

# Geophysical Abstracts 191 October-December 1962

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

---

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

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



**UNITED STATES DEPARTMENT OF THE INTERIOR**

**STEWART L. UDALL, *Secretary***

**GEOLOGICAL SURVEY**

**Thomas B. Nolan, *Director***

---

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 (March 14, 1962).

## CONTENTS

---

	Page
Introduction -----	473
Extent of coverage -----	473
List of journals -----	473
Form of citation -----	474
Abstracters -----	474
Age determinations -----	474
Cosmogony -----	481
Earth currents -----	488
Earthquakes and earthquake waves -----	490
Elasticity -----	507
Electrical exploration -----	523
Electrical logging -----	531
Electrical properties -----	535
Exploration summaries and statistics -----	535
General -----	537
Geodesy -----	541
Geotectonics -----	543
Glaciers -----	547
Gravity -----	550
Heat and heat flow -----	563
Internal constitution of the earth -----	566
Isotope geology -----	571
Magnetic field of the earth -----	573
Magnetic properties and paleomagnetism -----	584
Magnetic surveys -----	591
Microseisms -----	606
Radioactivity -----	609
Radioactivity surveying and logging -----	611
Seismic exploration -----	615
Strength and plasticity -----	625
Submarine geology -----	636
Volcanology -----	637
Index -----	641



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

## INTRODUCTION

### Extent of Coverage

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

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

### List of Journals

Lists of journals published in Geophysical Abstracts 160 (January-March 1955, Bulletin 1033-A) and subsequent issues through 184 (January-March 1961, Bulletin 1146-A) have been compiled into a single list, which may be obtained by writing to the U.S. Geological Survey, Washington 25, D. C.

Supplements to this master list have been published in each issue since Geophysical Abstracts 184. The following is an additional supplement that lists references cited in Geophysical Abstracts 191 that have not been listed previously.

- Akad. Nauk Kazakh. SSR., Trudy Altay. Gornometallurg. Nauchno-Issled. Inst. - Akademiya Nauk Kazakhskoy SSR. Trudy Altayskogo Gornometallurgicheskogo Nauchno-Issledovatel'skogo Instituta [Academy of Sciences of the Kazakh S.S.R. Transactions of the Altay Mining-Metallurgical Scientific Research Institute]. Alma-Ata, U.S.S.R.
- Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika -- Akademiya Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika [Academy of Sciences of the U.S.S.R., Siberian Division, Geology and Geophysics]. Novosibirsk, U.S.S.R.
- Akad. Nauk SSSR, Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki -- Akademiya Nauk SSSR, Sibirskoye Otdeleniye, Voprosy Razvedochnoy Geofiziki [Academy of Sciences of the U.S.S.R., Siberian Division, Problems of Exploration Geophysics]. Novosibirsk, U.S.S.R.
- Akad. Nauk Uzbek. SSR., Zapiski Uzbekistan. Otdeleniye Vses. Mineral. Obsch. -- Akademiya Nauk Uzbekskoy SSR, Zapiski Uzbekistanskogo Otdeleniye Vsesoyuznogo Mineralogicheskogo Obschestva [Academy of Sciences of the Uzbek S.S.R. Reports of the Uzbekistan Division of the All-Union Mineralogical Society]. Tashkent, U.S.S.R.
- Akad. Nauk SSSR, Yakut. Fil., Sibirskoye Otdeleniye Trudy -- Akademiya Nauk SSSR, Yakutskoye Filial, Trudy Sibirskoye Otdeleniye [Academy of Sciences of the U.S.S.R., Yakutsk Branch, Transactions of the Siberian Division]. Yakutsk, U.S.S.R.
- B"lgarska Akad. Nauk Izv. Otdelenie Fiz. Mat. i Tekh. Nauki, Ser. Fiz. -- Izvestiya na B"lgarskata Akademiya na Naukite. Otdelenie za Fiziko-Mate-

- matischenki i Tehnicheski Nauki, Seriya Fizicheska [Bulletin of the Bulgarian Academy of Sciences. Division of Physico-Mathematical and Technical Sciences]. Sofiya, Bulgaria.
- Canadian Surveyor -- The Canadian Surveyor. The Canadian Institute of Surveying. Ottawa, Canada.
- Central Astron. Inst. Czechoslovakia Bull. -- Central Astronomical Institute of Czechoslovakia Bulletin. Prague, Czechoslovakia.
- Ciencia Interamericana -- Ciencia Interamericana. Departamento de Asuntos Cientificos, Union Panamericana [Interamerican Science. Department of Scientific Affairs, Panamerican Union]. Washington, D. C.
- Earth Sci. [Chikyu Kagaku] -- Earth Science [Chikyu Kagaku]. The Journal of the Association for the Geological Collaboration in Japan. Tokyo, Japan.
- [India] Irrigation and Power Jour. -- Irrigation and Power. Journal of [India] Central Board of Irrigation and Power. New Delhi, India.
- Jour. Physics Chemistry Solids -- The Physics and Chemistry of Solids - An International Journal. Pergamon Press. New York, New York.
- Minno Delo i Metalurgija -- Minno Delo i Metalurgija. Komitet po promishlenostta [Journal on Mining and Metallurgy published by the Committee on Industry]. Sofiya, Bulgaria.
- New England Water Works Assoc. Jour. -- Journal of the New England Water Works Association. New England Water Works Association. Boston, Massachusetts.
- Planet. and Space Sci. -- Planetary and Space Science. Pergamon Press, Inc., New York and London.
- Royal Soc. Edinburgh Proc. -- Proceedings of the Royal Society of Edinburgh. Edinburgh, Scotland.

