the traps of the southwest part of the Russian platform and by the diabases associated with salt domes in the Dnieper-Donets basin; the age of the former is $506\text{-}566\times10^6$ yr and that of the latter $500\text{-}570\times10^6$ yr; therefore, they are Riphian-Early Cambrian. The second group is represented by the spilite-keratophyre formations which occur in boreholes in the Chernigov gravity anomaly; these are $353\text{-}393\times10^6$ yr old, or Ordovician-Silurian (Caledonian orogeny), although according to geologic evidence they should be Devonian. The third group includes the spilite-keratophyre formations of the southern Donbass, which are $270\text{-}320\times10^6$ yr old, or Devonian (Hercynian orogeny). — D. B. V.

184-77. Shcherbak, M. P. Pro stupīn' nadīynostī okremykh kryterīyiv pry vyznachennī vīkovykh vzayemovīdnoshen' mīzh crystalīchnymy porodamy dokembrīyu (verkīv'ya r. Tetereva) [On the degree of reliability of individual criteria in the determination of the age relations of Precambrian crystalline rocks (upper course of the Tetereva River)]: Akad. Nauk Ukrayin. RSR Heol. Zhur., v. 20, no. 1, p. 68-73, 1960.

The last section of this paper deals with absolute dating of crystalline rocks in the region of the upper course of the Tetereva River. According to uranium-lead and thorium-lead measurements, the Chudnovo-Berdichev and the plagioclase granites are 2,100 million years old, and the trachytic and pink aplitic-pegmatitic granites of the Zhitomir igneous complex are 1,700-1,750 million years old. — D. B. V.

184-78. Li, Pu; Chen, Yu-chi; Tu, Gon-chzhi; Tugarinov, A. I.; Zykov, S. I.; Stupnikova, N. I.; Knorre, K. G.; Polevaya, N. I.; and Brandt, S. B. Ob absolyutnom vozraste gornykh porod Kitayskoy Narodnoy Respubliki [On the absolute age of rocks of the Chinese People's Republic (with English summary)]: Geokhimiya, no. 7, p. 570-585, 1960.

The results of 45 potassium-argon determinations and 14 lead-uranium-thorium determinations of the age of rocks from different parts of China are tabulated. The oldest rocks are pegmatites in Liaoning province, $2,240\text{-}2,560\times10^6$ yr. Another cycle is indicated at $1,700\text{-}1,900\times10^6$ yr, in Liaoning, Kwantung, Shan-hsi, and Inner Mongolia. The Bayun'-Obo series is dated at 1,550 $\pm200\times1\text{-}^6$ yr. Sinian glauconites are $800\text{-}1,040\times10^6$ yr old, and Cambrian glau-

conites $500\pm50\times10^6$ yr; this suggests the possibility of correlating the Riphean of the Russian platform ($600-1,290\times10^6$ yr) with the Sinian of the Chinese-Korean platform ($500-1,040\times10^6$ yr). The upper age limit of the Hutai series, which forms the basement of the Sinian-Korean shield, is $1,800\pm100\times10^6$ yr. Magmatism is indicated in the Chinese-Vietnamese shield at 800×10^6 yr ago. Hercynian activity accompanied by mineralization and metamorphism is indicated in the Chinese-Korean platform, and Mesozoic activity in the Chinese-Vietnamese platform. Tertiary intrusions are known in Yunnan province and parts of Fukien. — D. B. V.

184-79. Imai, Hideki; Saito, Nobufusa; Hayashi, Shoichiro; Sato, Kazuo; and Kawachi, Yosuke. The absolute age of the granitic rocks in the Miyako-Taro district, Iwate Prefecture [in Japanese with English abstract]: Geol. Soc. Japan Jour., v. 66, no. 777, p. 405-409, 1960.

The absolute age of uraninite from the Yamaguchi mine as determined by the lead method is 100 million years. The deposit is related to the granitic intrusions in the Paleozoic formations of the Miyako-Taro district of northeastern Japan. The lead age agrees with the geologic relations, which indicate that the time of intrusion of the granites was between Early and Middle Cretaceous. — V. S. N.

184-80. Kuno, Hisashi; Baadsgaard, Halfdan; Goldich, Samuel [S.], and Shiobara, Kanji. Potassium-argon dating of the Hida metamorphic complex, Japan: Japanese Jour. Geology and Geography, v. 31, no. 2-4, p. 273-278, 1960.

Potassium-argon dating of five biotite samples from the gneisses of the Hida metamorphic complex, central Honshu, Japan, gives an average age of 180 million years, which corresponds to Late Triassic or Early Jurassic. This date may represent the time of the regional metamorphism; however, it is also possible that the complex was formed earlier and that the determined age marks a younger metamorphic event. — V. S. N.

184-81. Yesikov, A. D. Predvaritel'nyye rezul'taty i perspektivy deyatel'nosti vozrastnoy laboratorii IGEM AN SSSR [Preliminary results and prospects of the activity of the age laboratory of the IGEM AN SSSR]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 253-256, 1957 (1960).

The methods and processes of absolute age determination of rocks and minerals in the IGEM laboratory of the Academy of Sciences of the U. S. S. R. are analyzed, the accuracy of the results discussed, and measures for further improvement of the laboratory's activities are suggested. — A. J. S.

COSMOGONY

184-82. Hibbs, A. R. The distribution of micrometeorites near the earth: Jour. Geophys. Research, v. 66, no. 2, p. 371-377, 1961.

Statistical examination of impacts of micrometeorites recorded by the Explorer I satellite in February 1958 leads to the conclusion that the average particle measured was in a closed orbit around the earth rather than on an impact trajectory from a great distance toward the surface of the earth. — D. B. V.

184-83. Pettersson, H[ans]. The accretion of cosmic matter to the Earth: Endeavour, v. 19, no. 75, p. 142-146, 1960.

Although accretion of cosmic matter to the earth was demonstrated by deep-sea samples taken by the Challenger expedition of 1872-76 and by analyses of Arctic snow made at about the same time, it has only recently been possible to obtain sufficient samples to estimate the temporal and geographic variation of the fall of cosmic matter. The results of recent investigations of long deep-sea cores and air samples collected far from industrial contamination are reviewed. It is calculated that the total annual accretion of cosmic dust is 5 million tons; this is a thousand times greater than the accretion of cosmic spherules. — D. B. V.

184-84. Beals, C. S., Innes, M. J. S., and Rottenberg, J. A. The search for fossil meteorite craters: Current Sci. [India], (pt. 1), v. 29, no. 6, p. 205-218; and (pt. 2), v. 29, no. 7, p. 249-262, 1960.

The search for fossil meteorite craters to date has established the probable existence of three such craters of large size and sufficiently great age to justify the belief that others might be discovered by an exhaustive search. A considerable number of circular features in Canada may prove to be the result of meteorite impact, and recent evidence suggests an impact origin for certain cryptovolcanic structures. — D. B. V.

184-85. Fish, Robert A., Goles, Gordon G., and Anders, Edward. The record in the meteorites, 3. On the development of meteorites in asteroidal bodies: Astrophys. Jour., v. 132, no. 1, p. 243-258, 1960.

It is proposed that meteorites originated in planetesimals of asteroidal dimensions, heated by some transient internal energy source such as extinct radioactivity. Segregation of metal and silicate phases and mineral differentiation would take place on reasonable time scales even in small bodies. The occurrence of diamonds in meteorites is found to be inconsistent with an origin in large bodies; it is suggested that diamonds were formed as a metastable phase by decomposition of cohenite under localized stress, or upon impact with the earth.

At the onset of melting in an internally heated planetesimal, the equilibrium figure would comprise an inner core of metal and an outer core of silicate; a mantle of chondritic composition, compacted by sintering; and an unconsolidated surface layer. The expected properties of material from each of these layers agree well with those of the known classes of meteorites. Further temperature rise would result in quasi-volcanic eruptions due to evolution of gases and vapors from the interior; this would cause recycling of the material and could lead to the development of many detailed features of meteorites. This hypothesis can explain the capillary veins in stone meteorites and the discrepancies between the observed and predicted abundances of some chalcophile elements in chondrites. Extinct radioactivity seems to be the only possible energy source. — D. B. V.

184-86. Ringwood, A. E. Cohenite as a pressure indicator in iron meteorites: Geochim. et Cosmochim. Acta, v. 20, no. 2, p. 155-157, 1960.

Cohenite, $(FeNi)_3C$, has been recorded in several iron meteorites. It is analagous to cementite, Fe_3C, which occurs in steels and about whose properties and behavior a large amount of data are available. The enormous an-

nealing periods which iron meteorites have received are many orders of magnitude longer than would be required to decompose cementite completely. The retention of cohenite therefore implies that some other factor has contributed to its stability in meteorites.

The most likely explanation is that meteorites have crystallized under pressures sufficiently high to make cohenite thermodynamically stable. It is calculated that meteorites containing cohenite must have cooled to a temperature of 450°C at pressures exceeding 25,000 atm, in other words deep within a parent body of approximately lunar size. — D. B. V.

184-87. Clark, S[ydney] P., Jr., and Kullerud, G[unnar]. Iron meteorites: Carnegie Inst. Washington Year Book 58, July 1, 1958-June 30, 1959, p. 167-170, 1959; reprinted in Carnegie Inst. Washington Geophys. Lab. Ann. Rept. of Director for 1958-1959, 1959.

Information on the pressures and temperatures under which meteorites were formed will make it possible to improve earth models based on meteorites. Although iron and nickel in two metal phases (kamacite and taenite) make up more than 98 percent of the iron meteorites, it is unlikely that a sensitive thermometer and barometer, based only on the compositions of coexisting kamacite and taenite, can be developed. It is possible that the Fe-Ni ratios in the sulfide troilite, the phosphide schreibersite, or the carbide cohenite may provide the information needed to fix both the temperature and the pressure at which the mineralogy of a given meteorite formed. For this purpose that part of the system Fe-Ni-S between the FeS-NiS join and the binary system Fe-Ni have been investigated with two aims in mind: 1) for information on the direction of the tie lines connecting coexisting alloys and nickeliferous troilite, and 2) for knowledge of the melting relations in this system. — V.S.N.

184-88. Reed, George W. Activation analysis applied to geochemical problems, in Researches in geochemistry: New York, John Wiley and Sons, p. 458-475, 1959.

Activation analysis involves the production of a radioactive isotope by neutron absorption and the subsequent measurement of its amount by counting techniques. The radioactivation technique because of its great sensitivity and freedom from contamination, can be very useful in measuring trace-elements. The discussion in this paper is restricted to the neutron activation study of meteorites. The basic method is discussed and various previous investigations of uranium in meteorites reviewed. The cosmic abundance of uranium is estimated as 7.8×10^{-3} atoms of uranium to 10^6 atoms of silicon. The U, Pb, and He contents and age measurements; the uranium distribution ratio between the silicate and metal phase of planetary bodies; and the excess heat generated in the earth, moon, and Mars by radioactivity are also discussed. Investigations currently in progress are mentioned briefly. — V. S. N.

184-89. DuFresne, Ann. Selenium and tellurium in meteorites: Geochim. et Cosmochim. Acta, v. 20, no. 2, p. 141-148, 1960.

The selenium and tellurium contents were determined for samples of chondritic meteorites of various ages and conditions. Their concentrations do not follow each other nor the sulfur analyses in any systematic way except that the highest amounts of all three elements occur in Indarch, a carbonaceous chondrite. Some fractionation process evidently has operated. In view of such marked effects, it is not possible to regard the chondritic meteorites as reliable samples of the primitive abundances of these elements nor of other elements. — D. B. V.

184-90. Zähringer, J., and Gentner, W. Uredelgase in einigen Steinmeteoriten [Primordial inert gases in some stone meteorites]: Zeitschr. Naturforschung, v. 15a, no. 7, p. 600-602, 1960.

The chondrites Kapoeta and Abee have been found to contain excess amounts of inert gases. From their amounts and isotopic compositions it is concluded that these gases are of primordial origin. Kapoeta contains an excess of all the inert gases, whereas in Abee the primordial component consists mainly of the heavier inert gases. The Ne^{20}/Ne^{22} and Ar^{36}/Ar^{38} ratios show large deviations from those of atmospheric neon and argon, but krypton and xenon ratios do not. The inert gas content of Kapoeta is similar to that found by Gerling and Levskiy (see Geophys. Abs. 184-91) in the Pesyanoye meteorite, which at the time was regarded as exceptional. — D. B. V.

184-91. Gerling, E. K., and Levskiy, L. K. O proiskhozhdenii inertnykh gazov v kamennykh meteoritakh [On the occurrence of inert gases in stone meteorites]: Akad. Nauk SSSR Doklady, v. 110, no. 5, p. 750-753, 1956.

The contents and isotopic compositions of argon, helium, and neon in a number of stone meteorites were measured. Tabulated results also include the argon ages and various isotopic ratios. The isotopic composition of both neon and argon is entirely different from that of atmospheric neon and argon; this agrees with earlier findings. The unusual amounts and compositions of the rare gases in one meteorite, "Staroye Pes'yanoye," cannot be explained by cosmic ray processes; it is suggested that they are of primordial origin, representing gases trapped in the meteorite at the time of its formation. The results of this study support the view that meteorites were formed by the disintegration of one or more bodies of planetary dimensions (see also Geophys. Abs. 165-16). — D. B. V.

184-92. Levin, B. Yu., Kozlovskaya, S. V., and Starkova, A. G. Sredniy khimicheskiy sostav meteoritov [Average chemical composition of meteorites]: Akad. Nauk SSSR Meteoritika, no. 14, p. 38-53, 1956.

The chemical composition of meteorites is reviewed comprehensively, and the attempt is made to evaluate the true average composition of meteoritic material free of alteration that occurs as the meteorite passes through the atmosphere. The results are presented in tables. — J. W. C.

184-93. Starik, I. Ye., and Shats, M. M. Novyye dannyye po opredeleniyu soderzhaniya urana v meteoritakh [New data on determination of uranium content in meteorites]: Akad. Nauk SSSR Meteoritika, no. 18, p. 83-87, 1960.

The uranium content of meteorites is compared with that of analogous terrestrial rocks. The uranium content of olivine from dunite (Webster, N. C.) is 1.1×10^{-7} g per g. In the analyzed chondrites, achondrite, and olivine from pallasite it is $1\text{-}2 \times 10^{-7}$ g per g, and in the Sikhote-Alin and Chinge iron meteorites it is less than 1×10^{-9} g per g. The age of meteorites calculated from the ratios Pb^{206}/U^{238} and Pb^{207}/U^{235} is in agreement with the age now accepted. — A. J. S.

184-94. Gerling, E. K., and Levskiy, L. K. Produkty kosmicheskoy radiatsii v Sikhote-Alinskom meteorite [Products of cosmic radiation in Sikhote-Alin meteorite]: Akad. Nauk SSSR Meteoritika, no. 18, p. 100-105, 1960.

The investigation of isotopes of inert gases in chondrites is continued (see Geophys. Abs. 179-269). The content of inert gases in individual samples of the Sikhote-Alin shower was determined, and the distribution of these gases from the surface to the interior was studied. The sample that contains the greatest quantity of inert gas is thought to have been close to the surface of the original meteor. — A. J. S.

184-95. Stulov, N. N. Rentgenometricheskoye issledovaniye veshchestvennogo sostava nekotorykh meteoritov [X-ray investigation of the composition of certain meteorites]: Akad. Nauk SSSR Meteoritika, no. 19, p. 63-85, 1960.

An X-ray analysis of the mineral compostion of 20 iron and 3 carbonaceous chondrite meteorites is reported. The crystallographic parameters of kamacite and taenite are given for iron meteorites, and the chemical composition of chromite, troilite, schreibersite, and rabdite is presented in weight percentage. Hydrated silicates were found in the chondrites analyzed. — A.J.S.

184-96. Starik, I. Ye., Sobotovich, E. V., and Lovtsyus, G. P. Opredeleniye soderzhaniya svintsa v zheleznyk meteoritakh [Determination of the content of lead in iron meteorites]: Akad. Nauk SSSR Meteoritika, no. 19, p. 100-102, 1960.

A redetermination was made of the lead content of several iron meteorites, and it was found that the older determinations were exaggerated by the introduction of lead of terrestrial origin from the atmosphere during the fusion and in laboratory experiments. It is possible that the true lead content in the metallic phase of meteorites does not exceed $2X10^{-8}$ g per g. — A. J. S.

184-97. Van Dilla, M. A., Arbold, J. R., and Anderson, E[rnest] C. Spectrometric measurement of natural and cosmic-ray induced radioactivity in meteorites: Geochim. et Cosmochim. Acta, v. 20, no. 2, p. 115-121, 1960.

A nondestructive method of analyzing meteorites for natural and cosmic-ray induced radioactivity using low-level gamma-ray spectrometry of kilogram samples is reported. Results so far obtained are essentially qualitative but appear to be in agreement with previous chemical measurements of potassium and aluminum-26 in chondrites and achondrites. Cobalt-60 was detected in the Sikhote-Alin siderite but not in old falls such as Odessa and Canyon Diablo.

Thermalization of neutrons in a meteorite requires an appreciable mass. In irons most of the neutrons escape before capture, even in a specimen of one ton original mass. Thus the dependence of the production rate of a neutron capture species like cobalt-60 on meteorite mass is entirely different from that of a spallation product. This should provide a sensitive index of original meteorite mass. — D. B. V.

184-98. Shedlovsky, J. P. Cosmic-ray produced manganese-53 in iron meteorites: Geochim. et Cosmochim. Acta, v. 21, no. 1/2, p. 156-158, 1960.

The radioactivity of manganese in 3 iron meteorites (Odessa, Grant, and Williamstown) has been measured. The activities found are attributed to Mn^{53}. The measuring technique is described briefly and results are tabulated.

These results show considerably more Mn^{53} activity than predicted by Sheline and Hooper (1957). Either the low-energy secondary flux is 10 times as great as the primary flux; or else the half life of Mn^{53} is in the $5X10^7$-yr range, and 10^8 yr ago the cosmic-ray flux was several times its present value. As the stone meteorites have apparent cosmic-ray ages between 10^7 and $5X10^7$ yr, measurement of the Mn^{53} activity in the metallic phase might settle this point. It is of interest to note that these samples of cosmic-ray produced Mn^{53} are now free of Mn^{54} contamination, whereas all man-made samples contain enough Mn^{54} to mask completely the Mn^{53} activity. — D. B. V.

184-99. Murthy, V. Rama. Isotopic composition of silver in an iron meteorite: Phys. Rev. Letters, v. 5, no. 12, p. 539-541, 1960.

The isotopic composition of silver in the troilite of the Toluca iron meteorite was determined. The average of three runs gives an Ag^{107}/Ag^{109} ratio of 1.097±0.002, compared to a terrestrial ratio of about 1.074±0.002. The excess Ag^{107} may have been caused by selective fractionation during long cooling or during the last stages of nucleosynthesis, or it may be due to the decay of extinct Pd^{107}. If the latter is the case, the time interval Δt between nucleosynthesis and formation of iron meteorites can be estimated.

Assuming a silver content of 0.1 ppm, Δt for the "sudden synthesis" model would be about $8.4X10^7$yr, and for the more commonly accepted "continuous synthesis" model $\Delta t=4.5X10^7$ yr. The latter value is comparable to the $4X10^7$ yr obtained by Anders and Stevens for the Canyon Diablo iron, using the Pb^{205}-Tl^{205} decay scheme (see Geophys. Abs. 183-63). — D. B. V.

184-100. Baranov, V[ladimir] I. Zadachi vozrastnykh opredeleniy meteoritov [Problems of age determinations of meteorites]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 226-253, 1957 (1960).

The lead and inert-gases methods of age determination on meteorites indicate the time of disruption of the parent planet, the remnants of which constitute the meteorites. These methods can also be applied to determination of the age of the crust of the earth. The solution of the problem is presented by a graph of Pb^{206}/Pb^{204}, which is a straight line with an inclination that is a function of time t. For terrestrial rocks the age $t=4\text{-}4.5X10^9$ yr; for meteorites $t=0.650\text{-}4.82X10^9$ yr (see Geophys. Abs. 166-23, 180-248). — A. J. S.

184-101. Starik, I. Ye., Sobotovich, E. V., and Shats, M. M. Opredeleniye vozrasta meteoritov svintsovo-izotopnym metodom [Determination of age of meteorites by the lead isotope method]: Akad. Nauk SSSR Meteoritika, no. 18, p. 88-91, 1960.

The uranium and lead contents and the isotopic composition of lead in 6 stone and 2 iron meteorites were determined by mass spectrometry. The uranium and lead contents in these meteorites are approximately the same. The Pb^{207}/Pb^{206} ages range from 4.3 to 4.5 billion years; the Pb^{207}/U^{235} ages from 4.1 to 7.0 billion years; and the Pb^{206}/U^{238} ages from 3.2 to >20 billion years. — A. J. S.

184-102. Macleod, W. N., and Walls, R. Notes on meteorites from Nigeria: Nigeria Geol. Survey Recs. for 1958, p. 21-26, 1960.

Six meteorite falls have been recorded in various parts of Nigeria. The Uwet meteorite, from Uwet in Calabar Province is classified as a normal hexahedrite of the Braunau type with an approximate chemical composition of $Fe_{14}Ni$. The Udei meteorite, from north of the Benue River near Makurdi, is classified as a mesosiderite. It is the only representative of this type in Nigeria and is comparatively rare elsewhere in the world. The two Git Git meteorites, from near Bogoro in the Lere District of Bauchi Province, and the Karewar meteorite, from Karewar in Katsina Emirate, are white chondrites. The Geidam meteorite, from Garau in the Zajibiri Village Unit of Geidam District, Bornu Province, is a typical chondrite with a moderately high proportion of iron-nickel alloy. The ratio of silicates to iron-nickel is of the order of 4 to 1. Only small pieces were recovered from a meteorite that was observed to break up at a great height over Adamawa Province and the Cameroons in November 1952. — V. S. N.

184-103. Pokshivnitskiy, Ye. [Pokrzywnicki, Jersy]. Meteorite Zaboritsa [Zaboritsa meteorite]: Akad. Nauk SSSR Meteoritika, no. 18, p. 106-110, 1960.

The meteorite which fell on March 30, 1819, at Zaboritsa (ϕ=50°17'; λ=27°41') in Poland is studied from the original report to Wilna University. The weight was reported to be about 19.75 kg; it possessed magnetic properties, belonged to the class of crystalline chondrites, had a specific gravity of 3.49, and had a spectrophotometric color index of $+1.03^m$. — A. J. S.

184-104. Kostov, I. Meteority Sofiyskogo universiteta [The meteorites of Sophia University]: Akad. Nauk SSSR Meteoritika, no. 19, p. 155, 1960.

The name (or locality), weight, and date of the fall of 3 meteorites from Bulgaria, and 19 meteorites from other countries, collected by the faculty of mineralogy, petrography, and economic minerals of Sophia University are listed. — A. J. S.

184-105. Kashkay, M. A., Sultanov, G. F., Eminzade, T. A., and Aliyev, V. I. Yardymlinskiy zheleznyy meteorit [Yardymly iron meteorite]: Priroda, no. 9, p. 109-110, 1960.

Witnessed accounts are given of the fall of an iron meteorite at Yardymly, Azerbaijan S. S. R., on November 24, 1959. Fragments of the meteorite weighing 360 kg, 127 kg. 11.3 kg, 5.93 kg, and 5.7 kg were recovered. — A. J. S.

184-106. Florenskiy, K. P., Vronskiy, B. I., Yemel'yanov, Yu. M., Zotkin, I. T., and Kirova, O. A. Predvaritel'nyye rezul'taty rabot tungusskoy meteoritnoy ekspeditsii 1958 g. [Preliminary results of the work of the Tungus meteoritic expedition of 1958]: Akad. Nauk SSSR, Meteoritika, no. 19, p. 103-134, 1960.

The results of field work in 1958 in the region of fall of the Tungus meteorite in central Siberia are reported. The area of the forest felled by the meteorite was surveyed, and samples of soil in the area were collected and ex-

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amined for metallic remnants of the meteorite. The total area of the felled forest is about 1,500 km^2. The samples of soil trommelled for meteoritic particles were treated magnetically for separation of magnetic particles. In several samples a number of extremely small spherules, probably of magnetite or silicate, were found; these are considered to be of cosmic origin but not necessarily remnants of the Tungus meteorite. Iron particles (larger than 0.1 mm) found contain no nickel and are considered to be terrestrial. — A. J. S.

184-107. Vronskiy, B. I. O nakhodke zheleznogo meteorita susuman [On the finding of the iron meteorite Susuman]: Akad. Nauk SSSR Meteoritika, no. 19, p. 135-142, 1960.

The iron meteorite Susuman was found in November 1957 at lat 62°43'17" N. and long 148°07'49" E. by a mine worker in the Magadan region, northeastern Siberia. The meteorite was broken by the miners into 3 parts: 12.1 kg, 6.7 kg, and about 0.1 kg. The specific gravity is 7.8. The meteorite was found at a depth of 32 m in alluvial permafrost; the time of fall is considered to be 15,000-20,000 yr ago. — A. J. S.

184-108. Murayama, S. Japanese meteorites and the collection of the National Science Museum [in Japanese]: Nat. Sci. and Museums, v. 27, no. 3/4, p. 1-19, 1960.

Thirty meteorites that have fallen on the Japanese Islands from 1688-1958 are described. The meteorites are listed in a table which gives the name, class, date of fall, locality, longitude, latitude, number of individuals, and the total known weight of each. The location of each meteorite is shown on a sketch map. — V. S. N.

184-109. Edwards, A. B. The Lismore meteoritic iron: Royal Soc. Victoria Proc., new ser., v. 72, pt. 2, p. 93-94, 1960.

A mineralogic description is given of the Lismore meteorite collected about $1\frac{1}{4}$ miles west of the township of Lismore, Victoria, Australia. A few grams from the freshly cut surface of the main mass gave the following analysis: Fe, 91.40 percent; Ni, 7.79 percent; Co, 0.56 percent; and traces of P and S. Some schreibersite is present and a troilite nodule was exposed in a polished slice. — V. S. N.

184-110. O'Keefe, John A. Tektites as natural earth satellites: Science, v. 133, no. 3452, p. 562-566, 1961.

A study of the distribution of meteorites from the great meteor procession of February 9, 1913 (the "Cyrillids") leads to the conclusion that the theory of a lunar origin for tektites can be reconciled with the criticisms of Barnes, Kopal, and Urey (see Geophys. Abs. 175-395, -396, -397) with respect to their distribution, if it is assumed that the orbits are measurably eccentric, that the glassy form of tektites is the result of atmospheric ablation, and that lunar material also reaches the earth in considerable quantity in some other, probably inconspicuous, form. The conclusion of Kopal that some source nearer than the moon is required to account for the narrow distribution of the tektites is valid in the sense that the breakup into separate bodies takes place in the earth's atmosphere. — D. B. V.

184-111. Cohen, Alvin J. Trace element relationships and terrestrial origin of tektites: Nature, v. 188, no. 4751, p. 653-654, 1960.

Partial volatilization of several of the component oxides during formation of tektite glass might account for the negative correlation of Al_2O_3, FeO, MgO, and CaO with silica, without invoking a mixing of materials as suggested by Cherry, and others (see Geophys. Abs. 183-78). In order to test the proposition that tektites are produced at high temperatures and that volatilization takes place, the gallium-germanium ratios of a series of tektites and related terrestrial materials have been determined. It is clear from the results, which are tabulated, that tektites have higher Ga/Ge ratios than terrestrial impactite glasses. That volatilization took place is well shown in an australite sample, where the second melting that produced the flange has caused an increase in gallium and a decrease in germanium compared to the sandstone at the crater. The high temperature of formation of tektite glasses, the quenching of the melt before thorough mixing can take place, and the shapes (before secondary melting) all indicate an impact origin. — D. B. V.

184-112. Barnes, Virgil E. Significance of inhomogeneity in tektites: Internat. Geol. Cong., 21st, Copenhagen 1960, Proc., pt. 13, p. 328-338, 1960.

On the basis of petrographic examination of 37 tektites from different parts of the world, it is concluded that the lechatelierite present in some tektites originated from quartz similar to that in various terrestrial rocks; that tektites were melted at a temperature in excess of 1,710°C and remained molten only a short time; that australites, indochinites, and Java tektites may all represent one shower; and that two tektite showers are present in Texas, the younger of which may correlate with the Georgia tektites. If tektites were formed from terrestrial material, the explosive force that created some showers must have been sufficient to throw molten rock out of the atmosphere to solidify before plunging back to be partly remelted. — D. B. V.

184-113. Taylor, S. R. Abundance and distribution of alkalic elements in australites: Geochim. et Cosmochim. Acta, v. 20, no. 2, p. 85-100, 1960.

The mean contents of the alkali elements in 14 australites from different parts of Australia have been determined. The values are of the same order of magnitude as those for terrestrial abundances and match abundances in sedimentary rocks better than those in igneous rocks. The sodium and potassium averages are virtually identical with those found by Pinson and Schnetzler (1959) for philippinites and indochinites. The dispersion in concentration of the alkali elements is much smaller than in specific terrestrial rock types such as granites but distinctly greater than that found in chondrites. All the elements show close association with one another. It is concluded that such a coherence arises from a physical process such as mixing rather than from a chemical process. Any process invoked to explain the chemical composition of australites must not fractionate the alkali elements. A regional variation in composition, with higher alkali element concentrations toward the west, is observed. — D. B. V.

184-114. Reynolds, J[ohn] H. Rare gases in tektites: Geochim. et Cosmochim. Acta, v. 20, no. 2, p. 101-114, 1960.

Eight tektites from a number of localities have been examined for their contents of potassium, atmospheric argon, radiogenic argon, atmospheric neon, and possible cosmogenic neon. The helium diffusion rate of tektites was found to be so high that no radiogenic or cosmogenic helium can be retained.

The recent tektites should retain a substantial amount of any cosmogenic neon contained at the time of fall. In no case was any excess Ne^{21} detected. From the upper limits of original Ne^{21} content, a maximum "flight time" since last melting has been computed for each tektite. A result of 28,000 yr for a tektite from Kalgoorlie, Australia, is in apparent disagreement with the finding by Ehmann and Kohman of radioactive Al^{26} in australites (see Geophys. Abs. 175-330).

Potassium-argon ages have been computed for each tektite; these range from 0 to 32 million years and are usually in agreement with the stratigraphic age. Data in this paper do not support a recent suggestion that the tektites of Czechoslovakia and Georgia are part of the same fall (see Geophys. Abs. 179-43). — D. B. V.

184-115. Koenigswald, G. H. R. von. Tektite studies: Koninkl. Nederlandse Akad. Wetensch. Proc., ser. B, v. 63, no. 2, p. 135-141 (pt. 1) and p. 142-153 (pt. 2), 1960.

The first part of this paper discusses the age of the Indo-Australian tektites and the second part their distribution. It is concluded that the Indo-Australian tektites form a single natural group of the same chemical composition, which came down early in Middle Pleistocene time and arrived simultaneously in different "clouds" belonging to the same "swarm." There are primary differences between clouds, indicated by average size and surface sculptures. The peculiar form of the australites is believed to be due to longer passage through the atmosphere rather than to primary stratification within the cloud as a whole. — D. B. V.

184-116. Vorob'yev, G. G. Problema tektitov i silika-glassov [The problem of tektites and silica-glasses]: Akad. Nauk SSSR Meteoritika, no. 19, p. 26-62, 1960.

This is a comprehensive review of silica-glasses, impactites, fulgurites, and tektites. Ten varieties of tektites (the moldavites, australites, tasmanites, billitonites, indochinites, philippinites, livites, americanites, bediasites, and schonites) are classified according to their geographic and geologic locations, general appearance, shape, structure, physical properties, chemical composition, isotopic composition, absolute age, and gaseous and solid inclusions. An historical survey of the theories of origin of tektites is also given. The bibliography lists 155 titles. — A. J. S.

184-117. Firsoff, V. A. Strange world of the moon: New York, Basic Books, Inc., 226 p., 1959.

The present condition of the moon with special reference to the atmosphere, surface, and subsurface structure is the main subject of this book, which is designed for the nonspecialized reader. An appendix has been provided for treatment of mathematical arguments. The 16 chapters' headings are as follows: dead or alive; the importance of being a satellite; the earth's fair child or a foundling?; the telescopic panorama; the mountains of the moon; meteorite or lunavoes?; the sunless sea; realities or shadows?; seasonal changes; colors and hues; between the heat and the cold; the vexed question of lunar atmosphere; structure of the lunar air; wherein the answer lies; water and snow; and life? — V. S. N.

184-118. Bülow, Kurd von. Gesichtspunkte zur Beurteilung der ersten Photos von der Rückseite des Mondes [Aspects of the evaluation of the first photographs of the rear side of the moon (with English summary)]: Gerlands Beitr. Geophysik, v. 69, no. 3, p. 129-139, 1960.

In spite of ambiguities in the first photographs of the rear side of the moon due to indistinctness, vertical illumination, and relatively small scale, certain facts can be ascertained. There are no unknown features. True maria certainly are present and epicontinental maria probably exist. Craters seem to be very numerous, and there are indications of north-south structural trends. The belt of maria on the front side continues to the back. The differences between the front and back of the moon are in degree rather than in kind. — D. B. V.

184-119. Brockhaus, K., and Joksch, H. C. Bestimmung der hypsometrischen Kurve des Mondes aus Beobachtungen von J. Franz [Determination of the hypsometric curve of the moon from observations by J. Franz (with English abstract)]: Zeitschr. Geophysik, v. 26, no. 1, p. 9-23, 1960.

Absolute heights were determined from the differences of the coordinates for 547 objects measured by Franz on moon photographs taken at different libations. In spite of errors due to incompleteness of the published data, 150 heights thus determined corresponded exactly with heights determined by Schrutka-Rechtenstamm; however, a comparison of 41 heights with those determined independently by Weimer showed no correlation.

A hypsometric curve is unimodal and asymmetric, and shows no similarity to the curve previously determined by Joksch (1957) from Ritter's hypsographic map. — D. B. V.

184-120. Berlage, H. P. Sur l'origine des satellites en général et de la Lune en particulier [On the origin of satellites in general and of the moon in particular]: Ciel et Terre, v. 75, no. 5/6, p. 173-186, 1959.

Satellite systems are small-scale replicas of the planetary system; every theory of evolution of the planets is applicable to that of the satellites, and any theory that does not explain both is invalid. It is shown that a toroidal disk would spontaneously become a series of concentric rings, and these rings surrounding a planet in turn would become pairs of satellites. Mars, with its one pair of satellites with circular orbits coinciding with the planet's equator, corresponds exactly to the theoretical ideal. The moon was created at a distance of about 10 earth radii from the center of the earth; a second satellite only 1/10 as heavy might have revolved at a distance of 30 earth radii to be destroyed by the moon as it moved to a distance of 60 earth radii. It is also possible that the second satellite was larger than the moon and was formed from a ring closer to the earth, so that it was quickly drawn back to the earth. — D. B. V.

184-121. Kellogg, W. W. (chairman). Earth sciences session: Lunar and Planetary Explor. Colloquium (Sept., 1959) Proc., v. 11, no. 1, p. 15-33, 1959 [1960].

The earth sciences session of this colloquium was opened with a keynote speech by J. Green in which the problem of the origin of the craters of the

moon was introduced. The need for terrestrial research based both on the hypothesis of internal (defluidization) origin and the hypothesis of external (impact) origin is emphasized. J. Green presented the case for internal origin of the craters and E. M. Shoemaker the case for the external or impact origin; the latter analyzed the form of known maar and meteor craters in the United States and Mexico. — V. S. N.

184-122. Brereton, Roy G. Lunar exploration: Geotimes, v. 5, no. 3, p. 8-9, 27, 1960.

The first step in exploration of the moon will be a series of unmanned vehicles designed to impact on the moon, orbit the earth-moon system, orbit the moon, and finally soft-land an instrument package.

The second step will involve more powerful and more sophisticated manned rockets. The first men on the moon should be a geologist, a physicist, and an engineer. Preliminary geophysical work at the landing site should consist of a seismic survey to determine the elastic properties of surface and subsurface rocks, depth of surface material, and general seismicity of the moon; a gravity survey to determine anomalous density contrasts and to obtain information on lunar mass; a magnetic survey; and electrical surveys to locate any fissures and cracks hidden under surface dust. — D. B. V.

184-123. Oilweek. Tool to drill on moon? Oilweek, v. 11, no. 42, p. 36, 1960.

The completion of a lunar drilling system to be rocketed into space by an unmanned space ship sometime in 1963 is announced. The tool is 5 feet high, will weigh 10 pounds on the moon, and will drill a small diameter hole to a depth of several feet in either dust or a granite-like rock. — V. S. N.

EARTH CURRENTS

184-124. Yungul, S. H. Time variations of the ellipticity and preferred direction of the Pc telluric field: Jour. Geophys. Research, v. 66, no. 2, p. 557-561, 1961.

The objective was to determine the preferred direction of the telluric currents, at one point on the earth, that would depend only on the geologic setting. This is called the direction of the "geologic ellipse." From six days recording an experimental relation between the variations of the azimuth of the long axis and the ellipticity of the statistical "telluric ellipse" was established. By means of such a relation, it is possible under favorable conditions to obtain the direction of the geologic ellipse from only a few hours records, although the azimuth of the 10-min statistical telluric ellipse may vary 100° in 3 hr, and that of the daily statistical telluric ellipse may vary a few tens of degrees from day to day. — Author's abstract

184-125. Verö, Josef. Die Bestimmung der tellurischen Stationsellipsen [The determination of telluric station ellipses (with English summary)]: Gerlands Beitr. Geophysik, v. 69, no. 5, p. 257-268, 1960.

The "tangent method" of interpreting telluric measurements is described. This method gives a tensor, the so-called "station ellipse," which characterizes the resistivity conditions of the underground and facilitates telluric measurements. Formulas for determining station ellipses from the measurements are given in an appendix. — D. B. V.

184-126. Smith, H. W., Provazek, L. D., and Bostick, F. X., Jr. Directional properties and phase relations of the magnetotelluric fields at Austin, Texas: Jour. Geophys. Research, v. 66, no. 3, p. 879-888, 1961.

Directional properties and phase relations of the variable electric and magnetic field components of selected data samples taken at Austin, Tex., are presented in the form of X-Y plots. Power density spectra of component signals are shown, and data recording and analysis techniques are described and illustrated for the selected data samples.

The representativeness and absolute accuracy cannot be ascertained until a more extensive observation and analysis program is completed. Measurements obtained on three additional days appear to have the same general character as the sample period, suggesting that this sample does not represent an isolated case. In particular, the application of narrow-band filtering of the signals at a number of different frequencies holds the greatest promise of yielding significant new data in the area. — D. B. V.

184-127. Troitskaya, V. A. Pulsation of the earth's electromagnetic field with periods of 1 to 15 seconds and their connection with phenomena in the high atmosphere: Jour. Geophys. Research, v. 66, no. 1, p. 5-18, 1961.

Preliminary results of investigations of earth current pulsations in the period range of 1 to 15 sec are presented. Data of 5 earth current stations in the Arctic, 2 in the Antarctic, and 10 in middle latitudes of the U. S. S. R. were used as well as data of high-sensitivity magnetic field (Z) recording instruments at 3 stations. Several characteristic types of pulsations were defined and correlated with high-atmosphere phenomena. Short irregular pulsations ($T \sim 1$-15 sec) that constitute the microstructure of several forms of macroscopic disturbances of the magnetic field are closely correlated with aurora, and "pearl" type pulsations ($T \sim 1$-4 sec) of regular form are correlated with cosmic-ray bursts in the stratosphere. — D. B. V.

184-128. Berdichevskiy, M. N., and Raspopov, O. M. Statisticheskiy metod obrabotki nablyudeniy v metode tellurichеskikh tokov [Statistical method of treatment of observations in the method of telluric currents]: Prikladnaya Geofizika, no. 27, p. 64-72, 1960.

The method of statistical treatment of telluric current data, proposed originally by Kunetz and Kántás (see Geophys. Abs. 170-90, 171-124), is developed and supported by analysis and field investigations. Under conditions of nonlinear polarization of the telluric current field, quasi-sinusoidal form of telluric impulses, and parallel arrangement of the base and field measuring lines, the radiosynchronization procedure in telluric measurements can be eliminated, and a better stability of telluric measurements achieved. —A. J. S.

184-129. Cantwell, T., and Madden, T. R. Preliminary report on crustal magnetotelluric measurements: Jour. Geophys. Research, v. 65, no. 12, p. 4202-4205, 1960.

Some preliminary work on the determination of the earth's electric conductivity structure through simultaneous measurements of the natural electric and magnetic fields is reported. The work was confined to frequencies of 0.005 to 1 cycle per second, with skin depths distributed through the crust. The field measurements were made mainly in Massachusetts, with the majority of data obtained at Littleton.

Assuming a resistivity of 8,000 ohm-m in the surface layer, a two-layer interpretation fits the data reasonably well, with the upper layer about 70 km thick and resistivity in the lower layer less than 80 ohm-m; but it is not suggested that the earth's conductivity structure is actually as simple as this. Sources of error are discussed. — D. B. V.

184-130. Wescott, E[ugene] M. Magnetic and telluric current disturbances in Alaska: Geophysics, v. 25, no. 6, p. 1242-1250, 1960.

Much of Alaska lies in or near the auroral zone, where magnetic and telluric current disturbances are large compared to those at lower geomagnetic latitudes. Pronounced and different diurnal variations of disturbance are evident from analysis of K indices from Barrow, College, and Sitka magnetic observatories. The quietest period for magnetic or electrical surveying is the late morning and afternoon hours locally. Recordings of telluric current disturbances can be used as a sensitive indicator of ionospheric activity. The large amplitude and rich frequency spectrum of the telluric currents suggest their use as a prospecting tool in Alaska. — Author's abstract

184-131. Hessler, V. P. Telluric current micropulsations on Arctic Drifting Station Charlie: Nature, v. 188, no. 4750, p. 567-568, 1960.

Micropulsations of less than 1-sec period were recorded for an interval of more than 2 hr on December 11, 1959 by telluric current recording equipment that operated on Arctic Drifting Station Charlie during October 15-December 31, 1959. The frequency of these micropulsations was about 70 cycles per minute, and the rate of fluctuation tended to be very uniform throughout the activity; amplitude ranged from 0.05 to 0.10 mv per km. The circumstances of the experiment assure beyond any reasonable doubt that these were natural micropulsations and not variations introduced by the instrumentation. No previous record of telluric current micropulsations of this short period is known. — D. B. V.

184-132. Subieta, Marian. Uwagi o dolnośląskich łupkach grafitowych [Remarks on Lower Silesian graphitic schists (with English summary)]: Przegląd Geol., v. 8, no. 10, p. 532-533, 1960.

Exploration for graphite was renewed in Lower Silesia in 1959 using the earth current method. Quartz-graphite schist occurs in narrow, steeply dipping lenses interlayered with other schists. The graphite zones exhibit minimum potentials. — J. W. C.

184-133. Rikitake, Tsuneji. Electromagnetic induction in a hemispherical ocean by Sq: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 11, no. 3, p. 65-79, 1960.

A theory of electromagnetic induction within a hemispherical conducting sheet is described and applied to induction by geomagnetic Sq variations in a large ocean of uniform depth bounded by two meridians. The patterns of the induced currents are illustrated for the 24- and 12-hourly components. The effect of self-induction, which is rather important, is taken into account. The magnetic fields produced by the currents induced in the ocean amount to several gammas, and the electric field in the sea associated with the induction would be of the order of a few millivolts per kilometer. — D. B. V.

Bhattacharyya, B[ismal] K[rishna]. Correlation studies of radio-aurora, magnetic, and earth-current disturbances. See Geophys. Abs. 184-47.

184-134. Duke, C. Martin. The Chilean earthquakes of May 1960: Science, v. 132, no. 3442, p. 1797-1802, 1960.

The Chilean earthquakes of May 1960 were perhaps the largest to afflict a heavily populated area since those of San Francisco in 1906 and Tokyo in 1923. Besides the major shocks there were several others of destructive effect, and a tsunami was created which was responsible for most of the deaths in Chile and caused loss of life and property as far away as Hawaii and Japan.

The first large shock, magnitude 7.5 on the Richter scale, occurred on May 21 at 10:03 G. c. t.; its epicenter was near Concepción. The principal shock occurred on May 22 at 19:11 G. c. t., and the epicenter was near the coast at about the latitude of Puerto Montt. A focal depth of 50 km has been inferred from macroseismic evidence. Aftershocks included several of magnitude 7.5 to 8, and one of magnitude 7 occurred as recently as August 14. Construction of an isoseismal map will be difficult due to overlapping effects of the shocks.

Subsidence of 1.6 m occurred in the Valdivia region. Lava erupted from a new vent in the side of Mount Puyehue. Damage to structures is discussed. Buildings erected since 1939, when a new building code was put into effect following a disastrous earthquake in the Concepción region, suffered less damage than older buildings. Errors in design or construction or lack of knowledge about the behavior of the foundations in earthquakes were responsible for most of the damage to the newer buildings. — D. B. V.

184-135. Jordan, James N. The Chilean earthquakes of 1960: Geotimes, v. 5, no. 5, p. 8-11, 1961.

As a result of the swarms of earthquakes that began in Chile on May 21, 1960, and have continued to the present, about 2,000 persons were killed, a half million were made homeless, and property damage in Chile totals about 500 million dollars. Widespread damage due to tsunami occurred on many Pacific Islands and around the perimeter of the Pacific Ocean. The latitude range (lat $37\frac{1}{2}°$-51° S.) and the tremendous energy release within a relatively short interval (5 shocks of magnitude 7 or greater within 2 days) are unique. Preliminary epicentral locations have been made for 70 of the several hundred shocks; the majority of these had magnitudes greater than 6. Depths of the larger and more destructive shocks vary between 40-60 km; the epicentral area of these seems to fall in the ill-defined border zone of the two major Cretaceous geosynclines—the Andean and the Magellan. The Coast Ranges-Central Valley Fault Zone is believed to be the major structure involved in the shocks although earth and rock slides in the Andes followed closely a line of volcanoes (only one of which was reactivated) more or less parallel to this structure. — V. S. N.

184-136. Fiedler, Günther. Seismological study of the Caracas earthquake of 15 April, 1960 and problems of earthquake prediction: Bol. Inf., v. 3, no. 5, p. 133-137, 1960.

The instrumental results at the Cagigal Observatory from the small earthquake that occurred near Caracas, Venezuela, on April 15, 1960, place the epicenter of the shock in the sea about 20 km north of Macuto with a focal depth of about 10 km below the sea floor. A study of the epicenters of recorded earthquakes around the Caracas area suggests the presence of two fault systems: an ENE-WSW trending system between Maracay and Higuerote, and a NE trending system which crosses the other one near Cúa, and includes the focuses of the most disastrous earthquakes in the Caracas region. A system of earthquake prediction based on observation of compressional and dilatational tensions in the interior of the earth that are expressed at the surface as inclinations is recommended. — V. S. N.

184-137. Fiedler, Günther. Caracas earthquake of June 1960: Bol. Inf., v. 3, no. 7, p. 208, 1960.

On June 18, 1960, an earthquake occurred with a focus 35 km NW to NNW of the Seismological Institute, Caracas, Venezuela. The intensity had a mean value of 5.5 on the Mercalli-Caucani-Sieberg scale, and horizontal ground acceleration reached a maximum value of 8 cm per sec^{-2} indicating no material damage could have occurred. — V. S. N.

184-138. Belotelov, V. L., Savarenskiy, Ye. F., and Feofilaktov, V. D. Opredeleniye energii zemletryaseniya 15 noyabrya 1959 g. [Energy determination of the earthquake of November 15, 1959]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1593-1597, 1960.

The energy of body and surface seismic waves from the earthquake in Greece (38° N. and 20.3° E.) that occurred on November 15, 1959 at $17^h08^m40^s$ was calculated. The energy of the incident body waves ranged from 170 to 600 ergs per cm^2 for P-waves and from 190 to 670 ergs per cm^2 for S-waves; the total surface wave energy was 15,800 ergs per cm^2. The magnitude was 6.8, and intensity 8-9 points. The energy at the focus E_P+E_S was 3.2×10^{20}-11.4×10^{20} ergs. — A. J. S.

184-139. Butovskaya, Ye. M., Vvedenskaya, N. A., Iodko, V. K., Kondorskaya, N. V., Semenov, P. G., Treskov, A. A., Ulomov, V. I., and Tskhakaya, A. D. Bylleten' sil'nykh zemletryaseniy SSSR za 1957 g. [Bulletin of strong earthquakes in the U. S. S. R. for the year of 1957]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 3-26, 1960.

The paper gives: (1) the catalog of earthquakes of $M \geq 4$ that occurred in the U. S. S. R. in 1957; (2) the map of the epicenters of the earthquakes; and (3) a brief description of the strongest earthquakes. — Authors' abstract, A. J. S.

184-140. Puchkov, S. V., and Khovanova, R. I. Expeditsionnyye seysmicheskiye nablyudeniya v yugo-zapadnom Pribaykal'ye v 1958-1959 gg. [Seismic observations of the expedition in the southwest Baikal region in 1958-59]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 30-39, 1960.

An expedition was sent to study in detail the seismic regime of the southwest part of the Baikal region in the area adjacent to the zone of the Mondy earthquake of 1950, and to improve and develop methods of instrumental seismic regionalization. Four seismic stations were established, and observations were made from August 1958 to May 1959.

A map shows the distribution of epicenters of earthquakes recorded in that period, distinguished according to energy. Three strong earthquakes occurred, two at Kyren on August 10 and October 22, and the third about 50 km north of Arshan on October 29. The coordinates of the August 10 and October 22 shocks were calculated, but the epicenter of the October 29 shock has not yet been determined.

Results of studies of periods, amplitude ratios, and attenuation of P- and S-waves in local earthquakes, made in connection with seismic regionalization problems, are also reported briefly. — D. B. V.

184-141. Khovanova, R. I. Kyrenskoye zemletryaseniye 22 oktyabrya 1958 g. [The Kyren earthquake of October 22, 1958]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 40-43, 1960.

The coordinates of the first Kyren earthquake on August 10, 1958 have been determined instrumentally to be ϕ=51.73° N., λ=101.93° E., h=10 km; its intensity, calculated instrumentally, was 5-6 points. A second strong earthquake in the same area on October 22 at 8^h34^m was well recorded by the temporary seismic stations in the area. The coordinates of this shock were determined from P-wave arrivals at Arshan, Shimki, Mondy, and Zhemchug, using the methods of hyperbolas, as ϕ=51.45° N., λ=102.08° E. The position obtained by the analytical method, using the P-wave arrivals at these four stations, corresponds well with these values and with a focal depth of 10 km.

Both epicenters are close to a major regional fault along the northern edge of the Tunkin basin, on which movement evidently took place. The dip of the fault, calculated from data of the first earthquake, is 30°, or 45° if data from the second are used. Fault plane solutions by Vvedenskaya's method suggest the movement on the fault was in opposite directions in the two shocks.

Macroseismic data on the October earthquake are summarized briefly at the end of the paper. — D. B. V.

184-142. Misharina, L. A. Rezul'taty opredeleniya gipotsentrov Kyrenskikh zemletryaseniya 1958 g. metodom pryamolineynykh epitsentraley [Results of determination of the focus of the Kyren earthquakes of 1958 by the method of rectilinear epicentrals]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 44-45, 1960.

The focal coordinates of the Kyren earthquake of August 19, 1958, were determined by constructing three "rectilinear epicentrals" based on observations at the temporary stations at Kyren, Zhemchug, Arshan, and Mondy, and the permanent stations at Kyakhta and Irkutsk. These lines intersect at ϕ=51.72° N., λ=101.96° E. Depth of focus is 9 km. P-wave velocity is 6.49 kmps according to data of the permanent stations, and 5.7 kmps according to that of the temporary stations; by the differential method, observations at Irkutsk and Kyakhta give a P-wave velocity of 6.5 kmps. S-wave velocities are 3.65 and 3.66 kmps, according to the traveltimes and the differential method, respectively. Sediment thickness in the basin is calculated to be about 2 km for a velocity of 2.9 kmps in the layer.

These results are confirmed by those obtained for the second Kyren earthquake on October 22, 1958; for this, ϕ=51.75° N., λ=102.16° E., h=13-14 km, sediment thickness=2 km, and velocity in sediments=2.2 kmps. — D. B. V.

184-143. Aprodov, V. A. Seysmotektonicheskiye nablyudeniya v rayone Severokhangayskogo zemletryaseniya 1905 g. (MNR) [Seismotectonic observations in the area of the North Hangay earthquake of 1905 (Mongolian People's Republic)]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 91-97, 1960.

Two 11-point-intensity earthquakes have occurred in Mongolia in the last one hundred years: the North Hangay on July 9, 1905 and the Gobi-Altai on December 4, 1957. Even after 53 years, the earthquake faults of the former are well preserved; they can be traced for tens of kilometers and the nature of movement on them can be ascertained. Details of the main fault and the secondary fault branching southward from it near Undur-Hangay are discussed against their background of recent deformation. — D. B. V.

184-144. Golenetskiy, S. I., and Pshennikov, K. V. O zemletryasenii 7 fevralya 1957 g. v severnoy Mongolii [On the earthquake of February 7, 1957 in northern Mongolia]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 98-107, 1960.

The earthquake of February 7, 1957 at 4^h35^m local time (February 6 at 20^h35^m G. m. t.) was felt in the upper Angara valley, southwestern Transbaikal, and northern Mongolia. In places its intensity reached 6-7 points. The epicenter was near the eastern end of the Dzhidin range. Using data from three near stations (Kyakhta, Kabansk, and Irkutsk) and from 15 others in the U. S. S. R., the epicentral coordinates are calculated as $\phi=50.15°\pm0.06°$ N., $\lambda=105.46°\pm0.04°$ E., $t_o=20^h34^m56.1^s\pm0.3^s$. — D. B. V.

184-145. Solonenko, V. P., and Florensov, N. A. Gobi-Altayskoye zemletryaseniye 4 dekabrya 1957 g. [The Gobi-Altai earthquake of December 4, 1957]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 85-89, 1960.

This is virtually the same as the paper published in Priroda, no. 2, p. 61-66, 1960 (see Geophys. Abs. 183-113). — D. B. V.

184-146. Sapporo, D. M. O. The investigations on the Teshikaga earthquake of Jan. 31, 1959 [in Japanese]: Quart. Jour. Seismology [Tokyo] v. 25, no. 1, p. 9-17, 1960.

On January 31, 1959, the Teshikaga earthquake consisting of two major shocks of magnitude greater than 6 occurred in northeast Hokkaido, Japan. The first shock at 05^h39^m was located at lat 43°22.9' N., long 144°23.7' E. and the second at 07^h17^m was located at lat 43°28.8' N., long 144°23.7' E. Seismograph data including aftershock data are illustrated in maps and tables. — V. S. N.

Schulz, R[udolf], and Weyl, R[ichard]. Earthquakes and crustal structure in northern Central America. See Geophys. Abs. 184-426.

184-147. Petrushevskiy, B. A. O svyazi mezhdu zemletryaseniyami maksimal'noy sily i geologicheskoy obstanovkoy [On the relation between earthquakes of maximum force and geologic conditions]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 8, p. 28-35, 1960.

In the western part of the U. S. S. R. a systematic relation between seismic and structural phenomena is shown for three types of structural elements: (1) zones of Alpine folding (Caucasus, Turkmen S. S. R.); (2) young platform regions with folded Paleozoic basement (Urals, Kyzyl-Kum); and (3) platform areas, regardless of age, where preexisting structures have been reactivated in geologically recent times (Tien Shan).

Data on 26 earthquakes of magnitude $7\frac{1}{4}$ or more that occurred in Eurasia in 1897-1957 and on 26 earthquakes of magnitude 7 3/4 or more that occurred throughout the world in 1904-56 are tabulated. Examination of these data leads to the conclusion that the reactivated platform areas are much more favorable for the occurrence of very strong earthquakes than those in the Tethys zone of Alpine folding. — D. B. V.

184-148. Popov, V. V. Rol' inzhenerno-geologicheskikh usloviy v detal'nom seysmicheskom rayonirovanii [The role of engineering-geologic conditions in detailed seismic regionalization]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 8, p. 80-87, 1960.

In planning and building industrial establishments, cities, hydrotechnical, and other constructions in the U. S. S. R. it has been the custom to make detailed maps of seismic regionalization on a scale of 1:10,000 to 1:25,000 and

sometimes even as large as 1:1,000 or 1:1,500. These detailed seismicity maps are compiled on the basis of information obtained by detailed geologic, hydrogeologic, and engineering-geologic mapping and by detailed examination of the effects of earthquakes in a given area in addition to seismological data. Maps of engineering-geological regionalization and seismic regionalization and a geologic section in the vicinity of Gori in the Georgian S. S. R. are reproduced to illustrate the relationship of the nature of the ground to seismic regionalization. — D. B. V.

184-149. Kats, A. Z. Seysmicheskoye microrayonirovaniye zony Sochi-khosta [Seismic microregionalization of the Sochi-Khosta zone]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 27-31, 1960.

A brief account is given of a plan for seismic microregionalization based on values of dynamic deformation of the ground. A seismic microregionalization map of the Sochi-Khosta zone is given. — A. J. S.

184-150. Rustanovich, D. N. Epitsentral'naya zona Krasnopolyanskikh zemletryaseniy [Epicentral zone of Krasnaya Polyana earthquakes]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 90-98, 1960.

The seismic activity of Krasnaya Polyana and adjacent regions of the northwest slope of the Caucasus and Black Sea coastal region is discussed in the light of 8 earthquakes of 6-7 points intensity, 48 of 5-6 points, and 178 of 3-4 points, which have occurred during the last 126 years. The hypocenters were located at depths of about 10 km, rarely at 18-20 km. The energy level of the earthquakes studied indicates that the region has a relatively low seismicity. — A. J. S.

184-151. Rezanov, I. A., Rastvorova, V. A., and Leonov, N. N. Opyt detal'nogo seysmicheskogo rayonirovaniya na primere odnogo iz rayonov zapadnoy Turkmenii [Experience with detailed seismic regionalization exemplified by one of the regions of western Turkmenia]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 8, p. 131-141, 1960.

After consideration of the structural geology, recent movements, and engineering-geologic conditions (all shown in sketch maps) of western Kopet-Dag in the Turkmen S. S. R., a detailed seismicity map was constructed for the region on a scale of 1:200,000. This map shows areas of high recent seismic activity and distinguishes places where the probability of secondary effects such as slumping, landslides, and cracks is highest. — D. B. V.

184-152. Riznichenko, Yu. V., and Nersesov, I. L. K razrabotke osnov kolichestvennogo metoda seysmicheskogo rayonirovanniya [On working out the principles of a quantitative method of seismic regionalization]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 8, p. 36-59, 1960.

One of the main tasks of the Tadzhik Joint Seismological Expedition of 1955-57 was to work out a method of detailed seismic regionalization on a scale of about 1:500,000 and to supplement the present methods of general regionalization on a scale of about 1:5,000,000 and microregionalization on a very much larger scale. The methods used in constructing a map for the Garm-Stalinabad area, based on the relation between frequency of occurrence and energy,

are discussed. By means of quantitative geophysical calculations of the intensity of earthquakes, the amplitude-frequency spectrums of ground oscillations can be correlated with particular ground conditions.

These methods can also be used as the geophysical basis for micro- and general-regionalization. — D. B. V.

184-153. Nazarov, A. G., Karapetyan, B. K., Musayelyan, A. A., Piruzyan, S. A., Safaryan, A. N., and Shaginyan, S. A. Predvaritel'nyye itogi raboty inzhenerno-seysmologicheskogo otryada TKSE v rayone g. Stalinabada (Preliminary results of work of the engineering seismological detachment TKSE in the region of Stalinabad): Akad. Nauk Tadzhik. SSR Izv. Otdel. Yestestven. Nauk, no. 3 (30), p. 11-26, 1959.

A special detachment has been activated to work out methods of macroseismic, engineering geological, and seismometric investigation for seismic regionalization. Data on the earthquake of February 27, 1952, were reviewed, and the epicenter was found to be 15-20 km farther to the northeast of Stalinabad than had been indicated previously. Macroseismic and instrumental observations in the Stalinabad area demonstrate the presence of a so-called "seismic island" where the intensity of earthquakes is 1-2 points lower than in the rest of the city. — J. W. C.

184-154. Vvedenskaya, N. A. K voprosu ob ispol'zovanii dannykh o slabykh zemletryaseniyakh dlya zadach seysmicheskogo rayonirovaniya [On the question of the use of data on weak earthquakes in the problem of seismic regionalization]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 8, p. 60-66, 1960.

Analysis of data on earthquakes in central Asia during 1950-56 shows that weak earthquakes are relatively more frequent in areas where strong earthquakes have occurred or occur today. This paper investigates the possibility of using weak earthquake data to delineate seismic zones. In zones where activity is steady, observations made by a stationary seismic network might be used; and in zones where activity is irregular, observations made by highly sensitive stations during relatively calm periods might be used to study earthquakes of very low energy levels.

It is concluded that observations of weak earthquakes by the present stationary network might be adequate to define seismic zones if used in conjunction with geologic data, but that as yet the problem of predicting maximum intensity and frequency of strong earthquakes on the basis of weak earthquake data demands more ample information than is available from the present network (see also Geophys. Abs. 173-40). — D. B. V.

184-155. Treskov, A. A. Nekotoryye itogi seysmicheskikh issledovaniy v Pribaykal'ye [Some results of seismic investigations in the Baikal region]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 5-10, 1960.

Historical records of earthquakes in the Baikal area of the Buryat-Mongol A. S. S. R., go back only 200-250 yr. Instrumental study is just beginning. Earthquakes as strong as 9-10 points occurred in 1742, 1814, 1862, 1950, 1957, and 1959. The seismicity of the southern part of the region is related to that of Mongolia; knowledge of earthquakes in the northern part is scanty.

The Irkutsk seismic station (established in 1912) was the only one in the Baikal region until 1951-52, when instruments were set up at Kaban and Kyakhta; in 1957 another station was established at Ulan-Bator in Mongolia. Others are planned for the near future. — D. B. V.

184-156. Florensov, N. A. Neotektonika Pribaykal'ya v svyazi s yego seysmichnost'yu [Neotectonics of the Baikal region in relation to its seismicity]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 11-20, 1960.

The evidence of recent intensive differential movements in the Baikal region is reviewed. As in other areas of recent mountain building, two basic types of deformation are distinguished, tilting of the basement surface and overlying Neogene cover and fracturing of the older and of Neogene-Quaternary structural groups. The present relief and structure of the Baikal region have been governed by the brittleness of the crystalline basement, which has led to fractures of different types, magnitudes, and ages. — D. B. V.

184-157. Bumasov, A. P. Magnitnoye i gravitatsionnoye polya Pribaykal'ya v svyazi s yego seysmichnost'yu [The magnetic and gravitational field of the Baikal region in relation to its seismicity]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 49-58, 1960.

The results of gravity and magnetic surveys in the Baikal region are discussed. The gravity anomalies indicate a thickening of the crust, which in places exceeds 70 km and is also reflected in the high relief of the area; this thickening is a manifestation of a reorganization of the crustal structure of the Caledonian Siberian platform that leads to high seismicity.

The magnetic anomalies are of two types: within the Irkutsk amphitheater (on the Caledonian platform) local anomalies of +100γ to +400γ that trend generally north-south are superposed on a positive regional background of +200γ to +300γ, whereas in the folded area of the Baikal region linear positive anomalies stand out sharply against a negative regional background of -300γ to -500γ. The linear anomalies mark deep fractures (as much as 20 km deep) which divide the crust into blocks. These blocks are not isostatically compensated, and differential movements between them contribute to the high seismicity of the region. — D. B. V.

184-158. Solov'yev, S. L. K territorial'noye i statisticheskoy kharakteristike seysmicheskogo rezhime Pribaykal'ya [On the regional and statistical characteristics of the seismic regime of the Baikal region]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 65-72, 1960.

The distribution of earthquakes of different magnitude in space and time in the Baikal region is discussed. Since 1814 there have been 29 shocks of magnitude 5 or more; their epicenters are shown on a sketch map, and a table gives their dates, time, epicentral coordinates, magnitude (since 1912), and intensity (before 1912, and in some cases since). — D. B. V.

184-159. Petrushevskiy, B. A. K seysmogeologicheskoy kharakteristike gornykh sooruzheniy yuzhnoy Sibirii i severnoy Mongolii [On the seismogeologic characteristics of the mountain structures of southern Siberia and northern Mongolia]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 108-120, 1960.

The seismogeologic conditions of the Baikal-Altai region and of northern Mongolia are examined in order to point out some features not previously described in the literature that are pertinent to an appraisal of the seismicity of different parts of the territory in question. Information is summarized in a table giving the time of stabilization; subsequent mobility in Mesozoic, Paleogene, and Neogene-Quaternary time; character of Neogene-Quaternary movements; significance of inherited development in recent structural plan; and seismicity. — D. B. V.

184-160. Aprodov, V. A. O neotektonike i seysmichnosti territorii Mongol'skoy Narodnoy Respubliki [On the neotectonics and seismicity of the territory of the Mongolian People's Republic]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 121-133, 1960.

"Neotectonics" is defined as crustal movements and their resulting structures which are actively manifested in the recent relief of a locality. In the seismic western part of Mongolia the major movements have been due to the continued development of the chief orographic elements in Quaternary and Recent time. The movements are of six orders of magnitude: polyregional continental uplift and subsidence, regional upwarping and downwarping; formation of block mountains and troughs, rampart-like bulging athwart rivers that disrupts the drainage network, local dislocations of river terraces and erosion surfaces, and formation of earthquake scarps and cracks. — D. B. V.

184-161. Natsag-Yum, L. Rel'yef Mongol'skoy Narodnoy Respubliki v svyazi s tektonikoy i seysmichnost'yu [Relief of the Mongolian People's Republic in relation to the tectonics and seismicity]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 134-140, 1960.

The whole territory of Mongolia lies in one of the active seismic zones of Asia. A hypsometric map of the country is given, on which have been plotted the locations of Quaternary volcanoes and earthquake epicenters distinguished according to magnitude. The different altitude groups differ in geomorphic features and geologic structure and in tectonic mobility and seismicity. Most deep and regional faults, which delimit structural-facies zones or separate orographic elements, are related to negative relief forms. Steep mountain slopes and linear step-like breaks in relief indicate incipient tectonic fractures. The higher mountain area in west and northwest Mongolia is more active seismically than the east and southeast part of the country; in the latter, earthquakes do not exceed 7 points in strength. — D. B. V.

184-162. Solonenko, V. P. O nekotorykh osobennostyakh zemletryaseniy Mongolo-Baykal'skoy seysmicheskoy zony [On some features of earthquakes of the Mongolo-Baikal seismic zone]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 141-147, 1960.

The Mongolo-Baikal seismic zone is one of the most extensive and most active in the world. Distinctive features are its intracontinental location and the great age of its structural elements. Focal depths are normal; those of strong earthquakes lie on regional fractures, mostly in zones with steep geologic and geomorphic gradients representing old structural lines that have been reactivated periodically.

The different types of seismogenic structures are described. The intensity of strong earthquakes is not felt uniformly about their epicenters but is influenced by local geologic conditions. A number of examples are given to illustrate this point. — D. B. V.

184-163. Rezanov, I. A. O noveyshey tektonike i seysmichnosti Severo-Vostoka SSSR [On very recent tectonics and seismicity of northeastern USSR]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 156-167, 1960.

Plio-Quaternary movements in the northeastern part of the U. S. S. R. show a variety of features. Uplift has taken place in two stages, at the beginning of the Pliocene and, more strongly, in the second half of the Quaternary. In spite of the considerable extent, the contrast in neotectonic movements has been negligible except in certain areas. Seismic activity is governed entirely

by the character of recent movements. High seismic activity corresponds either to the zones of contrasting movements or to areas where old structures have been reactivated. These facts are reflected in the 1957 seismicity map, which is reproduced for this region. A 7-point zone extends along the coast of the Sea of Okhotsk and northeastward into the Anadyr River basin; this is a zone of contrasting movements. It is possible that this 7-point zone should be extended somewhat to the north of Magadan to take in the whole zone of contrasting Plio-Quaternary movements. — D. B. V.

184-164. Li, Shan-Pan. Nekotoryye itogi seysmologicheskikh issledovaniy v KNR [Some results of seismological investigations in the Chinese People's Republic]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 149-155, 1960.

This is a review of results of recent seismological investigations in China, where rapid industrial expansion makes a knowledge of the regional and temporal distribution of earthquakes very important. Historical records are scanty before the 15th century. The distribution of known earthquakes since 1189 B. C., broken down into groups according to magnitude, is tabulated for the periods 1189 B. C. - O, A. D. 1-1000, 1001-1400, the 15th, 16th, 17th, 18th, and 19th centuries, 1901-30, and 1931-55. Three maps show the location of epicenters, the general structural plan, and seismotectonic lines in China.

Earthquakes are associated with young mountain areas, with boundary zones between major structural elements, and with zones of weakness within platform areas.

A stable, convenient, and highly sensitive seismograph that has been developed by the Chinese Institute of Geophysics and Meteorology for field use is described. So far it has been used near Peiping, but plans call for several such instruments in other parts of the country. — D. B. V.

184-165. Gorshkov, G. P. Voprosy seysmotektoniki i seysmicheskoye rayonirovaniye territorii Kitayskoy Narodnoy Respubliki [Problems of seismotectonics and the seismic regionalization of the territory of the Chinese People's Republic]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 7, 54 p., 1960.

Historical studies of earthquakes in China are based on nontechnical sources, catalogues of earthquakes, and the contemporary (since 1920) studies of individual earthquakes. The seismicity of China is reviewed, and a list of strong earthquakes recorded from 999 B. C. to A. D. 1955 is compiled for each province; the date, location, epicentral coordinate, and intensity (6-12 points) of 200 earthquakes are given. An epicenter map of China for the period from 1000 B. C. to A. D. 1954, for the period from 1906 to 1955 instrumentally recorded, and an isoseismic map for the period of 1000 B. C. to A. D. 1956 are given on separate sheets. — A. J. S.

184-166. International Geophysical Year Center. Seismological observations in Japan during the International Geophysical Year 1957-58 [in Japanese]: Zisin, ser. 2, v. 13, no. 1, p. 43-60, 1960.

The seismological observations in Japan during the International Geophysical Year are summarized in tables in English as follows: list of seismological stations with their location, foundation, and type of observations made; a list, for each station, of the seismographs and their constants; a chart of the destination of various data; and a list of seismograms recorded on micro-

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film giving origin time, epicenter, location, depth, and magnitude for each earthquake. Maps are included to show (1) the distribution of the observation stations in Japan, and (2) the distribution of epicenters of earthquakes with M >6 for the period of observation. — V. S. N.

184-167. Chao, Tsi-Chen. Meteorologiya i seysmologiya v kitaye [Meteorology and seismology in China]: Priroda, no. 10, p. 27-34,1959.

Research in meteorology and seismology carried out by the Institute of Geophysics of the Academy of Sciences of the Chinese Peoples' Republic is discussed. Descriptions of more than 15,000 earthquakes in China are collected in a symposium entitled, "Chronological Tabulation of Chinese Earthquake Records." More than 8,000 references were investigated in preparation of this list. "The catalog of earthquakes in China" was based on the above symposium. The data were systematized and supplemented with the material of contemporary instrumental observations. The catalog contains information on 1,180 major earthquakes of the period from 1189 to 1955. First arrivals, epicenters, calculated intensity, and resulting destruction are given. Much seismic engineering work is being done, and construction of seismic instruments is on a large scale. — A. J. S.

184-168. Bolt, B. A. The revision of earthquake epicenters, focal depths and origin-times using a high-speed computer: Royal Astron. Soc. Geophys. Jour., v. 3, no. 4, p. 433-443, 1960.

A program for an automatic computer has been developed to revise rapidly, provisional foci and origin-times of normal and deep-focus earthquakes. For each earthquake, up to 300 equations of condition found from P, pP, and PKP observations are solved by least squares to give a correction to the trial location. Special attention is given to the weighting of observation and factors affecting convergence. Features of the program are that the theoretical traveltime tables are stored in complete form, and after each iteration a list of stations with corresponding distances, azimuths, and residuals as well as the root-mean-square error is printed. Applications to a 1954 hydrogen bomb explosion and a number of earthquakes are described. The results suggest that the program may be useful to research organizations requiring either regular or special location of epicenters. — Author's summary

184-169. Treskov, A. A., and Medvedeva, G. Ya. Kombinirovannyye metod opredeleniya gipotsentra [Combined method of determination of a focus]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 46-48, 1960.

It has been assumed until now that observations from 4 seismic stations give only the minimum information necessary for determining the focus of an earthquake; and by using Wadati's method, a unique but uncontrolled solution is obtained. This view does not fit in with the fact that the arrival times of one of the phases (for instance the S-phase) and the $\bar{S}$-$\bar{P}$ differences are independent observational data. With the observations of 4 stations, there are 8 initial data for 6 relevant determinations of values as follows: 2 epicentral coordinates, depth of focus h, origin time t_0, and 2 velocities (transverse, v, and imaginary, w, waves). This abundance of data provides a control of the solution.

An example is given, using the earthquake of February 22, 1952 in the northern Tien Shan where lines constructed on the basis of S-wave arrivals and $\bar{S}$-$\bar{P}$ differences at four stations intersect at a point. — D. B. V.

184-170. Mattern, G. Die Ortung ferner Erdbeben mittels seismischer Registrierungen [Location of distant earthquakes by seismic registration]: Geog. Rundschau, v. 12, no. 11, p. 445-449, 1960.

The various types of seismic waves generated by earthquakes and the method of determination of the focus are discussed for the nontechnical reader. — J. W. C.

184-171. Iida, Kumizi. Earthquake energy and earthquake fault: Nagoya Univ. Jour. Earth Sci., v. 7, no. 2, p. 98-107, 1959.

The results of an investigation of earthquakes in Japan and in other parts of the world that have been accompanied by some degree of fault breakage at the earth's surface are reported. Observation of fault breakage is an important aid in studying the earthquake-generating mechanism, the nature of the earth's crust, and the energy release patterns in the earth's crust.

The smallest earthquake for which surface effects have been observed is of the magnitude M=5.6~5.7; this also corresponds to the smallest shock accompanied by crustal deformation and tsunami. In Japan, earthquakes with a magnitude >7.3 are always accompanied by faulting. The amount of vertical and horizontal displacement of the earthquake fault is generally about 2-4 m, rarely 7-8 m, and not over 8 m. The greatest length observed for an earthquake fault is 435 m. A series of empirical equations is presented to show the relationship between earthquake magnitude and fault length in order to derive earthquake energy from the fault data of Japan and other parts of the world. Results suggest that energy released in the larger shallow earthquakes is approximately proportional to the fault length and to the area at the earth's surface of the zone of initially strained rock. — V. S. N.

184-172. Aki, Keiiti. Further study of the mechanism of circum-Pacific earthquakes from Rayleigh waves: Jour. Geophys. Research, v. 65, no. 12, p. 4165-4172, 1960.

The source functions of three western Pacific earthquakes (June 25, 1958; July 18 and 27, 1959) were obtained from Rayleigh waves recorded at many International Geophysical Year stations throughout the world, and analyzed by a method proposed in a previous paper (see Geophys. Abs. 182-117). It was found that the pattern of the force at the source is quadrant for all three earthquakes, in accordance with the model adopted in the fault plane studies. One of the two nodal lines is nearly parallel to the trend of the seismic zone for each of these earthquakes. If this nodal line is taken as the fault, the slip directions are right hand in all three cases. The result from the recent Chilean shocks also supports the hypothesis that right-hand strike-slip prevails along the circumpacific earthquake belt. — D. B. V.

184-173. Ritsema, A. R. Focal mechanisms of some earthquakes of the year 1950: Royal Astron. Soc. Geophys. Jour., v. 3, no. 3, p. 307-313, 1960.

Fault plane solutions are given for 15 earthquakes that occurred in 1950. The data used for this study were the compressions and dilatations of P and PKP listed in the International Seismological Summary for 1950, supplemented by information on initial motion directions of these waves furnished by seismic stations in the zones relevant to the determination. The results show a predominance of transcurrent fault motions at earthquake focuses over reverse and normal fault motions, confirming earlier results (see Geophys.

Abs. 178-67 through 178-75). The A- and C-axes also show a preference for directions that are about perpendicular to and parallel with the seismic zones in which the earthquakes take place. — D. B. V.

184-174. Oulianoff, Nicolas. Tassements et effondrements dans les séries sédimentaires [Packing and subsidences in sedimentary formations]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 1, p. 115-116, 1960.

Perpetual vibration of the earth's crust has been shown to cause accumulation of bodies of fossil water under impervious clay layers in sedimentary basins. When the sediments are fractured as a result of tectonic activity, the water escapes upward and leaves voids. Where the sum total of these voids becomes appreciable the overlying rock settles, producing a depression at the surface. The process is capable of generating earthquake shocks, in a manner analogous to the tremors caused by settling near coal mining excavations but on a much larger scale. — D. B. V.

184-175. Vvedenskaya, A. V., and Balakina, L. M. Metodika i rezul'taty opredeleniya napryazheniy, deystvuyushchikh v ochagakh zemletryaseniy Pribaykal'ya i Mongolii [Methods and results of determination of strains operating at the focuses of earthquakes of the Baikal region and Mongolia]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 73-84, 1960.

After a description of the method used, fault plane solutions are worked out and presented in stereographic diagrams for the earthquakes of June 27, 1957, January 5, 1958, and September 14, 1958 in the southeastern Baikal region; April 4, 1950, February 6, 1957, and June 23, 1958 in the southwestern Baikal region and the Selenga River basin; and December 4, 1957 in Mongolia. P- and S-wave data from seismic stations in the Russian Far East region and central Asia were used. — D. B. V.

184-176. Laclavère, G. Can we forecast and protect ourselves against earthquakes: Impact, v. 10, no. 4, p. 217-229, 1960.

The losses caused by earthquakes with reference to some of the major earthquakes on record are reviewed, and the international organization of seismological studies is described briefly. The need for an even distribution of seismological stations throughout the world is emphasized. The causes and frequency of earthquakes are discussed and our inability to predict them is admitted; it is shown how some degree of protection against their destructive effects may be attained by determining the degree of seismic activity in various regions and by erecting shock-resistant buildings. The tidal-wave warning system in the Pacific area is explained briefly and the relationship between earthquakes and volcanoes discussed. A program of fundamental seismic research is outlined. — V. S. N.

184-177. Lyamzina, G. A. Ob opredelenii seysmicheskikh svoistv gruntov pri promoshchi peredvizhnoy seysmicheskoy stantsii [On determination of seismic properties of grounds with the aid of a portable seismic station]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 141-152, 1960.

The effects that grounds of certain properties can exert on the intensity of oncoming seismic waves were studied, and an attempt made to determine the

rigidity of grounds and the periods of their natural oscillations. Amplitudes increase suddenly up to 2-3 points intensity when the seismic waves acting on the ground coincide with the period of natural oscillation of the ground. A portable seismic station was devised to study ground rigidity and elasticity for seismic microregionalization in the northwest Caucasus. — A. J. S.

184-178. Tan, Go-Tsyuan. O primenenii teorii veroyatnostey v zadachakh inzhenernoy seismologii [On application of the theory of probability to problems of engineering seismology]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 99-104, 1960.

The necessity is demonstrated for applying the probability method to solution of problems in engineering seismology arising from the fact that ground movements of earthquakes are not definite functions of time. — A. J. S.

184-179. Kats, A. Z. O kharaktere kolebaniy nekotorykh zhestkikh massivnykh sooruzheniy pri rasprostranenii seysmicheskikh voln [On the character of oscillations of certain rigid massive constructions acted upon by propagating seismic waves]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 175-181, 1960.

The problem of vibrations of a rigid massive structure carrying a load of an installation that has a rapidly rotating mass is considered. It is shown that additional gyroscopic moments appear in the rotating system effected by seismic movements of the ground, and that such additional moments can disturb the normal working rate of the system. Some experimental data are provided that characterize this phenomenon. — Author's abstract, A. J. S.

184-180. Korf, M. G. Primeneniye materialov seysmometrii k raschetam sooruzheniy na seysmicheskiye vozdeystviya [Application of seismometric data to construction designs for seismic effects]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 182-188, 1960.

Earthquake-resistant design of buildings is discussed on the basis of actually observed earthquake accelerograms. Effects of plasticity and elasticity of the ground are taken into account. The earthquake spectrum is determined by the graphic-analytical method (see Geophys. Abs. 168-23), and pendulum displacements of the seismometer calculated by the theory of probability. It is proposed that the method of successive integration of the differential equations of ground oscillations be applied instead of the graphical-analytical method. — A. J. S.

184-181. Murata, K. J. Vigil for disaster: Geotimes, v. 5, no. 5, p. 12-13, 1961.

An account is given of the tsunami generated by the Chilean earthquake beginning on May 21, 1960, that arrived in Hilo Bay, Hawaii, with destructive force early on May 23. The main wave, a 20-ft wall of water, demolished about half of the business district of Hilo, obliterated an older part of the city, and moved basaltic boulders weighing as much as 10 tons inland for a distance of more than 300 feet. The wave approached Hawaii at a speed of almost 500 mph. — V. S. N.

184-182. Écollan, Jean, and Rocard, Yves. Signaux microbarographiques en rapport avec les grands séismes du Chili [Microbarographic sig-

nals corresponding to the great earthquakes in Chile]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 4, p. 523-525, 1960.

On May 22, 1960, four microbarographic stations in France registered rather regular trains of acoustic waves of 25-sec period and 10-barye amplitude. It is suggested that these waves were atmospheric ripples provoked when the tsunami from the Chilean earthquake of May 21 impinged on the eastern Asiatic coasts. Rayleigh waves recorded an hour before the microbarographic signals by long-period seismographs at one of the four stations were related to the May 22 earthquake. Although Rayleigh waves coupled to the atmosphere are known, the signals in question are not believed to be of such origin. — D. B. V.

184-183. Alterman, Z., Jarosch, H., and Pekeris, C. L. Oscillations of the earth: Royal Soc. [London] Proc., ser. A, v. 252, no. 1268, p. 80-95, 1959.

Free and forced oscillations of the earth have been studied. The natural periods are determined for radial, torsional, and spheroidal types of oscillation, using five different earth models (homogeneous earth; homogeneous solid mantle enclosing homogeneous liquid core; Bullen's model B; and Bullard's models I and II). It is found that the second order spheroidal oscillation has a period of 53.5 min in all but the homogeneous earth model, in which it is only 44.3 min; the 53.5-min period agrees within observational error with the 57-min period observed by Benioff in the Kamchatka earthquake. Bullen's model B also has a second order spheroidal oscillation of about 101-min period, mainly in the core. Benioff's observation of an oscillation of 100-min period might be considered as evidence favoring this model; but it is calculated that the amplitude of the 100-min oscillation should be more than 1,000 times weaker than that of the 53.5-min oscillation, and thus it is not clear how a near-surface earthquake could have excited the core oscillation.

The spectrum of the free modes of oscillation has also been determined for n=3 and 4, including the fundamental and first two overtones for each case. The computed free periods of spheroidal oscillation range from 53.5 to 8 min for the fourth overtone in the case n=2. Love's numbers were also determined for Bullen's and Bullard's models in the case n=2 for bodily tidal periods of 6 h, $6\sqrt{2}$ h, 12 h, and ∞. Dependence of the Love numbers on period is small; maximum range of variation (13 percent) occurs in the K-values between 6 h and ∞. — D. B. V.

184-184. Alterman, Z., Jarosch, H., and Pekeris, C. L. Propagation of Rayleigh waves in the earth: Rehovot, Israel, Weizmann Institute, Department Applied Mathematics, 11 p., 1961.

The propagation of Rayleigh waves in the earth is investigated in the whole range of periods T from about 10 sec up to 1 hr. Three methods are necessary to cover this range of periods effectively. The standard flat earth method, with neglect of gravity, gives values for phase velocity C correct to within 1 percent up to T=50 sec and for group velocity U up to T=250 sec. The flattening of the earth method, with neglect of gravity, has accuracy limits of 1 percent for C and U at 300 and 400, respectively; inclusion of gravity effects does not alter the limits. For T>300 (n<25) the period of T(n) of free oscillation of the earth as a function of the order of the spherical harmonic n must be determined; this involves solution of a system of differential equations of the 6th order in which gravitational effects are included. Using these three methods, C(T) and U(T) are evaluated for Bullen's model B, the Jeffreys-Bullen model as modified by Dorman, Ewing, and Oliver, and the Gutenberg model. Results substantiate conclusions that the observed Rayleigh

wave data provide evidence in support of Gutenberg's low velocity layer. The few observed Rayleigh group velocities between T=400 and 600 are substantially lower than the theoretical values for all three models. — V. S. N.

184-185. Benioff, Hugo, Press, Frank, and Smith, Stewart. Excitation of the free oscillations of the earth by earthquakes: Jour. Geophys. Research, v. 66, no. 2, p. 605-619, 1961.

The free oscillations of the earth have been experimentally verified from an analysis of strain seismograph and pendulum seismograph recordings made in California and Peru from the great Chilean earthquake of May 1960. Both spheroidal and torsional oscillations were revealed by a power spectral analysis of the seismograms. The gravest spheroidal mode shows a split spectral peak with periods of 54.7 and 53.1 min; the theoretical prediction by Alterman and others for the Bullen B model is 53.7 min (see Geophys. Abs. 184-183). The oscillations were observed for all modes up to 38 with corresponding periods as short as 3.7 min. In almost all cases agreement between experimental and theoretical predictions is close; the differences that occur should make it possible to discriminate between proposed earth models.

The dissipation function Q^{-1} for the earth is 380 for the spheroidal mode S_3 (T=35.5 min) and 170 for the mode S_{18} (T=6.2 min). If Q is independent of frequency, this implies a higher Q in the core than in the mantle.

A method is described for deducing the fault length and rupture velocity from analysis of phase difference between components of ground motion. Preliminary results indicate a fault length for the Chilean earthquake of about 1,000 km and rupture velocities in the range 3-4 kmps. — D. B. V.

184-186. Ness, N[orman] F., Harrison, J[ohn] C., and Slichter, L[ouis] B. Observations of the free oscillations of the earth: Jour. Geophys. Research, v. 66, no. 2, p. 621-629, 1961.

Free oscillations of the earth excited by the Chilean earthquakes of May 1960 were recorded with high precision at Los Angeles by a LaCoste-Romberg tidal gravimeter. Spectral analysis of the records shows that the spheroidal modes of type ${}_0S_l$, where l=2, 3, 4,... 40, 41 were excited at periods in almost all cases within 1 percent of theoretical predictions of Alterman and others based on the Gutenberg earth model (see Geophys. Abs. 184-183). The first and second overtones for several modes were also identified. The Gutenberg model is in slightly better accord with the observations than the Bullen B model.

Upper and lower limits of the dissipation functions (Q) of these modes have been derived. These are generally of the order of 200 to 400; but the fundamental dilatational mode ${}_0S_0$ with a period of 20.46 min, for which shear stresses are absent, has a Q of at least several thousand and was observed even during quiet periods a month after the Chilean earthquakes. Three of the low-order modes are split, an effect which is ascribed to the earth's rotation. — D. B. V.

184-187. Alsop, Leonard E., Sutton, George H., and Ewing, Maurice. Free oscillations of the earth observed on strain and pendulum seismographs: Jour. Geophys. Research, v. 66, no. 2, p. 631-641, 1961.

Spectral analyses of seismograms of the great Chilean earthquake of May 22, 1960, from a strain seismograph at Ogdensburg, N. J., and from pendulum seismographs at Palisades, N. Y., have revealed peaks corresponding to fundamental spheroidal modes 2 to 34, fundamental torsional modes 2 to 9, and the first overtone of the second spheroidal mode.

The periods of the graver modes of oscillation, both spheroidal and torsional, are in agreement with the theoretical values of Alterman and others (see

Geophys. Abs. 184-183). The periods of the fundamental spheroidal oscillations between 250 and 500 sec show excellent agreement with theoretical values calculated for a mantle with velocities according to the Gutenberg model and densities according to the Bullen model A, and the torsional periods also agree well with theoretical values calculated from Jeffreys' velocities and densities of Bullen's model A (see Geophys. Abs. 182-159, -160). — D. B. V.

184-188. Bogert, B. P. An observation of free oscillations of the earth: Jour. Geophys. Research, v. 66, no. 2, p. 643-646, 1961.

The more extensive measurements by Benioff and others (see Geophys. Abs. 184-185, -186, -187) are supported by the results of spectral power analyses, using an electronic computer, of seismograms of the Chilean earthquake of May 1960, by a Columbia long-period vertical seismometer installed at Chester, N. J. Agreement is particularly good in the shorter period range (up to 17.7 min). It is suggestive that peaks at 20.4 and 10.06 min correspond to the lowest purely radial mode ${}_0S_0$ and the next lowest mode ${}_1S_0$, respectively. — D. B. V.

184-189. Pekeris, C. L., Alterman, Z., and Jarosch, H. Comparison of theoretical with observed values of the periods of free oscillation of the earth: U. S. Natl. Acad. Sci. Proc., v. 47, no. 1, p. 91-98, 1961.

The periods of free oscillations up to order n=61, calculated for two earth models—Bullen B and Gutenberg—are tabulated and compared with the periods of free oscillations from the Chilean earthquake of May 1960 as observed by strain and pendulum seismographs (see Geophys. Abs. 184-185) and tidal gravimeter (see Geophys. Abs. 184-186).

The periods deduced from power-spectra analysis of the seismic and gravimeter records agree to within 1 percent. The periods of spheroidal oscillations for the Gutenberg model agree with observed values to within 1 percent, and this is true also for the Bullen B model at periods less than 5 min. In the period range of 5-11 min the Bullen B values are systematically about 2 percent higher than the observed values. Torsional oscillations, recorded only in the seismograms, agree to within 1 percent with both models except for the n=1 mode, which was weakly recorded. An order-of-magnitude argument is presented in support of the hypothesis of the rotational origin of the frequency splitting of the free oscillations of the earth. — D. B. V.

184-190. Slichter, Louis B. The fundamental free mode of the earth's inner core: U. S. Natl. Acad. Sci. Proc., v. 47, no. 2, p. 186-190, 1961.

The Chilean earthquake of May 22, 1960, furnished the first fully convincing observational evidence concerning the free modes of oscillation of the earth. More than 40 free modes were identified in spectral analysis of tidal gravimeter observations (see Geophys. Abs. 184-186), each at a peak corresponding to theoretical predictions (see Geophys. Abs. 180-189). However, the first spectral peak (about 86-min period) appearing at the low end of the spectrum was not theoretically predicted; this peak also occurred in the spectral analysis of several of the subintervals of the 4.6-day gravimeter record, and significantly it is absent in analysis of the quiet period a month later.

It is suggested that a gravitational perturbation of the approximate observed magnitude (0.64 microgal) and period could be produced by oscillations of the inner core as a rigid body in the surrounding fluid core. This mode would escape detection by a strain meter because no first-order strain would be associated with such rigid body displacements. Results of some calculations concerning the dynamics of the mode are summarized here.

Study of this inner core oscillation provides new observational evidence about the center of the earth. The development of information concerning the physical properties of the outer core from studies of the core-mode should assist in identifying the material of the core. By this means, the mechanical properties of the core can be studied under conditions not obtainable in the laboratory (pressures of several million atmospheres and temperatures of about 4,000°C). — D. B. V.

184-191. Northrop, John, Blaik, Maurice, and Tolstoy, Ivan. Spectrum analysis of T-phases from the Agadir earthquake, February 29, 1960, 23h 40m 12s GCT, 30° N., 9° W. (USCGS): Jour. Geophys. Research, v. 65, no. 12, p. 4223-4224, 1960.

T-phases from the Agadir, Morocco, earthquake were recorded from several SOFAR-type bottomed geophones. The recordings were then examined with spectrum analysis equipment of a few cycles per second resolution. Tracings of the T-phase arrival at three stations are reproduced; they show a considerable amount of dispersion in the signal, giving it a "Christmas-tree" shape that has been observed before but never correlated definitely with the T-phase. The early branches of the "tree" correspond to the velocity maximum and the "peak" to the "rider" wave of Pekeris (1948); the "stem" shows the beginning of the Airy phase (see Geophys. Abs. 181-124). The trailing edge varies considerably from station to station and is probably due to reverberation, local excitation, and the arrival of later modes including the Rayleigh mode. The velocities computed for T are 1.49±0.005 kmps for all paths.

This is probably the first time the T-phase has been observed from a transatlantic earthquake. From a detailed study of the spectrum of such T-phases it may be possible to determine the parameters of the travel path—sediment thickness and velocity, holes in the mid-Atlantic ridge that passed T-phase energy, and refraction of rays toward the lower-velocity northern water paths.

Frequency analysis of T-phases may also provide a way to distinguish between earthquakes and atomic blasts (see Geophys. Abs. 179-95). In the present paper it is apparent that the later modes form a characteristic of the signal; a T-phase signature like this would probably not be excited by surface bomb explosions. — D. B. V.

184-192. Herrin, Eugene. On $\overline{P}$ and L_g: Jour. Geophys. Research, v. 66, no. 1, p. 334-335, 1961.

The results obtained by Herrin and Richmond in their paper on propagation of the L_g phase (see Geophys. Abs. 183-155) contain an error concerning the partitioning of energy between Sv- and P-waves. This error is corrected and the revised results tabulated, and the propagation of $\overline{P}(II_g)$ phases recently reported by Shurbet (see Geophys. Abs. 182-125) is analyzed in their light. Only the sedimentary basin model in the table would allow propagation of P-waves within the L_g wave guide; for all other models there is almost complete transformation from P to Sv at the free surface, resulting in high amplitude L_g but no detectable $\overline{P}(II_g)$. — D. B. V.

184-193. Bullen, K. E. Note on cusps in seismic travel-times: Royal Astron. Soc. Geophys. Jour., v. 3, no. 3, p. 354-359, 1960.

When there is triplication in traveltime curves, it is often assumed that the cusps in the curves are necessarily associated with large wave amplitudes. Models that give a good representation of various types of seismic velocity variation are here set up to show that there are important cases in which this assumption does not apply. The analysis, which is facilitated by use of the

variable α=2d log r/d log η (where η=r/v, v=velocity at distance r from the center of the earth model), shows fairly directly that dΔ/dp (where Δ and p are the angular length and parameter of ray) is sometimes discontinuous, sometimes continuous, at a cusp. — D. B. V.

MacDowall, J. Some observations at Halley Bay in seismology, glaciology, and meteorology (with discussion). See Geophys. Abs. 184-

184-194. Choudhury, Mansur Ahmed. PKP_2 et ses réflexions à l'interieur de la croûte terrestre [PKP_2 and its reflections in the interior of the earth's crust]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 3, p. 407-409, 1960.

Longitudinal PKP_2 waves that have been reflected twice at the inner boundary of the crust can be recognized in the records of deep earthquakes. A crustal thickness of 30 km is calculated from these waves in the records of 10 deep (h=100-600 km) earthquakes in Fiji, Tonga, and the Kermadec Islands, obtained in 1958-60 at the Garchy seismic station in France. — D. B. V.

184-195. Magnitskiy, V. A., and Khorosheva, V. V. K voprosu o volnovode v obolochke zemli i yego fizicheskoy prirode [On the problem of the wave guide in the earth's mantle and its physical nature]: Akad. Nauk SSSR Doklady, v. 135, no. 2, p. 305-307, 1960.

Using data obtained at seismic stations in the U. S. S. R. for nine earthquakes at epicentral distances chosen so that there would be no overlapping of other information with the phases sought, waves propagating in wave guides in the mantle were investigated. The velocities obtained for P_a and S_a are 8.30±0.03 kmps and 4.57±0.03 kmps and their periods are 5-12 sec and 7-30 sec, respectively. The results show clearly that these waves are cylindrical in nature. The velocity values preclude the possibility that they are surface waves or Stoneley waves, and they propagate only in the wave guide. Quantitative calculations show that the data are compatible with the old hypothesis that the material of the low velocity layer is amorphous. — D. B. V.

184-196. Ogurtsov, K. I. Otsenki intensivnostey seysmicheskikh voln, otrazivshikhsya ot ochen' slabykh granits razdela [Evaluations of intensities of seismic waves reflected from very weak interfaces]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1426-1431, 1960.

A mathematical analysis is made of the intensities of reflected waves in a seismic vertical ray. Both the zero (acoustic) approximation and the first term of the asymptotic series representing the solution are taken into account. It was found that in evaluation of intensities of seismic waves reflected from very weak interfaces the first term of the asymptotic series must be taken into consideration, since the zero approximation may be totally absent, be very small, or of the same magnitude as the first asymptotic term. — A. J. S.

184-197. Popov, I. I. O dispersii dlinnoperiodnykh voln Lyava v kontinental'noy i okeanicheskoy kore na trasse Indonesiya—Krym [On the dispersion of long-period Love waves in the continental and oceanic crust on the Indonesia-Crimea traverse]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1458-1462, 1960.

Results of an experimental investigation of long period Love waves from the earthquake of August 12, 1958, at $19^h25^m05^s$ in the region of the Molucca Sea (ϕ=0°, λ_E=126°) recorded at the Simferopol seismic station are discussed.

The mean thickness of the oceanic crust along the track of Molucca Islands, Arafura Sea, northeastern coast of Australia, New Zealand, and the Pacific Ocean was calculated to be 15 km, and that along the continental track of southwestern China, Himalayas, Tibet, Pamirs, Turanian Lowland, Caspian Sea, and northern Caucasus to be about 40 km. The energy absorption coefficient of the Love waves was found to be 0.00023. — A. J. S.

184-198. Khorosheva, V. V. Nekotoryye rezul'taty issledovaniya voln P_a i S_a po seysmogrammam stantsiy SSSR [Certain results of investigation of P_a and S_a waves according to seismograms of U. S. S. R. stations]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1563-1569, 1960.

P_a and S_a seismic waves recorded at stations in the U. S. S. R. were investigated. The approximate magnitude of the index of geometric divergence (about $\frac{1}{2}$) and the absorption coefficient (0.000144 per km on the average) of the P_a waves were obtained. The traveltime curves of P_a and S_a are found to be linear, and the velocities are 8.30(±0.03) and 4.57(±0.03) kmps, respectively. The linearity of the traveltime curves of the waves, their velocities, and the range of their propagation support the existence of a wave guide at the upper level of the earth's mantle. P_a and S_a waves were found not only from earthquake foci in the waveguide, but also from foci 50 to 640 km deep. — A. J. S.

184-199. Bulin, N. K., and Tryufil'kina, Ye. I. Ispol'zovaniye obmennykh voln SP, registriruyemykh pri blizkikh zemletryaseniyakh, dlya izucheniya glubinnogo stroyeniya zemnoy kory [Utilization of transformed SP waves recorded from local earthquakes for study of deep structure of the earth's crust]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 11, p. 1570-1579, 1960.

The problem of distinguishing transformed SP waves on seismograms of local earthquakes is discussed. The method of interpretation of SP records is explained, and the results of such interpretations in connection with studies of crustal structure in southeastern Turkmen S. S. R. are reported. The method can be used in the regions not more than 1,000-1,500 km from the epicenter of the earthquake. — A. J. S.

184-200. Medvedev, S. V. Uskoreniya kolebaniya grunta pri silnykh zemletryaseniyakh [Accelerations of ground oscillations in connection with strong earthquakes]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 32-89, 1960.

Accelerograms of 124 strong earthquakes (5-8 points) are reproduced and the method of their recording is explained. These accelerograms are interpreted, and the values of acceleration in ground oscillations due to earthquakes of various intensities and oscillation periods are calculated and presented in tables. — A. J. S.

184-201. Puchkov, S. V. Nekotoryye voprosy instrumental'nogo opredeleniya reologicheskikh svoystv gruntov na osnove rasprostraneniya seysmicheskikh voln [Certain problems of instrumental determination of rheologic properties of grounds on the basis of seismic wave propagation]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 118-132, 1960.

In accordance with Maxwell's concept, the ground is considered as an elastic-plastic medium. A theory of seismic-wave propagation is developed for such a medium. Differential equations of motion are derived, and formulas for travel velocity of longitudinal and transverse waves developed, along with correlations that permit a determination of attenuation coefficients and relaxation time of the medium. The formulas obtained were applied by the Baikal Region Expedition to the evaluation of seismic records. — Author's abstract, A. J. S.

184-202. Korf, M. G. Otsenka inzhenernykh kharakteristik zemletryaseniy metodami matematicheskoy statistiki [Evaluation of engineering characteristics by the method of mathematical statistics]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10(177)(Voprosy inzhenernoy seysmologii no. 3), p. 133-140, 1960.

A statistical method is proposed to evaluate the occurrence probability of seismic spectrums; this method is similar to one that has been used successfully to estimate river discharge. An example is treated in which several published spectra are used. — A. J. S.

184-203. Karapetyan, N. K. Nekotoryye osobennosti zapisi zemletryaseniy Malogo Kavkaza [Several features of the record of earthquakes of the Lesser Caucasus]: Akad. Nauk Armyan. SSR Izv., v. 12, no. 6, p. 57-62, 1959.

On the records of near earthquakes the arrivals of known waves are often accompanied by arrivals the nature of which has not been understood. The equipping of most of the Caucasus seismic stations with a single type of broadband (Kirnos) apparatus has made it possible to use correlation principles in clarifying these unknown waves. Such an arrival, recorded for the February 2, 1953 Lesser Caucasus earthquake, is interpreted as a PPS wave. This wave emerged from the focus as a longitudinal type, was reflected from the surface, propagated along the basalt-ultrabasalt interface (still longitudinal), and finally passed to the surface as a transverse type. — J. W. C.