#### Form of Citation

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

#### Abstracters

Abstracts in this issue have been prepared by E. J. Catanzaro, H. Faul, S. S. Goldich, Wanda L. Grimes, C. E. Hedge, W. S. Jardetsky, R. F. Marvin, A. J. Shneiderov, T. W. Stern, A. B. Tanner, H. H. Thomas, and J. S. Watkins, as well as by the principal authors. Authors' abstracts are used in many instances. The initials of an abstracter following the notation "Author's abstract" indicate a translation from the original language.

#### AGE DETERMINATIONS

- 191-1. Afanas'yev, G. D., Borisevich, I. V., and Shanin, L. L. O geologicheskoy interpretatsii radiologicheskikh dannyykh po opredeleniyu absolyutnogo vozrasta gornykh porod [On the geologic interpretation of radiological data according to determinations of the absolute age of rocks]: Akad. Nauk SSSR Izv. Ser. Geol., no. 1, p. 26-40, 1962.

The determination of the true age of rocks is complicated by the fact that various endogene and exogene factors can distort the ratios of radioactive elements to their decay products. In the case of igneous rocks, subsequent metamorphism is the chief factor leading to discrepancies in absolute dating. A detailed study of the geology, petrography, and radioactive age data (accord-

ing to different methods) of igneous rocks of different ages from different parts of the Caucasus leads to the conclusion that the problem of the true absolute age of a rock can be solved only when petrological-mineralogical investigations go hand in hand with the radioactive age determinations.— D.B.V.

- 191-2. Tugarinov, A. I. Geologu - O metodakh opredeleniya absolyutnogo vozrasta gornyykh porod [To the geologist - methods of absolute age determination on rocks]: Moscow, Gosgeoltekhizdat, 80 p., 1961.

The fundamentals of geologic age determination are given for the U and Th, the K-Ar, the Sr-Rb, and the C-14 methods. Brief treatment of common lead isotope variations is included. Calculations are explained with the aid of numerous nomograms and tables, and interpretation of geologic problems is discussed with Saxony and the Ukrainian shield as examples. Data from many other areas are compared and evaluated, geologic time scales are compared, and the selection of proper materials for analysis is discussed. The bibliography has 46 titles.— H.F.

- 191-3. Zhirov, K. K., Shestakov, G. I., and Ivanov, I. B. K voprosu ob interpretatsii tsifr vozrasta po svintsovomu metodu [On the problem of the interpretation of age figures according to the lead method (with English summary)]: Geokhimiya, no. 1, p. 49-55, 1961.

A nomogram is presented that shows the dependence of the age value calculated according to the different lead isotope ratios on the amounts of Pb, U, and Th lost at different times, for minerals having a true age of 1,900 m.y. If Pb is lost, the ages are distributed  $207/206 > 207/235 > 206/238 > 208/232$ ; if equal amounts of Th and U are lost, the distribution becomes  $208/232 > 206/238 > 207/235 > 207/206$ ; if Pb, Th, and U are lost simultaneously and in the same relative amounts, it becomes  $208/232 > 206/238 > 207/235$ ; and if Pb and U are lost simultaneously but in different amounts, the deviation of the 207/206 age from the true age may be either positive or negative, with a maximum of 1,500 m.y. for positive (too high) and 500 m.y. for negative (too low) errors.— D.B.V.

- 191-4. Chernyshev, I. V. Analiz oshibok svintsovogo metoda opredeleniya absolyutnogo vozrasta [Analysis of errors in the lead method of absolute age determination (with English summary)]: Geokhimiya, no. 1, p. 73-81, 1962.

Errors in absolute age determination by the lead isotope method are analyzed in the light of modern theory of errors based on probabilities. Formulas are derived for the calculation of square errors. It is shown that among the errors constituting experimental error, that concerned in calculating the amount of a radiogenically added lead isotope is subject to greatest variation.— D.B.V.

- 191-5. Chernyshev, I. V. Nomogrammy dlya vychisleniya oshibok opredeleniya absolyutnogo vozrasta svintsovyim metodom [Nomograms for calculation of errors in determination of absolute age by the lead method (with English summary)]: Geokhimiya, no. 3, p. 271-279, 1962.