184-204. Bolt, Bruce A. Revision of earthquake epicenters and seismic traveltime curves using the IBM 704 computer: Earthquake Notes, v. 31, no. 3, p. 25-26, 1960.

A program, coded for the IBM 704, is designed to reduce to a minimum by a least-squares method the differences between observed P traveltimes and P traveltimes calculated from standard tables. — V. S. N.

184-205. Melton, Ben S. Useful concepts for the engineering design of seismographs: Earthquake Notes, v. 31, no. 3, p. 26-27, 1960.

The important conclusions resulting from theoretical and experimental studies of electromagnetic seismographs are listed. They are given without proof to indicate the present possibilities and advisable practices that can lead to good seismograph design. — V. S. N.

184-206. Banerjee, K. N. Response characteristics of electromagnetic seismographs: India Natl. Inst. Sci. Proc., v. 26, pt. A, no. 4, p. 348-354, 1960.

A mathematical analysis is presented for the response characteristics of an electromagnetic seismograph associated with a combination of damped and sustained harmonic displacement of the ground. The seismometer and gal-

vanometer have been assumed to have initial motions. Numerical results show clearly that the magnitude as well as the direction of the initial motions of the seismometer and galvanometer play an important part in the nature of records obtained in seismograms; in many cases the recorded trace may be quite different from the ground motion. If the contributions of the initial motions of the seismometer and galvanometer and of the transient part of the response are taken into consideration in the interpretation of seismograms, the relationship between the amplitude in the seismogram and the extent of energy released at the hypocenter will be better understood. — V. S. N.

184-207. Duclaux, F[rançoise]. Séismométrie théorique [Theoretical seismometry]: Paris, Gauthier-Villars, 129 p., 1960.

This book consists of the following chapters: general principles of pendulum seismographs, horizontal pendulum, vertical pendulum, horizontal seismograph with mechanical amplification, standardization of a seismograph with mechanical amplification, general theory of electromagnetic seismographs, response of the electromagnetic seismograph to sinusoidal movements and to abrupt movement of the ground, apparatus without equivalent reaction to a given apparatus, principal types of electromagnetic seismographs, calculations of an apparatus having given properties, standardization of an electromagnetic seismograph, verification of standardization and functioning of an electromagnetic seismograph, and various questions of adjustment. — J. W. C.

184-208. Berckhemer, Hans, and Hiller, Wilhelm. Kurzperiodische Stationsseismographen mit Trägerfrequenzverstärker und mechanischer Registrierung [Short-period station seismographs with carrier-frequency amplifier and mechanical recording (with English abstract)]: Zeitschr. Geophysik, v. 26, no. 1, p. 1-8, 1960.

A new short-period seismograph system developed at Stuttgart, Germany, is described. The pendulum has a mass of 1 kg and a natural period of 1-1.5 sec. The mechanical displacement is converted into electric signals by means of variable inductances which form the branches of an a-c current bridge. This bridge is fed by a current of 50 cycles per second taken from a power line or from a transistor oscillator. An amplifier with 3 transistor stages and phase discriminator drives a pen motor of differential moving-coil type, recording on smoked paper. All three components are tuned naturally. Maximum magnification is adjustable between 3,000 and 40,000. The seismograph operates mainly as a displacement meter. The exact solution and an approximation of the dynamic magnification function are given. A schematic diagram and photographs illustrate the text. — D. B. V.

184-209. Heidrich, Werner, and Just, Heinz. Die Rückwirkung von Schwingungsmessgeräten auf das Messergebnis in der Bodendynamik (The reaction of vibration measuring devices on the results of measurements in ground dynamics): Freiberger Forschungshefte, C 81 Geophysik, p. 33-43, 1960.

In the measurement of ground motions in both seismology and seismic surveying it has been established that certain instruments, such as seismometers, may react preferentially to frequencies that are not their natural frequencies as determined in the laboratory. This is due to the fact that the motion recorded by any vibration measuring device that is placed on the ground is not the true ground motion, but the ground motion plus the motion of the instrument itself; the latter lags behind the ground motion slightly as a result of the mass inertia of the instrument. This paper shows how the distortion

can be estimated so as to obtain the true vertical ground motion. The corresponding distortion in the case of a horizontal seismometer can be calculated similarly. In that case, however, the coupling to the ground plays an important role so that general equations are less significant. Five pages of diagrams are given for calculating the effect of the inertia of masses of circular basal section on an harmonic elastic wave field. — D. B. V.

184-210. Arkhangel'skiy, V. T. Voprosy teorii dlinnoperiodnogo vertical'nogo seysmometra [Problems of the theory of the long-period vertical seismometer]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1432-1441, 1960.

The theory of pendulum suspension for a vertical seismometer is discussed, and the fundamental terms in the equation of motion of the pendulum that cause its instability when the period is increased are denoted. From the differential equation of the pendulum of a vertical seismometer, the period of natural oscillation of the pendulum and the basic factors of its stability are derived. Variants of the pendulum suspension are suggested that would eliminate "limping" of the natural oscillations, and methods are proposed for obtaining a large oscillation period of the pendulum. — A. J. S.

184-211. Moskvina, A. G., and Shebalin, N. V. Primeneniye seysmografa s dvumya gal'vanometrami dlya odnovremennoy zapisi zemletryaseniy na dvukh urovniyakh chuvstvitel'nosti [Adaption of a two-galvanometer seismograph for simultaneous recording of earthquakes on two sensitivity levels): Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1474-1478, 1960.

An automatic device for desensitizing seismographs when the amplitude of a recorded earthquake wave is greater than the recording capacity of the apparatus is discussed. Automatic systems that switch on and shunt the stronger signals are found unsatisfactory because of inertia during the initial change in the motion of their galvanometer (see also Geophys. Abs. 146-12932, 165-67). An automatic system of two galvanometers operating at two sensitivity levels is discussed (see also Geophys. Abs. 167-163). It was found that this system is practically free of the defects of the shunting galvanometer. A sample seismogram of the new apparatus is given. — A. J. S.

184-212. E, Shi-Yuan. Sposoby registratsii kolebaniy grunta pri silnykh zemletryaseniyakh [Recording methods of ground vibrations due to strong earthquakes]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 10 (177) (Voprosy inzhenernoy seysmologii no. 3), p. 105-111, 1960.

A description of seismic devices for recording of accelerations and displacements of ground during strong earthquakes is presented chronologically from 1880 to 1955. — A. J. S.

184-213. Gayskiy, V. N. O tochnosti opredeleniya uglov s pomoshchyu azimutalnoy ustanovki s naklonnymi seysmografami [On the accuracy of determination of angles by means of an azimuthal setup with inclined seismographs]: Akad. Nauk Tadzhik. SSR Inst. Seysmologii Trudy, v. 71, no. 2, p. 39-45, 1957.

The accuracy of determination of the azimuth and angles of propagation of seismic rays by means of an inclined seismograph is investigated. A series of formulas is derived for computation of errors due to distortion by the in-

struments. A comparison is made between the errors of the conventional three-component installation and those of a four-component installation with an inclined apparatus. — J. W. C.

184-214. Earthquake Notes. Recent seismic events: Earthquake Notes, v. 31, no. 3, p. 34-36, 1960.

A brief description is given of the planned expansion of the Canadian government seismograph network, of the new seismological observatory at Honiara, Guadalcanal, and of the seismological stations and program of the government of Finland. — V. S. N.

Savarenskiy, Ye. F., Solov'yeva, O. N., and Lazareva, A. P. Rayleigh wave dispersion and crustal structure in northern Eurasia and in the Atlantic Ocean. See Geophys. Abs. 184-430.

Nishimura, Eiichi; Kamitsuki, Akira; and Kishimoto, Yoshimichi. Some problems on Poisson's ratio in the earth's crust. See Geophys. Abs. 184-434.

ELASTICITY

184-215. Haskell, Norman A. Crustal reflection of plane SH waves: Jour. Geophys. Research, v. 65, no. 12, p. 4147-4150, 1960.

An equation has been derived for the amplitude of the free surface displacement due to plane SH waves incident at any angle at the base of a layered crust. Numerical computations have been carried through for the case of a single-layered model of the continental crust. At any given angle of incidence the surface amplitude goes through a series of minimums and maximums at periods which, in the single layered case, are harmonically related. At nearly grazing angles of incidence the surface amplitude is relatively small except at periods in the neighborhood of the cutoff periods of the second- and higher-order Love-wave modes. The results throw some doubt on the "whispering gallery" effect as an explanation of the mode of propagation of long-period (20 to 30 sec) S-waves at S_n velocity. Applied to the case of an alluvial layer over a hard-rock basement, the theory appears to give an adequate explanation of the abnormally large amplitudes that occur on unconsolidated formations in the epicentral region of earthquakes. — Author's abstract

184-216. Dix, C. H[ewitt]. The reflected seismic pulse: Jour. Geophys. Research, v. 66, no. 1, p. 227-233, 1961.

Cagniard's theory is recast in a form that simplifies the approximate numerical calculation of the shape of the reflected pulse. A new set of potentials is introduced from which the displacement components can be calculated by differentiations that are easier to perform than those with the usual scalar and vector potentials. Four potentials are used, two for the vertical and two for the horizontal components of displacement. The irrotational and rotational vertical-displacement components are found by differentiation of the potentials with respect to time; the horizontal-displacement contributions are derived by a single horizontal differentiation. For the rotational parts the number of differentiations is reduced from two to one. The time differentiation is much easier to carry out than the space differentiations for the forms used in this paper. A numerical example, selected to throw light on the problem of securing reflections from the M-discontinuity, is worked out. The variation of shape and strength of the reflection with time and distance from source to receiver is studied in this example. — D. B. V.

184-217. Dix, C. H[ewitt]. Elastic pulse reflection—evaluation of some determinants: Jour. Geophys. Research, v. 66, no. 1, p. 235-236, 1961.

The fourth-order determinants that occur in the theory of reflection are split into a sum (denominator) and difference (numerator) of two much simpler determinants. This makes the algebra much simpler. It also makes the form similar to that familiar for normal incidence. — Author's abstract

184-218. Peet, W. E. A shock wave theory for the generation of the seismic signal around a spherical shot hole: Geophys. Prosp., v. 8, no. 4, p. 509-533, 1960.

The shape of the seismic signal generated by an explosive charge is assumed to be governed by shock-wave phenomena in a nonlinear region around the shot hole. The dimensions of this shock-wave region are shown to depend on the weight of the charge and the properties of the medium in which the shot is fired. For an ideally elastic medium the amplitude of the pulse outside the nonlinear zone is found to vary as the 1/3 power of the charge weight. If the medium and (or) seismic instrument attenuate the high frequencies more than the low, a power law of the type $A=cQ^n$ (where A=amplitude, Q=charge weight, c=a constant) can be expected in which n=1/3. The exponent n is a function of charge weight and theoretically can reach a maximum value of 4/3 for very small charges; for large charges, however, values nearer to 1/3 are to be expected. — D. B. V.

184-219. de Hoop, A. T. A modification of Cagniard's methods for solving seismic pulse problems: Appl. Sci. Research, sec. B, v. 8, no. 4, p. 349-356, 1960.

A modification of Cagniard's method for solving seismic pulse problems is given. In order to give a clear picture of our method, two simple problems are solved, namely, the determination of the scalar cylindrical wave generated by an impulsive line source and the scalar spherical wave generated by an impulsive point source. — Author's summary

184-220. Craggs, J. W. On two-dimensional waves in an elastic half-space: Cambridge Philos. Soc. Proc., v. 56, pt. 3, p. 269-285, 1960.

Two-dimensional elastic waves in a half space $0\leqslant r<\infty$, $0\leqslant\theta\leqslant\pi$ are examined under the assumption of dynamic similarity, so that the stresses depend only on r/t, θ. Analytic solutions are given for constant surface traction on $\theta=0$, $0<r/t<V$, where V is constant, the rest of the surface being unloaded, and for a concentrated load at r=0. Numerical results are quoted for the particular case $V\to\infty$ corresponding to a load on half the bounding plane. — Author's abstract

184-221. Musgrave, M. J. P. Reflexion and refraction of plane elastic waves at a plane boundary between aeolotropic media: Royal Astron. Soc. Geophys. Jour., v. 3, no. 4, p. 406-418, 1960.

General equations in stress and displacement are set down and their implications qualitatively discussed. Detailed results are presented for the slownesses, amplitudes, and energy fluxes of body waves generated by the incidence of a body wave upon a range of differently oriented boundaries in hexagonal media. Results for ice and beryl show that assumption of isotropy preserves the qualitative form of the reflection characteristics; in contrast, the variations caused by changing the orientation of the boundary in zinc are too great to be adequately represented in terms of isotropic constants.

The problem was undertaken in order to investigate the effects of anisotropy in a simple reflection problem. Deviations from results obtained on the assumption of isotropy are of interest and could be of significance to seismologists and users of ultrasonic methods. — D. B. V.

184-222. Bolt, B[ruce] A., and Butcher, J. C. Rayleigh wave dispersion for a single layer on an elastic half space: Australian Jour. Physics, v. 13, no. 3, p. 490-504, 1960.

Numerical solutions of the period equation for Rayleigh waves in the single surface layer were calculated using the SILLIAC computer at the University of Sydney. Values of the phase and group velocities for both the fundamental and first higher mode are tabulated against period for 11 two-layer models. The related models allow a sensitivity analysis of the effect of variation in the seismic parameters. Values of the elastic constants used in the calculations were chosen to fit the seismic velocities determined for the crust in Western Australia, so that the solutions are relevant to studies of the crustal structure of Australia. — D. B. V.

184-223. Fredericks, R. W., and Knopoff, L[eon]. The reflection of Rayleigh waves by a high impedance obstacle on a half-space: Geophysics, v. 25, no. 6, p. 1195-1202, 1960.

The reflection of a time-harmonic Rayleigh wave by a high impedance obstacle in shearless contact with an elastic half-space of lower impedance is examined theoretically. The potentials are found by a function—theoretic solution to dual integral equations. From these potentials, a "reflection coefficient" is defined for the surface vertical displacement in the Rayleigh wave. Results show that the reflected wave is $\pi/2$ radians out of phase with the incident wave for arbitrary Poisson's ratio. The modulus of the "reflection coefficient" depends upon Poisson's ratio, and is evaluated as $r_R=0.265$ for $\sigma=0.25$. — Authors' abstract

184-224. Nagumo, Shozaburo; Kawashima, Takeshi; and Honsho, Shizumitsu. Model experiment on Rayleigh wave [in Japanese with English abstract]: Butsuri-Tanko, v. 12, no. 3, p. 129-133, 1959.

The propagation of a Rayleigh wave in a semi-infinite elastic medium was studied in a two-dimensional model. It was found that the wave length of a Rayleigh wave on the surface becomes longer with an increase in the shot depth; the wave length is approximately twice the shot depth. The underground propagation of a Rayleigh wave is illustrated; the wave front of maximum amplitude seems to be inclined to the surface. The reciprocity of the Rayleigh wave between source and detector is ascertained within the error of the experiment. — V. S. N.

184-225. Takeuchi, Hitoshi, and Kobayashi, Naoto. Surface waves propagating along a free surface of a semi-infinite elastic medium of variable density and elasticity (pt. 2) [in Japanese with English abstract]: Zisin, ser. 2, v. 13, no. 1, p. 1-8, 1960.

The variational calculus method used in part 1 (see Geophys. Abs. 181-134) is applied to the study of Love waves propagating along a free surface of a semi-infinite elastic medium, in which the density and elasticities change exponentially with depth. The method is also applied to the study of Love and Rayleigh waves in a uniform superficial layer upon a uniform semi-infinite medium. A trial function is shown that is useful in the study of Love waves in the case where the substratum is perfectly rigid. — V. S. N.

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184-226. Donato, R. J. Experimental investigation on the properties of Stoneley waves: Royal Astron. Soc. Geophys. Jour., v. 3, no. 4, p. 441-443, 1960.

This note describes measurements made both on the velocity and on the attenuation of the Stoneley wave and compares the results with theoretically predicted values. A barium titanate transducer placed on a paraffin wax block immersed in water excited the Stoneley wave. A similar transducer, whose height above the wax block could be varied, received the wave. The received signal was displayed on an oscilloscope together with a time "ruler" marked at 10μ sec and 100μ sec intervals. Oscillograms that show the different times of arrival of the Stoneley wave when the block is covered with water, and the Rayleigh wave when the block has a free surface and both the transducers rest on its surface, are reproduced. Time-distance curves were plotted for the dilatational and Stoneley waves for the block immersed in water; the velocities determined from this information are 21.3×10^4 cm per sec and 6.5×10^4 cm per sec, respectively. The Rayleigh wave velocities, determined similarly for the block in air, are 8.3×10^4 cm per sec. The dilatational and Rayleigh wave velocities are sufficient to specify the elastic constants of the paraffin wax, and with the added values of the velocity of sound in water and the densities of paraffin wax and water the Stoneley wave velocity can be calculated. The value found in this way is 6.8×10^4 cm per sec. — D. B. V.

184-227. Birch, Francis. The velocity of compressional waves in rocks to 10 kilobars, Part 1: Jour. Geophys. Research, v. 65, no. 4, p. 1083-1102, 1960.

The velocity of compressional waves has been determined by measurement of traveltime of pulses in specimens of rock at pressures to 10 kilobars and room temperature. Most of the samples, mainly igneous and metamorphic rocks, furnished three specimens oriented at right angles to one another. The present paper gives experimental details, modal analyses, and numerical tables of velocity as function of direction of propagation, initial density, and pressure. Discussion of various aspects of the measurements is reserved for part 2. —Author's abstract

184-228. Auberger, Michel, and Rinehart, John S. Energy loss associated with impact of steel spheres on rocks: Jour. Geophys. Research, v. 65, no. 12, p. 4157-4164, 1960.

The coefficient for restitution for impact between steel spheres and plexiglas, and between steel spheres and nine different rocks has been measured: granite, sandstone, limestone, and six marbles. The energy loss associated with the impact has been studied as a function of the sphere diameter, particularly for three diameters: 1/8 in., 1/32 in., and 1/64 in. Such a study permits a correlation with attenuation of shear wave as a function of frequency in the frequency range of 30 to 240 kc per sec. Attenuation has been found to be strongly dependent on the main constituents of the rocks, their grain size, and the nature and size of their intergranular particles. Attenuation increases with the number of grain boundaries per unit volume and is lowered when the intergranular cement is made up of grains a few microns thick. Shear attenuation is several times larger than longitudinal attenuation in most of the rocks tested. — Authors' abstract

184-229. Auberger, Michel, and Rinehart, John S. Ultrasonic velocity and attenuation of longitudinal waves in rocks: Jour. Geophys. Research, v. 66, no. 1, p. 191-199, 1961.

Hughes' pulse technique for measuring longitudinal velocities has been adapted and extended to measure attenuation of longitudinal waves in the frequency range from 250 to 1,000 kc. Data for velocity and attenuation in 8 different rocks (3 granite, 1 porphyry, 2 sandstones, 1 limestone, and 1 marble) are given at eight different frequencies ranging from 250 to 1,000 kc. The values of attenuation measured have been found to be much higher than for metals and plastics in the same frequency range. They lie between 1 and 37 decibels per centimeter. All of the curves of attenuation versus frequency show one or several peaks, none of the curves indicating a marked law of increase or decrease of attenuation with frequency. In one granite, in the limestone, and in the marble successive peaks occur at harmonic frequencies. A comparison between the wavelengths for which the peaks occur and the grain size of the rocks shows a good agreement for the coarse-grained rocks between the frequencies of occurrence of the peaks and the resonance frequencies of the largest crystals of the rocks, indicating a very large effect of the frictional boundary losses on attenuation when the wavelength approaches the grain size of the rock. — Authors' abstract

184-230. Peselnick, Louis, and Outerbridge, W. F. Internal friction in shear and shear modulus of Solenhofen limestone over a frequency range of 10^7 cycles per second: Jour. Geophys. Research, v. 66, no. 2, p. 581-588, 1961.

The internal friction in shear and modulus of rigidity of dry Solenhofen limestone was investigated over a frequency range from 4 cycles per second to 10 megacycles per second at room temperature. It was found that the rigidity modulus is constant ($U=2.64\times10^{11}$ d per cm^2) to within ±2 percent over the total frequency range covered, if the samples have the same density; that the shear internal friction in the cycle-per-second frequency range is about a factor of 5 lower than the internal friction in the megacycle frequency range; that the logarithmic decrement at 4 cycles per second is 3.4×10^{-3} and at 10^7 cycles per second is 17×10^{-3}; that the shear internal friction in the infrasonic frequency range increases by 18 percent with the application of a 7.2-kg per cm^2 static axial tensile stress, but no large change in the internal friction occurs for axial compressive stress of the same magnitude; and that the shear internal friction is strain-dependent even for strains as small as 10^{-6}, a static axial tensile stress being superposed on the dynamic torsional stress. — D. B. V.

184-231. Knopoff, L[eon], and Gangi, A[nthony] F. Transmission and reflection of Rayleigh waves by wedges: Geophysics, v. 25, no. 6, p. 1203-1214, 1960.

Experimental observations have been made of the transmission and reflection of Rayleigh waves by wedges. Results are reported for Rayleigh waves in aluminum wedges. It is observed that the wave shapes of the transmitted and reflected waves differ from that of the incident wave and depend on the angle of the wedge. The change of shape is attributed to an interference between part of the incident wave-form and the radiation from a line source placed at the vertex. A procedure is given for the calculation of the partition between the two terms. — Authors' abstract

184-232. Viksne, Andris, Berg, Joseph W., Jr., and Cook, Kenneth L. Effect of porosity, grain contacts, and cement on compressional wave velocity through synthetic sandstones: Geophysics, v. 26, no. 1, p. 77-84, 1961.

Compressional wave velocities through 36 synthetic sandstone cores were measured and related to porosity, manufacturing pressure, grain contacts,

and amount of cement. The results are presented graphically. For cement contents between 10.0 and 17.5 percent, the velocity is directly controlled by manufacturing pressure and porosity; it is also dependent to a great extent on the number of grain contacts, which is intimately associated with manufacturing pressure, and the cement content, which is intimately associated with porosity. For cement contents greater than 17.5 percent by volume, the sand grains float in the cement, and the analogy with natural sandstones is questionable. — D. B. V.

184-233. Donato, R. J. Seismic model experiments on the shape and amplitude of the refracted wave: Royal Astron. Soc. Geophys. Jour., v. 3, no. 2, p. 270-271, 1960.

The experimental verification by means of seismic model techniques of both the wave shape and the amplitude predicted by theoretical considerations is described. Liquid mediums were used; an electric spark immersed in the medium overlying the refractor simulated the seismic explosive source, and a lead zirconate transducer separated horizontally from the source by a distance R received the refracted wave. Photographic records of the original pulse, the pulse after passing through an electronic integrator, the refracted pulse, and the numerical integration of the original pulse are reproduced. — D. B. V.

184-234. Starodubrovskaya, S. P. Eksperimental'noye izucheniye osobennostey prodol'nykh voln, otrazhennykh ot tonkogo sloya [Experimental study of features of longitudinal waves reflected from a thin layer]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1466-1473, 1960.

On the basis of experimental data obtained for various depths for a thin layer with $h/\lambda_2=0.15$, $h/\lambda_1=0.3$, and $v_1/v_2=0.5$, the following conclusions were drawn. A wave reflected from a thin layer in both areas of investigation can be correlated clearly on the record. The dynamic properties of a wave—form of the record, amplitude, and frequency—do not change with distance from the source. Waves registered for various depths of the thin layer are characterized by different predominating frequencies and different attenuations of amplitude with distance. — J. W. C.

184-235. Panel on Seismic Improvement. The need for fundamental research in seismology: U. S. Dept. State Rept. of Panel on Seismic Improvement, 214 p., 1959.

A detailed report is presented on the need for fundamental research in seismology; it is the result of studies by a panel appointed to review the feasibility of improving the Geneva control system for detecting and identifying underground events. The first part summarizes the general need for seismic research, source phenomena, propagation of seismic waves, detection, data processing, and the administration and budget for a new level of seismological research. The second part includes twenty-one papers which are the subject of the following abstracts (184-236 through 184-256). — V. S. N.

184-236. Press, Frank, and Griggs, David T. Improved equipment for existing seismic stations: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 1, p. 17-18, 1959.

It is proposed that the 100-200 best seismograph stations in the world be equipped with modern instruments for the accumulation of valuable data which would be used in research programs for distinguishing earthquakes from ex-

plosions. Improvement in the United States seismic capability should be the first step with equipment to be selected by a panel of American seismologists and with the possible establishment of new stations. — V. S. N.

184-237. Romney, Carl. Short period shear waves and their application to discriminating between earthquakes and explosions: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 2, p. 19-21, 1959.

Four approaches are presented for developing suitable criteria for using the shear waves to discriminate between earthquakes and explosions: existence of SH, azimuthal variations of SH/SV ratio, absence of SN in some nuclear explosions, and the ratio of S/P. Six type questions are presented to be answered by a possible experimental program, and recommendations are made for the conduct of the program with an estimate of costs and time schedules. — V. S. N.

184-238. Gerrard, John. Unattended auxiliary seismic stations: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 3, p. 22-41, 1959.

Simplified, unattended auxiliary seismic units within the network of manned stations specified at the Geneva Conference are recommended for use to insure a sufficient signal-to-noise ratio at the manned control posts and to obtain comprehensive information on first-motion patterns caused by an event. The seismic stations will be arrayed to receive the incoming wave train associated with the P-wave. — V. S. N.

184-239. Press, Frank. Aftershocks as a means of identification of earthquakes: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 4, p. 42, 1959.

A statistical study, limited to earthquakes of magnitude 4-5 and aftershocks that occurred within one week after the initial tremor, was made of aftershocks with a view toward using their presence or absence as a means of identifying earthquakes. It was concluded that aftershocks could be of some use. The capability of the method depends upon how quickly temporary stations can be installed near the epicenter of a suspicious event; for southern California the capability is 50 percent. — V. S. N.

184-240. Press, Frank. Long period surface and body waves: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 5, p. 43-45, 1959.

It is believed that earthquakes are more efficient in the generation of lower frequency body waves and surface waves than are explosions of equivalent magnitude. Preliminary studies reveal differences in spectra of body waves and surface waves; therefore, these differences are a possible method of distinguishing explosions from earthquakes. An extensive research program is recommended that would emphasize statistical studies of spectra, Love/Rayleigh energy distribution, and SV/SH ratios of earthquakes, quarry blasts, and underground nuclear explosions. Also phase and group velocities of surface waves and their variations across continents would be studied with special tripartite arrays of long-period seismographs. — V. S. N.

184-241. Knopoff, Leon. Deductive seismology: U. S. Dept. State Rept. of Panel on Seismic Improvements, app. 6, p. 46-51, 1959.

Observational seismology is concerned with the inductive problem and should be evaluated in terms of some probability or other weighting factor that describes the likelihood of the solution being correct. The deductive problem, on the other hand, is a problem in mathematical analysis and is exact. If the problem to be solved is appropriately described, then a specification of the nature of the structure, the source, and the receiver must be made. Problems to be solved are assumed to be problems in linear mechanics so that linear transform procedures are permissible. Problems of linear wave motions in solids to be considered are those of physical theory which determine the character of the wave motions following the arrivals. Methods are discussed for obtaining solutions for the elementary geometries such as half-spaces, layered media, wedges, half-plane diffraction problems, imbedded spheres, imbedded circular cylinders, imbedded wedges, imbedded cylinders of irregular shape, the influence of irregularities in smooth simple surfaces, and others. Construction of a seismogram for more complex geometries is an exercise that may require extensive data processing and computational and data handling facilities of some size. — V. S. N.

184-242. Street, Kenneth. Need for high explosive and nuclear tests for research program: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 7, p. 52-57, 1959.

To date no exclusive phenomena have been found that are characteristic only of the seismic phenomena produced by a nuclear explosion. It is imperative that the parameters that can conceivably affect to a significant extent the magnitude and type of seismic effects produced by a nuclear explosion be explored in a thorough manner so that these effects can be compared with those produced by natural earthquakes. It is necessary to investigate either theoretically or experimentally the effect of the following parameters on the body and surface waves proposed for use in discrimination: dependence of the waves on yield of the explosion, effect of the medium in which shot is fired, depth of burial, local environment, and large-scale geologic environment. As experimental program for use of nuclear and HE explosions to explore a number of parameters is outlined. — V. S. N.

184-243. Oliver, Jack [E.]. Seismic waves in the intermediate period range: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 8, p. 58-59, 1959.

Body waves, surface waves, and microseisms in the intermediate period range from 1 to 20 or more seconds but generally in the 4 to 12 second range are discussed as important areas for emphasis in a research program. Good instrumentation is needed for these studies and in the case of body waves a large network of uniform instrumentation is important. — V. S. N.

184-244. Tukey, John W. Equalization and pulse shaping techniques applied to the determination of initial sense of Rayleigh waves: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 9, p. 60-129, 1959.

An empirical method or so-called "black-box" method is described that determines the effect of the propagating medium and the seismograph on the recorded wave train, and then applies this effect inversely to similar trains in order to infer the sense of the pulse, that is, the nature of the disturbance near the source. The method is best applied to long-period surface waves. Some details of the method and its implementation are discussed in Annexes A through E as follows: phase compensation, numerical techniques, synthesis of digital phase compensators, details of analysis, and possibilities of implementation in practice. — V. S. N.

184-245. Oliver, Jack [E.]. The phase compensation method of equalization: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 9a, p. 130-131, 1959.

A method of equalization based upon well-understood properties of the earth rather than upon the empirical behavior of waves from another earthquake is presented. Once phase velocities have been determined over an entire continent or over the world, phase compensation can be based upon known properties. The method of determining phase velocities and a simplified method of seismogram-analysis which permits the effects of these mechanisms to be subtracted from the recorded seismic wave train and thus determination of the nature of the sense or seismic pulse near the source are described. The method requires a network of stations so that individual phases of the seismic wave train may be traced across a given interval. Results of preliminary measurements in the United States demonstrate that such a study is feasible with a network of stations such as that proposed by the Geneva Conference. — V. S. N.

184-246. Press, Frank, and Griggs, David T. Geophysical investigation of continental crustal structure: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 10, p. 132-133, 1959.

A program is proposed for the investigation of crustal structure along several profiles, each 400 km long starting in the vicinity of the Sierra Nevada, the Great Basin, and the Rocky Mountains. Twelve-channel oscillographic and magnetic tape recording apparatus with groups of 4 seismometers per channel with each group spaced at intervals of 1,000 feet will be used. Overall channel response will extend down to 2 cycles per second with variable high and low frequency cutoff. Explosions will be loaded and detonated by the contractor and continuous radio contact will be maintained between shot point and recording position. It is also proposed to establish a network of long period seismograph stations to analyze the data for phase and group velocity of surface waves and to use Fourier transform methods to recover the shape of the initial impulse. Explosive and earthquake sources will be used and modern computing machine methods of data reduction and analysis will be exploited. This work will be performed jointly with the explosion studies. Explosion methods reveal fine details of crustal structure variation, whereas the surface wave method reveals the regional picture. — V. S. N.

184-247. Oliver, Jack [E.]. Ocean bottom seismographs: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 11, p. 134-136, 1959.

Determination of the seismic motion of the floor of the ocean is one of the more significant areas of experimentation open to the seismologist. Ocean bottom seismographs could obtain information on seismic noise level; on body waves; on surface waves, particularly the nature of the 5-15 second waves propagating across oceanic paths and the lack of short-period waves of the fundamental Rayleigh mode; on the near-surface wave guide of the oceanic crust; on microseisms; and on low frequency sound propagation. Seismometers connected to the shore by cable, or by telemetering data acoustically to a ship, or with the entire seismograph on the bottom could be used. — V. S. N.

184-248. Benioff, Hugo. Suggestions for standards of noise, amplitude, and spectrum: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 12, p. 137-138, 1959.

Seismic noise exhibits a continuous spectrum with superposed bright lines or bands corresponding to microseism frequencies. Both the continuous spectrum

and the microseism bands vary in amplitude and frequency with time and from place to place. The seismic amplitude spectrum should be measured with appropriate frequency resolution over a frequency range from about 20 millicycles per second to 10 cycles per second at several sites and for 3 components. Determinations of average spectrum levels for minimum, average, and maximum noise conditions should be made for each site, and measurement of other noise characteristics, such as spatial coherence and type of distribution, are desirable. To obtain the ratio of signal to noise, measurements of the amplitude spectrums in 3 components of the initial P-waves and surface waves of earthquakes and underground blasts at different distances from the source and at different observing sites are necessary. — V. S. N.

184-249. Benioff, Hugo. Improved seismographs: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 13, p. 139-144, 1959.

Suggested improvements for short period seismographs and for surface wave seismographs for improved detection and identification of earthquake and blast waves are discussed. Development of such seismographs must be coordinated with information on the spectrums of signals and noise not now available. — V. S. N.

184-250. Gerrard, John. "Throw-away" or portable seismic probes for operation on land: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 14, p. 145-151, 1959.

Simple "throw-away" or portable seismic units, which can be placed immediately and in quantity over a suspicious area, afford an effective means of supplying valuable information concerning aftershocks to the fixed seismic network. These units may furnish relatively detailed information on first-break patterns in any region where seismic activity is high. Analog data transmission and visual monitoring of results will be adequate. These probes could be placed on the ground manually or dropped from the air and would be particularly useful in detecting the nature of a shock in regions where aftershock activity is high. The following factors which might affect the feasibility of obtaining useful data from the units are discussed: environmental factors affecting seismic unit performance at the site, optimum placement and monitoring of units, and data interpretation. The seismic equipment to be employed and the method of data processing within the unit are also discussed. — V. S. N.

184-251. Gerrard, John. Use of multiple arrays in seismic detection: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 15, p. 152-163, 1959.

An increase in the effective signal-to-noise ratio can be realized by sampling the ground motion over a fixed area with an increased number of seismometers placed in a suitable array pattern. Enhancement for a given increase in number of sampling sites for a given incoming wave will depend upon the selection of the site pattern, the manner in which data recombines, and the numerical operations performed on the raw and combined data. These factors will vary from shock to shock and from station to station. The selection of array patterns will be dependent upon the digital computer capabilities. — V. S. N.

184-252. Gerrard, John. Data-processing requirements: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 16, p. 164-183, 1959.

This report discusses anticipated problems, possible procedures, and areas in which study and development will be required in establishing an advanced data-processing system to accompany the suggested Geneva seismic network.

Speedy performance of calculations will require automatic data-processing equipment, and special-purpose machines optimized for this task should be designed. A technical program is suggested and a preliminary estimate of cost and personnel presented. — V. S. N.

184-253. Gerrard, John. Program to establish a complete experimental seismic station for the evaluation of network instruments and methods: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 17, p. 184-185, 1959.

A complete, experimental seismic station is suggested as a single major unit in the expanded Geneva network. The station would provide a facility for field evaluation of the instrumentation and methods suggested by the proposed research program. Some of the problems to be worked out at this experimental station are itemized, and phases for the establishment of the station are listed. — V. S. N.

184-254. Romney, Carl. Deep hole detection techniques: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 18, p. 186-192, 1959.

Theoretical reasoning and some experimental work suggest that seismographs installed and operated at depths of several thousand feet below the surface may detect smaller P-wave signals than those at the surface. This is suggested by the belief that surface noises die off rapidly with depth. A long-term research program now in progress and problems for future study are discussed. — V. S. N.

184-255. Gerrard, John. Research computing facilities and a digital library of seismograms: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 19, p. 193-194, 1959.

The establishment of a computing center to assist in study and analysis of seismic records is proposed. Facilities which should be available at the center are listed and a preliminary budget is presented. — V. S. N.

184-256. Gerrard, John. Considerations on the standardization of seismometers to be used in the Geneva network: U. S. Dept. State Rept. of Panel on Seismic Improvement, app. 20, p. 195-214, 1959.

Standardization and calibration of the various seismic instruments constituting the stations of the Geneva network appears to be feasible. Calibration and limited standardization of seismometer ground "plant" appear to require considerable experimental evaluation and study. A technical program is outlined and an estimate of cost and personnel is presented. — V. S. N.

184-257. Griggs, D[avid] T., and Press, Frank. Probing the earth with nuclear explosions: Jour. Geophys. Research, v. 66, no. 1, p. 237-258, 1961; also in Univ. California Radiation Lab. Pub. UCRL 6013, 40 p., 1960.

Progress in seismology is reviewed with emphasis on the usefulness of past nuclear weapon tests in determining the internal structure of the earth. Shot times and locations are tabulated for 169 U. S. atomic explosions, with seismic data from Pasadena. The advantages of using large chemical explosions and future nuclear explosions detonated under the Plowshare program as controlled energy sources for carefully instrumented seismological experiments are discussed. Finally, an international program of explosions for seismological research is proposed, and specific suggestions are made for attacking

several outstanding problems in seismology by means of chemical and clean nuclear explosions and the instrumentation network proposed at Geneva for nuclear test detection. Deep oceanic seismometer lines are proposed as a means for making important improvements in seismic knowledge of the world and possible improvements in the detection of atomic explosions. —Authors' abstract

184-258. Adams, [William] M[ansfield], Preston, R. G., Flanders, P. L., Sachs, D. C., and Perret, W. R. Summary report of strong-motion measurements, underground nuclear detonations: Jour. Geophys. Research, v. 66, no. 3, p. 903-942, 1961.

This is the same as the paper published in U. S. Atomic Energy Comm. [Pub.] ITR-1711, 80 p., 1960 (see Geophys. Abs. 182-175). — D. B. V.

184-259. Latter, A[lbert] L., LeLevier, R. E., Martinelli, E. A., and McMillan, W. G. A method of concealing underground nuclear explosions: Jour. Geophys. Research, v. 66, no. 3, p. 943-946, 1961.

It is shown theoretically that the seismic signal from an underground nuclear explosion can be greatly reduced by carrying out the explosion in a large cavity. An estimate of the effectiveness of the method indicates that a yield of more than 300 kilotons (HE-equivalent) could be made to look seismically like a yield of 1 kiloton. Experiments with both chemical and nuclear explosions are needed to test the theory. — Authors' abstract

184-260. Murphey, Byron F. Particle motions near explosions in halite: Jour. Geophys. Research, v. 66, no. 3, p. 947-958, 1961.

Peak particle velocities and displacements were measured for tamped (coupled) and cavity (decoupled) explosions in halite. Recordings are illustrated of particle velocity versus time in the salt medium and of pressure versus time on the cavity wall. Peak particle velocities from tamped shots decrease as $d^{-1.65}$ over distances equivalent to 40 to 800 feet for 1,000 pounds of high explosive. Decoupling factors that were directly observed apply only to close-in stations. One method of extrapolating close-in data yields distant decoupling factors ranging from 40 to 100 for these particular experiments. Actual measurements (verbal communication from Herbst, 1960) of distant decoupling factors give larger numbers by a factor of 2. Extrapolation to nuclear explosions is not attempted here. — Author's abstract

184-261. Herbst, Roland F., Werth, Glenn C., and Springer, Donald L. Use of large cavities to reduce seismic waves from underground explosions: Jour. Geophys. Research, v. 66, no. 3, p. 959-978, 1961.

The results of "Project Cowboy," an experiment designed to test the theory of seismic decoupling of underground explosions proposed by Latter and others (see Geophys. Abs. 184-259), are analyzed. A series of 8 high-explosive shots were made in two spheres excavated in a salt dome, and 9 tamped shots were made for comparison. A salt-to-salt decoupling factor of 100 was obtained, which is consistent with the predicted tuff-to-salt factor of 300. The experiment verifies the prediction that seismic signals from cavities that yield elastically will be very small compared with the signal from fully tamped shots. The surface measurements and the close-in measurements are consistent with one another and with the decoupling theory. The results show further that an explosion in a sphere smaller than that necessary to insure elasticity will still decouple. — D. B. V.

184-262. Lamb, George L., Jr. Some seismic effects of underground explosions in cavities: Univ. California, Los Alamos Sci. Lab. Rept. La 2405, 65 p., 1960.

A number of the effects created by a seismic explosion contained within an underground cavity of a size sufficient to ensure elastic behavior of the side walls are investigated theoretically. The Rayleigh waves generated by a source of compressional waves in a semi-infinite homogeneous elastic medium are calculated; the stress concentration around a spherical cavity in a homogeneous elastic medium acted on by an arbitrary body force is determined and the results specialized to the case of a uniform gravitational field with vanishing lateral displacement; the stress distribution around a prolate spheroidal cavity in a uniform gravitational field with vanishing lateral displacement is considered, and the plastic expansion of a spherical cavity in an infinite elastic medium is discussed. A final chapter discusses seismic waves generated by an air burst. — V. S. N.

184-263. Johnson, Gerald W. Application of nuclear explosions as seismic sources: Univ. California Radiation Lab. Pub., UCRL 6030-T, 51 p., 1960.

The information of interest to earth science obtained from detonation of nuclear and large chemical explosions is briefly reviewed. The major geophysical questions as suggested by Griggs and Press (see Geophys. Abs. 184-257) that might be resolved under a program of earth structure research involving both nuclear and chemical explosions are given.

Underground nuclear explosions in the United States and their interpretation with a description of methods of stemming the explosion to assure containment of radioactivity are summarized. An estimate of typical costs that might be incurred in the United States to provide seismic sources is presented. It is concluded that nuclear explosions can be economical and safe seismic sources; chemical explosives can be used for low energies, but at about a kiloton nuclear explosions become comparable in cost, and at a few thousand tons they are much cheaper. — V. S. N.

184-264. Weston, D. E. The low-frequency scaling laws and source levels for underground explosions and other disturbances: Royal Astron. Soc. Geophys. Jour., v. 3, no. 2, p. 191-202, 1960.

A general approach is used to show that the source spectrum level for the energy radiated from a disturbance is usually proportional to $(\text{frequency})^2$ at low frequencies, and also that this low-frequency energy is proportional to $(\text{total energy})^2$ for body waves. There are differences for one- and two-dimensional propagation, and also for interface waves. Applied to underground explosions, the theory provides the best explanation of the empirical law that seismic amplitude is proportional to charge weight. The reason why underwater explosions have much more low-frequency energy than those underground (10 percent efficency compared to 0.05 percent), making underwater explosions more suitable as sources for seismic investigations, is discussed.

The general method is applicable to a wide range of other mechanical disturbances and also to electromagnetic pulses. — D. B. V.

ELECTRICAL EXPLORATION

184-265. Vozoff, K[eeva]. Numerical resistivity interpretation: general inhomogeneity: Geophysics, v. 25, no. 6, p. 1184-1194, 1960.

A linear approximation is developed for the equation of conduction in a medium where resistivity is an arbitrary function of x, y, and z. This is applied by assuming the earth to be subdivided into small, homogeneous blocks of arbitrary resistivity. Under this approximation, the apparent resistivity is just the sum of the effects of the individual blocks. The equations are linear, and surface apparent resistivity data can be inverted to yield block resistivities. The quality of the approximation has been checked by comparison with model measurements in two situations: remote current source (telluric method), and local current source (resistivity method). It was found that the results are satisfactory provided that the proper type of expression is used for the effect of the resistivity contrast of each block. — Author's abstract

184-266. Brundage, Harrison T. New radio reflection method finds oil and gas directly: World Oil, v. 152, no. 4, p. 54-57, 1961.

Radio wave reflection techniques have been developed for direct determination of the presence or absence of oil, gas, or gas condensate deposits, and field tests have been successful. Radio energy loaded into the subsurface is evidently reflected by the hydrocarbon deposit because of the electrochemical difference between hydrocarbons and salt water. This electrochemical difference is more pronounced at the edges of a pool than at the center; hence the method may be used to particular advantage in outlining pools. The radio frequency transmitter, which emphasizes stability of both power output and frequency, is installed in a light house trailer. The receiver is mounted on a light semi-amphibious vehicle equipped with power supply. — J. W. C.

184-267. Seigel, H. O. A theory of induced polarization effects (for step-function excitation), in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 4-21, 1959.

Overvoltage effects (induced polarization), including all polarization effects and considering a dynamic rather than a purely electrostatic model, are equivalent to a volume distribution of current dipolar sources, each dipole being antiparallel to the primary current density, j, at each point and with a volume current moment of strength M=-mj, where m is a constant which is called the "chargeability". If E is the impressed electrical field due to external sources, the total current density j due to both the external and dipole fields is $j=\sigma(1-m)E$, where σ is the conductivity of the medium. If σ is the voltage at time of current interruption due solely to the impressed external field and σ' that due to the external plus the dipole fields, the ratio of the peak secondary voltage to the total voltage is $(\phi'-\phi)/\phi'=m$, the chargeability, in a homogeneous medium. This ratio is thus independent of electrode configuration or shape or size of the body and is a function solely of the chargeability, as was observed experimentally and in the field.

For a heterogeneous ground composed of a series of media of resistivities ρ_i and chargeabilities m_i, the apparent chargeability m_a of the ground is

$$m_a = \sum m_i \frac{\partial \log \rho_a}{\partial \log \rho_i} \leq \frac{\partial \log \rho_a}{\partial \log \rho_i}$$

where ρ_a is the apparent resistivity of the ground. In the case of a 2-layer medium this reduces to

$$\frac{m_a - m_1}{m_2 - m_1} = \frac{\partial \log \rho_a}{\partial \log \rho_2}$$

Examples are given of the form of the response curves for a spherical ore body for 2, 3, and 4 electrode arrays, and of the application of the method to 2 actual field cases in Colorado and Peru. — J. H. S.

184-268. Wait, J. R. A phenomenological theory of overvoltage for metallic particles, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 22-28, 1959.

A brief theoretical derivation is presented for the effective conductivity and dielectric constant of a homogeneous medium loaded with a uniform distribution of spherical conducting particles. To account for the effect of induced polarization, the particles are taken to have a concentric membrane or film which has a blocking action to the current flow into the particle. — Author's abstract

184-269. Wait, J. R. The variable-frequency method, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 29-49, 1959.

It has been found that the complex conductivity of rocks is a function of frequency. These dispersion or overvoltage effects, which are very pronounced in mineralized media, can be attributed mainly to interfacial polarization at the boundaries of the metallic ore particles and the electrolyte in the pores of the host rock. In the first part of this paper, the variation of the magnitude and the phase of the conductivity for mineralized and non-mineralized samples is reported for frequencies in the range from 0.1 to 10^5 cycles per second. The mathematical relation between a frequency dependent conductivity and the transient build up of the field for a step function current is then derived. The interrelation is demonstrated by an actual example which is verified experimentally for a mineralized sample. In the second part, electromagnetic propagation and interwire coupling effects are discussed briefly from the standpoint of their masking effect on the overvoltage measurement when a four electrode array is employed. In the third part, results from a preliminary field trial of the frequency variation method carried out in the summer of 1950 in the vicinity of Jerome, Ariz., are described. — Author's abstract

184-270. Collett, L. S., Brant, A. A., Bell, W. E., Ruddock, K. A., Seigel, H. O., and Wait, J. R. Laboratory investigation of overvoltage, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 50-69, 1959.

The technique used for the laboratory studies of induced polarization in mineralized and nonmineralized rock specimens is discussed. The equipment for both the transient and the frequency variation procedures is described in outline. Some typical results are presented for pyrite, chalcocite, copper, graphite, chalcopyrite, bornite, galena, magnetite, malachite, and hematite. — J. W. C.

184-271. Wait, J. R., and Collett, L. S. Criteria from the transient decay curves, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 71-83, 1959.

Induced polarization decay curves on rock specimens are analyzed; particular attention is given to the shape of the curves. For this purpose the first, second, and third derivatives are evaluated and shown plotted against the magnitude of the response in each case. The rates of decay in the 3-sec region and in the 1-sec region appear to be diagnostic of mineralization. Percentages of mineralization, however, are not easily estimated from the induced polarization curves. — J. W. C.

184-272. Ness, N. F. Analysis of the frequency response data; in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 84-91, 1959.

A study of the frequency spectrum of induced polarization was undertaken to determine whether this might aid in the recognition of metallic mineralization. The frequency spectrum was derived by Laplace transform theory from the impulse function obtained from the decay curve

$$g(t)=\sum_{o}^{n} A_i [1 - \exp(-a_i \tau)] \exp(-a_i t)$$

where g(t) is the voltage difference between two step functions separated by a time interval τ, t is time since zero time, and A_i and a_i are constants. The time constants a_i are arbitrarily selected on the basis of previous experience, and the values A_i determined by minimizing the aggregate squared error. Four quantities may be determined: (1) in-phase component, (2) out-of-phase component, (3) phase angle, and (4) magnitude, only one of which is independent. Ness concludes that the out-of-phase component is best suited to the separation of possible effects. A total of 500 samples were available for analysis, but all could not be included. For practical reasons the frequencies used were restricted to 0.01-10.0 cycles per second. Within this frequency range the spectrum was well spread out, but there appeared to be no well-defined or characteristic differences in spectrum behavior that could be used to predict the presence of metallic particles. It is concluded that within this range no clear separation of mineralized-unmineralized responses is possible. — J. H. S.

184-273. Keller, G[eorge] V. Analysis of some electrical transient measurements on igneous, sedimentary, and metamorphic rocks, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 92-111, 1959.

After reviewing the mathematical theory of induced polarization, the decay curves for a series of rock specimens of diverse types are evaluated. A comparison with theoretical curves and the graphic integration of the observed transients led to values of the time constant, T_o; the Wagner distribution constant, b; the static capacity, E, for an infinite pulse; the resistivity, ρ; and the product ρE. These are listed in a table for 103 specimens of sedimentary, igneous, and metamorphic rocks, and summarized by rock types and the average values of ρ and ρE in another table, which also includes 335 U. S. Geological Survey measurements. An inverse proportionality is noted between ρ and E so that the product ρE is relatively constant for a given rock type. It is concluded that induced polarization would be ideally suited for seeking disseminated ores in limestone, dolomite, or coarse-grained igneous rocks, but would be of little use for deposits of massive sulfides or for mineralized zones in sandstone. — J. H. S.

184-274. Ruddock, K. A. Field equipment for prospecting by the overvoltage method, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 112-114, 1959.

Typical equipment for making transient overvoltage measurements is described and illustrated with block diagrams. — J. W. C.

184-275. Baldwin, R[obert] W. Overvoltage field results, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 115-124, 1959.

The overvoltage or induced polarization method has been successful in delineating sulfide mineralization associated with porphyry coppers. Examples are shown from San Manuel, Ariz., and from Cuajone and other Peruvian prospects. Examples of response from other types of mineralization are given from Lynn Lake, Manitoba, and from South Africa. Mention is made of extraneous responses due to nonsulfides. — Author's abstract

184-276. Mayper, V., Jr. The normal effect—Part I, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 125-141, 1959.

Various explanations of the normal effect are considered. Induced-polarization experiments are described, in which no normal effect whatever is obtained from "clean" artificial porous samples. Details of the experiments are given. The conclusion is drawn that, of the hypothesis so far advanced, the only ones still allowable are that the effect is due to a current-induced disequilibrium in the electrochemical properties of particles in the rock pores (probably ion exchange in clay), or that it is due to the presence of very slight true conductivity in some "nonconducting" minerals. Hypotheses involving electrokinetic effects, air bubbles, or surface conduction have been rejected. — Author's abstract

184-277. Mayper, V., Jr. The normal effect—Part II, in Overvoltage research and geophysical applications: Internat. Ser. Mon. Earth Sci., v. 4, p. 142-158, 1959.

It is concluded that the normal effect is caused by electrochemical phenomena within and on the surface of particles of clay and clay-like deteriorated mica in a rock. In addition, the presence of unrecognized conducting minerals has often caused effects indistinguishable from the normal effect. The anomalously high normals are ascribed to pore-structure effects in tight rocks, or to the presence of large amounts of unrecognized active material. These conclusions are arrived at principally on the basis of assays, petrographic analyses, porosity measurements, resistivity measurements, and critical experiments on a number of samples. The critical experiments consisted largely of measurements of induced-polarization response before and after the attempted elimination of clay by heating, by electrodialysis, and by crushing and removing the -2μ fraction. — Author's abstract

184-278. Malmqvist, David. Eine Analyse des zeitlichen Verlaufes von Polarisations-indikationen nach einer Gleichstrommethode [An analysis of the temporal course of polarization indications with a direct current method]: Freiberger Forschungshefte, C 81 Geophysik, p. 122-136, 1960.

The "S-method" of induced polarization, one that used direct current (originally proposed by Schlumberger in 1920), was tested in the Kankberg sulfide ore district in Sweden in 1958 with amazing results. A constant direct current was sent into the ground for 2-4 min, using the Wenner and Schlumberger configurations. Current intensity was 50-100 ma in one case, and 0.5-1.0 amp in another. The voltage between the two nonpolarizable potential electrodes was measured in the first second after closing of the circuit. After the current was cut off the voltage between the same electrodes was measured at given intervals (5, 15, 30, 60, 90, 120... sec). Both electrode arrangements gave clear anomalies over the orebody and over sulfide impregnations, corresponding well with their position as determined by electromagnetic measurements. Positive results have also been obtained with this method by Šumi

(see Geophys. Abs. 179-140) and by Komarov and Ryss (see Geophys. Abs. 177-117). The theoretical calculations and principles of the method are discussed at some length. — D. B. V.

184-279. Alfano, L[uigi]. The influence of surface formations on the apparent resistivity values in electrical prospecting. Pt. 1: Geophys. Prosp., v. 8, no. 4, p. 577-606, 1960.

The theory developed in a previous paper (see Geophys. Abs. 179-133) is applied to the problem of surface inhomogeneities with cylindrical structure. First, the case of measurements carried out with the potential electrodes near the irregularities and current electrodes farther from them is considered. A method is pointed out of separating the component of the electrical field due to deep formations from those due to surface irregularities.

Then the case of current electrodes near and potential electrodes more distant from the surface inhomogeneities is treated. For both cases numerical examples are given both for secondary values and for apparent resistivity values.

Finally, asymptotic values of vertical electrical soundings are calculated for some cases, showing rigorously that in the presence of surface disturbances these values are not generally equal to the true resistivity of a possible infinite substratum; therefore, resistivity measurement of an infinite substratum by means of the asymptotic resistivity value of only one sounding is not possible. — D. B. V.

184-280. Orellana Silva, Ernesto. Analogia entre los campos de corrientes y los electrostaticos aplicada a los metodos geoelectricos [Analogy between the electrokinetic and electrostatic fields applied to the geoelectric methods (with English abstract)]: Rev. Geofísica, v. 18, no. 69, p. 19-28, 1959.

The analogy that exists between the electrostatic and the electrokinetic fields is described and proved mathematically. Several examples of application of the analogy to elementary electrical prospecting are given, and it is shown that the analogy is valid only for prospecting using direct-current but not using alternating current. — V. S. N.

184-281. Korolenko, N. G., and Tsekov, G. D. Teoreticheskiye krivyye elektricheskogo zondirovaniya nad naklonnym kontaktom dvukh sred (paletki NK) [Theoretical curves of electric sounding over a sloping contact of two media (master charts NK)]: Prikladnaya geofizika, no. 24, p. 54-71, 1960.

Calculations of theoretical curves for electric sounding over a sloping contact of two media are described. An analysis is presented of the construction of master charts for an equatorial three-electrode set-up perpendicular to the strike of the contact for dips of α=5°, 10°, 20°, 30°, and 45°, and for ratios of the two media corresponding to reflection coefficients K=±0.2, ±0.4, ±0.6, ±0.8, ±0.9, and ±1.0. — A. J. S.

184-282. Kaufman, A. A. Ob amplitudnykh i fazovykh kharakteristikakh poley, primenyayemykh v nizkochastotnoy elektrorazvedke [On amplitude and phase characteristics of fields used in low frequency electrical exploration]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 6, p. 87-91, 1960.

Phase frequency characteristics do not give information on the field that cannot be determined from the amplitude frequency characteristic. Therefore, in those methods where the amplitude values of the field are studied in a

wide range of frequency, it is not necessary to have apparatus for measuring phase. In some cases the phase frequency characteristic reflects features of the field more prominently than does the amplitude characteristic. Therefore, methods of calculation should be developed for eliminating this discrepancy. — J. W. C.

184-283. Kamenetskiy, F. M., and Kovalenko, V. F. Otsenka dlitel'nosti impul'sa pervichnogo polya pri vozbuzhdenii nestatsionarnykh vikhrevykh tokov s tsel'yu poiskov khorosho provodyashchikh rud [Estimation of the length of the pulse of a primary field with excitation of nonstable eddy currents for the purpose of prospecting good conducting ore bodies]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 6, p. 92-94, 1960.

With a sufficiently long exciting impulse, the resolving capacity of the method of registration of the transient processes using periodic right-angle impulses shows practically no deterioration. The length of the exciting impulse should not be less than 50 m per sec. — J. W. C.

184-284. Zagarmistr, A. M., and Faradzhev, A. S. Ob ispol'zovanii trekhelektrodnoy ustanovki s ekranirovannym elektrodom pri kartirovanii ugol'nykh plastov vysokoy provodimosti [Application of a three-electrode apparatus with a shielded electrode in surveying and mapping coal seams of high conductivity]: Razvedka i Okhrana Nedr, no. 4, p. 35-38, 1960.

The effect of shielding the direct current used in electrical prospecting is discussed, and the apparent resistivity ρ_k is determined for a layer in the form of a curve represented by the $\Delta v/J$, Δv being the potential difference and J the current measured along the profile. A cross-check was made of field and model tests, the latter performed in a tank filled with a weak solution of copper sulfate and a copper sheet. The method can be used advantageously for finding location and dip of an ore body covered by several meters of alluvium. — A. J. S.

184-285. Svetov, B. S. Opyt primeneniya induktivnogo metoda razvedki [Experience in the use of the induction method of prospecting]: Razvedka i Okhrana Nedr, no. 7, p. 30-37, 1960.

Theoretical and model investigations demonstrated that the induction method increases the depth and effectiveness of prospecting for copper and polymetallic deposits as compared with other electrical methods. Using the frequency characteristics and amplitude-phase correlations of anomalistic fields, conducting ore bodies can be distinguished according to their resistivities. The results of field tests designed to check the model investigations are reported. — A. J. S.

184-286. Gasanenko, L. B. Normal'noye pole vertikal'nogo garmonicheskogo nizkochastotnogo magnitnogo dipolya [Normal field of vertical harmonic low-frequency magnetic dipole]: Leningrad Univ. Uchenyye Zapiski, v. 249, no. 10, Voprosy Geofiziki, p. 15-36, 1958.

A numerical analysis of the electromagnetic field produced by a harmonic, low frequency, vertical magnetic dipole over a homogeneous half-space of finite conductivity is given, and the characteristic points (zero and extrema points) of the field are derived. It was found that the expression of the "electric number" of the vertical magnetic dipole corresponds to the expression of the vertical "magnetic number" of the horizontal electric dipole. Mathemat-

ical expressions for the components of the normal fields of vertical and horizontal magnetic dipoles are obtained and tabulated. — A. J. S.

184-287. Queille-LeFèvre, C[olette], Bauer, [A.], and Girard. Premier essai de mesure électrique d'épaisseur d'un glacier [First attempt at electrical measurement of thickness of a glacier]: Annales Géophysique, v. 15, no. 4, p. 564-567, 1959.

The thickness of a glacier can be determined by electrical resistivity measurements. As an example, the thickness of the Saint-Sorlin glacier in the Alps was determined to be about 50 m and the resistivity of the ice to be 90 megaohm-m. The measurements confirmed the theoretical expectation that apparent resistivities would be strongly influenced by the presence of a surface layer of wet snow (see Geophys. Abs. 182-188). — D. B. V.

184-288. Fujino, Kazuo. An attempt to estimate the thickness of sea ice by electric resistivity method. I. [in Japanese with English résumé]: [Hokkaido Univ.] Low Temperature Sci., ser. A, no. 19, p. 203-213, 1960.

The electric resistivity method was used to estimate the thickness of the sea ice on the Okhotsk Sea coast of Hokkaido. The system is treated as a simple three-layered structure (surface granular ice, mosaic ice, and sea water) as a first approximation. Results are given in a table. The coincidence of actual and analyzed values for total ice thickness is not good. Since analyzed values are generally larger than actual values, a "conversion factor" might be determined by statistical studies. — V. S. N.

184-289. Granar, Lars J. Apparatur zur praktischen Ausführung elektromagnetischer Prospektierung auf tiefliegende Sulfiderze und ihre Aufwendung [Apparatus for the practical execution of electromagnetic prospecting for deep-seated sulfide ores and its application]: Freiberger Forschungshefte C 81 Geophysik, p. 137-150, 1960.

This describes the compensator and absolute field measurement (AB-meter) techniques of electromagnetic surveying used in Sweden to detect sulfide ores as deep as 200-300 m. Measurements can be made up to a distance of 4 km on either side of a 10-km cable laid transverse to the general strike of the region. With either the compensator or the AB-meter, a 12-man party can carry out a reconnaissance survey of 40-50 km^2 in about 10 months using a single cable layout. The apparatus is described in detail with wiring diagrams and photographs, and illustrative examples of its use are given. The weak anomalies over deep orebodies amount to only a few percent of the normal field. With the compensator, the maximum relative measurement error is 0.5 percent, whereas with the AB-meter an accuracy of only 1 percent is attained part of the time. — D. B. V.

184-290. Aleva, G. J. J. Geochemical and geophysical exploitation of the Nigadoo base metal deposit, N. B., Canada: Geologie en Mijnbouw, v. 39, no. 10, p. 429-499, 1960.

The results of geochemical, self-potential, resistivity, and electromagnetic surveys of the Nigadoo sulfide ore deposit in New Brunswick are presented and discussed. The self-potential and resistivity surveys, together with the geochemical survey, gave information that led to drilling the first hole through sulfide. However, water-saturation of the ground made the results of these surveys unreliable in parts of the area. The Turam method gave much more

detailed information than the other methods, especially where the drainage conditions were undisturbed by mine workings. Because of its sensitivity and depth of penetration (to 500 feet), the Turam method is a reliable tool for eliminating unproductive ground. — D. B. V.

184-291. Hiersemann, Lothar. Untersuchung der hydrogeologischen Verhältnisse im Raum südlich von Greifswald durch geoelektrische Messungen [Investigation of the hydrogeologic relations in the area south of Greifswald by means of geoelectric measurements]: Geol. Gesell. Ber., v. 4, no. 2/3, p. 243-261, 1959.

Old resistivity surveys in the vicinity of Greifswald in East Germany are analyzed, and recent surveys are interpreted in order to determine the limitations and possibilities of the method in this area. It was found that the contact of a salt invasion can be established. Channel-like depressions on this contact may represent thick sands or gravels carrying fresh water. It was only sometimes possible to determine sandy horizons in the Pleistocene from the resistivity data, and then only qualitatively. — D. B. V.

184-292. Homma, Ichiro; Hirukawa, Takashi; Kishi, Kazuo; and Noma, Yasuji. Hydrogeological investigation of the water resources in the Ota River basin, Hiroshima Prefecture: Japan Geol. Survey Bull., v. 11, no. 2, p. 117-134, 1960.

The distribution of aquifers in the delta region of the lower Ota River in Hiroshima City, Japan, was determined from borehole and electrical prospecting data. — V. S. N.

ELECTRICAL LOGGING

184-293. Tixier, M. P., Alger, R. P., and Tanguy, D. R. New developments in induction and sonic logging: Jour. Petroleum Technology, v. 12, no. 5, p. 79-87, 1960.

A new induction sonde with a radius of investigation twice that of present sondes has been developed for use where deep invasion is present. It has very nearly the same vertical resolution as current models. The characteristics of the new tool are described, and interpretation charts presented. Field examples are also discussed.

The design of sonic logging tools has been modified to improve reliability and to decrease maintenance. Steps are being taken to make calibration foolproof. The fact that porosity can be recorded accurately by the sonic log has prompted new interpretations. One approach consists of plotting transit time against true resistivity; saturations can thus be estimated conveniently even where formation water resistivity is not well known. In another approach a comparison is made of the values of the formation waters computed from the resistivity and sonic logs. This procedure makes possible a quick determination of zones of saturation in shaly sands or where the formation salinities vary appreciably with depth. — J. W. C.

184-294. de Witte, L[eendert]. Discussion of "Log interpretation in sandstone reservoirs" by M. R. J. Wyllie, Geophysics, August 1960, p. 748-778: Geophysics, v. 26, no. 1, p. 101, 1961.
Wyllie, M. R. J. Reply to discussion by L. de Witte on "Log interpretation in sandstone reservoirs": ibid., p. 102, 1961.

In the paper in question (see Geophys. Abs. 182-199), Wyllie stated that A. J. de Witte's method of determining percentage of water saturation pro-

posed in 1957 (see Geophys. Abs. 169-109) has not been widely used because its derivation was intuitive rather than theoretical. It is pointed out that the relations proposed by de Witte and confirmed by Wyllie's data were published by L. de Witte in 1955, derived by a coherent and concise theoretical treatment of the electrochemical behavior of shaly sands (see Geophys. Abs. 164-120). Field results showing the applicability of L. de Witte's shaly sand relations to the determination of resistivity index and connate water saturation were also reported by Blum and Martin in 1955 (see Geophys. Abs. 164-122).

In reply, Wyllie states that the paper by A. J. de Witte was cited because it was presented in a form well suited to practical use, and in that paper it was pointed out that the basic equations, although similarly derived, were identical to those in the L. de Witte's earlier work. The latter, however, does not constitute a complete treatment of the problem, either. — D. B. V.

184-295. Slack, Howard, and Otte, Carel. Electric log interpretation in exploring for stratigraphic traps in shaly sands: Am. Assoc. Petroleum Geologists Bull., v. 44, no. 12, p. 1874-1894, 1960.

Two quantities which can be calculated from conventional electric logs of shaly sands, shaliness and saturation ratio, provide useful information on the reservoir rock and the fluid it contains. The values of shaliness and saturation ratio when viewed together are related to the performance of the formation under production tests. Definite ranges in values of these quantities are associated with (a) formations which produce hydrocarbons readily, (b) formations which produce commercial quantities only when artificially stimulated, and (c) formations which produce water along with the hydrocarbons.

A single favorability criterion is developed which is a joint function of shaliness and saturation ratio; this criterion, based on electric-log derived quantities, is a numerical estimate of the production performance of a formation. Its use in exploration is demonstrated by maps of its variation in shaly sand reservoirs of several oil fields. It may be of use in detecting the proximity of good oil production from dry-hole data. — D. B. V.

184-296. Johnson, Jarl P. How to determine permeability from well log data: World Oil, v. 151, no. 7, p. 88-90, 1960.

A method based on well log information is presented for determining formation permeability when core data are not available. The logs used are those commonly employed in salt mud systems; they include focused microdevices (microlaterolog or F_0R_{xo}), an independent porosity measuring technique (velocity or neutron), and a means of measuring R_t (laterolog or guard). The method as applied to the San Anders formation of western Texas is discussed. A chart is presented by which the apparent residual oil saturation can be ascertained from the logging data. A second chart shows the relationship between the apparent residual oil saturation and permeability. — J. W. C.

184-297. Plewa, Stanislaw. Geophysikalische Verfahren zur Feststellung von Kohle in polnischen Bohrlöchern [Geophysical procedures for the determination of coal in Polish boreholes]: Freiberger Forschungshefte C 81 Geophysik, p. 94-110, 1960.

Electrical logging was begun in Poland in 1950 and gamma-ray logging in 1952. Neutron-gamma logging was introduced in 1956. The use of combinations of these methods makes it possible to interpret coal sections unambiguously. The results of self-potential, induced potential, resistivity, gamma, neutron-gamma, microlog, and caliper logging are discussed. Numerous examples of logs are reproduced. Thicknesses thus determined are 8-10 percent too high, compared to 14-18 percent too low from core extraction.

Resistivity logs give very good results in determining the location and in some cases the thickness of coal seams in areas where the resistivity of the coal is much greater than that of the surrounding rock (sandstone). Coal seams can be sharply distinguished on neutron-gamma logs, especially when short sondes and intense radiation sources are used. Resistivity logs together with micrologs indicate porosity of the rock and thickness of a coal seam. — D. B. V.

184-298. Kaufman, A. A. K obosnovaniyu induktsionnogo karotazha [Basis of induction logging]: Vyssh. Ucheb. Zavedeniy, Izv. Geologiya i Razvedka, no. 7, p. 107-114, 1960.

The attempt is made to determine mathematically to what extent the assumptions underlying Doll's induction logging method (see Geophys. Abs. 139-11592) correspond to actuality. Differences between results using Doll's methods and those obtained with models are discussed. — J. W. C.

184-299. Buryakovskiy, L. A. Opredeleniye pronitsayemosti po karotazhu soprotivleniy [Determination of permeability by resistivity logging]: Geologiya Nefti i Gaza, no. 1, p. 47-51, 1959.

A theoretical relationship exists between the permeability (k_{pe}), the thickness of the film of fixed water τ, and the coefficient of increase in resistance R_H of a rock. This relationship is expressed in the formula:

$$k_{pe}=40\tau\sqrt[3]{R_H^3}.$$

The formula was applied in the Neftyanyye Kamni field, where the resistivity measurements were made with a laterolog. The results of 290 such determinations are presented in a table and compared with data on permeability determined from cores from several of the same horizons. The agreement is good in general. — J. W. C.

184-300. Oilweek. New electric well-logging unit: Oilweek, v. 11, no. 47, p. 31, 1961.

The development of a new, completely self-contained electric well-logging unit is reported. The unit can be used with standard type probes and can be handled and operated by any driller; it replaces truck-mounted equipment. The tool measures 2 3/4 inches in diameter and 98 inches in length, is completely transistorized, is independent of outside power sources, will operate to a depth of 15,000 feet, and will withstand temperatures in excess of 300 degrees. — V. S. N.

184-301. Oil in Canada. New Schlumberger airborne logging unit: Oil in Canada, v. 13, no. 15, p. 14, 1961.

An economical and light-weight logging unit which can be easily transported by air to remote and inaccessible well locations is described. The unit is divided into 3 easily reassembled sections: recording equipment, winch, and engine drive. Each weighs 2,000 lbs or less. A multiconductor logging cable of small diameter holds down gross weight but allows running of all types of services to depths as great as 11,000 feet. — V. S. N.

184-302. Melik-Shakhnazarov, A. M., and Mel'nikov, A. G. Sistemy teleizmereniya (po metodu intensivnosti) dlya geofizicheskoy apparatury elektricheskogo karotazha [Systems of telemeasuring (by the intensity method) for geophysical apparatus of electrical logging]: Vyssh. Ucheb. Zavedeniy, Izv., Neft' i Gaz., no. 6, p. 129-134, 1960.

Systems of telemeasuring can use either direct or alternating current, and each of these in turn has two variants—balanced and inbalanced types. Most present systems use a direct current of the inbalanced type. All four variants are described and schematic diagrams are given. Recommendations for the use of the various systems are made as follows: With low sonde currents (0.1-10 ma), alternating current should be used. If the current necessary for the input electrode is considerably more than 5 v, it is better to use a direct current. — J. W. C.

184-303. Belen'kiy, Ya. Ye., Mikhaylovskiy, V. N., and Svenson, A. N. Mnogokanal'noye teleizmeritel'noye ustroystvo dlya kompleksnykh geofizicheskikh issledovaniy skvazhin [Multichannel telemeter for combined geophysical investigations of wells]: Geologiya Nefti i Gaza, no. 1, p. 52-55, 1959.

A multichannel telemeter has been constructed which permits simultaneous measurement of eight values of apparent resistivity and self potential using a standard single-strand cable. Concentration of all the channels into one cable is accomplished with a high-speed circuit electronic commutator which switches the measuring circuit at a frequency of 20 cycles per second. Such a frequency permits logging to be carried out at a rate up to 3,000 m per hr. The sonde is 2.2 m in length and 70 mm in diameter. Schematic diagrams are given of the sonde and receiver circuits, and an example of a log is illustrated. — J. W. C.

184-304. Kornfeld, Joseph A. How to choose eastern Oklahoma datum planes: World Oil, v. 151, no. 1, p. 124, 126-127, 130-131, 1960.

Selection of key marker reference datum planes in the Lower Pennsylvanian of eastern Oklahoma presents difficulties owing to rapid stratigraphic changes. Since so much production is controlled by stratigraphic traps in this region, correct selection of datum planes is essential in subsurface geological and geophysical exploration. A datum must be regional in extent, geologically reliable, and easily detectable on electric or radioactivity logs. Six key marker datum planes commonly used in eastern Oklahoma are discussed. — J. W. C.

184-305. Anpilogov, A. P. Litologicheskaya kharakteristika produktivnykh otlozheniy devona Tuymazinskogo mestorozhdeniya po promyslovo-geofizicheskim materialam [Lithologic characteristics of the productive sediments of the Devonian of the Tuymazy field according to logging data]: Geologiya Nefti i Gaza, no. 2, p. 40-44, 1959.

In order to determine the best method for detailed study of well sections in the Tuymazy field, several types of logs were compared with core data. The self potential, microsonde, and caliper logs were found to be the most reliable for distinguishing sandstone, shale, limestone, argillaceous siltstone, and sorted siltstone, provided the beds are greater than 0.5 m in thickness. —J. W. C.

EXPLORATION SUMMARIES AND STATISTICS

184-306. Phipps, Rollin E. A case history of the Bronte (Ellenburger) and Rawlings Fields, Coke County, Texas: Geophysics, v. 25, no. 6, p. 1167-1183, 1960.

The North Bronte area of the Midland basin, Texas, has been regarded as favorable for oil on the basis of surface, isopachous, and magnetic studies. A seismic survey was made, the results of which were confirmed subsequently by drilling. — J. W. C.

184-307. Patrick, Homer G. Geophysical activity in 1958: Geophysics, v. 24, no. 5, p. 925-942, 1959.

Worldwide geophysical exploration for oil and gas in 1958 is reviewed.— J. W. C.

184-308. Oil in Canada. Exploration—Geophysical work down 16 percent from 1959: Oil in Canada, v. 13, no. 8, p. 18, 1960.

Geophysical activity in western Canada and the Northwest Territories declined 16 percent during 1960. A total of 678 crew months were recorded as compared to 808 crew months in 1959. — V. S. N.

184-309. Vincenz, S. A. Geophysical exploration in Jamaica—A historical review: Geonotes, v. 3, pt. 1, p. 9-17, 1960.

Major geophysical exploration techniques are discussed briefly, and the gravimetric, magnetic, electric, seismic, radiometric, and geochemical surveys carried out to date in Jamaica are described. Most of the surveys have been for the purpose of locating mineral deposits. In the future geophysical techniques will be used to locate ground water and oil, and to continue exploration for metallic minerals. — V. S. N.

184-310. World Oil. How the Sahara's geophysical problems are being solved: World Oil, v. 152, no. 1, p. 76-77, 1961.

The first broad geophysical coverage of the Sahara started in the early post-World War II years. The gravimeter was used at that time for reconnaissance, but it has now been supplanted by the airborne magnetometer. A general reconnaissance gravity map has been prepared for the entire central Sahara. Good results are reported using telluric current exploration in southern Algeria.

A high signal-to-noise level hampered early reflection work. In later work this difficulty was overcome by using large numbers of geophones and multiple charges. In some regions a spread of 80 geophones per trace and 80 shot holes were used covering 1 hectare (2.471 acres) to obtain a multiplication coefficient of 6,400. Refraction has also been used extensively. — J. W. C.

184-311. Knape, Helmut, and Zeuch, Richard. Über einige neue Ergebnisse geologischer und geophysikalischer Erkundungsarbeiten auf Erdöl in der nordwestlichen Altmark [On some new results of geological and geophysical investigations for petroleum in the northwest Altmark]: Geol. Gesell. Ber., v. 4, no. 2/3, p. 178-182, 1959.

Petroleum investigations in the salt dome area of the northwest Altmark, East Germany, were resumed in 1950 after a 10-yr interval. At the present time a network of seismic reflection profiles has been measured, 9 boreholes (almost all more than 1,500 m deep) have been completed, and 3 more are being drilled. The subdivisions of the Tertiary are determined on the basis of electric logging, as no core was recovered from the boreholes.

Results are presented in the form of logging curves, an isopach map, a reflection profile across two salt domes, and a geologic section of the area between Waddekath and Peckensen. — D. B. V.

184-312. Antropov, P. Ya. Osnovnyye zadachi geologorazvedochnykh i poiskovykh rabot na neft' i gaz v 1959-1965 gg. [Main tasks of geological prospecting and exploration operations for oil and gas in 1959-65]: Geologiya Nefti i Gaza, no. 1, p. 1-8, 1959.

Geological and geophysical exploration in the U. S. S. R. during the seven-year plan (1959-65) is discussed. Particular attention is called to the low effectiveness of seismic surveying in locating low amplitude structures on the Russian and Siberian platforms. Further, the work undertaken in the majority of regions at the present time depends on the availability of seismic crews and their equipment rather than on the geological conditions. — J. W. C.

184-313. Ayzenshtadt, G. Ye. -A., Nevolin, N. V., and Eventov, Ra. S. O burenii sverkhglubokikh skvazhin v tsentral'noy chasti Prikaspiyskoy vpadiny [Drilling of extra-deep wells in the central part of the Pri-Caspian depression (with English abstract)]: Sovetskaya Geologiya, no. 12, p. 33-43, 1960.

Oil and gas exploration in the Pri-Caspian depression requires drilling of extra-deep (up to 7,000 m) wells. This drilling will be coordinated with seismic profiles and aeromagnetic surveys. — J. W. C.

184-314. Borisov, A. A. O metodike i rezul'tatakh rabot po sostavleniyu regional'noy strukturnoy karty Turkmenii po geofizicheskim dannym [On the methods and results of preparation of the regional structural map of Turkmenia according to geophysical data]: Prikladnaya Geofizika, no. 24, p. 190-212, 1960.

The use of gravity, magnetic, and electrical surveys in the preparation of a structural-geological map of the Turkmen S. S. R. is reported. —A. J. S.

184-315. Dneprov, V. S. Neftyanyye mestorozhdeniya i razvedochnyye ploshchadi Embenskoy neftenosnoy oblasti [Oilfields and exploration areas of the Emba oil-bearing district]: Vses. Neft. Nauchno-Issled. Geol. Razved. Inst. Trudy, no. 138, 275 p., 1959.

The Emba salt dome district, which lies to the northeast of the Caspian Sea, is discussed. Short descriptions are given of the geology, the history of geophysical and geological exploration, and the oil prospects of 15 oilfields and of the 38 exploration areas (36 salt domes and 2 interdome areas) that have been prospected. — J. W. C.

184-316. Central Water and Power Research Station Poona. Geophysical investigations at Chandan dam site: India Ministry of Irrigation and Power Central Water and Power Research Sta. Poona Ann. Research Mem., p. 67-68, 1959.

Seismic refraction and electrical resistivity surveys were made at the site of the proposed dam on the Chandan River, South Bihar, India, to locate a suitable site for a spillway along the left bank. Estimated depths to bedrock and structure contours are shown on a map. — V. S. N.

184-317. Shimura, Kaoru. Ground water survey at the foot of the west and east slopes of Mt. Fuji [in Japanese with English abstract]: Butsuri-Tanko, v. 13, no. 1, p. 46-64, 1960.

A compilation of results from a study since 1946 of ground water resources at the foot of the east and west slopes of Mt. Fuji, Japan, is presented. The mode of occurrence of the ground water in relation to the geologic structure as determined from geophysical surveys is discussed. — V. S. N.

184-318. Geological Survey of Japan. History and present status of geophysical prospecting in Japan, in Geology and mineral resources of Japan (2d ed.): Kawaskai, Japan, Japan Geol. Survey, p. 185-304, 1960.

A brief historical review is presented of approximately 20 years of geophysical prospecting in Japan. Diagrams show the percentage of application of each geophysical method to four general fields. A general discussion of the application of geophysical methods to specific problems is given in 7 short chapters as follows: prospecting for oil and natural gas; prospecting for coal; prospecting for radioactive minerals; prospecting for metallic and nonmetallic minerals; prospecting for ground water; prospecting for natural steam and hot springs; and applied geophysics in civil engineering. — V. S. N.

GENERAL

184-319. Jacobs, J. A., Russell, R. D., and Wilson, J. Tuzo. Physics and Geology: New York, McGraw-Hill, 424 p., 1959.

This book is an outgrowth of courses on the physics of the earth given for senior undergraduates and graduate students, and, as a consequence, has two aims: (1) To give students of geology an introduction to the physics of the earth; and (2) to give scientists in other fields some knowledge of geology and its relation to geophysics.

The text contains 17 chapters as follows: The universe and the solar system; seismology and the interior of the earth; composition of the earth; the figure of the earth and gravity; thermal history of the earth; geomagnetism; physics of the upper atmosphere; geochronology; isotope geology; mechanical behavior of earth materials; investigation of the ocean floors; the ocean floors; the mid-ocean ridges; island arcs and mountains; inactive mountains and continents; origin of the earth's surface features; and glaciology. The 6 appendixes are as follows: derivation of velocity-depth curves from traveltime tables; Clairaut's theorem; motion of a single charged particle in the earth's magnetic field; isotopic equilibria; the dynamics of faulting; and crevasses and crevasse patterns. — V. S. N.

184-320. Gassmann, Fritz, and Weber, Max. Einführung in die angewandte Geophysik [Introduction to applied geophysics]: Bern, Verlag Hallwag, 284 p., 1960.

The first chapter of this introductory book reviews applied geophysics describing the methods in general, fundamentals in planning operations, economic factors, and historical background. The second chapter deals with gravity exploration; measurement, reduction, and interpretation are treated. The third chapter is devoted to magnetic surveying; the static magnetic field, earth magnetism, magnetic measurements, rock magnetism, and interpretation of magnetic disturbance are discussed successively. The fourth chapter is on seismic surveying and consists of discussions on elasticity, reflection and refraction surveying, and seismographs. The fifth chapter deals with electical exploration. — J. W. C.

184-321. Laver, F. J. M. Waves: London, Oxford Univ. Press, 77 p., 1959.

The types, form, and behavior of waves are discussed in 18 chapters. The first 3 chapters deal with the general nature of a wave and some of the different kinds of waves. The next 9 chapters discuss the behavior of waves including speed and force; echoes, reflections, and interferences; shadows; mixing and separating; and vertical and horizontal motion. Specific types of waves are discussed in 4 chapters—water, sound, earthquake, and electromagnetic waves. The book is concluded with a chapter on waves in general and a list of references. — V. S. N.

184-322. Shapley, A. H. International Geophysical Calendar for 1961: Science, v. 132, no. 3444, p. 1941-1943, 1960; also in Am. Geophys. Union Trans., v. 41, no. 4, p. 722-728, 1960; Jour. Geophys. Research, v. 65, no. 1, p. 336-339, 1960; and Nature, v. 189, no. 4758, p. 9-11, 1961.

A committee under the International Council of Scientific Unions has issued a calendar for 1961 to encourage worldwide coordination of observations or analysis of those phenomena which vary significantly during the course of a year. These phenomena are mainly in the disciplines dealing with the earth's atmosphere. Three consecutive days each month are designated Regular World Days, intended for programs that can be carried out only about 10 percent of the time and for any unusual or special experiments. Regular World Intervals are 10 consecutive days each quarter, selected to include the Regular World Days of the month, the times of equinox and solstice, and if possible days of solar eclipse and meteor showers. World Meteorological Intervals are also 10 consecutive days each quarter, and International Rocket Weeks are two periods during the year when rocket studies of the atmosphere and of the sun will be on as nearly a synoptic basis as is possible at present. — D. B. V.

184-323. Gerson, N. C. From Polar Years to IGY, in Advances in geophysics, v. 5: New York, Academic Press Inc., p. 1-52, 1958.

The development of the International Polar Years culminating in the International Geophysical Year is reviewed. The discussion includes a history of the concept; observations and results of the First and Second International Polar Years; the objectives, general program implementation, scientific program, world data centers, and preliminary results of the International Geophysical Year of 1957-58; and the future of the International Years. A list of 95 references is included. — V. S. N.

Wertheim, Gunther K. The Mössbauer effect: a tool for science. See Geophys. Abs. 184-368.

184-324. Komarov, S. G., and Per'kov, N. A. Ob oboznacheniyakh velichin, ispol'zuyemykh v promyslovoy geofizike [On designation of quantities used in applied geophysics]: Prikladnaya Geofizika, no. 21, p. 211-222, 1958.

A table of 94 symbols and their subindexes used in applied geophysics is given. Differences in symbols used in the United States, in the U. S. S. R. (Moscow Petroleum Institute), and other countries are brought out, and a uniform designation of geophysical quantities is recommended. In the discussion that precedes the table some terms of applied geophysics are given in Russian and English. — A. J. S.

184-325. World Petroleum. New tools for the geophysicist: World Petroleum, v. 31, no. 3, p. 48-54, 57, 60, 62, 64, 66, 70, 1960.

A brief review of previously published information on new equipment and techniques developed during the past year for both aerial and marine reconnaissance geophysical exploration is presented. The following instruments are discussed: the airborne gravimeter, the continuous marine profiler, the marine seep detector, the stratigraph (originally called the summarizer), the nuclear magnetism log, the time base and d-c amplifier, the Decatrack, the ABEM MZ-4 magnetometer from Sweden, the Keyboard Input Unit, the single revolution Omnitape, miniature and refraction geophones, and the PMR-20 magnetic recording system. — V. S. N.

184-326. Morrison, L[aurence] S., and Watson, Robert. The electronic computer and geophysics: Geophysics, v. 26, no. 1, p. 40-44, 1961.

The principles of electronic computers are reviewed briefly. Such computers have been used in geophysical exploration to compute and contour derivative maps of gravity and magnetic data, to reduce gravity data to datum, to compute interval and average velocities from velocity profile data, and to solve many nonrecurring problems. — D. B. V.

184-327. Schedler, George D. Land geophysical techniques in oil exploration: Philippine Geologist, v. 14, no. 2, p. 73-80, 1960.

The application of seismology, magnetism, and gravity to exploration for oil on land is briefly reviewed. The basic principles underlying each technique and the factors influencing the interpretation of data are discussed. — V. S. N.

184-328. Shirokov, A. S., and Fedyuk, V. I. O primenenii geofizicheskikh metodov pri razvedke rudnykh mestorozhdeniy [Application of geophysical methods in prospecting for ore deposits]: Razvedka i Okhrana Nedr, no. 3, p. 28-38, 1960.

Methods of electric, magnetic, gravity, seismic, and radiometric prospecting and logging are discussed briefly. — A. J. S.

184-329. Onodera, Toru. General note on the geophysical prospecting in the Construction Ministry, especially on the dynamic method of determining Young's modulus of rocks in situ [in Japanese with English abstract]: Butsuri-Tanko, v. 13, no. 1, p. 65-72, 1960.

The methods of geophysical and chemical prospecting used by the Ministry of Construction in Japan for inspecting and testing each stage of any civil engineering construction are listed. A general description is given of some of the newer radioactive prospecting methods for the investigation of migration of littoral sands, fluvial loads, groundwater movements, and other such processes. The method of determining the Young's modulus of elasticity on foundation rocks in place is described and examples presented. The application of Young's modulus to the investigation of the consolidation of grouting is also discussed. — V. S. N.

184-330. Electronics. Russian television inspects wells: Electronics, v. 34, no. 13, p. 22, 1961.

A picture shows a television pickup unit for inspection of the sides of boreholes. Semiconductors and miniature components are used. The housing is 1,690 mm long and 60 mm in diameter. — J. W. C.

184-331. Lishman, J. R. The increasing value of well logging information: Canadian Oil and Gas Industries, v. 14, no. 1, p. 53-56, 1961.

Recent advances in well-logging techniques and in interpretation of the logs are discussed. The various methods treated are acoustic velocity, gamma-gamma density, resistivity, nuclear magnetism, spectrographic radioactivity, and acoustic attenuation. — J. W. C.

184-332. Nechvíle, Jiří. Bohrloch-Neigungsmesser mit Kreiselorientierung [Borehole inclinometer with gyroscopic orientation]: Freiberger Forschungshefte C 81 Geophysik, p. 80-93, 1960.

The IG 70 borehole inclinometer is described. With this model it is possible to measure the angular coordinates of any number of points in one down-hole trip of the sonde. Because the instrument is oriented by means of a gyroscope rather than by the usual magnetic needle, accuracy is not affected by the casing or by the magnetic properties of the wall rock. The diameter of the sonde is only 70 mm, permitting its use in a large majority of boreholes. A wiring diagram and photographs of the instrument are given, and the measuring procedure is described and illustrated by field examples. — D. B. V.

184-333. Decker, Robert W. Geophysics in Indonesia, 1921-1961: Univ. Indonesia, Inst. Technology Bandung, Dept. Geology Contr., no. 35, 27 p., 1960.

The history and results of geophysical activity in Indonesia since 1921 are summarized, its present status is described, and possible directions for research and application are suggested. The subjects covered (seismology, gravity, tectonophysics, magnetism, and other physical properties) are discussed mainly from the standpoint of the accomplishments of each scientist who has contributed to these fields in Indonesia. A comprehensive bibliography is included with each section. — V. S. N.

184-334. deMille, G. The Elbow structure of south-central Saskatchewan: Alberta Soc. Petroleum Geologists Jour., v. 8, no. 5, p. 154-162, 1960.

The Elbow structure in south-central Saskatchewan, discovered during a seismic survey for oil, is a symmetrical dome in Mesozoic rocks beneath which lies a cylindrical mass of broken Paleozoic rock. The structure is marked by a positive gravity anomaly that reflects the dome form and the upward displacement of the disturbed Paleozoics; this is further confirmed by deep drilling. Two episodes of deformation are indicated: (1) Post-Mississippian explosive activity which dislocated and displaced the Paleozoic rocks, and (2) Tertiary displacement resulting in upward movement of the broken Paleozoic rocks to form the unbroken dome in the Mesozoic strata. The Elbow structure is considered to be a modified cryptovolcano probably produced by super heated steam and not by the emplacement of high density or magnetically susceptible rock; the structure could not be located on a detailed aeromagnetic map.

A similar but smaller structure, the Gilroy structure, lies about 4 miles south of Elbow. It is not indicated by a gravity anomaly but is considered to be a cryptovolcanic structure. — V. S. N.

GEODESY

184-335. Hirvonen, R. A. The size and shape of the earth, in Advances in geophysics, v. 5: New York, Academic Press Inc., p. 93-115, 1958.

A general review of the problems concerned and of the precision obtainable with modern instruments and methods is given for each of the four groups—triangulation, astronomical fixations, spirit leveling, and gravity measurements—of principal geodetic observations for precise determination of the form of the earth. A new general theory of geodesy is outlined for the treatment of the combination of these four groups designed to avoid the drawbacks of Stokes' theory by deriving the integral formula for the physical surface of the earth rather than for the geoid or cogeoid. A list of 40 references is included. — V. S. N.

184-336. Ledersteger, Karl. Zur theorie des Normalsphäroides der Erde [On the theory of the normal spheroid of the earth (with English summary)]: Deutsche Geod. Komm. Veröffentl., ser. A, no. 36, p. 3-20, 1960.

An attempt is made to solve Clairaut's problem of inhomogeneous spheroidal equilibrium figures without any assumption concerning mass distribution by studying the possible linear series of these equilibrium figures. It is shown that the normal spheroid is defined by the earth's mass E, velocity of rotation ω, principal moment of inertia C, and the 4th-order mass function D. At sufficient heights above the earth's surface the level surface will hardly differ from the pertinent equipotential spheroid; within such a level surface there is only one equilibrium figure that is identical with the normal spheroid. The numerical computation of the normal spheroid is based on the velocity of rotation and dynamic flattening, which can be substituted for the static flattening by going back to the original ellipsoid of the homogeneous series (ω, K) of equilibrium figures, and on the assumed equatorial values of gravity and radius.

A purely hypothesis-free solution of the problem of the normal spheroid is not possible, but it gives valuable information about the solution of the total problem of the figure of the earth. The two parts of the problem—derivation of the normal spheroid and its coaxial mean earth ellipsoid, and determination of the absolute geoid undulations—can be solved almost without assumptions by mutual penetration. The substitutions described above then become superfluous. — D. B. V.

184-337. Ledersteger, Karl. Die theoretische Lösung des gesamtem Problemes der Erdfigur [The theoretical solution of the total problem of the figure of the earth (with English summary)]: Deutsche Geod. Komm. Veröffentl., ser. A, no. 36, p. 21-30, 1960.

A hypothesis-free solution of the earth's figure on a strictly physical basis requires simultaneous determination of the normal spheroid and geoid undulations. As the real vertical gradient of gravity outside the earth is not known accurately, the artificial "free-air" geoid must be interposed. Gravity distribution and the indirect effect can be derived accurately for the free-air geoid without assumptions as to mass displacements. The pertinent equipotential spheroid is either a level outer surface or the free surface of the normal spheroid that has to be determined. The heights N of the free-air geoid above the equipotential spheroid can be calculated from the free-air gravity anomalies via Stokes' integral, giving the ellipsoid of revolution coaxial with the equipotential spheroid. From the elevations $z=(N+h-c)$ of the actual geoid above this ellipsoid the "absolute adjustment of deflections of the vertical" gives the correction of the axis together with absolute location of the net, and the relative position of the continents separated by oceans.

It can be confirmed that the equipotential spheroid obtained is identical with the normal spheroid. The formula obtained for theoretical gravity on the normal spheroid is easily transformed by means of the free-air gradient into the coaxial ellipsoid of revolution, which is the mean earth ellipsoid. The main advantages of this strictly physical procedure are the elimination of the artificial equipotential ellipsoid and an exact connection, based on potential theories, of gravity anomalies and geoid undulations with irregularities of mass distribution in the crust. —D. B. V.

184-338. Ledersteger, Karl. Die geometrischen und physikalischen Daten des Normal-sphäroids der Erde [The geometric and physical data of the normal spheroid of the earth]: Bayerische Akad. Wiss. Sitzungsber. Math.-Naturw. Kl., v. 1959, p. 23-39, 1960.

At present the so-called "International Approximation System," based on the Hayford Ellipsoid and on the international gravity formula, is generally applied in determining the normal figure of the earth. It is becoming increasingly obvious that this approximation system is in need of revision, not only with respect to its numerical values, but even more because it represents a physically improbable figure. Various shortcomings of the system are discussed, chiefly in mathematical terms. — D. B. V.

184-339. Ledersteger, Karl. Die gravimetrische Methode zur Bestimmung der Erdfigur [The gravimetric method of determination of the earth's figure]: Bayerische Akad. Wiss. Sitzungsber., Math.-Naturw. Kl., v. 1958, p. 117-136, 1958.

A method is developed mathematically for calculating the normal spheroid of the earth. This new solution avoids the assumption of the value $\delta=+105\times10^{-7}$ used in an earlier work, and uses the empirically determined value of β_4 instead. (See Geophys. Abs. 174-158, -159.) — D. B. V.

184-340. Heiskanen, W. A. Achievements and limitations of the gravimetric method in geodesy: Deutsche Geod. Komm. Veröffentl., ser. A, no. 32, p. 9-22, 1959.

Recent applications of the gravimetric method to geodesy, carried out at the Ohio State University Institute of Geodesy, Photogrammetry and Cartography, are summarized. The principles, prerequisites, and practical procedures involved are outlined. The 1957 Columbus geoid for Europe, although preliminary, is the most complete geoid published so far; it is illustrated in two figures. The 1959 Columbus geoid will cover a larger portion of the earth's surface and will be more accurate.

Limitations of the gravimetric method are practical rather than theoretical. The desirability of continuous international cooperation is stressed. — D. B. V.

184-341. Gerke, Karl. Stand der westdeutschen geodätischen Schweremessungen und Schwerekarten 1958 und Vorschläge für die weiteren Arbeiten [State of West German geodetic measurements and gravity maps in 1958 and proposals for further work]: Deutsche Geod. Komm. Veröffentl., ser. A, no. 32, p. 24-30, 1959.

The status of geodetic gravity measurements and gravity maps of West Germany as of 1958 is reviewed. Progress in surveying and determination of mean altitudes for central Europe is shown on maps, and a sample of the gravity data form sheet is reproduced. — D. B. V.

184-342. Bodemüller, Hellmut. Höhensysteme, ihre Definition und ihre gravimetrische Bestimmung [Altitude systems, their definition and gravimetric determination]: Deutsche Geod. Komm. Veröffentl., ser. A, no. 32, p. 32-40, 1959.

Different systems of determining orthometric and dynamic (geopotential) heights and their approximations for practical purposes are reviewed and the question of the best method is discussed. It is concluded that geopotential heights should be used for all main lines of official altitude networks and could be used for intermediate lines wherever local gravity measurements have been made. Orthometric heights should be determined from the fixed altitude points. For ordinary purposes the Vignal-Molodenskiy approximation has no advantages over Helmert's method. Raw altitude differences can be used in technical levelings so long as they provide a sufficiently close approximation of Helmert's heights. — D. B. V.

184-343. Wolf, Helmut. Gravimetrisch-astronomische Punktbestimmung und Triangulation [Gravimetric-astronomic location of points and triangulation]: Deutsche Geod. Komm. Veröffentl., ser. A, no. 32, p. 46-52, 1959.

The gravimetric-astronomic absolute method of locating points and the relative method of triangulation are compared, and ways of utilizing the advantages of each for geodetic purposes are discussed, particularly in regard to the ultimate goal of the world geodetic system: to assign every point on earth to a definite place on a reference surface valid for the earth as a whole. — D. B. V.

184-344. Ramsayer, Karl. Genauigkeitsuntersuchungen der Schwerereduktion von Nivellements [Investigations of the accuracy of the gravity reduction of leveling]: Deutsche Geod. Komm. Veröffentl., ser. A, no. 31, 50 p., 1959.

In the calculation of geopotential heights, errors appear that are due to errors in interpolation and measurement of altitudes and of gravity. On the basis of sectors totaling 845 km in length, a system of formulas has been developed which permits the calculation of the effect of these sources of error on the geopotential height differences as a function of the mean altitude differences per kilometer and the average spacing of gravity stations. In addition, formulas are derived for calculating the permissible gravity station spacing. The formulas are valid for plains, hilly areas, and "Mittelgebirge. "— D. B. V.

Heiskanen, W. A. Assembly of gravity data. See Geophys. Abs. 184-375.

GEOTECTONICS

184-345. Belousov, V. V. Development of the earth and tectogenesis: Jour. Geophys. Research, v. 65, no. 12, p. 4127-4146, 1960.

Tectogenesis reflects the development of the earth under the influence of radioactive heating. The accumulated heat is removed partly by melting and differentiation of the mantle material. Melting took place first in the upper layers of the mantle; this is the granite stage of tectogenesis, during which there takes place geosynclinal platform development of the crust, with wavelike oscillatory movements. In this process the crust is filled with granitic material.

Later, melting occurs in a deeper mantle layer, whence superheated basalt rises to the surface. In this stage tectonic activity takes place and the granite crust is eventually destroyed and "oceanization" occurs. Thus, elevations and depressions of the crust, developed in the course of wavelike oscillatory movements, and sea deeps of mediterranean type (located on oceanic crust) and oceans are the result of genetically different processes. The basic difference between them is that the movements of the former type are compensated by accumulation of sediments and erosion whereas the second type are not.

All these processes proceed irregularly both in time and space. Melting does not occur simultaneously over the whole mantle, but in separate focuses; as these migrate the whole layer is ultimately involved. The activity of individual deep faults, which are very influential in the melting process and in vertical movements of mantle material, is also different at different times. Irregularity in space is expressed by the fact that different parts of the earth's surface may be in different stages of development at the same time; this increases the complexity and variety of crustal structure but also affords an opportunity to review the history of the crust by comparative studies of the different regions. — D. B. V.

184-346. Belousov, V. V., and Rudich, Ye. M. O meste ostrovnykh dug v istorii razvitiya struktury zemli [Place of island arcs in the history of development of the structure of the crust (with English abstract)]: Sovetskaya Geologiya, no. 10, p. 3-23, 1960.

The ocean basins are regarded as secondary structural features that have formed as a result of destruction and basification of continental crust. This process is attended by tension, deep faulting, and strong basaltic volcanism. Two types of island arcs are distinguished. The first is represented by folded ranges similar to continental folded arcs. They are formed in geosynclines, and their development is paralleled by subsidence of the adjacent area on the side toward the continent. These geosynclinal areas become weakened due to tension, and the resulting fractures lead to extensive volcanism. Arcs of the second type are not related to geosynclines but are formed in an oceanic envirnoment as a direct result of tension.

The basification of the earth's crust and the formation of the oceans is the last known stage in the development of the earth determined by the radioactive warming of the interior and the smelting to the surface of material from the mantle. — J. W. C.

184-347. Goryachev, A. V. Nokotoryye osobennosti noveyshey tektoniki Kuril'skoy ostrovnoy dugi [Some features of the recent tectonics of the Kurile Island arc (with English abstract)]: Sovetskaya Geologiya, no. 10, p. 24-41, 1960.

On a basis of seismic, gravity, and other geophysical and geological data on the Kurile Island arc, it is concluded that the central portion of the arc is characterized by a high rate of Quaternary downwarping (reflected in deformation of a denudation surface on the Kurile Range), increased volcanic activity and decreased seismic activity, minimum total values of energy of weak earthquakes, positive gravity anomalies, and a type of crust transitional from continental to oceanic. The region is regarded as being in the opening phases of a general oceanization process. — J. W. C.

184-348. Noble, Donald C. Stabilization of crustal subsidence in geosynclinal terranes by phase transition at M: Geol. Soc. America Bull., v. 72, no. 2, p. 287-291, 1961.