Nomograms for determining the error in lead isotope ages are given, with examples of their use. The ratios of errors of the various lead isotopes for typical cases of ancient monazites and uraninites are treated in detail. It is shown that the degree of accuracy required in the measurement of the Ph, U, and Th contents is proportional to the amounts of radiogenic Pb-206, Pb-207, and Pb-208 that are present; when these amounts are small, errors in their determination do not seriously affect the results. Independently of the accu-

racy of measurement of the isotopic content of the lead, the error in calculation of the age according to the Pb-207/Pb-206 ratio increases abruptly as age decreases for all minerals.—D.B.V.

- 191-6. Hatuda, Zin'itiro, and Nagai, Jiro. Geological age determination by lead: Alpha-ray method I. Determination of alpha-ray activity of zircon: Kyoto Univ. Coll. Sci. Mem., ser. B, v. 28, no. 4, p. 527-538, 1962.

A four-pi gas-flow counter is used to measure the alpha activity. The pulverized sample is mounted between sheets of aluminum. A standard sample was analyzed to check the method.—T.W.S.

- 191-7. Gerling, E[rik] K[arlovich], Shukolyukov, Yu. A., and Matveyeva, I. I. Opredeleniye vozrasta berillov i drugikh mineralov, sodержashchikh vklucheniya, po Rb/Sr metodu [Determination of the age of beryls and other minerals containing inclusions by the Rb/Sr method (with English summary)]: Geokhimiya, no. 1, p. 67-72, 1962.

The K, Rb, and Sr contents of 6 beryls, 2 tourmalines, and 1 quartz ranging in age from 350 to 2,400 m.y. were determined by the isotopic dilution method. Microinclusions containing a gaseous and a liquid phase were present in all the samples. Micas from the same formations as these minerals were dated by the K-Ar method. The ages obtained for the beryls and tourmalines by the Rb-Sr method differ widely from the K-Ar ages. This is attributed to the capture of strontium of anomalous isotopic composition by the tourmalines and beryls during crystallization. The Sr-87/Sr-88 ratios of the strontium trapped in 3 beryls from the same region, from rocks whose micas gave similar K-Ar ages, differ from each other by about 10 percent. The strontium in tourmaline from the Belomor'ye differs by 64 percent from the usual isotopic composition.—D.B.V.

- 191-8. Yashchenko, M. L., Varshavskiy, E. S., and Gorokhov, I. M. Ob anomal'nom izotopnom sostave strontsiya v mineralakh iz metamorfizovannykh porod [On the anomalous isotopic composition of strontium in minerals from metamorphic rocks (with English summary)]: Geokhimiya, no. 5, p. 420-425, 1961.

Anomalously high Rb-Sr ages for minerals from metamorphic rocks have been reported by Gerling and others (see Geophys. Abs. 188-71, -76). This paper investigates the effect of secondary processes on enrichment in radiogenic strontium. If the crystal lattice of a mineral is only partly reconstructed during secondary processes, anomalously high ages can result in the following ways: (1) rubidium and radiogenic strontium are retained in the lattice of the secondary mineral while common strontium is left over and removed; in this case the age given by the secondary mineral is really that of the primary mineral. (2) Rubidium is only partly retained in the secondary mineral; in this case the total amount of strontium and the ratio between radiogenic and common strontium may either change or may remain as before. If the latter, the presence of common strontium in minerals permits calculation of the true age of the formation of the secondary mineral, assuming that no additional strontium has been introduced from without. A formula is derived for this calculation.

Study of two series of minerals from the Kola Peninsula confirms these considerations. In one series, microcline and lepidolite give Rb-Sr ages of about 2,700-2,800 m.y., the albite -  $5,170 \pm 180$  m.y.; using the formula the age of albitization is calculated as 2,830 m.y. A K-Ar age of 1,830 m.y. for the lepidolite may represent a later metamorphism; muscovites from other pegmatites in the area give K-Ar ages that confirm the Rb-Sr dates. In the other series, feldspar from a greisenized granite gneiss gives an anomalously high Rb-Sr age of 3,890 m.y. while muscovite from the same rock is dated as 2,000 m.y. by the Rb-Sr method and 1,990 m.y. by the K-Ar method.—D.B.V.

- 191-9. Hart, S[tanley] R., and Dodd, R. T., Jr. Excess radiogenic argon in pyroxenes: Jour. Geophys. Research, v. 67, no. 7, p. 2998-2999, 1962.

Potassium-argon age determinations on two samples of pyroxenes from Bear Mountain, N. Y., yield results that are obviously too high. These results are explained as being due to the incorporation of radiogenic argon in the pyroxenes during crystallization.— E.J.C.

- 191-10. Cherdyntsev, V. V. Argon - opredelitel' geologicheskogo vozrasta [Argon - the determiner of geologic time]: Priroda, no. 6, p. 42-44, 1962.

An historical review is given of the K-Ar method of absolute age determination commemorating the award of the Lenin Prize to A. A. Polkanov and E. K. Gerling.— H.F.

- 191-11. Sardarov, S. S. Energiya svyazi i sokhrannost' radiogenogo argona v slyudakh [Bond energy and retention of radiogenic argon in micas (with English summary)]: Geokhimiya, no. 1, p. 30-38, 1961.

It is shown that the probability that Ar-40 will leave the muscovite lattice is practically zero. Ar-40 is lost only when the bound water leaves the lattice, or in other words, when the lattice begins to be destroyed.— D.B.V.

- 191-12. Gerling, E[rik] K[arlovich], Morozova, I. M., and Kurbatov, V. V. O sokhrannosti radiogenogo argona v izmel'chennykh kalisoderzhashchikh mineralakh [On the retention of radiogenic argon in pulverized potassium-bearing minerals (with English summary)]: Geokhimiya, no. 1, p. 39-48, 1961.

The effect of grinding on the retention of radiogenic argon in mica and microcline was studied. Mica samples were ground in a mortar, filed, and cut with scissors; microcline was ground in a mortar. The values of the activation energy (E) of the radiogenic argon liberated were determined for all particle sizes. The mica lost about 30 percent of its radiogenic argon; the muscovite from 20 to 70 percent. X-ray photographs show that structural changes are produced in the minerals as a result of grinding. (See also Geophys. Abs. 188-23.)— D.B.V.

- 191-13. Kuz'min, A. M. O sokhrannosti argona v mikroklivne [On the retention of argon in microcline]: Geokhimiya, no. 5, p. 456-458, 1961.

Deformation of the alkali feldspar in magmatic rocks as a result of pneumatolytic or hydrothermal processes, lowering of hydrostatic pressure in the rock, and supergene waters near the earth's surface all bring about, to one degree or another, losses of radiogenic argon and potassium that correspondingly affect the accuracy of K-Ar dating of rocks according to such feldspars.— D.B.V.

- 191-14. Murina, G. A., and Sprintsson, V. D. O sokhrannosti radiogenogo argona v glaukonitakh [On retention of radiogenic argon in glauconites]: Geokhimiya, no. 5, p. 459-462, 1961.

The relationship of argon retention in glauconites to natural grain size was investigated using four samples of known stratigraphic age with grain sizes of 0.25-1,  $\sim$ 0.01, 0.25-0.1, and  $\sim$ 0.01 mm, respectively, the last two being from the same rock. The results show that argon retention in glauconites is independent of grain size.

Further heating experiments show that argon is released only upon destruction of the glauconite crystal lattice. It is concluded that argon retention in glauconites is as good as in micas.—D.B.V.

- 191-15. Ovchinnikov, L. N., Kelarev, V. V., Panova, M. V., Dunayev, V. A., Shangareyev, F. L., and Osadchaya, R. I. K voprosu o sokhranosti argona v slyudakh [On the problem of argon retention in micas]: *Geokhimiya*, no. 8, p. 704-710, 1959.

The relation of argon retention to the degree of hydration of biotite has been studied experimentally. It is concluded that under normal conditions, changes in the crystal lattice caused by hydration do not affect the retention of argon in biotite. Upon heating, however, most of the argon in hydromicas is lost more easily and at a lower temperature than that in unaltered biotite; the greater the degree of hydration, the greater is the loss on heating.—D.B.V.

- 191-16. Overstreet, W[illiam] C., Stern, Thomas W., Ansell, Charles, and Westley, Harold. Lead-alpha ages of zircon from North and South Carolina: U.S. Geol. Survey Prof. Paper 450-C, Art. 88, p. C81, 1962.

Ages were determined at  $300 \pm 45$  m.y. for zircon from a syenite pegmatite at Zirconia, N. C., and at  $270 \pm 30$  m.y. for zircon from vermiculite at Tiger-ville, S. C. Other zircon crystals from the same sources were previously dated as  $280 \pm 30$  and  $255 \pm 30$  m.y. [see *Geophys. Abs.* 188-39].—Authors' abstract

Doe, Bruce R. Relationships of lead isotopes among granites, pegmatites, and sulfide ores near Balmat, New York. See *Geophys. Abs.* 191-415.

- 191-17. Winkler, Erhard M. Radiocarbon ages of postglacial lake clays near Michigan City, Indiana: *Science*, v. 137, no. 3529, p. 528-529, 1962.

Two radiocarbon dates were obtained for postglacial clays. One sample, 6,350 yr old, was taken from a bed of compacted and carbonized wood just above a bed of pebbly clay. Overlying the woody bed is 5 1/2 feet of organic bluish clays and beach sands near the present lake level. The upper clay layer contained a younger wood sample 5,475 yr old. The blue clays are of shallow swamp origin and were deposited during the late low-water stage of Lake Chipewewa; the pebbly clay is assumed to be of Glenwood age (about 11,000 yr) or older.—Author's abstract

- 191-18. Pearson, Robert C.; Tweto, Ogden; Stern, Thomas W., and Thomas, Herman H. Age of Laramide porphyries near Leadville, Colorado: U.S. Geol. Survey Prof. Paper 450-C, Art. 87, p. C78-C80, 1962.

Potassium-argon ages on biotite from the successive Pando, Johnson Gulch, and Lincoln porphyries of the Leadville area, Colo. are 70, 41, and 64 m.y., respectively, and that of granodiorite from the north Sawatch Range is 70 m.y. The aberrant age of 41 m.y. for the Johnson Gulch porphyry is believed to be a result of later heating during mineralization or intrusion.—V.S.N.