Isostatic calculations indicate that a mechanism of geosynclinal subsidence based on a phase transformation at the M-discontinuity possesses an inherent stability that will tend to maintain the upper surface of sediments near sea level regardless of fluctuations in the rate of geoisotherm depression or in the rate of sedimentation. This effect may help in the understanding of sedimentation in geosynclinal and stable-shelf terrane. — Author's abstract

184-349. Shibata, Isamu. Recent achievements in the seismic researches of the crust and some tectonic interpretations of crustal structure derived from them [in Japanese with English abstract]: Jour. Geography [Tokyo], v. 69, no. 3, p. 10-22, 1960.

Information on crustal structure as determined from seismic research in various parts of the world has been compiled and is presented in a table. The main crustal layers (seismic velocity layers) appear to show a gradual variation in their development according to their position in relation to the major physiographic divisions of the earth, that is, mid-continental, marginal, off-continental, and oceanic. The geologic and petrologic characteristics of these seismic crustal layers are discussed, and some tentative interpretations based on current theories in tectonics, geophysics, and other earth sciences for ma-

jor variations of crustal layers and structures are presented. The variation of the upper crustal layers is attributed mainly to the magnitude and age of the tectonic cycles during which they were formed. The major variation of lower crustal layers, common to continental and oceanic regions, has resulted ultimately from the original variation of the material from which they were derived in the above mentioned major earth provinces. A short discussion on the origin of magmas is also included. — V. S. N.

184-350. Borisov, A. A. Anomalii sily tyazhesti gornykh oblastey [Gravity anomalies of mountain regions]: Prikladnaya Geofizika, no. 21, p. 84-103, 1958.

Topographic relief and corresponding variations in Bouguer anomalies at the surface of the earth are correlated with the amplitude of Neogene and Anthropogene tectonic movements in the crust. These phenomena are believed to be due to a variation in density arising from relative compression or expansion in the deep interior of the earth. The parts of the earth's lithosphere in which a rarefaction takes place are characterized by crustal uplift and negative anomalies. An increase in density in the lithosphere leads to a subsidence of the region and positive anomalies. An attempt is made to interpret profiles of the Mediterranian, Carpathian, Crimean, central Caucasus, southeastern Caucasus, central Asian, Indonesian, and Siberian regions by tectonic processes in the crust and upper mantle (300-500 km deep). The mechanism of such changes is shown diagrammatically.—A. J. S.

184-351. Subbotin, S. I. Do pytannya pro mekhanizm formuvannya prohyniv zemnoyi koryi pro tektoniku fundamentu Dniprovs'ko-Donets'koyi zapadyny [On the problem of the formation of depressions in the earth's crust and of the structure of the basement of the Dnieper-Donets basin (with Russian summary)]: Akad. Nauk Ukrayin. RSR Heol. Zhur., v. 18, no. 6, p. 3-16, 1958.

Depressions in the earth's crust such as the Dnieper-Donets basin form as a result of intermittent compression of the material of the upper part of the mantle, related to polymorphic changes. The compression leads to the appearance of a zone of decreased pressure immediately below the crust, to melting, and to downwarping of the bottom of the crust. When the limit of rigidity of the crust is exceeded deep fractures are formed; subsidence along these may produce grabens, and the magma can rise along them to the surface. In the Dnieper-Donets basin the block structure of the Devonian, Carboniferous, and possibly part of the Permian formations, the complicated structural relations of the different sedimentary complexes of all ages, and the occurrence of the complicated and varied salt tectonics are all due to differential movements between basement blocks. — D. B. V.

184-352. Peive [Peyve], A. V. Fractures and their role in the structure and development of the earth's crust: Internat. Geol. Cong., 21st, Copenhagen 1960, Proc., pt. 18, p. 280-286, 1960.

The spatial, historical, and genetic associations of many geologic phenomena can be explained in terms of the interrelations of crustal blocks of different composition, shape, and size. According to the degree of fracturing and mobility, the crust is divided into geosynclines and platforms. The large blocks are bounded by large, long-lasting deep fractures along which are located belts of basement shattering, folding of the cover, metamorphism, magmatism, and orogenesis.

The three main types of displacement along these deep fractures are faulting, overthrusting, and shifting. In geosynclinal areas tangential strains and

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dislocations predominate. Magma sources are genetically associated with the lower boundaries of blocks, some tens of kilometers below the surface; they are connected to the surface by radial fractures. — D. B. V.

184-353. Quiring, Heinrich. Rindenmächtigkeit und Entstehung der Tiefseegräben und Vulkane des Nordpazifik [Crustal thickness and origin of the deep sea trenches and volcanoes of the North Pacific]: Forschungen und Fortschritte, v. 34, no. 6, p. 164-167, 1960.

The lack of sialic crust and the special character of the oceanite magmas in the north Pacific Ocean indicate a catastrophic event which tore away a 16-km-thick section of sial and allowed ultrabasic magma to fill the resulting depression up to the level of isostatic compensation. It is suggested that this event was the separation of the moon and the earth. The shortening of the earth's radius by 42 km that resulted from the removal of the moon's mass caused the Laurentian revolution. — D. B. V.

184-354. Higgins, Charles G. San Andreas fault north of San Francisco, California: Geol. Soc. America Bull., v. 72, no. 1, p. 51-68, 1961.

Present positions on opposite sides of the fault trace of areas that appear to have been marine entrances to Middle Pliocene basins east of the fault trace suggest that right-lateral displacement along the San Andreas fault north of San Francisco has not exceeded 15 miles, more likely has amounted to 4-10 miles, and possibly has not exceeded 1-1½ miles since Middle Pliocene time. During the same time, vertical movements have raised the east side of the fault about 500 feet relative to the west in some areas, possibly everywhere north of Bolinas. This vertical component may be attributable to movements on some other branching fault rather than on the San Andreas fault itself. — D. B. V.

184-355. Svoboda, Karel. Les mouvements de l'écorce terrestre et leur observation géodésique [Movements of the earth's crust and their geodetic observation]: Bull. Géod., no. 56, p. 211-224, 1960.

Large-scale movements of the earth's crust (epeirogenic, orogenic, tectonic, seismic, and tidal) are discussed. After consideration of the main sources of energy of such movements, their magnitude, and methods of measuring them (particularly geodetic), examples from Czechoslovakia are given with a map of isobases. It is concluded that horizontal and vertical, positive and negative movements are taking place all over the world, most noticeably in regions of young tectonics, and that in seismically active areas the direction of these movements may change. The movements produce stresses in the crustal rocks. When sufficient potential energy has accumulated as elastic stress, a minor impulse may suffice to transform it to kinetic energy; this produces rock pressures, shocks, and structural adjustments in rocks, leading in turn to secondary movements. As the movements are a function of time, changes in stress and rock deformations and their consequences appear to be a function of time. — D. B. V.

184-356. Sinyagina, M. I. Preliminary conclusions on vertical movements of the earth's crust determined by means of levelling: Bull. Géod., no. 52, p. 62-68, 1959.

Work was started in 1954 in the U. S. S. R. to establish a high-precision leveling network to indicate geologic and geomorphic conditions of various regions. At present 33,412 km of lines have been surveyed in the Baltic, Black Sea, and Azov Sea areas; of this, 21,767 km were levelled by modern methods

and 11,645 km by the old instructions of 1883. A map of recent tectonic movements over the western half of the European part of the U. S. S. R. has been compiled with isolines based on adjusted values of rate of movement determined from the geodetic data supplemented by oceanographic (tide gauge), geologic, and geomorphic data. Investigations in the Düna (Dvina) valley are cited as a typical study of recent tectonic movements. — D. B. V.

184-357. Meshcherikov, J. A. [Meshcheryakov, Yu. A.]. Secular crustal movements of the East European Plain and associated problems: Bull. Géod., no. 52, p. 69-75, 1959.

This is virtually the same as the paper published in Bur. Central Séismol. Internat. Pubs., Sér. A, Travaux Sci., no. 20, p. 261-275, 1959 (see Geophys. Abs. 182-271). — D. B. V.

184-358. Rastvorova, V. A. Sopostavleniye noveyshikh dvizheniy i regional'nogo gravitatsionnogo polya Kavkaza [Comparison of recent movements and the regional gravity field of the Caucasus (with English summary)]: Moskov. Obshch. Ispytateley Prirody Byull. Otdel Geol., v. 35, no. 2, p. 38-42, 1960.

As a result of comparison of the character of recent tectonic movements with the regional gravity field of the Caucasus, a discordance was established between near-surface and deep-seated interfaces. On this basis the processes of formation of near-surface interfaces are assumed to lag behind the processes that take place beneath the crust. — J. W. C.

184-359. Grechishchev, Ye. K. Metody otsenki sovremennykh tektonicheskikh dvizheniy na Baykal [Methods of estimating recent tectonic movements in Baikal]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 59-64, 1960.

The amount of recent tectonic movement in the Lake Baikal region is within the limits of accuracy of present releveling surveys. In order that future estimates of deformation may be more reliable, a number of recommendations are made concerning the establishment of a first-order leveling network around the lake, and more and better equipped stations for measuring water-level fluctuations. — D. B. V.

184-360. Sato, H[isashi]. Variation of mean tide level around the coast of Shikoku Island [in Japanese with English abstract]: Quart. Jour. Seismology [Tokyo], v. 25, no. 2, p. 55-61, 1960.

The results of study of tidal data from 1947 through 1957 along the coast of Shikoku, Japan, show that the tidal level has had a tendency to be regular with the highest ascent occurring along the Hiuchinada coast and the lowest descent along the coast of Tosa Bay. In 1950, the earth tilting caused by the Nankaido earthquake of December 1946 ceased for a time. The variations of sea level for each year are shown in figures. — V. S. N.

184-361. Suggate, R. P. The interpretation of progressive fault displacement flights of terraces: New Zealand Jour. Geology and Geophysics, v. 3, no. 3, p. 364-374, 1960.

The vertical and horizontal components of individual movements in a sequence of progressive displacements of flights of river terraces in New Zealand can be deduced according to a stated rule. Applied to the Wairau River, it is concluded that downcutting and faulting do not show the linear relation

deduced by Wellman, but that the rate of faulting has been substantially uniform while the rate of downcutting has diminished. Where the depositional surfaces typical of the highest of many terrace flights represent the principal outwash aggradation surfaces of the last glaciation, the age is thought to be closer to 20,000 yr than to the 10,000 yr previously estimated. Rates of fault movement would then be correspondingly halved; the average rate of horizontal movement probably has not exceeded 0.125 in. per yr, and vertical movement probably has not exceeded 0.006 in. per yr. — D. B. V.

Menard, H[enry] W. The East Pacific Rise. See Geophys. Abs. 184-587.

GLACIERS

184-362. Kinosita, Seiiti. The relation between the deformation velocity of snow and the types of its deformation, III [in Japanese with English résumé]: [Hokkaido Univ.] Low Temperature Sci., ser. A, no. 19, p. 135-146, 1960.

In Kinosita's earlier laboratory studies (1950, 1958) on plastic and destructive deformation of snow under compression at constant speeds v of different magnitudes, it was found that a snow pillar undergoes destructive compression when v is above a certain critical speed and plastic compression when v is below that critical speed. This paper discusses how stress, induced within the snow by compression, changes with time; the general features of the stress-strain, strain-rate curves; the relation between stress relaxation and strain rate; and the effect of the water content of snow on the critical speed. — V. S. N.

184-363. Kojima, Kenju. Viscous flow of snow cover deposited on a slope [in Japanese with English résumé]: [Hokkaido Univ.] Low Temperature Sci., ser. A, no. 19, p. 147-164, 1960.

A study of the behavior of viscous flows of snow deposited on a uniform slope is reported. Mathematical expressions are derived for the components of displacement of snow at a height Z during a time interval Δt. In 1959 and 1960 actual measurements of the components were made of snow layers on two slopes of different angle. The method of measuring the deformation of the vertically cut snow and the displacement of each portion over a set time interval is described and illustrated. The direction of displacement of every part of the snow cover on a slope was found to be almost parallel. The angle between the direction of the displacement of any point and the axis perpendicular to the surface of the slope is represented by an equation. —V. S. N.

184-364. Nobles, Laurence H. Glaciological investigations, Nunatarssuaq ice ramp, northwestern Greenland: U. S. Army Snow, Ice and Permafrost Research Estab., Tech. Rept. 66, 57 p., 1960.

The Nunatarssuaq ice ramp is a gently sloping ice mass approximately 4 miles long by 2 miles wide that forms part of the margin of the ice cap in northwest Greenland 30 miles northeast of Thule. The ice of the ramp is of subpolar type in which negative temperatures prevail throughout most of the year in all but the upper few feet; the temperature regime is analogous to that of perennially frozen ground. Comparison between the total amount of ice ablated from the lower ramp and the amount delivered to the ramp by flow through the gap south of Nuna Knob indicates a strongly negative budget balance for the ramp during the period studied.

Velocity of ice movement on the ramp is 1-2 in. per day. The angle of the movement vector never differs from the horizontal by more than 5°. Calculations of the amount of movement of ice toward the surface to replace that

lost by ablation also indicate a strongly negative budget balance and suggest complete decay of the ramp in 300-600 yr under present climatic conditions.

Deformation of the ice during flow has formed metamorphic structures of both tensional and shear origin including foliation, blue bands up to 20 feet thick, amber bands consisting of unequally-distributed finely-divided debris, joints, small crevasses, and ice dikes. — V. S. N.

184-365. Lliboutry, Louis. Mesure des mouvements d'un névé par prospection magnétique [Measurement of the movements of a névé by magnetic surveying]: Acad. Sci. [Paris] Comptes Rendus, v. 250, no. 26, p. 4415-4416, 1960; also in Jour. Glaciology, v. 3, no. 29, p. 879-881, 1961.

The settling and movement of névé can be followed with the aid of magnetized steel pipes sunk in vertical holes; the subsequent location and attitude of these pipes is determined by means of a vertical magnetometer. The method was tested in the upper Vallée Blanche, at the foot of the Aiguille du Midi laboratory, where net winter accumulation of snow is of the order of 4 or 5 m, most of which melts during the summer. — D. B. V.

184-366. Cornet, André. Déplacement du glacier de l'Astrolabe et bilan de masse en Terre Adélie [Displacement of the Astrolabe glacier and mass balance in Adélie Land]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 3, p. 404-406, 1960.

Ice velocities measured on the Astrolabe glacier in Antarctica in 1958-59 ranged from 90 to 150 cm per day from point to point. There was no appreciable seasonal variation. Assuming that velocity is constant with depth and allowing for surface and subglacial melting, it is calculated that the ice flow along the coast is of the order of 20,000 tons per meter per year. The measured accumulation is in excess of the flow. In spite of this excess, however, the coastal ice has been receding at a rate of 3 km per century since the discovery of Adélie Land in 1840. The ablation rate of 40 cm of ice per year is sufficient to explain the retreat. — D. B. V.

GRAVITY

184-367. Roy, Amalendu. On some properties of residuals and derivatives: Jour. Geophys. Research, v. 66, no. 2, p. 543-548, 1961.

It is demonstrated (1) that the nth vertical derivative of a gravity or magnetic field is equal to $2^n gk^n$, where k is the mean curvature of the equipotential surfaces and g is the value of gravity (or vertical component of magnetic field), and (2) that the grid residuals are identical in their properties with those of the second-derivative maps, except for a constant factor, and are, therefore, superfluous and sometimes misleading. — Author's abstract

184-368. Wertheim, Gunther K. The Mössbauer effect: a tool for science: Nucleonics, v. 19, no. 1, p. 52-57, 1961.

The concept has long been held that any atom that emits a gamma photon must recoil so that momentum is conserved. It has now been demonstrated, however, that if the emitting atom is bound in a solid, it can be the solid as a whole that recoils rather than the individual atom. Since momentum is conserved, the energy taken up by the crystal is in the ratio of the mass of the photon to twice the mass of the crystal. When the uncertainty of recoil energy is removed from gamma emission and absorption, gamma-ray line widths be-

come so narrow as to make possible many experiments undreamed of a few years ago. For example, the energy shift has been measured for a proton moving from a point of greater gravitational potential to one of lower potential—all within the same physics laboratory. — J. W. C.

184-369. Morelli, C[arlo]. Special Study Group No. 5, general report: Bull. Géod., no. 51, p. 7-43, 1959.

This report of Special Study Group No. 5 (absolute determinations of gravity) of the International Association of Geodesy compiles information concerning the definition and corrections to the Potsdam Gravity System, new absolute determinations in various parts of the world, a world calibration standard, connections between absolute stations and first-order network stations, and the international gravity formula. — D. B. V.

184-370. Reichender, Karl. Reference-value of gravity at Potsdam: Bull. Géod., no. 51, p. 80-81, 1959.

Absolute gravity determinations since 1900 show that the Potsdam reference value is too high by at least 10 mgal, but values obtained to date are insufficient to determine this difference to within about 1 mgal. Until the numerous new absolute determinations recommended by the International Gravity Commission in 1956 are completed in Europe and America, it is premature to establish a definitive correction to the Potsdam reference value. A variation of 10 mgal in this value causes a variation of 10^{-5} in any values dependent on the acceleration of gravity. — D. B. V.

184-371. Rieckmann, E., and German, S. Untersuchungen und Vorschläge zur Definition des Potsdamer Schweresystems und zu seiner Übertragung [Investigations and proposals concerning the definition of the Potsdam Gravity System and its transference]: Bull. Géod., no. 51, p. 44-49, 1959.

Examination of the problem of the definition of the Potsdam reference system shows that many uncertainties must be eliminated before the present system is changed. This report discusses the following points: the position, and especially the height, of the Potsdam, Teddington, and Washington reference points; the transference of the Potsdam reference point to the auxiliary points in the Potsdam Geodetic Institute; transference of these auxiliary points to Bad Harzburg, Teddington, Washington, and other absolute gravity points; the effect of gravity tides on measurements with reversible pendulums; and the deviation of the time used by Kühnen and Furtwängler in their 1960 measurements from Ephemerides time.

It is concluded that the height of the Potsdam reference point can be calculated from the data of Kühnen and Furtwängler, and that previously accepted gravity differences between Potsdam and the auxiliary points in the Potsdam Geodetic Institute must be corrected, preferable by gravimeter measurements. — D. B. V.

184-372. Reichender, K. Stellungnahme zu dem Manuskript E. Rieckmann und S. German (Untersuchungen und Vorschläge zur Definition des Potsdamer Schweresystems und zu seiner Übertragung) [Opinion on the manuscript of E. Rieckmann and S. German (Investigations and proposals concerning the definition of the Potsdam Gravity System and its transference)]: Bull. Géod., no. 51, p. 104-106, 1959.

The importance of knowing the correct height of a gravity reference station is emphasized. Reichender objects to the proposal of Rieckmann and German (see Geophys. Abs. 184-371) for using the reference height 86.24 m (based on Kühnen and Furtwängler's 1906 formula) for international purposes, as this formula has led to the erroneous Potsdam gravity value. Gravity tides and the difference from Ephemerides time must also be taken into account. A preliminary value of g=981,275.3 mgal is given for measurements made in the cellar of the Potsdam Geodetic Institute. — D. B. V.

184-373. Baranov, Vladimir [I.]. Gravité normale à l'extérieur de la Terre [Normal gravity outside the earth]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 15, p. 1546-1548, 1960.

A formula is derived in finite terms for normal gravity prolonged above the earth's surface, using spheroidal coordinates. — D. B. V

184-374. Smith, R. A. Some formulae for interpreting local gravity anomalies: Geophys. Prosp., v. 8, no. 4, p. 607-613, 1960.

Let Oxyz be a system of rectangular axes with origin at the earth's surface and with the z axis pointing vertically downwards. If a body B lies wholly between the planes z=h, z=l then for all x, y and for n=1, 2, 3 it is proved that

$$|D_n(x, y, d)| \leqslant K\hat{\rho}d[J_n(\alpha) - J_n(\beta)]$$

where α=h/d, β=l/d and K is the gravitational constant. D_n are very easily computed from the Bouguer anomaly and J_n are tabulated in this paper. — Author's abstract

Borisov, A. A. Gravity anomalies of mountain regions. See Geophys. Abs. 184-350.

184-375. Heiskanen, W. A. Assembly of gravity data: Ohio State Univ. Inst. Geodesy, Photogrammetry and Cartography Repts., no. 11, 59 p., 1959.

The methods of reduction, analysis, and computation of data used in the Columbus world geodetic project have been described in earlier reports; this report deals mainly with the theoretical studies, practical procedures, and results obtained during the report period (1957-59). Maps showing the available gravity material, the status of the isostatic reduction, and the mean free-air anomalies of 5°X5° squares are included. Three graphs illustrate the development of the free-air gravity anomalies in spherical harmonics (Legendrians) to the 8th degree for flattening values of 1/297.0 and 1/298.3. The most important problems facing the project at present are summarized at the end. A bibliography of 85 items is given. — D. B. V.

184-376. Visarion, Marius. Contribuţii la determinarea gradientului vertical al gravităţii cu gravimetrul static [Contribution to the determination of the vertical gravity gradient with a static gravimeter (with Russian and French summaries)]: Acad. Romîne Studii şi Cercetări de Geologie, v. 5, no. 2, p. 383-399, 1960.

As a result of differential determinations of the vertical gravity gradient at different levels on a vertical line at several stations in northern Transylvania under different geologic conditions, several conclusions were drawn. A Nörgaard gravimeter is accurate to $\pm 50 \times 10^{-9}$ cgs units for differences in elevation of 20 m. The effect of the housing of the instrument is insignificant if the

points of measurement are on an axis of symmetry. The topographic effect is great, as a result of which a method is proposed for evaluation of the reduction of the relief. The anomalies revealed range from $+375X10^{-9}$ cgs units to $-297X10^{-9}$ cgs units and depart up to 12 percent from the normal values of the vertical gradient. These anomalies are caused by density differences in the rocks close to the surface. — J. W. C.

184-377. Seya, Kiyosi [Kiyoshi]. A new method of analysis in gravity prospecting (running average method) II: Butsuri-Tanko, v. 12, no. 4, p. 166-177, 1959.

The application of the running average method of analysis of results in gravity prospecting to the general or two-dimensional case is discussed. The method is considered to be a residual gravity method that gives excellent results in (a) indicating anomalies, (b) eliminating regional gravity and noise, (c) simplifying interpretation of the anomaly map obtained, and (d) simplifying calculations (see also Geophys. Abs. 182-300). — V. S. N.

184-378. Lozano Calvo, Luis. Calculo de densidad y espesores del subsuelo en funcion de las anomalias de la gravedad [Calculation of the density and thickness of the subsoil as a function of gravity anomalies]: Rev. Geofísica, v. 18, no. 69, p. 1-17, 1959.

A new gravimetric method is proposed for determining the densities and thicknesses of horizontal strata. Instead of attributing to the subsoil between the station and the geoid a mean density with which to calculate the Bouguer correction, an anomaly is assumed that is due partly to a deficiency of the mean density, and from this the mean density is determined in relation to certain observation data. Taking these mean or apparent densities, the densities and thicknesses for horizontal layers are calculated with the assumption that Bouguer's hypothesis is right. Results are generalized in cases in which an adequately corrected isostatic compensation exists. An application of the method in north Segovia Province is described. — V. S. N.

184-379. Yungul, S. H. Gravity prospecting for reefs: effects of sedimentation and differential compaction: Geophysics, v. 26, no. 1, p. 45-56, 1961.

A study of case histories shows that deeply buried, "isolated" organic reefs frequently create recognizable but "mysterious" gravity anomalies, with no evident direct relation between the reef mass and the anomaly. The reef mechanism and depositional processes are such that there is a concentration of sand in the over-reef section. Investigation of densities in clay and sand mixtures, in terms of compaction and depth of burial, leads to the conclusion that sand concentration alone is capable of creating shallow positive and deep negative density contrasts sufficient to account for the major part of the gravity anomaly. The gravity effect calculated for a hypothetical reef is very much like observed anomalies. The gravity anomaly depends mainly on what has happened after the reef was buried rather than on the contrast at the reef level. — D. B. V.

184-380. Afanas'yev, N. L. Interpretatsiya anomaliy Δg pryamym metodom [Interpretation of Δg anomalies by a direct method]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1479-1484, 1960.

A discussion is presented of the approximation method for determination of an anomalous mass and the coordinates of its center of gravity by using the criteria for verifying interpretations of observed Δg of Lyapunov (see Geophys.

Abs. 164-164) and Smolitskiy (see Geophys. Abs. 164-160). Using the formulas derived by these authors for two-dimensional and three-dimensional bodies, coordinates of centers of gravity can be determined within a probable error of 3-5 percent, provided the width of the observed anomaly Δg is not less than double the width of its most intensive part. — A. J. S.

184-381. Service Hydrographique de la Marine and Compagnie Générale de Géophysique. Tidal gravity corrections for 1961: Geophys. Prosp., v. 8, supp. no. 1, 53 p., 1960.

Three tables give, for hourly intervals in 1961, the corrections to be added to observed gravity values to eliminate the disturbing effect of the sun and moon. The factor 1.2 introduced by elasticity of the earth has been incorporated in these values. The corrections are given in units of a hundredth of a mgal to the nearest half unit. The principles of calculation are explained briefly. — D. B. V.

184-382. Cook, A[lan] H[ugh]. Preparations for a new absolute determination of gravity at the National Physical Laboratory, Teddington: Bull. Géod., no. 51, p. 63-71, 1959.

The principles, advantages, and difficulties of the proposed method of determining absolute gravity at Teddington (by timing the flight of a ball projected upward and allowed to rise and fall freely under gravity) are discussed. Means of locating a ball in flight to 1μ are considered, and results of some studies given. The probable layout of the apparatus is outlined. — D. B. V.

184-383. Reichender, Karl. Method of the new measurements at Potsdam by means of the reversible pendulum: Bull. Géod., no. 51, p. 72, 1959.

The reversible pendulum has been chosen for redetermination of absolute gravity at Potsdam. Improvements in construction are described briefly. The new instrument will be portable. — D. B. V.

184-384. Kukkamäki, T. J. Two hundred metre pendulum: Bull. Géod., no. 51, p. 103, 1959.

A 220-m pendulum in a mine shaft 230 m deep is described briefly. It is to be used by the Finnish Geodetic Institute to measure absolute gravity with a total error of less than 1 mgal. — D. B. V.

184-385. Rose, John C., Haubrich, Richard A., and Woollard, G[eorge] P[rior]. A method for the measurement of absolute gravity: Bull. Géod., no. 51, p. 91-102, 1959.

This is virtually the same as the paper published in Am. Geophys. Union Trans., v. 39, no. 1, p. 27-34, 1958 (see Geophys. Abs. 172-104).—D. B. V.

184-386. Graf, A[nton]. Messungen mit dem Seegravimeter auf einer kreiselstabilisierten Plattform [Measurements with the sea gravimeter on a gyroscopically stabilized platform]: Deutsche Geod. Komm. Veröffentl., ser. A, no. 32, p. 41-45, 1959.

A theoretical study is made of the mean acceleration operating on the gravimeter mass, fixed firmly to a gyroscopically stabilized table, when the vessel rolls through an arbitrary angle. The results show that no acceleration of the gravimeter mass is produced by periodic movements of the vessel, assuming that the stabilization is perfect. — D. B. V.

184-387. International Geophysical Year Bulletin (No. 41). Gravity measurements on a surface ship at sea: Am. Geophys. Union Trans., v. 41, no. 4, p. 701-706, 1960.

This is a condensed version of a paper by Worzel, published in the Jour. Geophys. Research, v. 64, no. 9, p. 1299-1315, 1959 (see Geophys. Abs. 178-227). —D. B. V.

184-388. Gantar, C., and Morelli, C[arlo]. Alcuni effetti della pressione sul comportamento dei gravimetri Worden [Some effects of pressure on the behavior of Worden gravimeters]: Boll. Geofisica Teor. ed Appl., v. 1, no. 3, p. 221-228, 1959.

Four Worden gravimeters have been subjected to rapid variations of ambient pressure corresponding to elevation differences of 200 m to 4,000 m. It was found that adiabatic variations in temperature (up to 4°C) had no effect on gravimeter readings, whereas changes in pressure produced either negative or positive linear variations in the small dial readings. (See also Geophys. Abs. 181-267.)— A. J. S.

184-389. Fajklewicz, Zbigniew. Zastosowanie automatycznych maszyn liczących w interpretacji zdjeć grawimetry-cznych i magnetycznych [Application of automatic digital computers in interpretation of gravity and magnetic surveys (with English summary)]: Przegląd. Geol., v. 8, no. 9, p. 459-466, 1960.

The results of application of automatic digital computers to interpretation of gravity and magnetic surveys are presented. Computers may be used in two ways: (1) partial automation using formulas in conjunction with a digital computer, or (2) full automation using computers of such type as universal, electronic, XYZ digital, or "Aritma" statistical machines. The tests showed that the computers shorten calculating time 4-8 fold, reduce costs by 50 percent, and allow introduction of new precise methods of interpretation. —J. W. C.

184-390. Behrendt, J. C., and Woollard, G[eorge] P[rior]. An evaluation of the gravity control network in North America: Geophysics, v. 26, no. 1, p. 57-76, 1961.

Observations with a LaCoste and Romberg geodetic gravimeter having a very low nearly linear drift rate, a high reading precision, and a worldwide range were made at about 300 sites in order to check and extend the gravity control network in North America. The instrument was calibrated against the North American standardization range of pendulum measurements from Paso de Cortes, Mexico, to Fairbanks, Alaska. A statistical evaluation of the precision of the network based on reoccupations of 40 major control stations gives an estimated standard deviation of 0.08 mgal. Values for the 40 reoccupied stations of the airport network established in 1958 (see Geophys. Abs. 174-212), adjusted for the difference in calibration standard used, agree on the average to within 0.2 mgal with the results of this study. Reoccupations of old pendulum stations suggest that much of that network is in error by more than 3 mgal. Tables give descriptions of sites occupied and principal facts for position, elevation, observed gravity, and free-air and Bouguer anomalies. — D. B. V.

184-391. Preston-Thomas, H., Turnbull, L. G., Green, E., Dauphinee, T. M., and Kalra, S. N. An absolute measurement of the acceleration due to gravity at Ottawa: Canadian Jour. Physics, v. 38, no. 61, p. 824-852, 1960.

An apparatus for determining the absolute value of gravity by measuring the distances through which a rule falls in discrete time intervals is described. From the data associated with 64 drops with two nonmagentic stainless steel rules in vacuum, a value of g at the absolute gravity station at Ottawa of 980.6132 cm per sec^2 with a possible error of ±0.0015 cm per sec^2 has been obtained. This value is 13.7±2.0 mgal less than the Potsdam value at that position. — Authors' abstract

184-392. Preston-Thomas, H. Absolute determination of g at Ottawa: Bull. Géod., no. 51, p. 107-111, 1959.

The falling bar method used to determine absolute gravity at Ottawa is described briefly. A series of 19 drops gave a mean value of g=980.6134 cm per sec^{-2} with an average deviation of 1.65 mgal. The local Potsdam value is 980.6293 cm per sec^{-2}. — D. B. V.

184-393. Winter, P. J., and Valliant, H. D. Relative gravity determinations in the Prairie Provinces with Dominion Observatory bronze pendulum apparatus: Royal Astron. Soc. Geophys. Jour., v. 3, no. 2, p. 141-154, 1960.

Gravity values were determined at five locations in western Canada during 1958, using the bronze pendulum apparatus of the Dominion Observatory. Results, referred to the adopted value of 980.62200 cm per sec^2 for the National Reference Station, are as follows: Winnipeg—980.9963; La Ronge—981.3949; Saskatoon—981.1356; Estevan—980.8598; and Regina—980.9588.

The standard deviations obtained are due chiefly to drifts of up to 3 parts in 10^7 in the frequency standard and to errors of 1 or 2 parts in 10^7 which arise during the scaling of the photographic records. Errors due to temperature and pressure and to variations in arc are believed to be negligible. The spreads in determinations of pendulum periods are at least comparable to results obtained by other observers in recent years. — D. B. V.

184-394. Innes, M. J. S. Gravity connexions for Canada: Bull. Géod., no. 51, p. 73-79, 1959.

Gravity ties completed by the Dominion Observatory are listed. These together with recent transatlantic connections and ties within the European gravimeter network should provide a firm basis for appraising the consistency of North American (Ottawa and Washington, D. C.) and European absolute determinations. — D. B. V

184-395. Baglietto, Eduardo E. Gravedad absoluta en Buenos Aires [Absolute gravity in Buenos Aires]: Bull. Géod., no. 51, p. 52-62, 1960.

Details of pendulum measurements of absolute gravity in Buenos Aires, Argentina, made in 1954-57, are reported. The provisional result is g=979.696 gals. — D. B. V.

184-396. Rieckmann, E. Bericht über den Stand der Schweremessungen in Braunschweig [Report on the state of gravity measurements at Braunschweig]: Bull. Géod., no. 51, p. 50-51, 1959.

This is a brief progress report on absolute gravity measurements by the falling rod method at Braunschweig, Germany. First results are expected in a few months. — D. B. V.

184-397. Agaletsky, P. N., Yeforov, K. N., and Martsinyak, A. I. Results of absolute determinations of the acceleration due to gravity by three independent methods in the point "VNIIM" (Leningrad): Bull. Géod., no. 51, p. 82-90, 1959.

The results of determinations of the absolute value of gravity in Leningrad by three different methods are as follows (in 10^{-3} cm per sec^2): by three reversible quartz pendulums of equal mass but different length, g=981,918.7±0.4; by free and non-free fall method, 981,921.5±1.6; and by a falling rod in a vacuum, 981,923.3±2.2. In the Potsdam system the value for this point is g=981,930.8±0.6. — D. B. V.

184-398. Medvedev, V. Ya., and Stepanov, P. P. Plotnoctnaya kharakteristika drevnikh tolshch zapadnoy chasti Tyan'-Shanya [Density characteristic of ancient units of the west part of the Tien Shan (with English abstract)]: Sovetskaya Geologiya, no. 10, p. 81-98, 1960.

The geology of the western Tien Shan is examined in connection with problems of the density of the rocks that make up the older geologic units. The study is based on density determinations made on 3,000 specimens taken from outcrops; these data are tabulated. The average density of the basement rocks of the Kirgiz zone is 2.73, and for the Talass and Chatkal-Naryn zones, it is 2.70. —J. W. C.

184-399. Kane, M[artin] F., and Pakiser, L[ouis] C. Geophysical study of subsurface structure in southern Owens Valley, California: Geophysics, v. 26, no. 1, p. 12-26, 1961.

Gravity and seismic measurements in southern Owens Valley, Calif., have outlined a deep subsurface trough, bounded throughout the greater part of its length by steep faults. Depths to the bedrock floor along the central part of the valley range from 3,000 to 9,000 feet below the surface. The subsurface trough is divided into two parts, a narrow channel-like depression near Lone Pine bounded by northwest-trending faults, and a broad basin at Owens Lake bounded by a more complex series of border faults. The bedrock ridge that crops out to form Alabama Hills is shown to extend from Independence to the north edge of Owens Lake, nearly twice its visible extent. The main direction of faults that have formed the valley is northwest; subsidiary faults trend north, northeast, and east. A fairly sharp velocity boundary within the Cenozoic valley deposits suggests a change in the rate and character of deposition which was probably the result of renewed uplift in the nearby mountains. — Authors' abstract

184-400. Mabey, Don R. Gravity survey of the western Mojave Desert, California: U. S. Geol. Survey Prof. Paper 316-D, p. 51-72, 1960.

In the western Mojave Desert gravity exploration is an effective method of obtaining subsurface information in areas where the Quaternary sediments cover most of the underlying geology. The results of a gravity survey conducted over this area and consisting of 1,900 gravity stations are discussed; data are reduced to the complete Bouguer anomaly and presented on a contour map along with the generalized geology.

The gravity anomaly map indicates the areas in which the basement complex is overlain by Cenozoic deposits and also the order of magnitude of depth to the basement. Two-dimensional theoretical analyses are presented to show distribution of Cenozoic deposits along profiles across seven major gravity lows. Gravity anomalies are associated with several major faults; they generally exhibit a parallel trend. — V. S. N.

184-401. Bott, M[artin] H[arold] P[hillips], and Masson-Smith, D[avid]. A gravity survey of the Criffel granodiorite and the New Red Sandstone deposits near Dumfries: Yorkshire Geol. Soc. Proc., v. 32, pt. 3, no. 13, p. 317-332, 1960.

The gravity results are presented for an area of nearly 4,000 sq mi of south Scotland along the north shores of the Solway Firth. The pattern of relatively low gravity anomalies observed over the Criffel granodiorite indicates a batholith probably reaching more than 7 miles in depth and with a major gradational increase of density toward the southeast margin. The mass deficiency represented by the granite is of the same magnitude as the additional surface load of the corresponding high ground, suggesting an isostatic balance between the two. Negative anomalies (15 mgal) are associated with the New Red Sandstone deposits at Dumfries and Lochmaben and suggest thicknesses of 3,500 feet for both basins; the shapes are best explained by contemporaneous sinking and filling. As the Irish Sea is approached, a regional increase of gravity anomalies that does not correlate with surface structure is observed. The cause may lie within the upper crust. — V. S. N.

184-402. Kneissl, M[ax], and Marzahn, K[urt]. Das deutsche Schweregrundnetz. Pendelmessungen 1958 [The German gravity base network. Pendulum measurements in 1958]: Deutsche Geod. Komm. Veröffentl., ser. B, no. 23, pt. 7, 38 p., 1960.

The results of pendulum measurements made in 1958 along two routes in Europe are presented.

The apparatus, procedure, and reductions are described briefly; then the data are presented in tables and graphs, which constitute the greater part of the paper. — D. B. V.

184-403. Gloden, A[lbert]. Nouvelles mesures gravimétriques au Grand-Duché de Luxembourg [New gravimetric measurements in the Grand Duchy of Luxembourg]: Ciel et Terre, v. 75, no. 11/12, p. 359-360, 1959.

Calculation of free-air and Bouguer anomalies at the 96 gravimetric stations in Luxembourg revealed irregularities that necessitated remeasurement of two stations, at Borne and Sinningen. These and 5 control stations were remeasured and compared with the results obtained in 1948; agreement was good in the control stations. Calculation of the anomalies for the two stations in question, using the new values, completes the gravimetric survey of Luxembourg. (See also Geophys. Abs. 158-22, 165-203.) — D. B. V.

184-404. Gerke, Karl, and Waterman, Heinz. Die Karte der mittleren Freiluftanomalien für Gradabteilungen 6'X10' von Westdeutschland [The map of mean free-air anomalies for 6'X10' geographic sections of West Germany]: Deutsche Geod. Komm. Veröffentl., ser. B, no. 46, pt. 2, 15 p., 1959.

A map showing mean free-air gravity anomalies for each 6'X10' section of West Germany is presented; its scale is 1:1,000,000. The map is based on measurements performed in the course of perparation of the Bouguer anomaly map of Germany. For each section of the topographic map, the free-air anomaly is given as a function of station elevation. — D. B. V.

184-405. Gantar, C., and Morelli, C[arlo]. Revisione critica delle misure effectuatte con gravimetri Worden dal 1951 al 1959 [A critical revision of relative measurements from 1951 to 1959 with Worden

gravimeters (with English abstract)]: Boll. Geofisica Teor, ed Appl., v. 1, no. 3, p. 181-220, 1959.

Measurements of relative gravity carried out by the Experimental Geophysical Observatory of Trieste with the aid of Worden gravimeters are reworked in order to account for the recently discovered time and temperature variations in the gravimeters' performance. Large dial measurements have been corrected for the total nonlinearity range of response. The gravity differences so obtained are expressed in the Italian conventional calibration standard (Bologna to Ferrara, Δg=+161.06 mgal; Morelli, 1952). — A. J. S.

Marchetti, M. P. The occurrence of slide and flowage materials (olistostromes) in the Tertiary series of Sicily. See Geophys. Abs. 184-554.

184-406. Visarion, Marius, and Andrei, Justin. Noi date geofizice asupra zonei centrale a depresiunii Haţeg [New geophysical data on the central zone of the Hateg depression (with Russian and French summaries]: Acad. Romîne Studii şi Cercetări de Geologie, v. 5, no. 1, p. 197-210, 1960.

The results are presented of gravity and magnetic surveys made in 1956-57 in the central zone of the Haţeg depression. The gravity map shows three anomaly zones: a minimum reflecting subsidence along the line Haţeg-Sarmizegethuse, a maximum due to a projection of the basement in the Ciopea-Valea Dîljii anticline, and a minimum corresponding to the Pui basin. A magnetic maximum and minimum were determined. The maximum is not due to a body in the basement but to tuffs in the sedimentary section. The minimum is due to proximity to the surface of weakly magnetized schists in the Ciopea-Valea Dîljii anticline. — J. W. C.

Bumasov, A. P. The magnetic and gravitational field of the Baikal in relation to its seismicity. See Geophys. Abs. 184-157.

184-407. Rouillon, Gaston. Variations de la pesanteur dans la région de Pointe Géologie en Terre Adélie [Variations of gravity in the Point Geology region in Adélie Land]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 4, p. 570-572, 1960.

The results of gravity surveys on rock outcrops (71 stations), on sea ice (12 stations), and on a glacier tongue (5 stations) in central Adélie Land, Antarctica, are reported. A Worden gravimeter no. 332 was used. The Bouguer anomalies suggest the presence of a vast subglacial fjord. — D. B. V.

184-408. Rouillon, Gaston. Anomalies de pesanteur et profile de la calotte glaciaire antarctique en Terre Adélie [Gravity anomalies and profile of the Antarctic icecap in Adélie Land]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 5, p. 762-764, 1960.

Gravity values on the Antarctic icecap were determined at 128 stations along a 520-km traverse southward from the Dumont d'Urville station in Adélie Land. Bouguer anomalies, calculated with the aid of information from 28 seismic soundings, show a mass deficit for this region and provide a detailed profile that confirms the free air anomalies. The effect of bedrock irregularities on ice flow is revealed in the profile. — D. B. V.

184-409. Harada, Yoshimichi; Suzuki, Hiromiti; Kakinuma, Seiichi; and Yoshida, Arao. Report on the gravity measurement by the Japanese Antarctic Research Expedition, 1958-59 (in Japanese with English abstract): Antarctic Rec., no. 9, p. 43-51, 1960.

During the 3d Japanese Antarctic Research Expedition, 1958-59, only gravimeter observations were made. A Worden gravimeter used for the measurements had a small but stable drift as confirmed by continuous readings and close observations at Singapore and Capetown during both the 2d and 3d Antarctic expeditions (see Geophys. Abs. 177-219). The final gravity value at Syowa station, lat 69°00.4'S., long 39°35.4 E., elevation 29.2 m, is 982.540, relative to an absolute value at Capetown of 979.6470.

Observations were also made in East and West Ongul Islands, where 5 stations were established, and on the closed pack ice in Lützow-Holm Bay. These values are summarized in tables. The values of the gravity anomaly in Lützow-Holm Bay are more than +50 mgals, far exceeding the estimated error, whereas those at Syowa station are all negative. It is concluded from this that a large gravity gradient exists along the coast of Lützow-Holm Bay. — V. S. N.

184-410. Pratt, J. G. D. A gravity traverse of Antarctica: Trans-Antarctic Exped., 1955-58, Sci. Repts., no. 2, 22 p., 1960.

The raw data are presented for a gravity traverse across the Antarctic from Shackleton to Scott Base. No interpretation can be made until reliable heights above sea level are available. Part 1 discusses the Worden gravimeter no. 14 that was used in the Antarctic work. The testing program carried out on the instrument in England is described, and all resulting data on instrumental drift summarized. Part 2 describes the journey across Antarctica, discusses instrumental drift, and presents the raw gravity values. Part 3 describes the use of the gravimeter to measure motion on the pack ice and ice shelves. The method is applicable for quick mapping of areas that are aground near the edge of an ice shelf. — V. S. N.

HEAT AND HEAT FLOW

184-411. Okai, Bin. A perturbation method for thermal convection problem (pts. 1 and 2) [in Japanese with English abstract]: Zisin, ser. 2, v. 13, no. 1, p. 9-36, 1960.

In part 1, a perturbation method is presented to determine the form and amplitude of a convection which occurs in a regular cellular pattern for the values of the Rayleigh number in excess of a critical value when a layer of fluid is heated uniformly from below. The essential point is to expand the velocity and temperature functions describing the field in a power series of a parameter ϵ, while the Rayleigh number is put as a product of its critical value times $(1+\epsilon^2)$. The set of inhomogeneous equations obtained can be solved by the perturbation method used in nonlinear oscillation problems. In the two-dimensional case the slope of the heat transport curve steepens abruptly at the critical Rayleigh number. A study of convection in a sphere is presented as another example.

In part 2, the method is extended to a problem with inhomogeneous boundary conditions, that is, to the problem of steady thermal convection in a two-dimensional fluid layer heated uniformly from below under the simultaneous constraint of nonuniform temperature on its upper surface. It was found that the site of spontaneous convection cells is decided according to the surface temperature disturbance having the critical wave length. Surface disturbances having much larger or smaller wavelength play little part in this but those having wavelengths close to the critical one are effective in determining the general feature of fluid motion. — V. S. N.

184-412. Kangos, James D. A preliminary investigation of the heat flux from the ocean to the atmosphere in Antarctic regions: Jour. Geophys. Research, v. 65, no. 12, p. 4007-4012, 1960.

Estimates have been made for the summer and fall seasons of the sensible and latent heat flux for 5° latitudinal zones from 40° S. to 70° S. eastward between 20° E. and 180°. Results indicate that there are large variations in the total heat flux from summer to fall and from zone to zone, the largest seasonal variations occurring in the zones 40° to 45° S. (183 cal/cm^2/day) and 65° to 70° S. (187 cal/cm^2/day). A minimum in the total heat flux for both summer (16 cal/cm^2/day) and fall (-54 cal/cm^2/day) is found in the zone 50° to 55° S., the approximate mean position of the Antarctic Convergence. Annual evaporation values were determined, revealing a minimum (15 cm) in in the zone 50° to 55° S. with a secondary minimum (32 cm) along the coast. — Author's abstract

Lear, John. Canada's continent-spanning look inside earth. See Geophys. Abs. 184-438.

184-413. Clark, Sydney P. [Jr.]. Absorption spectra of some silicates in the visible and near infrared: Am. Mineralogist, v. 42, no. 11-12, p. 732-742, 1957.

Absorption coefficients of olivine, diopside, and three varieties of garnet were measured in the spectral range between 0.3 and 4 mu. The positions of the absorption peaks can be explained by electronic transitions between a relatively small number of excitation levels. At wave numbers between 2,000 and 7,000 cm^{-1} the absorption coefficient of olivine is less than 0.5 cm^{-1} and that of diopside is about 1 cm^{-1}. These results support the hypothesis that radiative heat transfer is important in the earth's mantle. — D. B. V.

184-414. Goldsmid, H. J., and Bowley, A. E. Thermal conduction in mica along the planes of cleavage: Nature, v. 187, no. 4740, p. 864-865, 1960.

The results of measurements of heat flow along the cleavage planes of phlogopite, a mica that is effectively uniaxial and isotropic within the layers, are reported here. The thermal conductivity was measured both directly by an absolute method and indirectly using the apparatus described by Green and Cowles. The results obtained by both methods are in good agreement. The indirect method yielded a value of 0.0190 cm^2 per sec for the thermal diffusivity at 27°C, leading to a thermal conductance of 0.0163±0.0009 W. per °C for a rectangular block 1 cm long with a mass of 1 g. By the direct method this quantity was found to be 0.0185±0.0018 W. per °C, with no significant variation over the temperature range -85°C to 35°C. Assuming a density of 2.8 g per cm^3, the values of thermal conductivity corresponding to these conductance values are 0.046 and 0.052 W. per cm per °C, respectively. It is concluded that the thermal conductivity of phlogopite along the cleavage planes is an order of magnitude greater than in the perpendicular direction. — D. B. V.

184-415. Somerton, W[ilbur] H., and Boozer, G. D. Thermal characteristics of porous rocks at elevated temperatures: Jour. Petroleum Technology, v. 12, no. 6, p. 77-81, 1960.

Thermal diffusivities of several sedimentary rocks were measured by a rapid unsteady-state technique for the temperature range 200° F - 1,800°F. These data are compared with steady-state conductivity measurements, and agreement between the two methods is satisfactory. Thermal diffusivity de-

creases markedly with increased temperature. The reliability of the thermal values decreases at higher temperatures; the reported values of diffusivity and conductivity may be up to 20 percent too high at temperatures in excess of 1,500°F. — J. W. C.

184-416. Joyner, William B. Heat flow in Pennsylvania and West Virginia: Geophysics, v. 25, no. 6, p. 1229-1241, 1960.

In order to obtain heat-flow values for six wells in Pennsylvania and West Virginia a simple technique was developed for estimating thermal resistivities from well-sample logs. This technique made use of average resistivity values for various categories of sedimentary rocks. The averages were calculated from available resistivity measurements on rock specimens, many of which did not come from the region in which the wells were located. The results indicate that, allowing for error in the estimates, the heat flow at the wells lies between 1.1 and 1.5 microcal per cm^2 sec. The problem of developing a more accurate technique for estimating resistivity is discussed. Such a technique would be valuable in extending our knowledge of the earth's heat flow. — Author's abstract

184-417. Jaeger, J. C. The effect of drilling fluid on temperatures measured in bore holes: Jour. Geophys. Research, v. 66, no. 2, p. 563-569, 1961.

A series of measurements of water temperature and flow were made during diamond drilling of a hole, and a few temperature logs were taken. In this particular case it was found unnecessary at any time to wait more than a day after drilling ceased to determine the geothermal gradient to within 5 percent. This is because the drilling system acts as a heat exchanger. For the relatively small circulation of water used in diamond drilling, heat exchange takes place in restricted regions at the top and bottom of the hole. Therefore, unless very large quantities of water are circulated, the temperature gradient near the center of the hole is little affected. In rotary drilling, on the other hand, in which very high fluid velocities are used, the temperature in the hole is determined almost entirely by the input temperature of the fluids. Methods of correcting observed temperatures for the effects of drilling fluid are discussed. — D. B. V.

184-418. Cheremenskiy, G. A. O zone narusheniya teplovogo sostoyaniya gornykh porod bureniyem skvazhiny [On the zone of disturbance of the thermal state of rocks by drilling of a borehole]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1507-1509, 1960.

Disturbance of the thermal equilibrium in the rock surrounding a borehole is governed by the duration of the drilling, the temperature of the drilling mud, the thermal properties of the rock, and the geologic and hydrologic features of the region. The radius of this disturbance may reach 10-20 m or more. — A. J. S.

184-419. Ovnatanov, S. T., and Tamrazyan, G. P. O termicheskikh usloviyakh antiklinal'noy zony Surakhany-Karachukhur-Zykh-Peschanyy (Apsheronskiy poluostrov) [Thermal conditions of the Surakhany-Karachukhur-Zykh-Peschanyy anticlinal zone (Apsheron Peninsula) (with English abstract)]: Sovetskaya Geologiya, no. 10, p. 99-111, 1960.