- 191-19. Hurley, P[atrick] M., Fairbairn, H[arold] W., Pinson, W[illiam] H., Jr., and Hower, J. Unmetamorphosed minerals in the Gunflint formation used to test the age of the Animikie: *Jour. Geology*, v. 70, no. 4, p. 489-492, 1962.

A potassium-bearing mixed-layer clay from the Gunflint formation near Port Arthur, Ontario, was dated by the K-Ar and Rb-Sr methods at approximately 1,600 m.y. Biotite from the granite basement complex was dated at

2,570 (K-Ar) and 2,365 (Rb-Sr) m.y. The age of the Gunflint formation is suggested to be 1,900 m.y. on the basis of an empirical correction applied to the determined age of the clay mineral.— C.E.H.

- 191-20. Rosholt, J[ohn] N., Emiliani, C[esare], Geiss, J[ohannes], Koczy, F[ritz] F., and Wangersky, P. J. Pa-231/Th-230 dating and O-18/O-16 temperature analysis of core A254-BR-C: *Jour. Geophys. Research*, v. 67, no. 7, p. 2907-2911, 1962.

Oxygen-18/oxygen-16 paleotemperature analysis of core A254-BR-C from the central Caribbean Sea has yielded a temperature curve similar to the temperature curves previously obtained from other cores from the same area. Pa-231/Th-230 dating of significant temperature events has yielded a set of dates that are identical, within the limits of error of the analytical methods and of the stratigraphic correlations, to the set of dates previously obtained from the Caribbean deep-sea cores A240-M1 and A179-4.— Authors' abstract

- 191-21. Pinson, W[illiam] H., Jr., Hurley, P[atrick] M., Mencher, E., and Fairbairn, H[arold] W. K-Ar and Rb-Sr ages of biotites from Colombia, South America: *Geol. Soc. America Bull.*, v. 73, no. 7, p. 907-910, 1962.

Age analysis of biotites from eight samples of crystalline rocks either exposed at the surface or encountered in oil well drilling gave similar K-Ar and Rb-Sr results of approximately 110, 470, and 1,200 m.y. These ages are thought to represent the ages of three orogenic events that resulted in the emplacement of the granites of the north-south arch of northern Colombia and in the formation of the crystalline rocks of the Macarena Mountains basement and the western part of the Guayana shield.— R.F.M.

- 191-22. Curtis, G[arniss] H., and Evernden, J[ack] F. Age of basalt underlying Bed I, Olduvai: *Nature*, v. 194, no. 4828, p. 611-612, 1962.

Two rock samples of the basalt underlying Bed I, Olduvai, Tanganyika, were analyzed by K-Ar methods. Ages of 4.2 and 1.7 m.y. were obtained. These dates and the 1.3 m.y. value previously reported by von Koenigswald (see *Geophys. Abs.* 190-17) are interpreted as being at least 4.2 m.y., and as being an unsuitable material for K-Ar dating. Petrographic evidence supports the latter conclusions.— C.E.H.

- 191-23. Miller, John A. The potassium-argon ages of the Skiddaw and Eskdale granites: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 3, p. 391-393, 1962.

Potassium-argon measurements by the total volume method give the ages of biotites from the Skiddaw and Eskdale granites of the English Lake District as  $399 \pm 6$  and  $383 \pm 2$  m.y., respectively.— D.B.V.

- 191-24. Miller, John, A., Shibata, Ken, and Munro, Mary. The potassium-argon age of the lava of Killerton Park, near Exeter: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 3, p. 394-396, 1962.

Potassium-argon age determinations on samples of biotite from the Killerton Park lava using both the total volume and isotope dilution techniques have yielded an age of  $279 \pm 6$  m.y.— Authors' summary

- 191-25. Komlev, L. V., Savonenkov, V. G., Danilevich, S. I., Ivanova, K. S., Kuchina, G. N., and Mikhalevskaya, A. D. O geologicheskome znachenii regional'nykh protsessov omolozheniya v drevnykh format-siyakh yugo-zapada Ukrainского kristallicheskogo shchita [On the

geologic significance of regional processes of rejuvenation in the ancient formations of the southwest Ukrainian crystalline shield (with English summary): *Geokhimiya*, no. 3, p. 195-206, 1962.

The lead isotope method gives an age of  $2,000 \pm 100$  m.y. for accessory monazites from rocks in the Pobuzh'ya and Podolya regions of the Ukrainian shield; the K-Ar method gives ages ranging from 1,500 to 1,750 m.y. for micas from different rocks in the same area. The micas were rejuvenated in the late Proterozoic epoch of intensive metamorphism connected with the formation of the granites of the Uman complex; the latter have been dated by both the argon and strontium methods as  $1,500 \pm 50$  m.y. A geochronological map of the central Ukraine is given.—D.B.V.

- 191-26. Gol'denfel'd, I. V. K voprosu o vydelenii dvykh raznovozrastnykh grupp v arkheye yugo-zapada Ukrainy [On the problem of distinguishing two groups of different age in the Archean in southwest Ukrainian SSR (with English summary)]: *Geokhimiya*, no. 6, p. 475-481, 1962.

Absolute age determinations made by the lead isotope method on 5 specimens of monazite from the Chudново-Berdichev group and on 11 monazites from the charnockite formation in southwestern Ukrainian S.S.R. show that the former is  $2,260 \pm 130$  m.y. old and the latter  $2,040 \pm 120$  m.y. old. Results are tabulated. The deviation of values obtained by the different isotope ratios for the same specimen is generally within experimental error.—D.B.V.

- 191-27. Slepnev, Yu. S., and Shanin, L. L. Absolyutnyy vozrast redkometal'nykh pegmatitov V. Sayana [Absolute age of the rare-metal pegmatites of the eastern Sayan (with English summary)]: *Geokhimiya*, no. 1, p. 55-59, 1961.

The geology of the rare-metal pegmatites of the eastern Sayan is outlined briefly. They have been dated as 1,700-1,800 m.y. by K-Ar determinations on muscovite and as 1,300 m.y. by K-Ar determinations on microcline. The muscovite age is taken as the more accurate due to incomplete argon retention by the microcline.—D.B.V.

- 191-28. Nagai, Jiro. Age of Hiei granite determined with zircon and lead-alpha method: *Kyoto Univ. Coll. Sci. Mem.*, ser. B, v. 28, no. 4, p. 471-483, 1962.

An age of 111 m.y. was obtained on zircon from the Hiei granite, Uryu-Yama, Kitashirakawa, Kyoto Prefecture, Japan by the lead-alpha method. Samples from two other Japanese localities were dated, but the ages are not considered reliable. The Th/U ratio and the alpha activity were determined by counting techniques and the lead was determined by spectrochemical analyses.—T.W.S.

- 191-29. Compston, W., and Pidgeon, R. T. Rubidium-strontium dating of shales by the total-rock method: *Jour. Geophys. Research*, v. 67, no. 9, p. 3493-3502, 1962.

Rubidium-strontium measurements on total-rock samples of three shale formations from Australia are reported. Sr-87/Sr-86 plotted against the ratio of Rb-87/Sr-86 give a minimum of 420 m.y. and a maximum of 430 m.y. for the State Circle shale of known Early Silurian age from the Canberra District. Samples of the Cardup shale from Western Australia were found to be variable, suggesting differences in the initial Sr-87/Sr-86 ratio throughout the formation and making it impossible to calculate a meaningful age. Specimens of meta-sediments from the Binjura beds west of Cooma, N. S. W., give a minimum of 395 m.y. and a maximum of 460 m.y. A Silurian age for the Binjura formation is suggested.—S.S.G.

Komovskiy, G. F. Thermoluminescence of stone meteorites. See Geophys. Abs. 191-48.

Baranov, V. I., and Knorre, K. G. Age and evolution of meteorite and terrestrial matter in the light of subsequent investigations. See Geophys. Abs. 191-30.

## COSMOGONY

- 191-30. Baranov, V. I., and Knorre, K. G. Vozrast i evolyutsiya meteoritnogo i zemnogo veshchestva v svete poslednikh issledovaniy [Age and evolution of meteorite and terrestrial matter in the light of subsequent investigations]: Akad. Nauk SSSR Meteoritika, no. 21, p. 15-31, 1961.

Present knowledge does not deny the possibility that terrestrial and meteoritic matter were formed in an identical and possibly the same process of nucleogenesis. During formation of the earth and also of the large meteorites and asteroids there was an initial differentiation of Fe, U, and Pb. The maximum known age of terrestrial minerals is 3.5 b.y., which is a lower limit to the age of the earth. The upper limit of the earth and of the meteorites is not more than 6 b.y. The lead isochron method indicates that the beginning of accumulation of the radiogenic isotopes Pb-206 and Pb-207 in rocks was about 4-4.5 b.y. ago. This indicates that the main processes of differentiation and agglomeration ended at this time.—J.W.C.

- 191-31. MacDonald, Gordon J. F. On the internal constitution of the inner planets: Jour. Geophys. Research, v. 67, no. 7, p. 2945-2974, 1962.

The internal structures of the moon, Mars, Venus, and Mercury are examined in the light of what is known about the constitution of the earth. It is concluded that the inner planets differ both in the abundances of the heavy elements and in the abundances of K, U, and Th. Chondrites may provide a satisfactory chemical model for the earth but not for the other inner planets; Venus is a possible exception, but only on the grounds of our ignorance of its internal constitution.—D.B.V.

- 191-32. Potapov, I. I. K probleme proiskhozhdeniya Zemli [On the problem of the origin of the earth]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 1, p. 3-18, 1962.

This is a summary of recent knowledge concerning the origin of the earth based on a review of works published in the last decade or so by Russian authors. The formation of the earth is inseparably linked to the genesis of atoms of the heavy and radioactive elements.—D.B.V.