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Results are presented of geothermal investigations in one of the most important anticlinal zones of the Apsheron Peninsula. A total of 2,321 measurements were made in 286 boreholes, most of which were shut-down and therefore in thermal equilibrium. Maps and a cross-section show a definite correlation between the structure of the anticline and a geothermal anomaly. The geothermal step at shallow depths (200-500 m) is 20-30 m per °C, whereas it increases to 40-80 m per °C at depths of 1-4 km. — J. W. C.

184-420. Ananyan, A. L. Podzemnoye teplo rayona Dzhermuk i problema osvoyeniya yego prirodnykh goryachikh vod [Subsurface heat of the Dzhermuk region and the problem of utilization of natural hot waters (with English abstract)]: Sovetskaya Geologiya, no. 12, p. 98-105, 1960.

The upper Senonian limestones of the Armenian S. S. R. are strongly fractured and constitute excellent aquifers. Within the Daralagyaz basin in the vicinity of Dzhermuk the water in the aquifers has an anomalously high temperature, which is attributed to igneous activity in the region. The geothermal step in the depth interval 10-100 m is 4-5 m per °C; below this depth the rise is less rapid. These thermal waters can possibly be used in heating of buildings. — J. W. C.

INTERNAL CONSTITUTION OF THE EARTH

184-421. MacDonald, Gordon J. F. Chondrites and the chemical composition of the earth, in Researches in geochemistry: New York, John Wiley and Sons, p. 476-494, 1959.

The present rate of heat loss from the earth is consistent with the hypothesis that a major portion of the earth is composed of chondritic material. The observed ratio of iron to stony meteorites and the abundance of iron in the sun favor an earth consisting wholly of chondritic material. If this is true, then the earth's core probably contains major amounts of silicon alloyed with iron; this type of core is consistent with seismic data interpreted in terms of high-pressure equations of state. On the chondritic model the mantle must be chemical differentiated with heat-producing elements within the upper 600-700 km. A material intermediate in chemical composition between dunite and basalt is thus suggested for the upper mantle under the oceans. A similar but less stringent requirement on the composition of the mantle, independent of the chondritic hypothesis, is set by its solid nature. — V. S. N.

184-422. Clark, Sydney P., Jr. Equations of state and polymorphism at high pressures, in Researches in geochemistry: New York, John Wiley and Sons, p. 495-511, 1959.

A qualitative and general discussion of phase changes and equations of state is given. Theoretical and experimental results from the field of high-pressure physics lead to generalizations that can be applied to the earth. Reviews of Thomas-Fermi theory and of the present status of quantum-mechanical equations of state of simple substances are included. The results of studies of equations of state and polymorphism can be related to the earth through seismic velocities. The ratio of bulk modulus to density (elastic ratio) at various depths in the earth is known from velocities of elastic waves; it can be obtained also from the equation of state, and comparison of these two sets of data yields the most important body of information about the internal constitution of the earth. Information about the homogeneity of the earth can also be derived from the elastic ratio; expected changes in this quantity with pres-

sure or depth derived from the equation of state are much less than those observed in the earth. The departures occur at the M-discontinuity and at the boundaries of the outer and inner core. Equations of state suggest that none of the discontinuities could result from compression of homogeneous material. — V. S. N.

184-423. Turekian, Karl K., and Wedepohl, Karl Hans. Distribution of the elements in some major units of the earth's crust: Geol. Soc. America Bull., v. 72, no. 2, p. 175-192, 1961.

This paper presents a table of abundances of the elements in the various major units of the earth's lithic crust with a documentation of the sources and discussion of the choice of units and data. — Authors' abstract

Pekeris, C. L., Alterman, Z., and Jarosch, H. Comparison of theoretical with observed values of the periods of free oscillation of the earth. See Geophys. Abs. 184-189.

Choudhury, Mansur Ahmed. PKP_2 and its reflections at the inside of the earth's crust. See Geophys. Abs. 184-194.

184-424. Oliver, Jack [E.], Kovach, Robert [L.], and Dorman, James. Crustal structure of the New York-Pennsylvania area: Jour. Geophys. Research, v. 66, no. 1, p. 215-225, 1961.

Phase velocities of Rayleigh waves in the period range from 15 to 45 seconds were determined from seismograms of the Waynesburg, Pennsylvania-Ottawa, Ontario-Palisades, New York, tripartite array. A theoretical model, compatible with these data and with previously published seismic refraction data of Katz, consists of a low-velocity sedimentary layer overlying two crustal rock layers which in turn overlie the earth's mantle. The total crustal thickness is about 37 kilometers. Calculations of Rayleigh wave dispersion for a variety of theoretical models show that small variations in elastic properties from place to place may cause significant errors in the determination of total crustal thickness if such variations are neglected when the phase-velocity method is used independently. The error is considerably less if supplementary data are used in conjunction with phase-velocity data as was done in the example cited above. — Authors' abstract

184-425. Diment, W[illiam] H., Stewart, S[amuel] W., and Roller, J. C. Crustal structure from the Nevada Test Site to Kingman, Arizona, from seismic and gravity observations: Jour. Geophys. Research, v. 66, no. 1, p. 201-214, 1961.

The time of the first arrival of seismic waves generated by explosions at the Nevada Test Site and recorded along a 300-km line southeastward through Kingman, Arizona, is expressed as $T_0=\Delta/5.2$, $T_1=0.34+\Delta/6.15$, and $T_2=5.82+\Delta/7.81$, where time is in seconds and the shot-detector distance (Δ) is in kilometers. Assuming constant velocities for the layers, the thicknesses are $H_0=1.7$ km, $H_1=26.7$ km, and $H_0+H_1=28$ km (below a 1-km datum). The average Bouguer anomaly is about -120 milligals, and the average elevation is about 1.1 km. Seismograms were examined for P-waves indicating the presence of other discontinuities within and below the H_2 layer, but the separation between seismic stations was too great to establish the presence of such discontinuities. A questionable alinement of weak arrivals following the T_2 refraction time by less than 1 second may indicate the presence of a discontinuity below 28 km. Fair alinements of strong second arrivals in the range 200-400 km might be interpreted as direct P-waves or channel waves in the H_1 layer. — Authors' abstract

Adams, W[illiam] M[ansfield], Preston, R. G., , Flanders, P. L. ,Sacks, D. C., and Perret, W. R. Summary report of strong-motion measurements, underground nuclear detonations. See Geophys. Abs. 184-258.

Narans, Harry D., Jr., Berg, Joseph W., Jr., and Cook, Kenneth L. Subbasement seismic reflections in northern Utah. See Geophys. Abs. 184-569.

184-426. Schulz, R[udolf], and Weyl, R[ichard]. Erdbeben und Krustenaufbau im nördlichen Mittelamerika [Earthquakes and crustal structure in northern Central America (with Spanish summary)]: Neues Jahrb. Geologie u. Paläontologie Monatsh., no. 5, p. 193-201, 1960; also in El Salvador Servício Geol. Nac. Bol. Sismol., v. 5, p. 36-40, 1959.

Crustal structure in northern Central America is inferred from earthquakes registered at the seismic stations in El Salvador, which were modernized in 1954. Shocks originating in the region of the volcanic chain of El Salvador indicate a fairly homogeneous ground; focuses are shallow and are related to the fault system of the Pacific coast. A line of earthquake focuses at depths of 70-150 km lies off the Pacific coast, parallel to the shore. The region of the Middle American Trench is characterized by shallow focuses. Unusually long-period surface waves observed in this region are evidence that the trench is filled with rather thick unconsolidated sediments. The mechanism of the deeper focuses has been investigated; it is probable that low-angle overthrusting of the continental plate is responsible.

Waves originating in the Gulf of Honduras, western Guatemala, and the Caribbean Sea travel continental paths to El Salvador; this agrees with geologic observations. The interpretation of earthquakes from southern Guatemala is more difficult. — D. B. V.

184-427. Aldrich, L. T[homas], Bass, M[anuel] N., Tuve, M[erle] A., and Wetherill, G[eorge] W. The earth's crust. Seismic studies: Carnegie Inst. Washington Year Book 58, July 1, 1958-June 30, 1959, p. 234-236, 1959; reprinted in Carnegie Inst. Washington Dept. Terrestrial Magnetism Ann. Rept. of Director for 1958-59, 1959.

The first set of seismic recorders with electronic instrumentation that requires attention only once a week has been installed in the Andes near Arequipa, Peru. A program for further such installations, and the development of relatively portable equipment for brief periods of attended recording of explosion waves are reported. The latter equipment is for observations along the west flank of the Andes and in New Mexico, Arizona, Utah, and Wyoming to obtain definitive information on subsurface structures of the Andes and beneath the great western plateaus of the United States. Establishment of a series of unattended stations is also suggested for these observations.

Current observations on density contrasts between the crust and the mantle and the implications concerning the depth of mountain roots are discussed briefly. — V. S. N.

Ewing, J[ohn] [I.], Antoine, J., and Ewing, M[aurice]. Geophysical measurements in the western Caribbean and in the Gulf of Mexico. See Geophys. Abs. 184-

184-428. Neprochnov, Yu. P. Glubinnoye stroyeniye zemnoy kory pod Chernym morem po seysmicheskim dannym [Deep structure of the

crust under the Black Sea according to seismic data (with English summary)]: Moskov. Obshch. Ispytateley Prirody Byull. Otdel Geol., v. 35, no. 4, p. 30-36, 1960.

On the basis of 10 seismic profiles of an aggregate length of 1,000 km (see Geophys. Abs. 177-363), an interpretation is presented for the crustal structure of the northern part of the Black Sea to the south of the Crimea. The crust beneath the Black Sea depression differs from a continental type by the absence of a granitic layer and from an oceanic type by the presence of a thick sedimentary section. — J. W. C.

184-429. Khalevin, N. I. Stroyeniye Urala v svete geofizicheskikh dannykh [Structure of the Urals in the light of geophysical data]: Sovetskaya Geologiya, no. 12, p. 22-32, 1960.

On the basis of gravity and magnetic data, the Ural Mountain region is divided into nine belts; these have a north-south trend parallel to that of the mountain system. Marginal to these belts are oval areas of positive gravity anomaly. The axial area of the Urals, which is characterized by positive gravity values, was formed by a pre-Hercynian orogeny. The amplitude of upwarp of the basaltic substratum here is 5-10 km, and the thickness of the granitic stratum is 8-12 km. — J. W. C.

184-430. Savarenskiy, Ye. F., Solov'yeva, O. N., and Lazareva, A. P. Dispersiya voln Releya i stroyeniye zemnoy kory na severe Evrazii i v Atlanticheskom okeane [Rayleigh wave dispersion and crustal structure in northern Eurasia and in the Atlantic Ocean]: Akad. Nauk SSSR Sovet po Seysmologii Byull., no. 10, p. 168-175, 1960.

The group velocity of Rayleigh waves has been determined for earthquakes originating in the northwestern Pacific Ocean and recorded at the Moscow and Pulkovo seismic stations. The paths traversed northern Eurasia and the North Arctic Ocean. In all cases examined the group velocity values are consistent among themselves and indicate a continental crust. The thickness of the crust is 35-40 km in general; the upper and lower layers are approximately 20-25 km and 15-18 km, respectively.

Group velocities of Rayleigh waves from earthquakes originating in the Atlantic Ocean and on the west coast of Central and South America were also examined on the basis of the Moscow and Pulkovo records and found to be consistent among themselves. They indicate a homogeneous crust about 25-30 km thick. — D. B. V.

184-431. Weizman [Veytsman], P. S., Gal'perin, E. J. [E. I.], Zwerjew, C. M. [Zverev, S. M.], Kosminskaja, J. P. [Kosminskaya, I. P.], and Krakschina [Krakshina], R. M. Seismische Untersuchungen über den Tiefenbau der Erdkruste, die in der UdSSR nach dem Plan des Internationalen Geophysikalischen Jahres durchgeführt wurden [Seismic investigations of the deep structure of the earth's crust, which were carried out in the USSR as part of the International Geophysical Year project]: Freiberger Forschungshefte C 81 Geophysik, p. 150-159, 1960.

Crustal structure in the transition zone between the Asiatic continent and the Pacific Ocean was investigated during the International Geophysical Year by several cooperating Soviet institutions, using the method of deep seismic sounding. The results, presented in the form of maps, graphs, and seismograms, and discussed here.

Three groups of waves were recognized in the seismograms: (1) P_O, with apparent velocities v=4-7 kmps; (2) P_X, with v=6-8 kmps; and (3) P, with v=6-10 kmps. These are refracted along the sedimentary and granitic layers, the basaltic layer, and on the M-discontinuity, respectively. The traveltime curves were of three types. The oceanic type, with two branches corresponding to P_X and P-waves, was registered in the ocean basin east of the Kurile arc. It represents a crust that consists of basalt overlain by a thin (about 1 km) sedimentary layer, with a total thickness—including a water layer more than 5 km deep—of 12-18 km at most. The continental type, with three branches corresponding to P_O, P_X, and P-waves, was registered in the Kuriles, on the Kamchatka coast, and in the northern part of the Sea of Okhotsk. It represents a three-layered crust that consists of sedimentary, granitic, and basaltic zones, with a thickness of 25-30 km. The intermediate type with branches corresponding to P_X and P-waves, was registered in the deep southern part of the Sea of Okhotsk and in the vicinity of the Commander Islands. It represents a crust with an undifferentiated layer overlying the basalt, with a maximum total thickness of 20 km. — D. B. V.

184-432. Matuzawa, Takeo; Matumoto, Tosimatsu; and Asano, Shuzo. The crustal structure as derived from observations of the second Hokoda explosion [in Japanese with English abstract]: Zisin, ser. 2, v. 13, no. 2, p. 78-89, 1960.

The crustal structure of the Kwanto area and of northeast Japan as derived from observations of the second Hokoda explosion are discussed. In the Kwanto area three layers were observed above the M-discontinuity: the first layer (velocity 1.74 kmps, thickness 0.92 km) does not exist north of Hitati; the second layer (velocity 5.5 kmps, thickness 4.3 km) thins northward at a distance of 40 km from Hokoda, and near Tamura the third layer (velocity 6.2 kmps) approaches the surface. The near-surface presence of the 6.2 kmps layer is also supported by surface geology and gravity data. In northeast Japan, except in the areas of Siroiwa and Kaneyama, a thin surface layer is underlain by a 5.8 kmps second layer with a thickness of 4-8 km; it corresponds to the 5.5 kmps layers of the Kwanto area. Under Hokoda the velocity of the P_n waves is 7.7 kmps and the depth to the M-discontinuity is 27.5 km; the discontinuity rises northward at an angle of about 2°. — V. S. N.

184-433. Research Group for Explosion Seismology. Observations of seismic waves from the second Hokoda explosion (in Japanese with English abstract]: Zisin, ser. 2, v. 13, no. 2, p. 90-96, 1960.

Seismic waves from the detonation of about 1 ton of explosives near Hokoda, Ibaragi Prefecture, Japan, on August 16, 1957, were observed at 18 temporary stations in Japan. The purpose of the study was to determine the crustal structure of the northern Kwanto district and of northeast Japan; moreover, the profile obtained is in reverse to that from the earlier Kamaisi explosions and can be used to verify the structure for northeast Japan derived from the earlier profile. Traveltime tables and diagrams are included. — V. S. N.

184-434. Nishimura, Eiichi; Kamitsuki, Akira; and Kishimoto, Yoshimichi. Some problems on Poisson's ratio in the earth's crust: Tellus, v. 12, no. 2, p. 236-241, 1960.

The P-S diagram was used instead of the time-distance graph to estimate the value of Poisson's ratio in the earth's crust. Applying the method to 18 earthquakes in southwestern Japan, a region of anomalously large Poisson's ratio was found in the Kyushu district at a depth of about 20-40 km; this suggests the possible existence of a local magma reservoir. The azimuthal dis-

tribution of Poisson's ratio in the crust in the case of two earthquakes (Daishoji-Oki and Tokushima) was found to be considerably different in the push- and pull-zones of initial motion; this may be related to the conditions of stress accumulation leading to the earthquake. — D. B. V.

Popov, I. I. On the dispersion of long-period Love waves in the continental and oceanic crust on the Indonesia-Crimea traverse. See Geophys. Abs. 184-197.

184-435. Petroleum Times. Why Guadalupe?: Petroleum Times, v. 65, no. 1656, p. 93, 1961.

The AMSOC Mohole Committee has proposed an experimental drilling operation in 12,000 feet of water 14 miles off Guadalupe Island in the Pacific Ocean west of Mexico. The CUSS 1 drilling barge is to be used. This hole is not designed to reach the M-discontinuity but to test the feasibility of drilling from an unanchored ship. Several hundred feet of core are expected to be recovered. — J. W. C.

184-436. Magnitskiy, V. A. Proyekt "Mokho" [The Moho project]: Priroda no. 1, p. 87-88, 1960.

The drilling of a hole into the earth's mantle is considered essential as a direct method in the study of the composition and the structure of the crust. The Moho project calls for drilling in either the Pacific Ocean (near Acapulco) or the Atlantic Ocean (near Puerto Rico). The surface drilling ship will be anchored to have a drift of not more than 2 percent of the ocean depth over the hole; pipe sections up to 1 km long are to be transported under water; and sea water is to be used for the drilling solution. — A. J. S.

184-437. Krauss, W. Die erste Durchbohrung der Sedimentschicht unter dem Ozean [The first boring through the sediment layer under the ocean]: Umschau, v. 60, no. 6, p. 176-177, 1960.

This is a report on the "Mohole" project for drilling through the earth's crust. (See also Geophys. Abs. 182-360.) — D. B. V.

184-438. Lear, John. Canada's continent-spanning look inside earth: New York, Saturday Review, v. 44, no. 5, p. 35-40, 1961.

As a part of the "Upper Mantle Project" of the International Union of Geodesy and Geophysics, the Dominion Observatory of Canada is establishing 27 seismic stations throughout Canada to be completed by 1963. As the heat mechanism of the earth is important also for understanding the deepest mysteries of the planet, Canada intends to drill a hole from 1,000 to 2,000 feet deep at each station and to take temperature readings at 100-ft intervals as regularly as readings will be made of the atmospheric thermometer. It is possible that this program will provide more information concerning the interior of the earth in a shorter period of time than will be provided by the Mohole project of the United States. — V. S. N.

184-439. Arnold, Kurt. Die Präzessionsbewegung der Erde und der Bahn der künstlichen Erdsatelliten, die Abplattung der Erde and die Dichtverteilung im Innern [The precessional motion of the earth and the orbit of artificial earth satellites, the flattening of the earth, and the density distribution in the interior]: Gerlands Beitr. Geophysik, v. 69, no. 4, p. 191-199, 1960.

Values obtained from satellite observations for the static and dynamic flattening of the earth show that the density distribution in the deep interior of the earth deviates within certain limits from hydrostatic equilibrium. — D. B. V.

184-440. Dauvillier, Alexandre. Sur l'état convectif interne du Globe et les phénomènes hydromagnétiques [On the internal convective state of the globe and hydromagnetic phenomena]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 15, p. 1449-1450, 1960.

The scale and velocity of thermal convections in the earth's interior are discussed. Using a value of 1.5×10^{-14} cal per g per sec for the average heat discharge of stony meteorites, a maximum velocity of 30 m per yr in the mantle is obtained, which is compatible with the duration of orogenic-magmatic cycles.

Using a value of 18×10^{-16} cal per g per sec for the heat discharge from iron meteorites, the maximum velocity of convection in the core is calculated to be 11 m per yr. This is much smaller than the amount required by dynamo theories of geomagnetism. — D. B. V.

184-441. Shneiderov, A[natol] J. On the temperature of the earth's mantle-core boundary: Boll. Geofisica Teor. ed Appl., v. 2, no. 8, p. 647-649, 1960.

A mantle-core boundary—the plutosphere of the earth's core—is assumed to be gaseous, and a minimum theoretical temperature of 1,800° K derived for it from the equilibrium state between the weight of the mantle and the gaseous pressure in the plutosphere for the given density ρ=9.4 g per cm^3, and the mean atomic weight μ =1.008. The approximate temperatures for atomic weights 2, 3, and 4.7 are found to be 3,600°, 5,400°, and 8,500°, respectively. The mantle-core boundary temperatures for the same molecular weight in a contracting earth should be lower, and for the expanding earth—higher than the above given temperatures determined for a static model of the earth. A method is proposed for determining whether the earth expands or contracts. — Author's summary

Slichter, Louis B. The fundamental free mode of the earth's inner core. See Geophys. Abs. 184-190.

184-442. Lucke, Otto. Bemerkungen zur Dissertation von A. Vogel "Über die Unregelmässigkeiten der äusseren Begrenzung des Erdkerns (auf Grund von am Erdkern reflektierten Erdbebenwellen)" [Remarks on the dissertation by A. Vogel "On the irregularities of the outer boundary of the earth's core (on the basis of earthquake waves reflected at the core)" (with English summary)]: Zeitschr. Geophysik, v. 26, no. 1, p. 50-56, 1960.

Calculations are given to show that the depths to the core calculated by Vogel in the paper in question (see Geophys. Abs. 184-443) cannot correspond to reality. — D. B. V.

184-443. Vogel, Andreas. Über Unregelmässigkeiten der aüsseren Begrenzung des Erdkerns auf Grund von am Erdkern reflektierten Erdbebenwellen [On irregularities of the outer boundary of the earth's core on the basis of earthquake waves reflected at the core (with English summary)]: Gerlands Beitr. Geophysik, v. 69, no. 3, p. 150-174, 1960.

The method of determining the depth to the earth's core from deviations in travel times of PcP, ScS, PcS, and ScP waves reflected from the core boundary is described. Anomalies in core depth calculated from 1948 to 1954 earthquake records are obviously correlated with the magnetic nondipole field and the gravity field of the earth. Together with variations in the rate of rotation of the earth, which seem to be related to geomagnetic secular variations, these phenomena are apparently due to dynamic processes in the core. Comparison of data from 1930 to 1936 indicates that the rate of change in the depth of the core also can be correlated with the rate of change of the magnetic field. If anomalies in the depth to the core and in the nondipole field change with time, there must be a corresponding change in the earth's gravity field. — D. B. V.

ISOTOPE GEOLOGY

184-444. Stuiver, M[inze]. Variations in radiocarbon concentration and sunspot activity: Jour. Geophys. Research, v. 66, no. 1, p. 273-276, 1961.

Variations in cosmic-ray intensities will produce variations in C^{14} production in the atmosphere. A comparison is made between variations in sunspot activity and fluctuation in C^{14} concentration during the past 13 centuries. Although a definite conclusion is not reached, the evidence given suggests some correspondence between sunspot activities and C^{14} concentration in the atmosphere. — Author's abstract

184-445. Hahn-Weinheimer, P. Bor- und Kohlenstoffgehalte basischer bis intermediärer metamorphite der Münchberger Gneismasse und ihre $^{12}C/^{13}C$-Isotopenverhältnisse [Boron and carbon content of basic to intermediate metamorphic rocks of the Münchberg gneiss massif and their C^{12}/C^{13} isotope ratios (with English summary)]: Internat. Geol. Cong., 21st, Copenhagen 1960, Proc., pt. 13, p. 431-442, 1960.

The usefulness of boron and carbon in determining the origin of the eclogitic rocks of the Münchberg gneiss massif in northeastern Bavaria has been investigated. The boron content (in ppm) and elementary carbon (in percent) of samples of many different rock types are tabulated. It is found that the degree of metamorphism and relative age of ultrabasic rocks are reflected in boron content.

Comparison of the C^{12}/C^{13} ratios of the elementary carbon with carbonate carbon of certain samples suggests that the eclogites represent metamorphosed Precambrian graphite-bearing dolomitic-marly shales. — D. B. V.

184-446. Flesch, G. D., Svec, H. J., and Staley, H. G. The absolute abundance of the chromium isotopes in chromite: Geochim. et Cosmochim. Acta, v. 20, no. 3/4, p. 300-309, 1960.

The abundances of the chromium isotopes in 18 samples of chromite from countries responsible for 81 percent of chromite production in 1900-50 have been determined. The use of mixtures of separated isotopes to determine the accuracy indicates that the measurements are absolute. The natural abundances of the chromium isotopes in atoms percent are: Cr^{50}=4.352±0.024, Cr^{52}=83.764±0.036, Cr^{53}=9.509±0.027, and Cr^{54}=2.375±0.018. At the 99.7 confidence level of these measurements, no variation in the isotopic composition of the chromium was found in any of the samples.

The chemical atomic weight, computed on the basis of these abundance values and the latest accepted values for the masses of the isotopes involved, is $51.998_5 \pm 0.001_3$. — D. B. V.

184-447. Surkov, Yu. A., Vorob'yev, A. A., Korolev, V. A., and Vilenskiy, V. D. Issledovaniye isotopnogo sostava urana v redkozemel'nykh mineralakh [Investigation of the isotopic composition of uranium in rare earth minerals]: Atomnaya Energiya, v. 9, no. 6, p. 477-482, 1960.

Investigation of Cm^{247} obtained from a reactor showed it to have a half life of 40 million years. The possibility of its existence in nature was therefore considered. As Cm^{247} changes into U^{235} in the course of its breakdown, an excess in the U^{235}/U^{238} ratio should indicate the former presence of this nuclide. Such an excess was found in a specimen of gadolinite, which is 2 billion years old. This anomaly may reflect the presence of curium in nature. — J. W. C.

184-448. Botter, René, Lorius, Claude, and Nief, Guy. Sur la teneur en deutérium des précipitations en Terre de Victoria, Antarctique [On the deuterium content of precipitations in Victoria Land, Antarctic]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 4, p. 573-575, 1960.

The deuterium content of precipitation collected at ground level in Victoria Land, Antarctica, increases almost linearly with temperature of formation (estimated from radiosonde data). This relationship might be of use in meteorologic and glaciologic studies. — D. B. V.

184-449. Libby, W[illard] F. Tritium in hydrology and meteorology, in Researches in geochemistry: New York, John Wiley and Sons, p. 151-168, 1959.

It has been clear from the beginning of research on the tritium produced by cosmic radiation that labeled water resulting from production of tritium in higher levels of the atmosphere is of real usefulness. This paper reviews some of tritium research findings stemming from nuclear tests, including atmosphere-storage time for water; Castle bomb tritium deposition in the northern hemisphere; ground-water inventory, storage times, and water balance for the northern Mississippi Valley; surface ocean mixing rates; and regional hydrological applications. It concludes with a brief description of possible uses of synthetic tritium in studies of local hydrology. — V. S. N.

184-450. Bolin, B[ert]. On the use of tritium as a tracer for water in nature: Woods Hole Oceanographic Inst. Collected Repr. 1959, Contr. no. 1006, 8 p., 1960.

The interpretation of tritium data for use in deducing the ocean circulation and hydrological cycle over the American continent has become more difficult since the explosion of thermonuclear bombs beginning in 1954. Some aspects of the problem of obtaining a clear picture of naturally occurring tritium are discussed as well as some of the assumptions made by Begemann and Libby (see Geophys. Abs. 171-222) in their study of the water cycle over North America using bomb tritium as a tracer.

The microphysical processes at work in evaporation and condensation are analyzed with a discussion of the exchange of tritium between a freely-falling water drop and its environment and of the turbulent exchange of tritium in the atmosphere. Lastly, the exchange of tritium between different reservoirs in continental areas is discussed. It is concluded that the presence of moist soil is of great importance in tritium exchange over a continent; it has a shielding effect in that most of the tritium brought down by precipitation is returned to the atmosphere, and the exchange between the ground water reservoir and the atmosphere is reduced considerably. — V. S. N.

184-451. Slawson, William F., and Austin, Carl F. Anomalous leads from a selected geological environment in west-central New Mexico: Nature, v. 187, no. 4735, p. 400-401, 1960.

A detailed study of lead isotopes has been undertaken in order to evaluate variations in the isotopic composition of lead with respect to the geologic environment of the sample area. An area of about 5,000 sq mi in west central New Mexico was chosen because the number of geologic variables is at a minimum. Fresh galena was the mineral chosen for this preliminary study.

Three samples were cut from a single crystal from the wall of an open fracture zone in the Hansonburg district; the isotopic composition of a corner sample was found to be distinctly different from that of internal samples. Other samples were collected along east-west lines across north-south mineralized fractures in the Hansonburg district; a small consistent increase in radiogenic lead was found from west to east. The isotopic variations appear to reflect basement structures underlying the mineral deposits.

A plot of Pb^{207}/Pb^{204} versus Pb^{206}/Pb^{204} gives a straight line with a slope of 0.0938. The maximum age of the source of the radiogenic lead additions, calculated according to the method of Farquhar and Russell (see Geophys. Abs. 170-22), is $1{,}530 \times 10^6$ yr; this agrees fairly well with the age of $1{,}300\text{-}1{,}450 \times 10^6$ yr given by Tilton and Davis (see Geophys. Abs. 184-3) for the basement rocks of the southwestern United States. — D. B. V.

184-452. Marshall, Royal R. The amounts and isotopic compositions of lead in eclogites from the Münchberg gneiss massif (Fichtelgebirge): Internat. Geol. Cong., 21st, Copenhagen 1960, Proc., pt. 13, p. 404-417, 1960.

The isotopic composition of lead from eclogites of the Münchberg gneiss massif in Bavaria has been determined, using the mass spectrometer and isotope dilution techniques. The concentrations of lead ranges from 0.6 to 1.6 ppm, considerable lower than in most other rocks. Two types of lead are distinguished. The first has a high Pb^{206}/Pb^{204} and low Pb^{208}/Pb^{204} ratio compared to modern average lead at the surface of the earth. A negative model age is deduced from the high Pb^{206}/Pb^{207} ratio of this lead, which therefore is anomalous in the J-type sense. It corresponds to the lead in peridotites observed by Tilton, Patterson, and Davis (1956).

The second type of lead in the eclogites is surprisingly radiogenic, but its isotopic composition lies on the zero isochron corresponding to modern lead; apparently there has been no change in the relative amounts of uranium and lead in the source for this lead for 4.5×10^9 yr. Some eclogites contain both types of lead. The eclogite lead seems to be quite different from that in most rocks. Both the amounts and isotopic compositions, however, suggest a close relation to the serpentinite of the Münchberg massif. — D. B. V.

184-453. Epstein, Samuel. The variations of the O^{18}/O^{16} ratio in nature and some geologic implications, in Researches in geochemistry: New York, John Wiley and Sons, p. 217-239, 1959.

A few of the more recent studies of the oxygen-isotope composition of naturally occurring oxygen-containing materials are reviewed as examples of applying stable isotopes to the study of natural processes. The following are discussed: theoretical considerations including formulas for determination of the equilibrium constant K and for the fractionation factor α; effect on α of factors other than temperature; the measurement of the O^{18}/O^{16} ratios; kinetic effects; variation of O^{18}/O^{16} ratio in natural waters; paleotemperatures by the oxygen-isotope thermometer; and the O^{18}/O^{16} ratio in minerals and rocks and in coexisting minerals. — V. S. N.

184-454. Ault, Wayne [U.]. Isotopic fractionation of sulfur in geochemical processes, in Researches in geochemistry: New York, John Wiley and Sons, p. 241-259, 1959.

Knowledge of the extent of isotopic fractionation in certain geologic processes may place limitations on the theories of origin of the crust of the earth and of ore deposits. and may aid in the study of regional geology. The stable isotopes of sulfur are important as natural tracers because of the large variations in the isotopic composition of sulfur in various phases of the lithosphere and hydrosphere. Oxidation-reduction processes, both biochemical and geochemical, are the most effective in causing sulfur isotopic fractionation; the quantitative importance of diffusion is yet to be demonstrated. Various applications of isotopic fractionation of sulfur are discussed—geologic thermometry, nature of the sulfide source in sulfide deposits, tracer experiments involving complex-ion transport, and paleoclimate. From several lines of evidence it seems that terrestrial sulfur (22.14) is heavier than meteoritic sulfur (22.21). — V. S. N.

184-455. Stanton, R. L. The application of sulphur isotope studies in ore genesis theory—a suggested model: New Zealand Jour. Geology and Geophysics, v. 3, no. 3, p. 375-389, 1960.

In emphasizing fractionation factors, most investigators of the relationship of sulfur isotope ratios to ore genesis have made insufficient allowance for three other important factors: source variation and hybridization, migrational contamination, and homogenization not only during but also following deposition. The probable influence of these factors as well as that of fractionation during derivation, migration, and deposition on the isotopic constitution of the five classes of sulfide ore (orthomagmatic, sedimentary "normal," sedimentary "volcanic," fissure-filling, and replacement) are discussed.

A theoretical pattern of S^{32}/S^{34} ratios is deduced for the different types of ores; because of the paucity of data, this model is put forward strictly as an approximation intended to guide the systematic application of sulfur isotope studies to problems of ore genesis. Several avenues of investigation are suggested. — D. B. V.

184-456. Rafter, T. A., Kaplan, I. A., and Hulston, J. R. Sulphur isotopic variations in nature. Part 7—Sulphur isotopic measurements on sulphur and sulphates in New Zealand geothermal and volcanic areas: New Zealand Jour. Sci., v. 3, no. 2, p. 209-218, 1960.

The average S^{32}/S^{34} ratio for 14 samples of sulfur from New Zealand geothermal areas is 22.13; this is significantly lower than the average of 22.36 found for 20 specimens from the White Island volcanic area. A smaller number of "geothermal" and "volcanic" sulfurs from New Guinea show the same trend. In 12 specimens in which sulfate and sulfur are intimately associated, wide variations in isotopic ratios are observed. An attempt has been made to correlate these variations with the biogeochemical history of the specimens (see Geophys. Abs. 184-457). — D. B. V.

184-457. Kaplan, I. A., Rafter, T. A., and Hulston, J. R. Sulphur isotopic variations in nature. Part 8—Application to some biogeochemical problems: New Zealand Jour. Sci., v. 3, no. 2, p. 338-361, 1960.

Laboratory experiments with bacteria were made in an attempt to use measurements of stable sulfur isotopes to explain some biogeochemical problems. Bacterial sulfate reduction and chemosynthetic oxidation of sulfides gave en-

richment in S^{32} in laboratory experiments. Measurements of natural deposits gave conflicting results. — D. B. V.

184-458. Thode, H. G., Harrison, A. G., and Monster, J. Sulphur isotope fractionation in early diagenesis of recent sediments of northeast Venezuela: Am. Assoc. Petroleum Geologists Bull., v. 44, no. 11, p. 1809-1817, 1960.

Data are presented for the sulfur isotope ratios in different sulfur compounds (sulfate sulfur, elemental sulfur, pyrite sulfur, organic sulfur, and sulfides soluble in hydrochloric acid) in recent marine sediments from the Pedernales oil field of northeastern Venezuela taken at depths of 20, 80, and 160 feet. All were found to be depleted in S^{34}, within a range of 10-20 permil, with respect to the original isotope ratio of sea-water sulfate. The results further indicate that bacterial reduction of marine sulfate is almost complete at depths of 12-20 feet; deeper sulfates are probably formed by oxidation of pyrite in place without further isotope fractionation.

It is suggested that over very long periods of time a partial exchange of sulfur isotopes between sulfate and pyrite in close contact takes place; this could account for the high S^{34} depletion found for pyrite and sulfate of ancient sedimentary rocks. — D. B. V.

Zähringer, J., and Gentner, W. Primordial inert gases in some stone meteorites. See Geophys. Abs. 184-90.

Reynolds, J[ohn] H. Rare gases in tektites. See Geophys. Abs. 184-114.

Murthy, V. Rama. Isotopic composition of silver in an iron meteorite. See Geophys. Abs. 184-99.

MAGNETIC FIELD OF THE EARTH

184-459. Chapman, S[ydney]. Alexandre von Humboldt et l'etude du geomagnetisme [Alexander von Humboldt and the study of geomagnetism]: Ciel et Terre, v. 75, no. 9/10, p. 269-284, 1959.

This is a French translation of an address given before the American Academy of Arts and Sciences in Boston in commemoration of the centenary of the death of Alexander von Humboldt in 1859, reviewing his contribution to our knowledge of terrestrial magnetism. In addition to observations of the intensity of the geomagnetic field, the magnetic equator, and short-period magnetic variations (he introduced the term "magnetic storm"), von Humboldt together with Gauss promoted the establishment of observatories for systematic study of the earth's field and its variations.

The four principal problems of geomagnetism are reviewed: the origin of the principal field, the cause of its secular variation, the regular diurnal variation, and magnetic disturbance. Worldwide magnetic observations, particularly during the International Geophysical Year, are discussed.—D. B. V.

184-460. Priroda. Magnetizm i zemnoye yadro [Magnetism and the earth's core]: Priroda, no. 6, p. 99-100, 1960.

The cause of the earth's magnetic field is discussed. The core is accepted as being fluid, electrically conductive, and carrying magnetic lines of force by means of convection currents in the fluid. Bullard's hypothesis of self-exciting dynamo mechanism in the core is discussed (see Geophys. Abs. 144-12525, 160-28; Kozulin 169-236). It follows from Bullard's hypothesis that there is a gradient of electric current density in the core and mantle, and that

this makes a westward drift of the variable path of the earth's general magnetic field of 0.2° per yr possible. — A. J. S.

184-461. Nanikawa, Tomikazu. Fluid motions in a sphere: (part 4). Thermal instability of a rotating fluid sphere heated within under a uniform magnetic field (2): Jour. Geomagnetism and Geoelectricity [Kyoto], v. 11, no. 4, p. 111-124, 1960.

A mathematical analysis is presented of the conditions under which a fluid sphere, heated from within and subjected to the simultaneous action of rotation and a uniform magnetic field, can become unstable through a marginal state of purely oscillatory motion. Contrary to the results obtained in an earlier work (see Geophys. Abs. 175-230), overstability is found to occur under both astrophysical and terrestrial conditions. — D. B. V.

184-462. Unterberger, R. R. Direct recording of small geomagnetic fluctuations: Jour. Geophys. Research, v. 65, no. 12, p. 4213-4216, 1960.

Several magnetometers of the alkali vapor type have been constructed, with additions, improvements, and modifications on the one pioneered by Skillman and Bender (see Geophys. Abs. 175-306). The essential parts of the new instrument are described briefly. The sensitivity of this magnetometer is 10-50 times greater than any currently available commercial magnetometer. Instruments of this type promise to open a new area of investigation into previously unknown small-amplitude magnetic phenomena. Sensitivity can be increased still further by reducing line widths, increasing available signal-to-noise ratio, or both. Line width reductions are expected from further research on spin exchange. — D. B. V.

184-463. Fournier, Hugo. Description des installations d'une station d'enrégistrement des variations très rapides du champ magnétique terrestre [Description of the installations of a station for recording of very rapid variations of the earth's magnetic field]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 5, p. 671-673, 1960.

The Nivernais station of the Centre d'Études des Géophysique of France is equipped with induction magnetometers that have mu-metal bars. Electronic amplification of very low noise level provides very high sensitivity (of the order of 0.001γ per mm of record in the period range 0.025-0.3 sec, 0.0007γ in the 0.1-3 sec range, and about 0.0005γ in the 1-30 sec range). Calibration is effected in a very uniform auxiliary magnetic field of known amplitude and period that can be varied at will. — D. B. V.

184-464. Cagniard, Louis. Relation empirique approximative entre la variation séculaire magnétique et les fluctuations de la rotation terrestre [Approximate empirical relation between secular magnetic variation and fluctuations of the earth's rotation]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 10, p. 1142-1144, 1960.

The relationship between geomagnetic variations and fluctuations of the earth's rotation can be expressed approximately by the empirical formula $M_z=\alpha+\beta_a+\gamma(\Delta T_m)_{a-\delta}$, where M_z is the negative component of the moment M of the field generated by a central dipole as observed at a given station; ΔT_m is the aleatory fluctuation of rotational velocity; a is the year, counting from 1900.0; and α, β, γ, and δ are constants that differ from one observatory to another. This rule seems to be valid for all usable stations in the world except Washington, D. C., which is aberrant. — D. B. V.

184-465. Forbush, S. E. Theoretical and statistical geophysics: Carnegie Inst. Washington Year Book 58, July 1, 1958-June 30, 1959, p. 253-256, 1959; reprinted in Carnegie Inst. Washington Dept. Terrestrial Magnetism Ann. Rept. of Director for 1958-59, 1959.

The results of investigations during the year of the equatorial electrojet and of cosmic rays are briefly reported. Preliminary studies indicate that the magnetic-disturbance diurnal variation, S_D, is sometimes augmented under the electrojet band in about the same way as the quiet-day diurnal variation, S_q, always is; however, the S_D current system does not always extend from middle latitudes all the way to the equator and thus is not always influenced by the electrojet. Observations are continuing to determine whether the semidiurnal lunar variation, L, in horizontal intensity is enhanced under the electrojet band.

New cosmic-ray investigations included studies of the worldwide decreases in cosmic-ray intensity which accompany some magnetic storms, of the sudden decreases and recoveries in cosmic-ray intensity at the equator and at high latitude in the period from September 1956 to December 1957, and of a harmonic analysis of ionization-chamber data from Huancayo, Cheltenham, and Christchurch observatories to obtain yearly means of the 24- and 12-hourly waves of cosmic-ray intensity corrected for pressure. — V. S. N.

184-466. Hope, E. R. Low-latitude and high-latitude geomagnetic agitation: Jour. Geophys. Research, v. 66, no. 3, p. 747-776, 1961.

At high latitudes there are statistical morning, afternoon, and night maximums of geomagnetic agitation (irregular disturbance or activity), the complicated distribution and seasonal behavior of which can be explained only in terms of patterned corpuscular bombardment. At subequatorial latitudes there are noon, afternoon, and night maximums, of which only the last two are related to the corresponding high-latitude maximums; the noon maximum, which differs in character from the others, represents a locally generated (Sq) agitation, presumably due to direct solar radiation. Since the afternoon and night maximums are traceable continuously from auroral through middle to low latitudes, and since their respective seasonal variations are everywhere the same, they may be explained as agitation transported from high to low latitudes by an ionospheric current system resembling (and probably identical with) the SD circulation. If so, this circulation is a physical reality, not an analytical construct; the SD currents must flow at their own level, independently of the Dst and Sq circulations. Besides the SD and Sq components of current-transported agitation, there is also a Dst component which, so far as identified, represents pulsative compressions of the geomagnetic field. Sudden commencements have SD, Sq, and Dst components largely analogous to those of agitation. — Author's abstract

184-467. Whitham, K[enneth], Loomer, E. I., and Niblett, E. R. The latitudinal distribution of magnetic activity in Canada: Jour. Geophys. Research, v. 65, no. 12, p. 3961-3974, 1960.

Hourly ranges in the principal horizontal field component have been measured for sixteen Canadian International Geophysical Year magnetic observatories and variation stations. The latitudinal variation of disturbance measured by this index has been determined seasonally and as a function of disturbance. One station, Alert, at the northern end of Ellesmere Island, confirms the existence in these longitudes of an apparently narrow zone or area of enhanced magnetic activity, as defined by this measure of disturbance. Semipersistent structure is also apparent in the principal auroral zone in the meridian sections of magnetic activity. Diurnal occurrence patterns, ampli-

tude-frequency plots, the diurnal variation of the mean disturbance field, and the physical significance of this range index have been investigated in an attempt to explain this apparent inner maximum of magnetic activity. More homogeneous very high latitude data are required to determine the morphology of the anomalous region found. — Authors' abstract

184-468. Stefant, Robert. Detection de l'activité du champ magnétique terrestre dans la bande 5-50 hz [Detection of activity of the earth's magnetic field in the 5-50 cycles per second band]: Acad. Sci. [Paris] Comptes Rendus, v. 251, no. 6, p. 857-859, 1960.

A sensitive apparatus for registering rapid geomagnetic variations in the range of 5-50 cycles per second is described briefly. The records obtained with this apparatus at the Chombon-la-Forêt observatory in France on July 15, 1960, when ordinary magnetometers recorded a quiet day, show fluctuations in the 40-50 cycles per second band that have a clear diurnal variation, a rather abrupt diminution around 15 cycles per second, and a slight resumption of activity at frequencies around 5 cycles per second. These results tend to confirm the hypothesis that this activity is due to resonance of the sodium ions of the high atmosphere in the magnetic field. — D. B. V.

184-469. Bockel, Marc. Magnétisme terrestre à Port-aux-Français (îles Kerguelen). Premiers résultats (1er octobre 1957 au 28 fevrier 1958) (Terrestrial magnetism at Port-aux-Français (Kerguelen Islands). First results (October 1, 1957 to February 28, 1958)]: Acad. Sci. [Paris] Comptes Rendus, v. 250, no. 26, p. 4417-4418, 1960.

The average geomagnetic field in the Kerguelen Islands (geomagnetic lat 56.5° S., long 127.8° E.) in January 1958, consisted of 0.18710γ in the horizontal component and 0.44000γ in the vertical component, with a declination of 47°38' W.

The diurnal S_q variation in the horizontal component was striking (amplitude of the order of 80-100γ, with a maximum of 115γ in November 1957); the S_q variation in the vertical component on the other hand was feeble (average amplitude 15γ). The amplitude of SD variation was almost the same in both components.

Diurnal magnetic activity was typical of polar regions. The frequent appearance of a characteristic magnetic bay, always related to auroral phenomena, was another feature of the magnetic field in the Kerguelens. — D. B. V.

184-470. MacDowall, J. Geomagnetic observations at Halley Bay: Royal Soc. [London] Proc., v. 256, no. 1285, p. 219-221, 1960.

The annual variation of geomagnetic activity is described on the basis of monthly mean K-indices for three selections of days according to activity. The difference between the diurnal variation of geomagnetic activity, as defined by K-indices, in June and December is shown to be due to a universal effect accounted for by the annual change in the diurnal variation of the angle between the earth's geomagnetic axis and the line joining the sun and earth. The observed field changes in winter (May, June, July) are interpreted as being due to a disturbing line current in the ionosphere; the diurnal variation and movement of this current are described. — Author's abstract

184-471. Bhattacharyya, B[ismal] K[rishna]. Correlation studies of radio-aurora, magnetic, and earth-current disturbances: Canadian Jour. Physics, v. 38, no. 5, p. 624-637, 1960.

Correlation studies have been made of the radar echo occurrence rate from aurora in half-hourly intervals at Ottawa, S and Sd components of the horizontal magnetic field H at Agincourt, and the disturbance diurnal variation of earth current at Crow River, in Canada. The diurnal variation of auroral echo occurrence rate seems to be similar to that of H. Auroral activity invariably precedes magnetic activity. The variation in the delay time between the auroral and magnetic phenomena shows a local time dependence; this variation seems to be related to the reversal of the direction of auroral ionization drift from west to east about midnight, with a subsequent change from positive to negative magnetic perturbations.

No definite conclusion could be reached concerning the relation of earth currents to the other factors; the month-to-month variation of cross-correlation coefficients were practically random. — D. B. V

Troitskaya, V. A. Pulsation of the earth's electromagnetic field with periods of 1 to 15 seconds and their connection with phenomena in the high atmosphere. See Geophys. Abs. 184-127.

Smith, H. W., Provazek, L. D., and Bostick, F. X., Jr. Directional properties and phase relations of the magnetotelluric fields at Austin, Texas. See Geophys. Abs. 184-126.

Wescott, E[ugene] M. Magnetic and telluric current disturbances in Alaska. See Geophys. Abs. 184-130.

Rikitake, Tsuneji. Electromagnetic induction in a hemispherical ocean by Sq. See Geophys. Abs. 184-133.

184-472. Bond, F. R. Motion of the aurora and magnetic bays: Australian Jour. Physics, v. 13, no. 3, p. 477-483, 1960.

Observations from the Australian Antarctic station at Macquarie Island show that the development of an auroral display is characterized by a slow northward drift, east to west longitudinal motion, and an associated positive bay in the horizontal component magnetogram in the evening hours. This is followed by a sudden change in structure of the aurora and appearance of a negative bay. The latter persists for some hours, accompanied by west to east longitudinal motion and slow southward drift of the aurora. The co-latitude of the northern limits of the aurora is strongly dependent on the level of geomagnetic disturbance. These motions are interpreted as the mass motions of electrons which constitute the magnetic bay-producing current within the boundaries of the auroral form. — D. B. V.

184-473. Cole, K. D. A dynamo theory of the aurora and magnetic disturbance: Australian Jour. Physics, v. 13, no. 3, p. 484-497, 1960.

A model of an aurora regarded as a plane slab of highly ionized air parallel to the geomagnetic field within the ionosphere is examined. The model is stable in the presence of a wind of neutral molecules which, blowing the slab across the geomagnetic field, generates an electrical polarization field perpendicular to its faces and a current along its length. This current is concentrated in a small height range and is due chiefly to electron drift. The major movements of the aurora and associated bay type magnetic disturbances can be explained by assuming an equatorward wind in the evening and a poleward wind in the night and morning hours in the equatorial vicinity of the auroral zone. It is suggested that the magnetic K and K_p indices are indicators of wind speed. The general features of magnetic disturbance current

systems within the auroral zone are considered briefly in relation to the theory, and it is suggested that auroras are visible manifestations of the current flow. — D. B. V.

184-474. Cole, K. D., and Bond, F. R. Criticism of the theory of magnetic bays of Bless, Gartlein, Kimball, and Sprague: Jour. Geophys. Research, v. 66, no. 1, p. 327, 1961.

The presence of inhomogeneities in the ionosphere (such as auroras) would cause current systems entirely different from those predicted by the theory of Bless and others (see Geophys. Abs. 181-358). A theory of these processes has been recently developed by Cole (see Geophys. Abs. 184-473) which explains in terms of a simple realistic model the observed relationship between magnetic bays and auroras and, at the same time, the typical movements of auroras and auroral ionization that correspond in fact with the movement of electrons (Bond, see Geophys. Abs. 184-472). The theory predicts that this movement may be at speeds greater than wind speeds by a factor of 10. — D. B. V.

184-475. Campbell, Wallace H., and Leinbach, H. Ionospheric absorption at times of auroral and magnetic pulsations: Jour. Geophys. Research, v. 66, no. 1, p. 25-34, 1961.

A study in March and April 1960 showed variations in the auroral zone ionospheric absorption of cosmic noise to be closely related to magnetic field micropulsations and short period coruscations of λ 3914. At times of polar-cap type absorption, magnetic micropulsation amplitudes were diminished. Auroral ionization in the E region, estimated from a particular luminosity-height profile, accounted for 50 percent, at least, of the cosmic noise absorption. — Authors' abstract

184-476. Antsilevich, M. G., and Shevnin, A. D. K voprosu o geomagnitnykh nablyudeniyakh na pervoy sovetskoy kosmicheskoy rakete [On the problem of the geomagnetic observations by the first Soviet space rocket]: Akad. Nauk SSSR Doklady, v. 135, no. 2, p. 298-300, 1960.