- 191-33. Weinreb, Sander. A new upper limit to the galactic deuterium-to-hydrogen ratio: Nature, v. 195, no. 4839, p. 367-368, 1962.

The deuterium-to-hydrogen ratio  $N_D/N_H$  is of astrophysical interest because it will give information on the composition and nucleogenesis of the interstellar medium. Attempts to observe deuterium absorption in the Cassiopeia A radio source lead to the conclusion that the minimum detectable  $N_D/N_H$  should be raised to about 1/13,000 and that the  $N_D/N_H$  in the region examined is less than half the terrestrial value.—D.B.V.

- 191-34. Briggs, Michael, H. Recent advances in the investigation of meteorites: Science Progress, v. 50, no. 199, p. 376-387, 1962.

The fundamental properties of meteorites are summarized briefly followed by a discussion of recent advances in knowledge of the chemistry of meteorites.

rites, the relationship of meteorites to comets and meteors, and the probable origin of meteorites.— V.S.N.

- 191-35. Pearson, Ronald. Life-forms in carbonaceous chondrites: *Nature*, v. 194, no. 4833, p. 1064-1065, 1962.

It is suggested that the organized elements in carbonaceous chondrites reported by Claus and Nagy (see *Geophys. Abs.* 187-60) may be contaminating pollen grains, and that the simplest explanation that these structures are of terrestrial origin should be disproved before moving on to more elaborate hypotheses.— D.B.V.

- 191-36. Gregory, P. H. Identity of organized elements from meteorites: *Nature*, v. 194, no. 4833, p. 1065, 1962.

It is pointed out that the elements found by Nagy, and others (see *Geophys. Abs.* 189-51) in the Orgueil and Ivuna meteorites could well be terrestrial spores.— D.B.V.

- 191-37. Palik, P. Further life-forms in the Orgueil meteorite: *Nature*, v. 194, no. 4833, p. 1065, 1962.

Some test material derived from the Orgueil meteorite, obtained from Claus and Nagy (see *Geophys. Abs.* 187-60), was crushed and examined under the microscope. Six different filamentous formations were found; they are reminiscent of algae, and part of them may possibly be indigeneous to the meteorite.— D.B.V.

- 191-38. Vdovykin, G. P. Bitумы uglistykh khondritov Groznaya i Migei [Bitumens of the carbonaceous chondrites Grosnaya and Mighei (with English summary)]: *Geokhimiya*, no. 2, p. 124-139, 1962.

The bitumen content of the Grosnaya and Mighei carbonaceous chondrites was determined quantitatively by cold extraction and analyzed by means of luminescent-bituminological, chemical, and spectral methods. It was found that they are mainly represented by the light reduced part, are aliphatic, but also contain an acid part. The bitumens from Grosnaya are low in C and H. The formation of the bitumen inclusions occurred by polymerization upon condensation of the meteoritic matter in a reducing environment at rather low temperatures (300°C).— D.B.V.

- 191-39. Vinogradov, A. P. Atomnyye rasprostranennosti khimicheskikh elementov solntsa i kamennykh meteoritov [Atomic abundances of the chemical elements of the sun and stony meteorites (with English summary)]: *Geokhimiya*, no. 4, p. 291-295, 1962.

Comparison of experimental data shows that the atomic abundances of the sun and of stony meteorites are similar. In both cases the abundances without exception are regulated by the Oddo-Harkins rule and by the law of decrease from light to heavy elements within each vertical column of the periodic table. This shows that the material of the planets in the solar system was ejected directly from the sun, or in other words, was not captured from other regions of the galaxy. Differences in composition of the planets are due to secondary processes related to differentiation of meteoritic material, especially changes in the ratio of the silicate to iron phases.— D.B.V.

- 191-40. Hinterberger, H., König, H., and Wänke, H. Uredelgase im Meteoriten Breitscheid [Primordial rare gases in the meteorite Breitscheid (with English summary)]: *Zeitschr. Naturforschung*, v. 17a, no. 4, p. 306-309, 1962.

Primordial rare gases have been found in the dark portions of the chondrite Breitscheid in the amounts of  $179 \times 10^{-6} \text{cm}^3 \text{STP/g He}$  and  $221 \times 10^{-8} \text{cm}^3 \text{STP/g Ne}$ . The isotopic compositions of these gases have been determined by subtracting the amounts of radiogenic and cosmic-ray-produced rare gases measured in the light portions. Possible alterations of the isotopic abundances of the primordial rare gases in the time interval between the end of nucleosynthesis and their capture in the meteoritic matter are discussed. The radiogenic helium age of the meteorite has been determined to be 1.63 b.y.—D.B.V.

- 191-41. Yanvel', A. A. O zavisimosti struktury zheleznykh meteoritov ot khimicheskogo sostava i usloviy kristalizatsii [On the dependence of the structure of iron meteorites on chemical composition and conditions of crystallization]: Akad. Nauk SSSR Meteoritika, no. 20, p. 114-120, 1961.