The observations made by the first Soviet space rocket on January 2, 1959 are analyzed in the light of geomagnetic conditions on that day. The results are compatible with the idea that the jump in the curve of geomagnetic field intensity versus distance from the earth (see Geophys. Abs. 181-346) is related to the existence of an equatorial current system connected with the occurrence of a small geomagnetic disturbance that day. — D. B. V.

184-477. Ziauddin, Syed. Simultaneous observations of pulsations in the geomagnetic field and in ionospheric absorption: Canadian Jour. Physics, v. 38, no. 12, p. 1714, 1960.

On September 20 and 21, 1960, shortly after 7 a. m. local time, regular pulsations were recorded simultaneously on the cosmic noise absorption monitor and magnetometer at Saskatoon, Saskatchewan. The magnetic pulsations had an amplitude of 30-50 gammas; those in cosmic noise absorption, 2.5-3 db. For many cycles the two phenomena remained in phase but on occasion they were exactly 180° out of phase; this occasional sudden change in phase rules out the possibility that the geomagnetic pulsations are a purely local phenomenon. Observed periods of oscillation of 2.5-3.0 minutes support the concept that the magnetic pulsations are due to toroidal hydromagnetic oscillation of the outer atmosphere (see Geophys. Abs. 181-372). — D. B. V.

184-478. Ward, Fred [Frederick W., Jr.], and Shapiro, Ralph. Influence of sunspots on geomagnetic disturbance: Jour. Geophys. Research, v. 66, no. 3, p. 739-746, 1961.

The hypothesis that the ejection of solar corpuscles is influenced by interactions of "active region" magnetic fields is tested empirically. The results do not support the hypothesis. — Authors' abstract

184-479. Hansen, Richard T. Bright 21-centimeter solar regions and geomagnetic storms in 1952-1953: Jour. Geophys. Research, v. 65, no. 11, p. 3827-3829, 1960.

Numerous attempts have been made to relate the nonsolar-flare-associated magnetic storms, which are most characteristic of periods of declining solar activity, to specific solar features. Results are reported here of an investigation based on solar regions producing enhanced radio flux in the decimeter range. The study discovered a marked tendency for geomagnetic storminess to increase 5-7 days after CMP (central meridian position) passage of solar regions characterized by strong radio emissions at 21 cm. This 21-cm radio flux is attributed to thermal radiation from regions in the corona having about twice the normal electron density and occurring above chromospheric plages. Plages have been shown to be identical with regions of enhanced solar magnetic fields. Decimetric radio emission therefore may be considered a particularly sensitive indication of the likelihood of an active solar region producing a geomagnetic disturbance. — D. B. V.

184-480. Francis, W. E., and Karplus, Robert. Hydromagnetic waves in the ionosphere: Jour. Geophys. Research, v. 65, no. 11, p. 3593-3600, 1960.

A numerical integration of the hydromagnetic wave equations in the ionosphere has been carried out. Tables and graphs are given for the relations between the field amplitudes above and below the ionosphere and for the power dissipated as a function of altitude. The case of a vertically incident plane monochromatic wave near 45° geomagnetic latitude is treated. The results are used to confirm earlier estimates of ionospheric heating by hydromagnetic waves and to estimate the transit time of extremely low-frequency signals. The time delay is found to be approximately 1.4 sec for the ordinary wave and 1.6 sec for the extraordinary wave. This transit time is too short to be significant in the propagation of the sudden commencement of magnetic storms. — D. B. V.

184-481. Murakami, Kazuaki, and Kudo, Shoko. The onset times of cosmic-ray storms: Sci. Papers [Tokyo], v. 54, no. 2, p. 155-161, 1960.

The onset times of cosmic-ray storms are investigated with the use of data from detectors located at different places throughout the world. It is assumed that the onset times of cosmic-ray storms occur predominantly within a few hours before or after the sudden commencement of a geomagnetic storm (SC) because in most storms the worldwide component of the cosmic-ray variation begins to decrease with SC. It is observed that among stations at the same latitude the onset time depends on the local time of the station and has a tendency to be early in the morning although the actual moment fluctuates.

To investigate the energy dependency of the onset time, detectors located at the same longitude and sensitive to different energies were used. No definite conclusion could be derived concerning the energy dependency of the onset time, but it was observed that in the initial stage of cosmic-ray storms low energy particles are depressed earlier than high energy particles.

Finally, it is concluded that a diffusion model is the most probable one for the cosmic-ray storm, at least in its initial stage. — V. S. N.

184-482. McLean, D. J. Solar radio emission of spectral type IV and its association with geomagnetic storms: Australian Jour. Physics, v. 12, no. 4, p. 404-417, 1959.

Type IV solar radio bursts have been identified on radio-spectrographic records at Dapto, New South Wales. They are distinguished from type I storms in several ways, including a remarkably close association with geomagnetic storms. Like some type I storms, all type IV storms are associated with very large solar flares. — D. B. V.

MAGNETIC PROPERTIES AND PALEOMAGNETISM

184-483. Shimizu, Yoshio. Magnetic viscosity of magnetite: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 11, no. 4, p. 125-138, 1960.

The magnetic viscosity of 4 samples consisting of medium-sized grains of natural magnetite was examined at various temperatures in the range of about 100°K-850°K. The magnetic viscosity coefficient S (defined as $I-I_0=S(Q+\log t)$, where I and I_0 are intensity of magnetization at time t and t_0) was found to be proportional to the external magnetic field and to be a linear funct on of temperature except at temperatures near the Curie point and at -160°C, so far as the Rayleigh region of magnetization is concerned. S tended to have a finite value if the grain size tended to be of the order of a single domain.

For a group of magnetite grains S is extremely small, and the limit of half life of thermoremanent magnetization is 10^{120} yr. The half life of the "detrital magnetization" of sedimentary rocks, containing grains with scattered magnetization, is calculated to be about 10^{10} yr for w=1/5 (w is a reduction factor). These results show that the remanent magnetization of igneous and sedimentary rocks has been extremely stable against thermal viscosity during geologic time; therefore, if proper care is used in sampling, the results of paleomagnetic measurements should be reliable. — D. B. V.

184-484. Grabovskiy, M. A., Zherdenko, O. N., and Skovorodkin, Yu. P. O vozmozhnosti primeneniya magnitnogo poroshka pri izuchenii veshchestvennogo sostava zheleznykh rud [On the possibility of application of magnetic powder for study of the composition of iron ores]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 7, p. 970-973, 1960.

A method of using finely ground magnetite (Fe_3O_4) or iron oxide (γFe_2O_3) for microstructural analysis is proposed for determination of magnetic susceptibility. — A. J. S.

184-485. Syono, Yasuhiko. Magnetic susceptibility of some rock forming silicate minerals such as amphiboles, biotites, cordierites, and garnets: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 11, no. 3, p. 85-93, 1960.

The magnetic properties of some silicate minerals were examined. The magnetic susceptibility of garnets at room temperature is in good agreement with the theoretical value, whereas in the case of amphiboles, biotites, and cordierites, which contain water in their crystal structure, the magnetic susceptibility at room temperature is larger than expected. — D. B. V.

184-486. Kushiro, Ikuo. γ-α transition in Fe_2O_3 with pressure: Jour. Geomagnetism and Geoelectricity [Kyoto], v. 11, no. 4, p. 148-151, 1960.

Experiments show that the temperature of transition of synthetic γ-Fe_2O_3 (maghemite) to α-Fe_2O_3 (hematite) is lowered by increasing the pressure. The transition line is represented by the equation p=150-0.3T, where p is pressure in bars and T is temperature in °C. The transition of titaniferous maghemite (titanomaghemite) needs higher pressure and temperature than that of pure maghemite. The results suggest that maghemite is formed only near the surface of the earth, at depths of less than 500 m in the crust. — D. B. V.

184-487. LeBorgne, E[ugène]. Influence du feu dur les propriétés magnétiques du sol et sur celles du schiste et du granite [Effect of fire on the magnetic properties of soil and on those of schist and granite (with English and Russian summaries)]: Annales Géophysique, v. 16, no. 2, p. 159-195, 1960.

Experiments in the field showed that the effect of combustion on the surface on the magnetic properties of the underlying soil is limited in depth but intense near the surface. Between 0 and 1 cm depth the magnetic susceptibility is increased 2 to 10 times, whereas below 2 cm there is practically no change. Supplementary laboratory experiments showed that the soil must contain iron and the temperature must reach at least 300°C before any noticeable effect on the magnetic properties is produced. The effect is believed to be a series of transformations of the type $Fe_2O_3\,\alpha \rightarrow Fe_3O_4 \rightarrow Fe_2O_3\,\gamma$ stabilized.

When schist and granite samples that were originally very weakly magnetic were heated to moderate temperatures (up to 700°C) and cooled in the earth's field they acquired a relatively large thermoremanent magnetization. This confirms the fact that metamorphism can affect the magnetic properties of rocks. — D. B. V.

184-488. Lindsley, Donald H. Rock magnetism studies in the Spray quadrangle, Oregon: Carnegie Inst. Washington Year Book 58, July 1, 1958-June 30, 1959, p. 250-253, 1959; reprinted in Carnegie Inst. Washington Dept. Terrestrial Magnetism Ann. Rept. of Director for 1958-1959, 1959.

A brief progress report is given of results from a geologic and magnetic study of Eocene to Miocene basic lava flows in the Spray quadrangle, Oregon. The purpose of the investigation was to determine any properties of lavas related to the magnetic stability or instability that would be useful in choosing rock units for paleomagnetic studies. — V. S. N.

184-489. Griffiths, D. H., King, R. F., Rees, A. I., and Wright, A. E. The remanent magnetism of some recent varved sediments: Royal Soc. [London] Proc., v. 256, no. 1286, p. 359-383, 1960.

The remanent magnetism of Swedish and Icelandic varved sediments with average particle sizes between 5 and 25 μ is described. Measurements were also made of these sediments redeposited in the laboratory under controlled conditions. In the artificial sediments the inclination of the remanence may be some 20° less than that of the magnetic field, but in natural sediments this inclination error seems never to be more than 5-10°. In neither case was the dependence of inclination error on particle size suggested by earlier work (see Geophys. Abs. 176-264) confirmed. Under both natural and artificial conditions, deposition on a sloping bed produces a deviation of the remanence

from the direction for deposition on a horizontal surface. Experiments with running water showed that velocities up to about 30 cm per sec produce deviations of up to about 20° in a direction related to that of flow; the magnitude of this effect is almost independent of velocity over the range of 5-30 cm per sec. It is concluded that deviations of remanence from the field direction are mainly the result of rolling of particles on the bed during the last stage of settling.

From a review of the evidence it would seem possible in principle to determine magnetic secular variation from varved sediments, but a vast amount of data would be required. (See also Geophys. Abs. 166-278, -283; 171-261; 176-270). — D. B. V.

184-490. Irving, E. Palaeomagnetic directions and pole positions, part 2. Pole numbers 2/1 to 2/41 and 1/71 (m 1): Royal Astron. Soc. Geophys. Jour., v. 3, no. 4, p. 444-449, 1960.

Results of paleomagnetic measurements and calculations of pole positions available up to April 1960 are compiled to supplement the first list (see Geophys. Abs. 181-384). Where rocks previously studied are resampled so that the primary data are entirely new, the result is given a new list number; when old data are reworked or supplemented, the old number is retained followed by (m 1), signifying the first such modification, and the nature of the change is indicated in the footnotes. This list includes 41 new results and 1 revision. — D. B. V.

184-491. Blackett, P. M. S., Clegg, J. A., and Stubbs, P. H. [S.]. An analysis of rock magnetic data: Royal Soc. [London] Proc., v. 256, no. 1286, p. 291-322, 1960.

Paleomagnetic data of the past decade have been reanalyzed, using a minimum number of theoretical assumptions concerning the ways in which the rocks became magnetized and the origin of the geomagnetic field. The results strongly support the supposition that the wide divergence between the directions of the remanent magnetic vectors of older rocks and that of the present earth's field is a systematic rather than a random effect. It appears that (a) the directions of magnetization of the earlier rocks have been changed by some widespread physical or geological processes since the time of their formation, (b) the earth's field has had strong multipolar components in past ages, or (c) a relative drift of the continents across the earth's mantle has occurred.

The third alternative is considered to be the most plausible. If continental drift is the explanation of paleomagnetic results, then it is possible to estimate the ancient latitude and orientation of each continent relative to the earth's axis of rotation, but changes in longitude cannot be revealed by paleomagnetic measurements alone. — D. B. V.

184-492. Kropotkin, P. N. Paleomagnetizm i yego znacheniye dlya stratigrafii i geotektoniki [Paleomagnetism and its significance for stratigraphy and geotectonics]: Akad. Nauk SSSR Izv. Ser. Geol., no. 12, p. 3-25, 1960.

The results of paleomagnetic research to date are reviewed. The stratigraphic significance of reversals of the earth's field; remanent magnetization and its stability; the plotting of pole positions; paleomagnetism, paleoclimate, and astronomic data on recent latitude variations; and paleomagnetic evidence of continental drift are discussed. It is concluded that the value of paleomagnetism as a stratigraphic correlation tool is unquestionable, and that the paleomagnetic evidence of large-scale horizontal movements seems to be substantiated by recent geologic and geophysical data. — D. B. V.

184-493. Martinez, Joseph D., Statham, Edwin H., and Howell, Lynn G. A review of paleomagnetic studies of some Texas rocks: Texas Univ. Pub., no. 6017, p. 15-47, 1960.

The mechanisms by which rocks acquire permanent or remanent magnetization are reviewed, and the application of measurements of remanent magnetism to location of ancient magnetic pole positions is discussed. Paleomagnetic measurements on sedimentary, many igneous, and some metamorphic rocks from Texas are reported and some discussed in detail. Application of paleomagnetic data for correlation purposes was tested using Tertiary volcanics in the Big Bend National Park.

It is concluded that studies of rock magnetism are of great value in solving broad problems of polar wandering and continental drift, as well as such specific problems as the correlation of volcanic sequences. — V. S. N.

184-494. Irving, E., and Tarling, D. H. The paleomagnetism of the Aden volcanics: Jour. Geophys. Research, v. 66, no. 2, p. 549-556, 1961.

The directions and intensities of the natural remanent magnetization of 164 specimens from 12 sites in the Aden volcanics on the Aden Peninsula have been measured. The results provide the first information on secular variation and reversals of the earth's magnetic field in low latitudes during the Late Cenozoic and are also of interest in connection with the origin of the Red Sea. The directions deviate systematically from true north, with an average declination of N. 7° W. This could be due to anticlockwise rotation of Arabia relative to Africa by an amount sufficient to account for the formation of the Red Sea. Other explanations are possible; however, these can be tested only when results are available from northeast Africa. — D. B. V.

184-495. Airinei, Ştefan. Magnetizări normale şi inverse în regiunea vulcanului andezitic Uroiu (regiunea Hunedoara) [Normal and reverse magnetization in the region of the Uroiu andesite volcano (Hunedoara region) (with French and Russian summaries)]: Acad. Romîne Studii şi Cercetări de Geologie, v. 5, no. 1, p. 169-196, 1960.

The Uroiu andesite volcano in Rumania is characterized by positive magnetization toward the periphery of the mass, including the basement, and by negative magnetization in the central part. The annular positive anomalies represent normal thermoremanent magnetization of the cooling period. The negative values in the center represent reverse magnetization, a later phenomenon due to physical-chemical modifications of the basement rocks. These changes are explained by the action of fumaroles altering the rock and by external agents that produce oxidization. It is possible that the process of inversion of the normal thermoremanent field is in progress at the present time. — J. W. C.

184-496. Valiyev, A. A. Opyt paleomagnitnogo raschleneniya Marguzarskogo razreza kaynozoyskikh kontinental'nykh molassovykh formatsiy [Experiment in paleomagnetic subdivision of the Marguzar section of the Cenozoic continental molasse formations]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 7, p. 974-976, 1960.

As a result of paleomagnetic investigation of the molasse section at Marguzar in northern Fergana, variations in magnetic susceptibility and remanent magnetization to a depth of 1,800 m were established. Based on a duration of $0.4 \pm 0.1 \times 10^6$ yr for the Pliocene magnetic epoch, the length of time for

formation of the Marguzar molasse is estimated at 6.4 million years. Valiyev's estimation of the Pliocene magnetic epoch is 0.5 million years, which is in agreement with the result obtained by Khramov (see Geophys. Abs. 172-171). — A. J. S.

184-497. Bull, C., and Irving, E. The palaeomagnetism of some hypabyssal intrusive rocks from South Victoria Land, Antarctica: Royal Astron. Soc. Geophys. Jour., v. 3, no. 3, p. 211-224, 1960.

The magnetic properties of specimens from two quartz dolerite sheets and from a series of older mafic and felsic dikes from South Victoria Land are described. All are normally magnetized and have declinations to the southwest with inclinations between 40° and 75°; the inclinations of the older dikes are lower than those of the dolerites. The age of the dolerite sheets is uncertain, but they are regarded by some as approximately contemporaneous with the Mesozoic dolerite intrusives and basalt flows of India and the southern continents. The pole position corresponding to the magnetization of the dolerites is in the South Pacific Ocean, significantly different from that of the present pole and from the pole positions obtained from the dolerites and basalts of the other southern continents. (See also Geophys. Abs. 181-392). — D. B. V.

MAGNETIC SURVEYS

184-498. Hull, Paul, and Coolidge, John E. Field examples of nuclear magnetism logging: Jour. Petroleum Technology, v. 12, no. 8, p. 14-22, 1960.

Nuclear magnetism logging is based on the behavior of the hydrogen nucleus in a magnetic field. The hydrogen nucleus can be likened to a spinning magnetic top. Just as an ordinary top precedes about the lines of the earth's gravity field, the hydrogen nucleus precedes about the lines of a magnetic field. The frequency of the precession is determined by the strength of the magnetic field, while the time for alignment is a function of the rate of exchange of energy between the precessing nucleus and the surrounding matrix. Conversely, upon removal of an applied magnetic field, protons will return to a disordered state while precessing about the earth's magnetic field lines at a frequency proportional to the earth's field strength. It is this free precession about the earth's field lines that is used in nuclear magnetism logging. By means of an energy source and polarizing coil, a magnetic field is set up within the formation. Upon de-energizing the coil, the freely precessing protons cause flux changes within the coil and induce an alternating voltage at the precession frequency. The initial magnitude of this alternating current is proportional to the number of hydrogen nuclei. Field examples of the application of the method are presented. Permeability can be measured, and hydrocarbons and water can be differentiated with good reliability. — J. W. C.

184-499. Brown, R. J. S., and Gamson, B. W. Nuclear magnetism logging: Jour. Petroleum Technology, v. 12, no. 8, p. 201-209, 1960.

The nuclear magnetism log is the only log that responds solely to formation fluids. It operates equally well in both oil- and water-base muds and can be used in all kinds of formations except strongly magnetic ones. The free fluid log is believed to indicate a minimum effective porosity in most formations. This log not only delineates fluid-containing zones but also provides excellent curves for correlation. Nuclear magnetic logs may also help distinguish oil and water zones and provide information on permeability and wettability. — J. W. C.

Roy, Amalendu. On some properties of residuals and derivatives. See Geophys. Abs. 184-367.

184-500. Jacobsen, P., Jr. An evaluation of basement depth determinations from airborne magnetometer data: Bol. Inf., v. 3, no. 7, p. 199-207, 1960.

Airborne magnetometer data for a portion of the Eastern Venezuela basin were submitted to two different geophysical contractors for independent analysis to evaluate the reliability of interpretations of local basement relief from magnetic data. The study included areas for which considerable knowledge of basement depths and local configuration existed from other sources. Aeromagnetic maps prepared by the contractors are shown and compared with a generalized basement depth map based on seismograph and well information. The interpretations were entirely different, particularly of local basement relief, suggesting either that the techniques used for analyzing the magnetic data are inadequate, or that such detailed interpretation is beyond the resolving power of magnetometer surveys. — V. S. N.

184-501. Strakhov, V. N. O vychislenii vertikal'nogo gradiyenta dvukhmernykh magnitnykh poley [On the calculation of vertical gradients of two-dimensional magnetic fields]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 7, p. 979-987, 1960.

A graphical method for determining the vertical gradient dZ/dy of two-dimensional magnetic anomalies is proposed. A special master chart for computation of H and Z of the anomaly is constructed, and the method of construction is explained. This method was tested at five local anomalies (Shchigry, Panki, Saltykovo, Smorodino, and Yakovlevo) of the Kursk magnetic anomaly. The accuracy was found satisfactory, which indicates that in most of the two-dimensional magnetic anomalies no special measurements of the field's vertical gradient is necessary. — A. J. S.

184-502. Pudovkin, I. M. Universal'naya paletka dlya vychisleniya H_a, Z_a, $\partial Z/\partial n$, $\partial Z/\partial x$ na raznyye gorizonty verkhney poluploskosti, po zadannym znacheniyam Z_a na ploskosti nablyudeniya [A universal master chart for calculation of H_a, Z_a, $\partial Z/\partial n$, and $\partial Z/\partial x$ for different horizons of the upper half-plane for given values of Z_a on the observation plane]: Prikladnaya Geofizika, no. 26, p. 99-106, 1960.

A master chart for the transformation of a potential function and its derivatives in interpretation of magnetic anomalies is proposed, and its construction is analyzed mathematically. The master chart is called universal because it permits determination of Z_a, H_a, $\partial Z_a/\partial n$, and $\partial Z_a/\partial x$ without the reconstruction of the proposed master charts for given values of Z_a. — A. J. S.

Lliboutry, Louis. Measurement of the movements of a névé by magnetic surveying. See Geophys. Abs. 184-365.

184-503. Heinrichs, Walter E., Jr. Mobile magnetometer gives rapid regional coverage: World Oil, v. 152, no. 4, p. 82-84, 1961.

The mobile truck-mounted magnetometer has proved a practical exploration tool where detailed magnetic coverage is required on a regional basis. Results are presented of a profile made along 190 miles of highway in northeastern New Mexico at an average speed of 40 mph. Contoured aeromagnetic

data between Vaughn and Cuervo presented on U. S. Geological Survey Geophysical Maps 16, 17, and 18 correlate precisely with the mobile magnetometer data. — J. W. C.

184-504. Brundage, H[arrison] T. Nuclear precession magnetometer successfully field tested: World Oil, v. 148, no. 5, p. 127-128, 1959.

The principle of operation of the nuclear precession magnetometer is described, and a schematic diagram of its component parts is given. This instrument provides a quantitative measurement of the earth's magnetic field invariable from one individual instrument to another. It is not sensitive to orientation relative to the earth's magnetic field, provided the latter does not happen to be exactly parallel to the axis of the coil. Data from the nuclear magnetometer are readily interpreted at the time they are read; therefore, it might be possible under certain circumstances to detail areas of interest at the time the anomalies are first noted instead of returning to the area at a later date. Normal accuracy is on the order of 3 gammas but can be reduced to 1 gamma if desired. — J. W. C.

184-505. Webster, Jack C. The airborne magnetometer aids in the search for new gold reefs: Rhodesian Mining Jour., v. 32, no. 392, p. 12-15, 1960.

The results of an airborne magnetometer survey of the Far West Rand area, South Africa, for the purpose of delineating the sub-outcrop of the Lower Witwatersrand are reported. Dikes, faults, and basic igneous intrusions were detected along outcrops and sub-outcrops of the Lower Witwatersrand. The results should be useful in locating the gold-bearing Main Reef. Aeromagnetic maps are included. — V. S. N.

Fajklewicz, Zbigniew. Application of automatic digital computers in interpretation of gravity and magnetic surveys. See Geophys. Abs. 184-389.

Visarion, Marius, and Andrei, Justin. New geophysical data on the central zone of the Haţeg depression. See Geophys. Abs. 184-406.

184-506. Agoshkov, M. I., and Yenikeyev, N. B. Kurskaya magnitnaya anomaliya [Kursk magnetic anomaly]: Moscow, Akad Nauk SSSR, 40 p., 1959.

A popular account is given of the history of exploration and the current status of development of the Kursk magnetic anomaly. Geophysical and geological prospecting have revealed several iron deposits that are suitable for commercial exploitation. A yearly production of 150-160 million tons is scheduled for 1965. — J. W. C.

Bumasov, A. P. The magnetic and gravitational field of the Baikal in relation to its seismicity. See Geophys. Abs. 184-157.

184-507. Agocs, W[illiam] B., Hartman, R. R., and Curtis, C. E. Interpretation of airborne magnetometer and scintillation counter survey in four selected areas of Laos: Philadelphia, Pa., Aero Service Corp., 107 p., 1960.

The results are reported of an airborne magnetometer and scintillation counter survey in Laos. Four areas in the north-central portion were covered in detail and 9 single line profiles were made in the central and southern parts of the country terminating at the Mekong River. The purpose of the detailed survey was to determine extensions of known mineralization, concen-

trations of magnetite, structural conditions favorable to nonferrous mineralization, and general geologic conditions. The line profiles were designed to determine geological information that would be helpful in locating oil, water, coal, salt, and potash sources.

The maximum magnetite content of any anomaly is not greater than 4 percent, and the average content is between less than 1 and $2\frac{1}{2}$ percent. The dimensions of most of the bodies suggest large hematite deposits altered from the original magnetite. Several anomalies are best explained as intrusive bodies; therefore, as much of the area is overlain with Paleozoic limestones, the presence of nonferrous mineral deposits is suggested. It is recommended that all the anomalies be field checked, and an order of priority is given. An appendix describing the instruments and their applications is included. —V. S. N.

184-508. Geographical Survey Institute. The second order magnetic survey of Japan (3): Japan Geog. Survey Inst. Bull., v. 6, pt. 1, p. 12-22, 1960.

The results of the second order magnetic survey in the Chugoku-Shikoku district in 1956 and in the Kyushu and Izushichito districts in 1957, are reported in tables. Results were reduced to the epoch 1955 using data of the Kakioka Magnetic Observatory; these reduced values are plotted on a base map and isomagnetic lines drawn to represent the most probable features. Maps showing lines of equal declination, equal horizontal intensity, and equal dip are also included. — V. S. N.

MICROSEISMS

184-509. Gutenberg, B[eno]. Microseisms, in Advances in geophysics, v. 5; New York, Academic Press Inc., p. 53-92, 1958.

This general discussion of the nature and causes of microseisms includes the following subjects: the definition, history, and classification of microseisms; instruments for the investigation of microseisms; artificial causes for microseisms; natural microseisms with periods less than 2 sec, periods 1-3 secs, periods of about 4 sec, periods of 4-10 sec, and periods of 10 sec to several minutes; and theory of microseisms. A list of 182 references is included. — V. S. N.

184-510. Darbyshire, J., and Hinde, B. J. Microseisms: Research Appl. Industry, v. 14, no. 1, p. 8-17, 1961.

The origin of microseisms is discussed briefly, and their use for detecting and tracing storms at sea is described. Emphasis is placed on recent work in England. Vertical and horizontal electronic seismographs have been designed and installed at the National Institute of Oceanography for the specific purpose of recording microseisms. The instruments have high magnification and a flat response for waves of periods between 2 and 10 sec; their outputs are recorded on a triple pen recorder. Since 1958, 3 seismographs have been used with automatic analysis by instruments. Examples of the tracking of specific storms from the instrumental records are given. Correlation coefficients are used not only to find the direction of approach of the storm but also the ratio of Rayleigh wave activity to Love wave activity. The distribution of this ratio over the North Atlantic shows that the ratio diminishes away from the recording station. This confirms the view that microseisms form as Rayleigh waves and are converted to Love waves in transit; thus the distribution of their ratio should be useful in studying the nature of the earth's crust. — V. S. N.

184-511. Okano, Kennosuke. Direction of approach of microseisms observed by vector seismographs [in Japanese with English abstract]: Zisin, ser. 2, v. 13, no. 1, p. 37-42, 1960.

To find the origin of microseisms, the arrival directions of microseismic waves must be observed clearly. For this purpose, orbital motions in UP-EW, EW-NS planes were recorded simultaneously by vector seismographs, and the frequency distribution of arrival directions of pure Rayleigh-type waves was investigated. With one exception, all directions found point toward the coast. The frequency of the direction shows a constant pattern of distribution with respect to the coast regardless of the position of a center of low pressure. The particle orbits suggest that microseismic waves do not always come continuously from definite directions. — V. S. N.

184-512. MacDowall, J. Some observations at Halley Bay in seismology, glaciology, and meteorology (with discussion): Royal Soc. [London] Proc., v. 256, no. 1285, p. 149-197, 1960.

Considerable microseismic activity was observed at Halley Bay, Antarctica, during the summer season from December to February, particularly during onshore winds (see Geophys. Abs. 180-323). Examples of microseisms and wind observations illustrate the nature of their relationship. The short-period three-component Willmore seismograph used on the floating ice-shelf recorded P-waves from earthquakes at most epicentral distances, but S-waves were badly recorded.

The major part of this paper is devoted to the results of elevation, temperature, and accumulation studies on the ice-shelf and to a variety of meteorological observations, made during the International Geophysical Year. — D. B. V.

RADIOACTIVITY

184-513. Farley, Thomas A. Half-period of Th^{232}: Canadian Jour. Physics, v. 38, no. 8, p. 1059-1068, 1960.

The half life of Th^{232} has been redetermined by ion chamber alpha particle spectroscopy. The average for 12 samples is 1.41×10^{10} yr, with a standard error of 1 percent. This result is in substantial agreement with the half lives of greater uncertainty already reported in the literature. It is concluded that discrepancies between geologic ages determined from Th/Pb ratios and those determined from U/Pb ratios cannot be attributed to an error in the Th^{232} half life value. — D. B. V.

184-514. Vogler, Gerhart. Ursachen emanometrischer Anomalien [Origins of emanometric anomalies]: Zeitschr. Geophysik, v. 26, no. 2, p. 57-71, 1960.

The assumption that radon anomalies near the surface are due to increased radon diffusion from an underground source is questioned; the small radon diffusion coefficient and the thickness of the fine-grained weathered layer or crevice fillings would largely prevent diffusion of radon to the surface.

Radon profiles were measured over faults with relatively thick and very dense covers, and soil samples were taken at various depths at each measuring point and measured with a Geiger counter after a storage time several times longer than the half life of radon. The conditions of the tests exclude the effect of diffused radon, yet both methods showed a maximum over the faults.

It is concluded that radon accumulates near the surface with the aid of ground water, charged with both stable and active cations, which is carried upward by capillarity and evaporates near the surface. In clays the cations are accumulated by ion exchange. Three mechanisms causing radon anomalies are therefore possible: (1) accumulation of uranium and radium by ion exchange; (2) accumulation of uranium and radium by ion exchange, and radon diffusion; and (3) radon diffusion alone (in rare cases). — D. B. V.

184-515. Budde, Ernst. Der Beweglichkeitskoeffizient der Radium-Emanation in Lockergesteinen [The diffusion coefficient of radium emanation in unconsolidated rocks]: Zeitschr. Geophysik, v. 26, no. 2, p. 72-76, 1960.

Israël (see Geophys. Abs. 180-330) has questioned Budde's concept that diffusion coefficients on the order of less than $10^{-3}cm^2sec^{-1}$ exist for radon in unconsolidated masses (see Geophys. Abs. 174-314). Extensive laboratory measurements on unconsolidated materials consisting of two different layers as well as field experience confirm the existence of a diffusion coefficient of that order. — D. B. V.

184-516. Saha, N. K., and Gupta, J. B. The γ/β branching ratio in the decay scheme of K^{40}: India Natl. Inst. Sci. Proc., v. 26, pt. A, p. 486-491, 1960.

The γ/β branching ratio in the decay scheme of K^{40} is determined by the uranium X_2 and Co^{60} comparison methods in thick samples. The ratio comes out to be 0.112±0.007, with the absolute rates of K^{40} β and γ-disintegration n_β=28.8±0.9 per sec per g and n_γ=3.22±0.15 per sec per g, in good agreement with results of other recent determinations.

From the observed half life of K^{40} and the distribution of potassium in the earth's crust, the heat production of potassium is estimated to be about 0.65×10^{-6} cal per g per yr of the crust; this in only ~12 percent of the heat produced by the uranium and thorium in the crust at present. Since the earth is $\sim3\times10^9$ yr old, the amount of K present at the earth's creation could not have seriously affected the heat balance of the earth's interior.

Since the electron-capture decay of K^{40} produces ~3.2 Ar^{40} atoms per sec per g, $\sim3.8\times10^{-12}$ cc of argon per g per yr is provided. The total available argon content of the atmosphere can be explained by assuming its liberation from potassium-bearing rocks during volcanic eruptions throughout earth history. — V. S. N.

184-517. Bovin, V. P. Metody napravlennoy registrantsii γ-izlucheniya [Methods of directional registration of γ-radiation]: Atomnaya Energiya, v. 9, no. 6, p. 483-487, 1960.

The main characteristics and parameters of directional radiation receivers are analyzed, and particular attention is given scintillation radiometers of the compensation type. Descriptions are given of the construction of several compensation systems that can be used in various areas of measurement of radioactive elements. — J. W. C.

184-518. Zaghloul, Z. M. The distribution of alpha-radioactivity in Lamorna Granite—Land's End: Royal Geol. Soc. Cornwall, Trans. (1957-58), v. 19, pt. 2, p. 116-121, 1960.

"Nuclear" type photographic emulsion was used to investigate the distribution of radioactivity in a thin section of Lamorna granite. The sample of granite was collected from the edge of the Land's End granite intrusion on the

southeast side of Land's End Peninsula. A distribution analysis is given, and it is shown that 73 percent of the total alpha-particle emission comes from accessory mineral inclusions in quartz, feldspar, mica, apatite, topaz, cordierite, and andalusite. — V. S. N.

184-519. Hamilton, E. Distribution of radioactivity in some fine-grained igneous rocks: Geol. Mag., v. 97, no. 3, p. 255-260, 1960.

The quantitative distribution of alpha particle activity was determined by nuclear emulsion techniques for the following fine-grained igneous rocks: the Loch Ba felsite and Mhoire Choire trachyte from Scotland, an oligoclase andesite and a trachyte from Hawaii, and two basalts from East Greenland. The distribution of radioactivity was found to be comparable to that observed in equivalent coarser-grained rock types, which are more suitable to nuclear emulsion studies. — V. S. N.

184-520. Armands, Gösta, and Landergren, Sture. Geochemical prospecting for uranium in northern Sweden; the enrichment of uranium in peat: Internat. Geol. Cong., 21st, Copenhagen 1960, Proc., pt. 15, p. 51-66, 1960.

A peat discovered during radioactivity prospecting in the Masugnsbyn area of northern Sweden shows a remarkably high uranium and radon content, related to the occurrence of radioactive springs in the vicinity. The source of the uranium is beneath the cover of postglacial sediments; the radioactive matter is transferred to the peat, the humus of which serves as a collector of uranium. Preliminary laboratory experiments with leaching of uranium from radioactive iron ores from the area showed that waters containing HCO_3^- and having a pH of about 7.5 can leach an amount sufficient to account for the uranium content of the natural waters of the region. — D. B. V.

184-521. Miholić, S[tanko]. Secondary enrichment of uranium in sediments: Internat. Geol. Cong., 21st, Copenhagen 1960, Proc., pt. 15, p. 73-77, 1960.

Drilling in 1958 at the Fojnica thermal springs and Klokoti mofettes in Bosnia provided new information on the secondary enrichment of sediments in uranium by mineral waters (see also Geophys. Abs. 175-338). At Fojnica the water issuing from a fault in Carboniferous schists has a radioactivity of 3.640 millimicrocuries per liter and flows over an extensive sinter terrace. The radioactivity of springs in this terrace increases with increasing distance from the fault, due to secondary enrichment of uranium and radium in the sinter.

At Klokoti, carbon dioxide gas from pools in a bog showed a radioactivity of 3.74 millimicorcuries per liter, whereas drilling yielded gas with a radioactivity of 8.526 millimicrocuries per liter; in the borehole the gas can reach the surface before much of the radon has decayed. — D. B. V.

184-522. Gabinet, M. P. O radioaktivnosti bituminoznykh porod menilitovoy serii [Radioactivity of bituminous rocks of the Menilitov series]: Problemy Geokhimii, no. 1, p. 256-260, 1959.

A study was made of the organic matter of the bituminous argillites of the Menilitov series; the specimens were recovered largely from drill holes. The radioactivity and organic carbon content were determined for 130 specimen, the data for 38 of which are presented in a table. The relatively high radioactivity of these bituminous rocks is attributed to the presence in the same

sedimentary basin of silicic tuffs and bentonitic clays. The radioactive elements in the argillites were adsorbed from the sea water by the clays and fine-grained organic matter. — J. W. C.

184-523. Shmonin, L. I., Cherdyntsev, V. V., Kashkarov, L. L., and Ostapenko, V. F. Issledovaniya neytronnogo potoka zemnoy kory [Investigation of the neutron flux of the earth's crust]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 6th sess., p. 234-243, 1957 (1960).

This is the same as the paper previously published in Geokhimiya, no. 2, p. 105-109, 1959 (see Geophys. Abs. 180-328). — A. J. S.

Baranov, V[ladimir] I., and Khristianova, L. A. New data on radioactivity of the Indian Ocean. See Geophys. Abs. 184-592.

184-524. Zartman, R. E., Wasserburg, G. J., and Reynolds, J[ohn] H. Helium, argon, and carbon in some natural gases: Jour. Geophys. Research, v. 66, no. 1, p. 277-306, 1961.

The helium, radiogenic argon, and atmospheric argon contents of 39 samples of natural gases representing varied chemical compositions and geological occurrences were determined. The total range in the $(He/Ar)_{rad}$ ratio (1.6-130, with most values falling between 6 and 25) is essentially equal to the production ratio from the uranium, thorium, and potassium in average igneous rocks and a wide variety of sediments; this indicates that all of these natural gases have obtained their radiogenic gases from rather average rock types. This is true in spite of the fact that the helium content of the gases ranges from 37 to 62,000 ppm.

The isotopic composition of the carbon in the methane of these gases is very light. For coexisting CH_4-CO_2 pairs the carbon dioxide was always isotopically heavier. — D. B. V.

184-525. Lockhart, Luther B., Jr. Atmospheric radioactivity in South America and Antarctica: Jour. Geophys. Research, v. 65, no. 12, p. 3999-4005, 1960.

Information on the concentration of the major natural radioactive species and of gross-fission-product activity in the ground-level air at Lima, Peru; Chacaltaya, Bolivia; Rio de Janiero, Brazil; and Little America, Antarctica is reported.

The radon content of the air was found to be generally less than that in North America. Thorium seems to be relatively more prevalent in the surface soils there than in North America. In Antarctica the natural activity of the air is extremely low; thoron is a negligible contributor. Fission products are minor contributors to atmospheric radioactivity in the southern hemisphere except in Antarctica, where it assumes relatively more importance compared to the low natural activity present.

Seasonal changes in one or more of the radioactive components are evident at each of the sites. These changes are probably related to meteorological factors and the location of soils rich in radioactive elements, whereas changes in the fission product concentration are related to seasonal changes in the mixing rate of air masses. — D. B. V.

Van Dilla, M. A., Arbold, J. R., and Anderson, E[rnest] C. Spectrometric measurement of natural and cosmic-ray induced radioactivity in meteorites. See Geophys. Abs. 184-97.

Shedlovsky, J. P. Cosmic-ray produced manganese-53 in iron meteorites. See Geophys. Abs. 184-98.

RADIOACTIVITY SURVEYING AND LOGGING

184-526. Beckerley, J. G. Nuclear methods for subsurface prospecting: Ann. Rev. Nuclear Sci., v. 10, p. 425-460, 1960.

The use of nuclear techniques for measuring in place the properties of subsurface formations is reviewed. Nuclear techniques applied to aerial and surface prospecting are discussed briefly in the introductory section to give a complete and comparative picture. The economic importance of subsurface prospecting and the fundamental limitations of nuclear techniques are indicated; and after a discussion of existing "boundary conditions" in subsurface methods, the status of each nuclear logging method—natural gamma, density (gamma scattering), neutron activation, and neutron capture and inelastic gammas—is considered. Finally, the major gaps in the technique are identified, and the future course of development of nuclear methods in subsurface prospecting discussed. A bibliography of 86 items is included. — V. S. N.

184-527. Gregory, A[lan] F. Geological interpretation of aeroradiometric data: Canada Geol. Survey, Dept. of Mines and Tech. Surveys, Bull. no. 66, 29 p., 1960.

A new quantitative technique for the interpretation of regional geology from field measurements with integrating detectors is presented. The major determinants of gamma flux density are: the air distance between the source and the detector, the effective radiating area of the source, and the specific surface activity of the source material. Over large air distances, the multiple-scattered radiation approximates a state of spectral equilibrium, and the attenuation of this equilibrium flux may be described by a single, effective absorption coefficient. A mathematical expression is derived for the signal measured over a source, with both area and thickness infinite in extent.

In the interpretive technique, maximum values of signal intensity and flight altitude above ground are used to plot a lithological clearance-signal curve for each rock type in the area. Values of the theoretical signal at the surface of an elementary unit area of source material and of the effective absorption coefficient of its equilibrium flux in air that are characteristic of the rock may be determined from these curves. Accordingly, the automatic correction of data for flight altitude, based on the assumption of a single absorption coefficient, is not valid for comparative aeroradiometry. The lithological clearance-signal data suggest that spectral analysis of gamma radiation may provide useful data for a more detailed geological interpretation than the present technique permits. — V. S. N.

184-528. Rothe, Klaus. Problematik radiometrischer Messungen über Ölstrukturen [Problems of radiometric measurements over oil structures]: Geol. Gesell. Ber., v. 4, no. 2/3, p. 183-187, 1959.

A number of oil structures in East Germany have been investigated in order to determine whether radiometric measurements made at the surface can delineate anomalies that indicate the presence of oil. The first tests were made on the old Fallstein oilfield, and in the Diesdorf-Waddekath area. A counting apparatus was carried along foot traverses. The intensity of radioactivity was averaged for every 20 m of traverse in order to eliminate any very local effects. An accuracy of 0.2-0.5 μr per hr was found to be sufficient. The results show that such radiometric measurements on the ground can definitely be used for oil prospecting. — D. B. V.

184-529. Walker, R. Y., and Litzenberg, Samuel R., Jr. New exploration technique shows promising results: World Oil, v. 148, no. 5, p. 134-137, 1959.

The emission technique of oil exploration, based on the radiation and detection of low energy (soft) gamma rays from the subsurface, has been field tested in producing areas of Texas, Louisiana, New Mexico, and Oklahoma with good results. This method is particularly useful in outlining the productive limits of fields. Faults are also detected by the gamma radiation from radon gas that passes along the fault plane. The direction of dip of the fault can be determined by the leakage of radon upward from the fault plane on the downdip side. —J. W. C.

Agocs, W[illiam] B., Hartman, R. R., and Curtis, C. E. Interpretation of airborne magnetometer and scintillation counter survey in four selected areas of Laos. See Geophys. Abs. 184-507.

184-530. Tittle, C. W. Theory of neutron logging I: Geophysics, v. 26, no. 1, p. 27-39, 1961.

An analytical theory of epithermal neutron logging is presented. One-group diffusion theory is applied to the slowing down of neutrons from a point fast neutron source in infinite continuous media, in a single cylinder, and in concentric cylinders representing a fluid-filled borehole and the surrounding formation. Numerical results are given for the epithermal neutron flux in a water-filled hole six inches in diameter, passing through limestone of 10 percent or 30 percent porosity. Preliminary semiquantitative agreement is obtained with the relative response of a commercial logging instrument in the range of 10 to 100 percent porosity. — Author's abstract

184-531. Gomonay, V. I., Krivskiy, I. Yu., Ryzhkina, N. V., Shkoda-U'yanov, V. A., and Parlag, A. M. O razgranichenii neftenosnykh i vodonosnykh plastov po sredstvom ispol'zovaniya elektronnykh i fotonnykh puchkov [Delimiting oil-bearing and water-bearing strata by means of electron and photon beams]: Atomnaya Energiya, v. 9, no. 4, p. 313-315, 1960.

A direct method of locating the water-oil interface in cased wells may be found in the use of the diverse nuclear properties of isotopes present in the water- and oil-bearing strata. These isotopes differ in the threshold energies of the (γ, n) reactions induced by an electron beam. For example, the carbon isotopes of oil have distinctive threshold energies that stand in contrast to those of the oxygen in water. Consequently, using electron beams on the order of 8 Mev and higher, oil- and water-bearing strata can be recognized. A small-clearance electron accelerator must now be designed for this purpose. — J. W. C.

184-532. Androsenko, A. L., Broder, D. L., and Lashuk, A. I. Gamma-luchi, voznikayushchiye pri neuprugom rasseyanii neytronov s energiyey 3 Mev [Gamma radiation produced by inelastic scatter of neutrons with energies of 3 Mev]: Atomnaya Energiya, v. 9, no. 5, p. 403-406, 1960.

Results are presented of a study of the gamma radiation arising from inelastic scatter of neutrons in the nuclei of boron, hydrogen, fluorine, sodium, magnesium, aluminum, silicon, phosphorous, sulfur, iron, cobalt, nickel,

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copper, zinc, selenium, zirconium, niobium, molybdenum, cadmium, tin, antimony, lanthanum, tantalum, platinum, iron, and lead. A schematic diagram is given of the apparatus, and a table contains data on the energies of the gamma radiation for each of the elements studied. — J. W. C.

184-533. Kantor, S. A. O glubinnosti issledovaniya gornykh porod neytron-neytronnym karotazhem [On the depth of investigation of rocks by neutron-neutron logging]: Prikladnaya Geofizika, no. 21, p. 111-132. 1958.

Discussing the neutron-neutron method of logging, a kinetic equation is derived for neutrons in cylindrical coordinates, and a method is developed for calculating the effective radius of investigation. — A. J. S.

184-534. Williams, Milton. Applications of nuclear science in petroleum production: Jour. Petroleum Technology, v. 12, no. 8, p. 11-13, 1960.

Although no application of nuclear science can be said to have revolutionized the operations of the petroleum industry, its contributions have been numerous and distinct; they constitute a real advance. The various fields where nuclear studies have been important are geochronology, well logging, well completion and repair, reservoir performance, and production. — J. W. C.

184-535. Moore, E. James, and Holmes, Charles. Interpreting cable tool hole well logs: World Oil, v. 148, no. 5, p. 142-147, 1959.

The borehole environment of a cable-tool hole differs from that of rotary holes in that there is no significant invaded zone nor build-up of mud cake, and the resistivity of the borehole fluid changes rapidly with time and depth. Therefore, logging procedures in the cable-tool holes are different. After completion of an oil well with the "dry hole" technique, the hole must be conditioned for electric logging operations; it is filled with fresh water to a depth approximately 100 feet above the section to be logged. The resistivity (Rm) of the fresh logging water decreases continually with time and may vary considerably with depth due to influx of salty formation water. The effective porosity may be determined from radioactivity logs by using the gamma corrected neutron curve; this parameter can then be used to determine permeability and formation factor.

The successfully completed flowing gas well is a "dry hole" completion, and no conditioning of the borehole prior to logging is required. The logging program consists of running a suite of radioactivity and temperature logs designed to determine the average porosity and vertical extent of the gas filled zones. The presence of such zones and the volumetric flow rate of the gas is revealed on the temperature log as a result of marked cooling of the well bore at these levels due to the rapid expansion of the escaping gas. — J. W. C.

184-536. Caldwell, Richard L. Tracers in oil wells: Nucleonics, v. 19, no. 2, p. 58-63, 1961.

The use of tracers in oil wells is reviewed. Among the many applications, tracers can be used to show the vertical permeability distribution in a well; a permeability profile based on radiotracers is illustrated. The most important uses of this method, however, are in oil-well engineering. — J. W. C.

184-537. Tittman, J., and Nelligan, W. B. Laboratory studies of a pulsed neutron-source technique in well logging: Jour. Petroleum Technology, v. 12, no. 7, p. 63-66, 1960.

The status of laboratory studies of a radiation logging technique using a borehole accelerator as a neutron source is reported. The accelerator is a small-diameter, cylindrical neutron-generator tube which utilizes the principle of accelerating deuterons by a high voltage and allowing them to bombard a tritium target. The resulting reactions produce large numbers of neutrons of 14 Mev energy. For the experiments being described, neutron-pulse repetition rates in the range between 500 and 5,000 pulses per second are adequate. The environments investigated consisted of 40 percent porous, clean silica sands filled with 15 percent NaCl solution or with No. 2 fuel oil. The curves for the salt-water sand exhibit characteristic peaks for chlorine, oxygen, and silicon; those for the oil sand correspondingly reflect the presence of carbon, oxygen, and silicon. — J. W. C.

184-538. Frentrop, Arthur H., and Sherman, Harold. Neutrons from small tubes II. Schlumberger tube: for oil-well logging: Nucleonics, v. 18, no. 12, p. 72-74, 1960.

An accelerator neutron source, substituted for the radioactive sources usually used for oil-well logging, offers the advantages of greater source strength, decreased safety hazard, monoenergetic neutron output, and increased information from pulsed operation. A compact neutron-generator tube is described that is intermediate in yield and size between radioactive sources and previous laboratory neutron sources. An applied power of 25-30 w will produce more than 10^8 neutrons per sec in either continuous or pulse operation at temperatures as great as 145°C and for periods of more than 100 hr. — J. W. C.

Plewa, Stanislaw. Geophysical procedures for the determination of coal in Polish boreholes. See Geophys. Abs. 184-297.

SEISMIC EXPLORATION

184-539. Walter, Edward J. Decay of seismic pulses near the source: Earthquake Notes, v. 31, no. 1-2, p. 17-19, 1960.

A series of tests was conducted to measure the attenuation of seismic pulses near the source. The pulses were generated by dropping an 122 lb weight onto an anvil from heights beginning at 5 feet. Measurements were made at 5-ft intervals from 5 feet up to 60 feet after which 10-ft intervals were used up to 120 feet. The data curve when plotted as acceleration versus distance has the appearance of a negative exponential function. A function of the form $ax^k=c$ was assumed, and a good fit for the data was obtained. Values computed for k and c give the equation $ax^{1.725}=3.242$, This function and the data appear linear when plotted in double logarithmic coordinates. The type of function used does not separate geometrical effects and absorption effects but is a useful method for delineating critical values in the region of observation and for small extrapolations. — V. S. N.

184-540. Molotova, L. V., and Vasil'yev, Yu. I. O velichine otnosheniya skorostey prodol'nykh i poperechnykh voln v gornykh porodakh. 1. [On the magnitude of the ratio of the velocities of longitudinal and transverse waves in rocks. Pt. 1]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 7, p. 930-945, 1960.

Methods of determination of v_P/v_S values in rocks are discussed, and improvements consisting of a simultaneous correlated treatment of traveltime curves of longitudinal and exchange-refracted waves are proposed. Five examples of field determination of v_P/v_S are given for layers with depths from

zero to several km. No direct and unique correlation was found between the values of v_P/v_S and those of v_P in the various mediums. For low velocities in dry clastic rocks, v_P/v_S ranges between 1.7 and 1.8. For sandy clay, clay, and weathered rocks the value of v_P/v_S increases when v_P and v_S increases.— A. J. S.

184-541. Puzyrev, N. N. Interpretatsiya dannykh seysmorazvedki metodom otrazhennykh voln [Interpretation of data of seismic exploration by the method of reflected waves]: Moscow, Gostoptekhizdat, 451 p., 1959.

The fundamentals of the method of reflected waves are reviewed. Various stages of interpretations, beginning with the correlation of waves through the construction of structural maps, are discussed. Among the topics considered are: tracing of reflections under diverse seismological conditions and control methods of the correlation accuracy according to dynamic and kinematic data; evaluation of accuracy of results obtained at various stages of interpretation and substantiation of more rigid methods for obtaining means of observed data; traveltime curves of reflected and other types of waves, their construction and correction for nonhomogeneous media and curvilinear interfaces; correlation between effective and mean seismic velocities in nonhomogeneous media of various types and for curvilinear interfaces; development of more accurate methods for calculation of effective velocities from the traveltime curves of reflected waves; development of simpler approximate methods in accounting for the nonhomogeneities of media the reflecting boundaries of which are constructed; construction of structural maps and selection of profiles and scales for them; and practical construction of seismic-ray diagrams. A list of 182 references is given. — A. J. S.

184-542. Seabrooke, David S. Anomalous events on the reflection seismogram: Geophysics, v. 26, no. 1, p. 85-99, 1961.

Events other than simple reflections are becoming more evident with the advent of magnetic tape and the various types of display sections such as variable area, variable density, and full trace. Multiple reflections, diffractions, and other anomalous events must be recognized if optimum use is to be made of the data. Simple parameters such as arrival time, apparent dip step out, and normal moveout, which are readily obtained from reflection seismograms, permit a quantitative approach to the problem. Events associated with direct, refraction, reflection, and diffraction energy are discussed. — J. W. C.

184-543. Fry, John C., and Raitt, Russell W. Sound velocities at the surface of deep sea sediments: Jour. Geophys. Research, v. 66, no. 2, p. 589-597. 1961.

A study of the initial amplitude of reflection of explosive sound from the sea floor in the Pacific has shown many cases in which the amplitude decreases with increasing angle of incidence and becomes negative at angles of about 74° to 80°. If the sediment can be treated as a fluid, the angle of phase change gives a measure of the sound velocity in sediments at the sea floor. Throughout most of the Pacific, velocities average about 2 percent less than the bottom water velocity. At some stations, notably those in the Chilean and Aleutian Trenches, in the Hawaiian Deep, and off the western coast of the United States, sediment velocities were found to be higher than the sound velocity in the overlying water, suggesting the effect of turbidity-current deposits in these areas. Illustrations of these two types of reflection from the sea floor area presented.— Authors' abstract

184-544. Van Siclen, DeWitt C. Seismic velocity effects may hide organic reefs: World Oil, v. 148, no. 5, p. 118-122, 1959.

A limestone reef near Stamford, Tex., produces a false uplift on seismic maps of horizons below the reef because seismic waves travel much faster through the limestone than through the shale around it. The usefulness of this effect for mapping reefs depends on the degree of velocity contrast between the limestone and shale. Theoretically this contrast decreases with increased porosity of the limestone, as oil replaces water, and as gas replaces oil in the reef, and also as the depth of burial becomes greater. Geologically reasonable changes can be envisaged that would render a reef like that at Stamford practically unrecognizable. In general, the potentially more productive reefs are less likely to be distinguishable.

Numerical models based on the Stamford reef were constructed using Brandt's (1955) formula for the speed of sound in porous granular mediums and with time-average equations. Changes in seismic velocity produced by assumed changes in lithologic and interstitial fluid properties were calculated for the models. These computations should be considered as only semiquantitative. — J. W. C.

184-545. Backus, Milo M. Inverse filtering helps solve problem of offshore multiples: World Oil, v. 150, no. 6, p. 156-160, 1960.

Water reverberations can be eliminated from marine seismograms by data-processing techniques. The theoretical aspects reported earlier (see Geophys. Abs. 177-344) are extended to operational usage. Inverse filtering, when applied to problems of water reverberations, will provide seismic records that are approximately equal to those which would be obtained in the absence of a water layer. These records, however, become less valid as the ocean floor structure becomes increasingly complex. This technique may also have onshore applications. — J. W. C.

184-546. Pierau, H., and Müller, W. Improvement in the quality of deep reflections by uniformly linear shotpoint arrays: Geophys. Prosp., v. 8, no. 2, p. 154-163, 1960.

A new shooting technique has proved satisfactory in oil prospecting in northwest Germany in areas unfavorable for reflections. The technique uses uniformly linear shotpoint arrangements that are parallel to and extend the full length of the geophone spread. Charges are detonated simultaneously.

Details of the technique are discussed, particularly the problem of the optimum geophone spreads in continuous profiling, as well as the position of the uphole geophone. Seismograms are reproduced to illustrate the difference in quality of reflections obtained by normal pattern shooting and by the linear shotpoint arrangement. Some special interpretation problems are also mentioned. — D. B. V.

184-547. Pierau, H., and Rosenbach, O[tto]. Comparative considerations on the energy content of seismic waves in central and linear pattern shooting: Geophys. Prosp., v. 8, no. 2, p. 164-177, 1960.

This is a continuation of the work by Pierau and Müller on linear shotpoint arrays (see Geophys. Abs. 184-546). Theoretical and experimental comparisons are made of the energy content of seismic waves in central and linear shotpoint arrangements. It is concluded that for the same size charge, the energy content of deep reflections is greater in linear than in central pattern shooting, and that seismograms obtained with the linear arrays are less dis-

turbed by surface waves. Therefore, the signal-to-noise ratio is considerably better in the case of linear shooting, giving better quality deep reflections. — D. B. V.

184-548. Bortfeld, R[einhard], Hürtgen, H., and Köppel, H. Direction shooting: Geophys. Prosp., v. 8, no. 4, p. 534-562, 1960.

The direction shooting method is described, including all pertinent procedures and proofs. Direction shooting is a method of continuous seismic profiling with shots distributed along the whole length of the geophone spread; the shots are fired either with time delays in the field, or recorded singly on magnetic material and composited with time delays. In this way the subsurface can be probed in any desired direction, enhancing reflections from one direction and attenuating or eliminating events from all other directions. For each reflection, the correct delay can be determined simply from a single trial record. Synthetic and field examples illustrate the efficiency of the method and its resolving power. — D. B. V.

184-549. Seelis, Karl-Heinz. Directional scanning when playing-back seismic magnetic records: Geophys. Prosp., v. 8, no. 4, p. 563-575, 1960.

A magnetic playback procedure is described and illustrated by examples, by means of which reflections of appreciably different slopes across the record can be effectively separated from each other. This "skipping-mixing" ("überschlagende Mischung") principle consists of mixing between nonadjacent channels, using either direct, or more often, reversed-polarity mixing signals. — D. B. V.

184-550. Berzon, I. S. Seismische Hochfrequenzuntersuchungen [High-frequency seismic investigations]: Freiberger Forschungshefte C 81 Geophysik, p. 111-121, 1960.

The high-frequency seismic surveying method is described. The main differences between high-frequency seismic apparatus and the conventional (middle-frequency) instruments is that the former must have frequency characteristics in the range of 70-500 cycles per second, a steep characteristic (up to 30-36 db per octave) in the frequency range below the maximum to cut out low-frequency components, and a greater sensitivity because the high-frequency waves are weaker.

The method is useful for locating water-bearing sandy layers and coal seams, ores, and oil, where detailed subdivision of layers—even in vertical structures—is desired. For very complex structure a combination of high-frequency and middle-frequency methods is usually used.

The high-frequency method was used in the Soviet International Geophysical Year program to measure ice thickness in Antarctica and in glaciers in the Caucasus and Tien Shan. It is a useful method of investigating seismic wave propagation in different rock types because of the excellent resolution of high-frequency waves in seismograms. Many seismograms are illustrated. (See also Geophys. Abs. 163-92, 166-338, 175-357, 177-349.)— D. B. V.

184-551. Willmore, P. L., and Bancroft, A. M. The time term approach to refraction seismology: Royal Astron. Soc. Geophys. Jour., v. 3, no. 4, p. 419-432, 1960.

In all seismic refraction surveys, the problem is to determine the constants in a system of equations of the type $t_{ij}=a_i-b_j-\Delta_{ij}/v$, where a_i and b_j

are "time terms" which are characteristic of the shot-point and seismograph station, respectively, Δ_{ij} is the distance between the shot-point and the seismograph, t_{ij} is the time of propagation of a refracted wave, and v is the velocity of propagation of seismic waves in an underlying marker layer. It is shown that the equations can be solved for interpenetrating networks of shot-points and seismographs provided that certain general conditions are satisfied. Factors which determine the uncertainties of the final solution are discussed, and methods of correcting for the effects of steeply dipping boundaries are included. — Authors' summary

184-552. Karayev, N. A. Opredeleniye srednikh skorostey po dannym KMPV dlya nekotorykh rayonov Zapadnoy Sibiri [Determination of mean velocities according to KMPV for certain regions of western Siberia]: Prikladnaya Geofizika, no. 27, p. 57-63, 1960.

An approximation method is presented for determining mean velocities in the correlation method of refracted waves (KMPV). In the traveltime curves obtained for 2 regions of western Siberia, it is shown that under favorable conditions the method yields mean velocities within 10 percent error. — A. J. S.

184-553. Just, Heinz. Erfahrungen mit der Fallgewichtsmethoden [Experiences with the falling weight method]: Freiberger Forschungshefte C 81 Geophysik, p. 44-52, 1960.

The falling weight method is particularly suitable where the use of explosives is impracticable in investigating the elastic properties of foundations. The use of falling weights is described in connection with checking the construction of a railroad embankment. Different size weights were used, as the effect depends on the nature and density of the material at the point of impact; the less consolidated the sediments, the higher the energies required. A 500-kg weight dropped from 1.60 m gave refractions to a depth of about 30 m. It is not yet possible to reach horizons below the water table. — D. B. V.

184-554. Marchetti, M. P. The occurrence of slide and flowage materials (olistostromes) in the Tertiary series of Sicily: Internat. Geol. Cong., 20th, Mexico 1956, (Proc.) sec. 5, v. 1, p. 209-225, 1957.

Thick, continuous, extensive layers of chaotic materials intercalated in the normal Tertiary sedimentary sequence in Sicily are described. These are termed "olistostromes" and their origin is attributed to gravitational sliding, slumping, and flowage.

The average densities of olistostromes are comparable to those of shale, but within them there sometimes occur humps of dense rock ("olistoliths") that can produce sharp gravity anomalies such as that near Roccapalumba in central Sicily. The presence of an olistostrome at the surface does not appreciably affect the transmission of energy in refraction surveys, but reflection surveys are difficult or impossible because olistostromes absorb all the reflected energy, including that coming from the autochthonous formation below. Commonly, the passage from a normal sedimentary area to one with an olistostrome is marked by a sudden absence of reflections. — D. B. V.

184-555. Nolting, R. P. Accurate depth determination of the velocity survey well phone: Geophysics, v. 26, no. 1, p. 100, 1961.

Many velocity surveys have been shot in which the actual depth of the well phone was in question at one or more of the levels shot in the borehole. Accurate depth control of the well phone can be established by fully utilizing the geophysical tools that are normally run in the borehole. Most velocity sur-

veys are shot with the well phone and other logging equipment connected into one logging tool; by running a section (100 feet) of one of the standard logs either immediately before or after the check level is shot, this section of log can be correlated to the standard log and depth of the well phone established from this correlation. — D. B. V.

184-556. Gretener, P[eter] E. F. An analysis of the observed time discrepancies between continuous and conventional well velocity surveys: Geophysics, v. 26, no. 1, p. 1-11, 1961.

Discrepancies between times obtained by conventional well velocity methods and the Shell continuous velocity tool are analyzed and found to be due to a random scatter and a systematic deviation, the integrated continuous velocity curves being short. Possible causes are discussed, but no final explanation is offered. — D. B. V.

184-557. Wachholz, Helmut. Geometrische Faktoren bei Akustik-Log-Messungen und ihr Einfluss auf die Messsondenkonstruktion [Geometric factors in acoustic log measurements and their bearing on the construction of measuring probes]: Erdöl und Kohle, v. 13, no. 8, p. 545-549, 1960.

The geometric factors in acoustic log measurements are examined and discussed from the standpoint of the instrument maker. After brief mention of the choice of measuring principle, the geometric error in traveltime measurements is treated. The behavior of the traveltime curves in the case of variations in borehole diameter is described for the idealized case of a right-angle step. Different transmitter-receiver arrangements are discussed. Rules for construction and development of acoustic log apparatus are obtained from a comparison of the relative advantages and disadvantages of these arrangements and consideration of the problems imposed by geology and geophysics. — D. B. V.

184-558. Młynarski, Stefan. Karotaż sejsmiczny w latach 1953-1959 no obszarze Polski [Seismic logging in Poland in the years 1953-1959 (with English summary)]: Przegląd Geol., v. 8, no. 10, p. 525-529, 1960.

The distribution of boreholes in Poland that have been logged seismically during the years 1953-59 is discussed and plotted on a map. Field procedures are described and several comparisons of seismic logs are presented. The number of shot wells dropped from 6 per year in 1953-55 to 3 in 1958. The distance between in-hole geophones ranged from 20 to 100 m in the early period, but since 1958 it has been 25-50 m. — J. W. C.

Tixier, M. P., Alger, R. P., and Tanguy, D. R. New developments in induction and sonic logging. See Geophys. Abs. 184-293.

184-559. Dow, Willard. A telemetering hydrophone: Deep-Sea Research, v. 7, no. 2, p. 142-147, 1960.

A deep, telemetering hydrophone which transmits information acoustically through the water to a surface vessel is described and illustrated. The instrument has the advantage of requiring no electrical cable to the ship, may be quickly hung on any suitable supporting line or wire, and can be made to operate completely free of the ship. Among other applications, the unit may be used to detect sounds reflected from subbottom strata. Luskin and others (1960) using a similar instrument have recorded seismic refraction arrivals

in deep water. Tests are being planned that will combine the instrument with a repetitive pulse source, both submerged near the bottom in deep water. (See also Geophys. Abs. 183-583). — V. S. N.

184-560. Behnke, C. Über Speicherung mehrerer durch Flüssigkeitsfunken erzeugten seismischer Impulse auf einem einzigen magnetischen Tonträger [On the recording of several seismic impulses generated by fluid sparks on a single magnetic tape (with English abstract)]: Zeitschr. Geophysik, v. 26, no. 1, p. 24-40, 1960.

A new type of equipment for generating seismic impulses by means of impulse-capacity discharges through a fluid spark-gap is described. The resulting ground motion, perceptible several hundred meters away through solid rock or several kilometers away through a water body, is recorded on magnetic tape. It is possible to amplify real and simultaneous diminution of arbitrary oscillation onsets by multiply recording the same impulse on a single tape. Numerous diagrams, photographs, and reproduction of tapes are presented. — D. B. V.

184-561. Seelis, Karl-Heinz. Vorzüge magnetischer Registrierung in der Seismik unter Hervorhebung einiger spezieller Abspielmöglichkeiten [Advantages of magnetic recording in seismic surveying with emphasis on some special playback possibilities]: Erdöl und Kohle, v. 13, no. 7, p. 461-466, 1960.

The possibilities and advantages of playbacks of magnetically recorded seismograms are outlined briefly, and the appropriate circuit for the playback process is illustrated schematically. Some examples of different playback possibilities adapted to actual problems are given; these include statically and dynamically corrected playbacks, playbacks filtered and mixed in different ways, and different styles and scales of recording. Methods of distinguishing reflections from differently-dipping horizons appearing in the same seismogram are mentioned. Real reflections can be distinguished from multiple reflections; in the case of profiles transverse to narrow synclines, the reflections associated with each limb are represented on separate playback series. — D. B. V.

184-562. Wood, C. A. Plot seismic data with electronic computers: World Oil, v. 148, no. 5, p. 131-133, 1959.

The large number of repetitious operations involved in plotting seismic data make it a likely possibility for some type of automation. A method is presented here for preparing point-plotted cross-sections using a digital computer and an accounting machine that has been modified to function as a plotting device. The time required in this experimental stage is at present slightly greater than that required to plot the same sections by hand. The accuracy of the computer method is much greater, however, and the time involved should be reduced considerably by research in programming. — J. W. C.

Heidrich, Werner, and Just, Heinz. The reaction of vibration measuring devices on the results of measurements in ground dynamics. See Geophys. Abs. 184-209.

184-563. Gol'tsman, F. M., and Limbakh, Yu. I. Pribor dlya chastotnogo analiza i sinteza neustanovivshikhsya signalov [A device for frequency analysis and synthesis of unstabilized signals]: Prikladnaya Geofizika, no. 21, p. 26-36, 1958.

A device for frequency analysis and synthesis of unstabilized signals is discussed; it allows determination of 73 points in analysis of a seismic spectrum S(f) and 73 points in synthesis of a signal F(t). Operation instructions for the apparatus are given, and examples of analysis and synthesis of signals are presented. The device was tested in the field. The graphs obtained agreed well with those constructed theoretically. — A. J. S.

184-564. Slutskovskiy, A. I. O nekotorykh voprosakh effektivnosti chastotnoy selektsii i razreshayushchey sposobnosti seismicheskikh usiliteley [Some problems of the effectiveness of frequency selection and of the resolving power of seismic amplifiers]: Prikladnaya Geofizika, no. 24, p. 3-25, 1960.

The advantages and disadvantages of connecting frequency filters before the loop or in the loop of the seismic amplifier ARU are discussed. A method of computing the optimum frequency for seismic amplifiers for a given frequency spectrum of the signal and interference waves is developed and discussed. — A. J. S.

184-565. Polshkov, M. K. K teorii i metodike rascheta reostatnogo usilitelya s polosovym fil'trom [On the theory and method of design of a rheostat amplifier having a band filter]: Prikladnaya Geofizika, no. 24, p. 222-245, 1960.

The theory of design of the stabilized filter amplifier used by seismic stations of the rheostat type having separately regulated filters of upper and lower frequencies and also band filters is discussed. A simplified equivalent circuit of an intermediate cascade rheostat amplifier equipped with a band filter is analyzed mathematically. — A. J. S.

184-566. Gaither, V. U. Index of wells shot for velocity (eighth supplement): Geophysics, v. 24, no. 5, p. 944-955, 1959.

Information is tabulated on 516 well velocity surveys not reported in previous indexes. Most of the wells listed were shot between September 1958 and September 1959. Corrections and (or) additional information on 17 previously listed surveys are also given. — D. B. V.

184-567. Gaither, V. U. Index of wells shot for velocity (ninth supplement): Geophysics, v. 25, no. 6. p. 1251-1259, 1960.

Information is tabulated on 340 well velocity surveys not reported in previous indexes. Corrections and (or) additional information on 5 previously listed surveys are also given. — D. B. V.

Oliver, Jack [E.], Kovach, Robert [L.], and Dorman, James. Crustal structure of the New York-Pennsylvania area. See Geophys. Abs. 184-424.

184-568. Biggs, Maurice, Blakelym, Robert F. , and Rudman, Albert J. Seismic velocities and synthetic seismogram computed from a continuous velocity log of a test well to the basement complex in Lawrence County, Indiana: Indiana Dept. Conserv. Geol. Survey Prog. Rept., no. 21, 15 p., 1960.

A continuous velocity log of a test well in Lawrence County, Ind., has been analyzed for interval and average vertical velocities from the New Albany shale to the basement complex. Average vertical velocities from a datum within the New Albany shale were 13,500 fps to the Trenton limestone, 14,900

fps to the Knox dolomite, 16,500 fps to the Mt. Simon sandstone, and 16,250 fps to the basement.

A synthetic seismogram was computed from the continuous velocity log data. Comparison with a field seismogram from the Trenton limestone made near the well shows good correlation reflections from the Trenton limestone, the upper and lower parts of the Knox dolomite, the Eau Claire formation, the Mt. Simon sandstone, and a metasedimentary rock unit resting on basalt that is assigned to the basement complex. Although the continuous velocity log does not show a sharp velocity contrast at the top of the metasedimentary unit, the synthetic seismogram demonstrates that energies reflected from a series of small velocity contrasts combine to give a prominent reflection. — D. B. V.

184-569. Narans, Harry D., Jr., Berg, Joseph W., Jr., and Cook, Kenneth L. Sub-basement seismic reflections in northern Utah: Jour. Geophys. Research, v. 66, no. 2, p. 599-603, 1961.

Seismic experiments were conducted in the Rozel Hills area of northern Utah with small (50-300 lb) charges and geophone spreads of 703-1,324 m in order to determine the possibility of obtaining normal incidence reflections from horizons within the subbasement. The explosion of a 490,500-lb charge at Promontory, Utah, in December 1958 was also recorded by a spread at 412-546 m). In spite of low signal-to-noise ratio and multiple reflections, various reflected events were obtained at both sites. Two of the events yielded horizon depths of about 8.5 and 26.3 km, in close agreement with the depths of refraction horizons derived in the area by Berg and others (see Geophys. Abs. 183-395). Evidence of other reflected events suggests that the crustal section may be more complex than is indicated by the refraction studies. — D. B. V.

Kane, M[artin] F., and Pakiser, L[ouis] C. Geophysical study of subsurface structure in southern Owens Valley, California. See Geophys. Abs. 184-399.

184-570. Ewing, J[ohn] [I.], Antoine, J., and Ewing, M[aurice]. Geophysical measurements in the western Caribbean and in the Gulf of Mexico: Jour. Geophys. Research, v. 65, no. 12, p. 4087-4126, 1960.

The data from 48 seismic refraction profiles in the western Caribbean Sea and in the Gulf of Mexico are presented in the form of structure sections crossing the Colombian Basin, Nicaraguan Rise, Cayman Trough, Cayman Ridge, Beata Ridge, Yucatan Basin, Campeche Bank, and Sigsbee Deep. The Cayman Trough has a remarkably thin crust, which suggests that it is a tensional feature. Although parts of the basins have a relatively thin crust, similar to the oceanic type, the shallower areas are intermediate or almost continental in structure. In the Gulf of Mexico the main basin is similar to typical ocean basins in structure except that the high-velocity crust is overlain by very thick sediments. The depth to the mantle is appreciably greater in the Gulf than in an ocean basin. This may be partly the result of loading by the sediments, but large scale tectonic activity is a more likely cause. The Sigsbee Escarpment, the northern boundary of the main basin, appears to be the surface expression of a fault or sharp flexure in the layers beneath the unconsolidated sediments. — Authors' abstract

184-571. Pallister, A. E. The preparation of seismic depth maps in oil exploration: Alberta Soc. Petroleum Geologists Jour., v. 8, no. 9, p. 235-246, 1960.

Sufficient subsurface geologic and seismic velocity controls are now available in western Canada to warrant the preparation of depth maps from seismic reflection results. In order to prepare maps of the actual structure of the reflecting horizon in a seismic survey, the effects of the velocity gradient across the area and of the differential erosion on the Paleozoic surface must be removed. A method of depth conversion of seismic reflection data is suggested that utilizes a regional geologic structure map of a shallow formation on the basis that the major scene of velocity gradient is in the interval between this formation and the surface. Deeper maps are prepared by adding thickness intervals to this regional map, with these intervals being calculated in a series of steps determined by velocity interfaces and recorded reflection times. The method is illustrated with an example from the Innisfail field using seismic reflection times calculated at a minimum number of wells together with a regional Blairmore geologic map. — V. S. N.

184-572. Allen, Adrian. Seismic refraction investigations of the preglacial valley of the River Teifi near Cardigan: Geol. Mag., v. 97, no. 4, p. 276-282, 1960.

Two seismic refraction profiles were made across the preglacial valley of the Teifi River, above and below Cardigan, to determine the depth to the bedrock floor. Results indicate a reasonably long profile gradient of 3-6 feet per mile for the preglacial valley. A comparison of this gradient with that of the lower reaches of modern British Rivers (about 6 feet per mile) indicates that a recent east-west tilt of more than about 1/10 of a degree is unlikely. A relative rise of sea level of between 75 and 107 feet since glacial times is indicated. — V. S. N.

184-573. Reinhardt, Hans-Günter. Korrelation eines vermutlich an der Zechsteinbasis liegenden reflexionsseismischen Horizontes im Nordwestteil der Deutschen Demokratischen Republik [Correlation of a seismic reflection horizon probably lying at the base of the Zechstein in the northwest part of the German Democratic Republic]: Geol. Gesell. Ber., v. 4, no. 2/3, p. 169-177, 1959.

A well known deep reflecting horizon, believed to mark the base of the Zechstein, is recorded in the West Mecklenburg, Prignitz, and Altmark areas in East Germany. It has been contoured on the basis of reflection results and seismic velocity measurements. The horizon shows a general rise from northeast to southwest; the maximum depth of 5,000 m occurs in the center of the Pritzwalk gravity high and the minimum south of the Salzwedel in the Altmark. An upwarp extends from the western Altmark into southwest Mecklenburg.

The trend of the isopachs is similar to that of the isogams on the gravity map of East Germany. The coincidence of the maximum depth of the horizon and the longest refraction traveltimes with positive gravity and magnetic anomalies is of particular interest. — D. B. V.

184-574. Pepel, Andrzej. Badania sejsmiczne w dolinie Wisły [Seismic studies in the valley of the Vistula (with English summary)]: Przegląd. Geol., v. 8, no. 2, p. 91-92, 1960.

Seismic and resistivity studies were made on the Quaternary deposits of the Vistula valley in 1959; the seismic work is discussed here. Special attention was given to recording the traveltime of elastic waves and to eliminating the effect of the weathered zone. Several velocities corresponding to the surficial layers were distinguished. A boulder clay horizon was traced through the entire area. — J. W. C.

Buben, Jiří. Electronic investigations of strain conditions in the mine bump region near Kladno. See Geophys. Abs. 184-583.

184-575. Kolgina, A. M. Seysmīchnī doslīdzhennya v zonī kontaktu kyslykh ta osnovnykh porīd u rayonī m. Volovars'ka-Volyns'koho [Seismic investigations in the zone of contact between acid and basic rocks in the Volodarsk-Volyn region]: Akad. Nauk Ukrayin. RSR Heol. Zhur., v. 18, no. 6, p. 17-27, 1958.

High frequency seismic surveys were made in the pegmatite area of the Volodarsk-Volyn district in the southwest part of the Ukrainian shield. The maximum frequency that was detectable was less than 100 cycles per second. In some cases better results were obtained by using low-frequency filters. Certain features, such as intense absorption by the rocks, necessitated small-scale spreads; geophones were usually spaced at 2.5 m intervals along profiles 5-10 m apart. Optimum shot-point distance was determined experimentally for each spread, guided by knowledge of the elastic wave absorption, form, position, and size of each pegmatite body. Reflections from distant contacts were clearer than those from nearby ones.

The results show that the high frequency seismic method can be used to locate contacts between rocks of different petrographic composition, such as granite and pegmatite, even when their elastic properties are similar. — D. B. V.

184-576. Germanyuk, M. M., Komissarov, G. I., and Lovitskiy, D. K. Novyye dannyye o geologicheskom stroyenii yugo-vostochnoy Turkmenii [New data on the geology of southeast Turkmenia]: Geologiya Nefti i Gaza, no. 2, p. 10-14, 1959.

Structural studies were accomplished in the southeastern part of the Turkmen S. S. R. by a coordinated program of seismic surveying and structural drilling. Several uplifts that are of considerable interest with respect to oil and gas have been revealed on the overall monoclinal dip of the Kara Kum platform. — J. W. C.

184-577. Zamarenov, A. K., Broytman, A. R., Dunayev, V. F., and Skibel'skiy, V. L. O yugo-vostochnom obramlenii Severnogo Prikaspiya [Southeast frame of the north Pri-Caspian area]: Geologiya Nefti i Gaza, no. 1, p. 26-32, 1959.

A buried anticlinal zone is traced by seismic surveying within the little deformed Tertiary cover of the Ustyurt Plateau. This structure has an inherited Ural Hercynide trend. Three maps are presented in which various seismic reflecting horizons are contoured at either 50 or 100 m intervals. — J. W. C.

Weizman [Veytsman], P. S., Gal'perin, E. J. [E. I.], Zwerjew, C. M. [Zverev, S. M.], Kosminskaja, J. P. [Kosminskaya, I. P.], and Krakschina [Krakshina], R. M. Seismic investigations of the deep structure of the earth's crust, which were carried out in the USSR as part of the International Geophysical Year project. See Geophys. Abs. 184-431.

184-578. Central Water and Power Research Station Poona. Geophysical investigations at Nagileru crossing, right bank canal, Nagarjunasagar project: India Ministry of Irrigation and Power Central Water and Power Research Sta. Poona Ann. Research Mem., p. 62-63, 1959.

A seismic refraction survey was made at the site of the proposed aqueduct crossing over the Nagileru River at Nagileru, India, to determine the depth to sound limestone. Results are shown in a cross section. — V. S. N.

184-579. Izaki, Akira, and Kaneko, Tetsuichi. Sonic survey on the Strait of Akashi [in Japanese with English summary]: Butsuri-Tanko, v. 13, no. 1, p. 36-45, 1960.

A sonic survey of the eastern half of the Akashi Strait, carried out in 1959, is reported. A continuous seismic profiler (or sparker) was used, and the records obtained were compared with dredged samples and rock cores from the sea bottom. The knowledge obtained of the geologic structure is to be used for designing an interisland railway. — V. S. N.

184-580. Kashiwagi, Hideji. Actual result of seismic prospecting in Electric Power Development Co., Ltd. [in Japanese with English abstract]: Butsuri-Tanko, v. 13, no. 1, p. 73-78, 1960.

Errors in results from seismic prospecting as compared with results from test pits or borings at sites for dams, power stations, surgetanks, tunnels, or sources of concrete aggregate were investigated. It was found that the error in determination of gravel depth is less than that for talus depth, whereas the error in determination of weathered rock depth is larger than that for talus depth. An area of level topography produces less error than one of irregular topography. The ratio of the error has no relation to depth. — V. S. N.

184-581. Overeem, A. J. A. van. Sonic underwater surveys to locate bedrock off the coasts of Billiton and Singkep, Indonesia: Geologie en Mijnbouw, v. 39, no. 10, p. 464-471, 1960.

Offshore sonic surveys of bedrock and overlying layers were made to facilitate the exploration and exploitation of the submarine tin placer deposits at Billiton and Singkep, Indonesia. The instrument was operated at a frequency of 6 kc of 11.5 kc, and the pulse length was variable from 1 to 9 milliseconds. Bedrock was reached in almost all places. Because operations can be performed rapidly, the sonic methods provide a comparatively cheap means of determining geologic and geomorphic features that formerly could be found only by extensive drilling. — D. B. V.

STRENGTH AND PLASTICITY

184-582. Round, G. F. The shear strength of McMurray oil sands: Canadian Mining Metall. Bull., v. 53, no. 576, p. 233-238, 1960; also in Canadian Inst. Mining Metallurgy Trans., v. 63, p. 145-150, 1960.

In order to obtain values of angles of shearing resistance and initial resistance for the McMurray oil sand for use in general design of mining and processing equipment, the shear strength of this oil sand was measured in a controlled strain type tester modified so that the rate of deformation could be varied between 0.01725 and 0.1869 in. per min. Data are reported in terms of angle of shearing resistance and initial resistance for varying rates of deformation, composition, and temperature. Increase of oil content and decrease of temperature each cause an increase in shear strength. The bulk density range 108.7-109.5 lb per cu ft gave angles of shearing resistance from 30° to 40° and initial resistance values of 0.37-0.85 psi. For the bulk density range 101-102 lb per cu ft, lower values of shear strength were obtained indicating that compaction density is also important. — V. S. N.

184-583. Buben, Jiří. Elektronische Untersuchungen des Spannungszustande im Detonations-gebiet bei Kladno [Electronic investigations of

strain conditions in the mine bump region near Kladno]: Freiberger Forschungshefte C 81 Geophysik, p. 53-63, 1960.

In the Kladno coal mining district in Czechoslovakia the ground is constantly in motion; mine bumps occur several times a day and rockbursts, registered at Prague as weak near earthquakes, occasionally cause considerable damage. The nature of the ground motion was studied seismically in place and in the laboratory.

In the laboratory studies it was found that pressures applied slowly produced 60-80 impulses per second with natural frequencies in the 600-1,800 cycles per second range, and that when pressures were applied rapidly the deformational energy took the form of a series of impulses whose frequency of occurrence decreased from the moment of application. From curves plotted on the basis of the results of these measurements, a measuring device could be constructed to give warning when a certain deformation quotient is exceeded.

The mine bumps showed three types of vibrations; the first were relatively regular and weakly damped, the second appeared strongly damped, and the last and most common were very complex. As changes in the form of these signals can be a warning of danger, a monitoring apparatus was developed. It showed that the bumps are less frequent at night than during the day. The energy curve showed a regular sequence of calm periods followed by periods of rockburst or strong bumps. — D. B. V.

184-584. Denkhaus, H. G., Hill, F. G., and Roux, A. J. A. Review of recent research into rockbursts and strata movement in deep-level mining in South Africa: Inst. Mining and Metallurgy [London] Trans., v. 68, 1958-1959, p. 285-309, 1959.

A general survey of the various aspects of research into the problem of rock-bursts in South Africa since 1952 and the results so far obtained are given under four main headings: (1) The condition of, and the state of stress in the ground around excavations at depth; (2) properties of rock; (3) investigations into the nature of rockbursts; and (4) methods for ameliorating rockburst conditions. — Authors' abstract

184-585. Wakahama, Gorow. Internal strain and changes in the microscopic texture of snow caused by compression: I. Compression of a thin section of snow by a static load. II. Compression of thin section of snow at a constant speed [in Japanese with English résumé]: [Hokkaido Univ.] Low Temperature Sci., ser. A, no. 19, p. 37-71, 73-96, 1960.

When snow is subjected to a load not large enough to destroy its structure, its form is changed slowly by creep. In part 1, the results of a thin section study of deformation in snow under compression by constant static loads are reported. Deformation of the compact snow is found to be due mainly to basal slip, slip at grain boundaries and separation of ice grains along weak textural lines. The viscosity of the snow, derived from creep curves, agrees well with Kojima's (1956) results from study of a natural snow layer; snows of the same density may vary in viscosity with variation in size distribution of ice grains.

In part 2, the results of a thin section study of deformation of snow compressed at a slow speed (0.02 mm per min) are reported. In the early stage the section undergoes elastic compression resulting in displacement of ice grains; after the yield point, plastic compression begins and slip lines appear parallel to the basal plane of the ice grains. With further compression many other kinds of deformation appear. In most cases grain boundaries migrate

from the grains of less marked slip lines toward the ones with stronger slip lines. Poisson's ratio for plastic compression of the snow was found to be 0.25-0.35 in agreement with Kojima's results from natural snow on a slope. — V. S. N.

SUBMARINE GEOLOGY

184-586. Shepard, Francis P. The earth beneath the sea: Baltimore, Johns Hopkins Press, 275 p., 1959.

This is a popularized but more up-to-date version of Shepard's earlier book, "Submarine Geology" (see Geophys. Abs. 137-11150). The text includes eleven chapters as follows: Waves and currents modify the sea floor; catastrophic waves from the sea; our transient beaches; the continental shelves that surround the lands; origin of continental shelves; the world's greatest slopes; canyons of the sea floor; the deep-ocean floor; under the ocean bottom; coral reefs and their undersea wonderlands; and using the present sea-floor deposits to interpret the past. — V. S. N.

184-587. Menard, H[enry] W. The East Pacific Rise: Science, v. 132, no. 3441, p. 1737-1746, 1960.

The results of the Scripps Expedition Downwind and others before and after are combined to give a progress report of research on the East Pacific Rise. The location and topography, seismicity, and crustal section of the rise are described, and then attention is focused on three questions: Does the rise extend under western North America? Are transverse wrench faults part of the rise structure? What is the origin of the rise?

The rise, identifiable as an elevated region with a seismically active crest and high heat flow, extends from the south Pacific under western North America and into the northeasternmost Pacific. The corresponding elevation of the mantle that is found in the oceanic regions has not been found under the intervening continent. The rise is probably genetically related to fracture zones; thinning of the rise crust seems to require large horizontal movements on the flanks with differential movement between blocks, and the fracture zones have the right geographic distribution and magnitude to be the boundaries between displaced blocks.

The hypothesis of a youthful convection current in the mantle suggested by Bullard and others to explain high oceanic heat flow (see Geophys. Abs. 176-207) offers a simple qualitative explanation of all the facts concerning the East Pacific Rise. If a random distribution of relatively short-lived "oceanic" rises is accepted, the picture is compatible with continental drift. It appears probable that most rises are centered in ocean basins because the margins of the basins have been adjusted by convection currents moving out from the center. If so, the African and East Pacific rises may mark relatively young or rejuvenated currents which have not yet had time to produce continental displacement. Even so, east Africa is being torn by deep rifts and Baja California has almost been separated from North America along the crest of the East Pacific Rise. — D. B. V.

184-588. Gems and Minerals. Great underwater geological feature traced: Gems and Minerals, no. 279, p. 14-15, 1960.

The expeditions in the Pacific conducted by the Scripps Institution of Oceanography during the International Geophysical Year have resulted in evidence of one of the largest physical structures on earth, the East Pacific Rise. It extends in a sickle-shaped curve for 8,000 miles or more from near New Zealand to the coast of Mexico where its crest disappears; some scientists believe

the crest underlies western North America in which case this crest reappears in the shoal area off the coast of Canada and reaches almost to Alaska. The Rise is the site of many shallow earthquakes; beneath its crest the crust of the earth is only 2 miles thick; the rate of heat flows through its crest is 8 times that in the deep ocean floor or on land and on the flanks is much less than elsewhere; and it is intersected by at least 11 fracture zones trending almost due east-west, which contain most of the volcanoes of the eastern Pacific. Magnetic anomaly maps show north-south trending anomalies whose continuity is interrupted by the fractures. The original patterns can be reconstituted by shifting the maps back and forth, showing that blocks of land as large as Texas have been moved several hundreds of miles. — V. S. N.

184-589. Menard, H[enry] W. Consolidated slabs on the floor of the eastern Pacific: Deep-Sea Research, v. 7, no. 1, p. 35-41, 1960.

Tabular masses, largely phillipsite coated with manganese oxide, are abundant on the floor of the eastern Pacific Ocean. The size range of the specimens described in the included table is from 61X61X32 cm down to 3X4X2 cm. They appear to be remnants of layers of volcanic ash derived in large part from volcanoes within the basin. Some of the ash may correlate with the Worzel ash of Central and South America. — V. S. N.

184-590. Fairbridge, Rhodes W., and Stewart, Harris B., Jr. Alexa Bank, a drowned atoll on the Melanesian Border Plateau: Deep-Sea Research, v. 7, no. 2, p. 100-116, 1960.

The Melanesian Border Plateau covers an area 1,000 by 200 miles along the northeastern edge of Melanesia and occurs at an average depth of 2,700 m. It has an E-W trend and is broken up into a series of narrow en echelon ridges and troughs approximately 250 by 100 miles in dimension. The troughs rarely exceed 4,000 m in depth; some are closed basins, whereas others open out into a funnel shape and slope gradually down into the Central Pacific Basin to the north. Although the plateau is bordered by the andesite line there is an anomalous absence of deep trenches on the basin margin. The ridges are capped by a few small volcanic islands and a large number of slightly submerged atolls of dead corals. Alexa Bank is a characteristic example. Vulcanism and foul upwelling are possible explanations of the cause of the coral death. — V. S. N.

184-591. Starik, I. Ye., Kuznetsov, Y. V., Lisitsyn, A. P., Grashchenko, S. M., and Frenklikh, M. S. O tempakh sedimentatsii v yuzhnoy chasti Indiyskogo okeana [On the rate of sedimentation in the southern part of the Indian Ocean]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 370-391, 1958 (1960).

A study of sedimentary deposits on the floor of the Indian Ocean is reported. The basic features of the submarine relief are described, and present sedimentation is discussed. The rates of sedimentation at 26 stations in the Indian Ocean were determined by measuring the radioactivity in the core sample, and then by comparing this with the concentration in a reference sample, the accurate sedimentation rate of which was determined by other methods. — A. J. S.

184-592. Baranov, V[ladimir] I., and Khristianova, L. A. Novyye dannyye o radioaktivnosti Indiyskogo okeana [New data on radioactivity of the Indian Ocean]: Akad. Nauk SSSR, Kom. Opredeleniyu Absolyut. Vozrasta Geol. Formatsiy Trudy, 7th sess., p. 392-410, 1958 (1960).

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The concentrations of uranium, thorium, ionium, and radium in the cores taken from the Indian Ocean floor are reported. The average rate of sedimentation of ooze was found to range between 1,000 and 2,000 yr per 1 cm. Diatom, foraminiferal, and limey clay oozes were found to be 10 times less radioactive than the red oceanic ooze. — A. J. S.

184-593. Laughton, A. S. An interplain deep-sea channel system: Deep-Sea Research, v. 7, no. 2, p. 75-88, 1960.

The system of channels connecting the Biscay and Iberia abyssal plains is described. The two plains are separated by only 40 miles but have a difference in elevation of 100 fathoms with the change of level occurring where the two main channels first leave the upper plain. The total length of channels between the plains is 50 miles with the channels joining at the end of 20 miles; the widths vary from 2 to 10 miles and show meander formation similar to subaerial rivers.

It is concluded that turbidity currents initiated on the continental shelves and flowing across the Biscay Plain are rejuvenated by the increase in gradient and lateral constriction and flow through to the Iberia Plain where they deposit their load. — V. S. N.

184-594. Laughton, A. S., Hill, M[aurice] N[eville], and Allan, T. D. Geophysical investigations of a seamount 150 miles north of Madeira: Deep-Sea Research, v. 7, no. 2, p. 117-141, 1960.

An elongated seamount rising to 678 fathoms was surveyed by echo-sounding, dredging, photography, magnetic and seismic methods, the results of which are described. The feature appears to be the result of volcanic extrusion along a fault running obliquely across a broad rise. — Authors' abstract

184-595. Klenova, M. V. Geologiya Barentsova morya [Geology of the Barents Sea]: Moscow, Akad. Nauk SSSR. 367 p., 1960.

The geology of the Barents Sea is reviewed comprehensively. The chapters cover the following: geology of the coast and origin of the sea, relief of the sea floor, physical geographic features, investigation of the sediments, distribution of sediments in relation to relief, mineral composition of the sediments, chemical composition and chemical processes in the sediments, and stratigraphy of the sediments. — J. W. C.

VOLCANOLOGY

184-596. Macdonald, Gordon A. Volcanology: Science, v. 133, no. 3454, p. 673-679, 1961.

Volcanoes furnish clues to the nature of the earth's interior. The major problems of volcanology are today, as they always have been, the origin of the volcanic heat, the locus and origin of magma, the mechanics of its rise to the earth's surface, the processes that account for the considerable range in composition of magmas that reach the surface, the subsurface structure of volcano systems, and the origin of the water that forms the major portion of volcanic gases. These problems are reviewed briefly, showing the complex interplay of various scientific disciplines within the field of modern volcanology. — D. B. V.

184-597. Ishikawa, Toshio, and Katsui, Yoshio. Some considerations on the relation between the chemical character and the geographical po-

sition of the volcanic zones in Japan: Hokkaido Univ. Faculty Sci. Jour., ser. 4, v. 10, no. 1, p. 163-182, 1959.

A petrochemical classification of the volcanoes of Japan and the Kurile Islands is proposed. The major zones proposed are as follows: volcanoes on the Kurile arc; volcanoes on the northern Honshu arc; volcanoes within the Fossa Magna region and on the Izu and Iwo-Jima islands; and volcanoes of southwest Japan. A study of the chemical composition of the lavas of each zone shows that the volcanoes on the outer (southeast or Pacific) side are more calcic than those on the inner (northwest) side. The Japanese trench lies immediately outside the most calcic zone, and it is suggested that the magmatic character of the volcanoes is closely related to their tectonic position. This is further demonstrated by the fact that among quaternary volcanoes of Japan those made up of the more calcic lavas occur on the outer side. Moreover, Rittmann (1953) has shown that the calc-alkaline character of the magmas of the Indonesian volcanoes decreases regularly from the foredeep to the hinterland. — V. S. N.

184-598. Decker, Robert [W.]. Renewed activity of Anak Krakatau: Univ. Indonesia, Inst. Tech. Bandung, Dept. Geology Contr., no. 34, 5 p., 1959.

Anak Krakatau is a cinder cone located in the submerged caldera formed by the catastrophic collapse of Krakatau in 1883. This cone first appeared in 1927, and its last reported activity was in September 1953. Renewed activity was observed in June 1959 during a reconnaissance flight over the area. Four cycles of vulcanian-type eruption took place during a 30-min period. Photographs show various stages of this sctivity. — J. W. C.

184-599. McCall, G. J. H. The Menengai caldera, Kenya Colony: Internat. Geol. Cong. 20th, Mexico 1956 [Proc.] sec. 1, v. 1, p. 55-69, 1957.

Menengai is one of many volcanoes, now reduced to fumarole activity, situated on the floor of the Gregory Rift Valley in Kenya. It is a caldera of Krakatoa type, formed as a result of rapid emptying of the magma chamber. During the later stages of a sequence of trachyte eruptions, explosions scattered pumice and ash over the surrounding country; the superstructure was left unsupported and the central area of the volcano foundered piecemeal until a vast caldera (more than 35 mi^2) was formed. The evidence for the subsidence is still perfectly perserved in scalloped facets, partially foundered and inwardly tilted blocks, and lateral grabens.

Secondary eruptions along a north-south zone traversing the caldera have piled up flows within the caldera and spilled lava down the outer slopes from fissures. These eruptions continued until about a hundred years ago. The age of caldera formation can be dated by lithologic correlation of Menengai ash deposits with the Makalian ash (8000 B. C.) as about 10,000 yr old or possibly less. — D. B. V.

184-600. Tanaka, Y[utaka]. Investigation of volcanic activity of Torishima (II). On the earthquakes near Torishima [in Japanese with English abstract]: Quart. Jour. Seismology [Tokyo], v. 25, no. 1, p. 1-8, 1960.

About 60 percent of the volcanic earthquakes at Torishima belong to swarms of shocks, and their occurrences may be expressed as $NPt^{1.5}$=const., where NP is the number of volcanic earthquakes, and t is the time interval between successive shocks. The frequency curve of the volcanic earthquakes has 3

local maximums that are related to tidal phases—at 2-3 hr before and 2-3 hr after high tide and at low tide. About 14 percent of the earthquakes are closely related to the tide.

A close relationship exists between the deep-focus earthquake zone and the Fuji volcanic zone which extends through the island of Torishima. Eruptions in 1902 and 1939 at Torishima were accompanied by many deep-focus earthquakes. —V. S. N.

184-601. Takeyama, I., Tanaka, Y[utaka], and Kobayashi, E. On the seismic waves and air-shocks caused by the explosion of Volcano Asamayama, Nov. 10, 1958 [in Japanese with English abstract]: Quart. Jour. Seismology [Tokyo], v. 25, no. 2, p. 45-53, 1960.

The results of analysis of the seismic waves and air-shocks produced by the explosive eruption of Mount Asama, Japan, on November 10, 1958, are summarized. Seismic wave analysis indicates the presence of two layers under Mount Asama. The thickness of the upper layer is about 7-8 km; the velocities of $\overline{P}$, $\overline{S}$, P, and S are 4.5, 2.7, 5.8, and 3.6 kmps, respectively; and Poisson's ratio in the upper layer is 0.23 and that of the lower layer 0.18. One of the air-shock waves had a period of 5 sec and velocity of 350 m per sec, and the other a period of <0.5 sec and velocity of 320 m per sec. The energy of the explosion earthquake is estimated at about 4×10^{19} ergs. In the first outer zone of audibility, sounds were heard 2 or 3 times. The second outer zone of audibility was separated from the first by a wide zone of silence. The air-vibration (period 0.5-1 min, propagation velocity 280 m per sec) was recorded by barographs and microbarographs at many weather stations. The energy of the first shock of air-vibration is estimated at 10^{17}-10^{18} ergs. — V. S. N.

184-602. Kamo, Kosuke. On the long-period volcanic micro-tremors at Volcano Aso: Volcanol. Soc. Japan Bull., v. 5, no. 1, p. 35-48, 1960.

The results of a study of the long-period microtremors associated with the volcanic activity of Mount Aso, Japan, since 1958 are reported. The long-period microtremors observed before the eruption of June 24, 1958, had a period of 40-55 sec. About 20 hr before the eruption the wave trains were composed of 3 or 4 crests and troughs; about 5 hr before they were characterized by 6 or 7 crests and troughs; and about 1 hr before they decayed. It is believed that these microtremors were not induced by the volcanic microtremors of shorter periods but were due to the state of the magma beneath the crater. — V. S. N.

184-603. Nakamura, Hisayoshi; Ando, Takeshi; Sumi, Kiyoshi; and Suzuki, Takashi. Geology and hot springs of Takinoue geothermal area, Iwate Prefecture: Japan Geol. Survey Bull., v. 11, no. 2, p. 79-84, 1960.

Fumaroles and hot springs of the Takinoue geothermal area along the Kakkonda River, Iwate Prefecture, Japan, issue from Tertiary sediments, lava, and tuff overlain by Quaternary andesite and are distributed along anticlinal axes and faults. It is not known whether or not the porous Tertiary beds form a reservoir for the natural steam or hot water. — V. S. N.

184-604. Nakamura, Hisayoshi; Ando, Takeshi; and Suzuki, Takashi. Geology and hot springs of Kuroyu geothermal area, Akita Prefecture: Japan Geol. Survey Bull., v. 11, no. 2, p. 85-88, 1960.

The hot springs of the Kuroyu geothermal area, Akita Prefecture, Japan, occur along the Sendatsu River in an area of Tertiary tuff, tuffaceous sand-

stone, mudstone, and shale overlain by Quaternary volcanic detritus. One group of springs is characterized by high contents of Cl^{-1} and HCO_3^{-1}; a second group is accompanied by fumaroles. The hot spring reservoir has not been determined. — V. S. N.

184-605. Seno, Kinzo, and Yuhara, Kozo. Study of fumarole (Pt. 1). Vertical temperature distribution in steam wells: Volcanol. Soc. Japan Bull., v. 5, no. 1, p. 1-8, 1960.

The vapor temperature in a well bored in a thermal area rises in general with depth, but the temperature gradient varies with the flow rate, the temperature of the vapor, and the geothermal condition of the surrounding rocks. If ground temperature and vapor temperature in the well are approximately the same, the steam is cooled only by adiabatic change; if ground temperature is lower than vapor temperature, cooling by the surrounding rocks may control the vertical temperature distribution. Three wells (Geyser 4, Beppu-Hakuryu, and Kuzyu-Otake 3) are cited as examples. — V. S. N.

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