The problem of the origin of meteorites is discussed from the point of view of phase transformations in artificial alloys. A correlation is sought between the contents of Ga, Ge, and Ni in iron meteorites using a graph of the width of kamacite rods plotted against the percentage of Ni.—A.J.S.

- 191-42. Kvasha, L. G. Nekotoryye dannyye o stroenii khondritov [Some data on the structure of chondrites]: Akad. Nauk SSSR Meteoritika, no. 20, p. 124-136, 1961.

The results of microscopic investigation of 60 chondrites from the collection of the Academy of Sciences of the U.S.S.R. are reported. Particular attention is given to the structure of particles of metallic iron and troilite and to a correlation between the content of metallic iron and the iron content of the silicates. A new term "meteoritography" is proposed to designate the branch of meteoritics that deals with the structure of meteorites.—A.J.S.

- 191-43. Kashkay, M. A., and Aliyev, V. I. Struktura i veshchestvennyy sostav Yardymlynskogo zheleznoy meteoritnoy dozhdya [Structure and composition of the Yardymly iron meteoritic shower]: Akad. Nauk SSSR Meteoritika, no. 20, p. 137-162, 1961.

Fragments recovered from the meteorite shower at Yardymly in the Azerbaijan S.S.R., November 24, 1959 are described. Six specimens weighing 127, 11.3, 5.9, 5.7, 2.3, and 0.36 g were found, and the fusion crust, mineralogical and chemical composition, and magnetic properties were investigated for three of these.—A.J.S.

- 191-44. Levskiy, L. K. Kosmogennyye izotopy v Yardymlynskom meteorite [Cosmogenic isotopes in the Yardymly meteorite]: Geokhimiya, no. 4, p. 358, 1961.

The results of determinations of the isotopic composition and isotope ratios of cosmogenic argon, helium, and neon in the Yardymly iron meteorite, which fell on November 24, 1959, are tabulated along with those of the Sikhote-Alin meteorite for comparison.—D.B.V.

- 191-45. Wänke, H. Scandium 45 als Reaktionsprodukt der Hohenstrahlung in Eisenmeteoriten. II [Scandium-45 as a cosmic-ray reaction product in iron meteorites, pt. 2]: Zeitschr. Naturforschung, v. 15a, no. 11, p. 953-964, 1960.

The scandium content of 24 samples from 11 different iron meteorites was measured. Comparison with the ratios of the cosmic ray spallation products He and Ne suggests that the scandium was formed in the same way. The cosmogenic fraction is  $4.6 \times 10^{-9} \text{g Sc per g}$ , compared to a noncosmogenic fraction

of  $2 \times 10^{-10}$  g Sc per g. Scandium cannot be lost by diffusion as can He and the other inert gases.

Scandium in iron meteorites serves as a monitor for particles with energies of 200-1,000 Mev. From the relative concentration of Sc to Ne, it was possible to calculate the minimum fraction of particles with energies below 1 GeV with respect to the total intensity of cosmic radiation; it was found that there must have been at least 2.1 times as many particles with energies below 1 GeV as those with energies higher than 1 GeV. A total intensity value of 0.65 particles per  $\text{cm}^2$  sec sterad was obtained. These figures are mean values for the total time that the meteorites were exposed to cosmic radiation, and of the space traversed by the meteorites.—D.B.V.

- 191-46. Starik, I. Ye., Sobotovich, E. V., Lovtsyus, G. P., Shats, M. M., and Lovtsyus, A. V. K voprosu ob isotopnom sostave svintsa zheleznnykh meteoritov [On the problem of the isotopic composition of lead of iron meteorites]: Akad. Nauk SSSR Meteoritika, no. 20, p. 103-113, 1961.

The lead found in iron meteorites is considered to represent most typically the isotopic composition of primordial lead. The percentage and isotopic composition of the lead of 14 iron meteorites is presented in tables. These samples can be divided into two groups: one (5 meteorites) which contain primordial lead, and one (9 meteorites) which contains ordinary lead. No samples of intermediate isotopic composition were found, which is interpreted as indicating at least two parent bodies for the meteorites.—A.J.S.

- 191-47. Alekseyeva, K. N., and Tovarenko, K. A. Dielektricheskaya postoyannaya kamennykh meteoritov [The dielectric constant of stone meteorites]: Akad. Nauk SSSR Meteoritika, no. 20, p. 121-123, 1961.

The dielectric constant was measured for several stone meteorites and compared with measurements made on ultrabasite. A value of 49 was obtained for the Yelenovka chondrite, 14.3 for the Pianto Mountains chondrite, 15 for the Norton Country achondrite, and 20 for ultrabasite. Their respective volumetric electrical conductivities were found to be  $8 \times 10^{-6}$ ,  $7 \times 10^{-9}$ ,  $1.3 \times 10^{-8}$ , and  $3 \times 10^{-8}$  ohm $^{-1}$ /cm $^{-1}$ .—A.J.S.

- 191-48. Komovskiy, G. F. Termolyuminestsentsiya kamennykh meteoritov [Thermoluminescence of stone meteorites]: Akad. Nauk SSSR Meteoritika, no. 21, p. 64-70, 1961.

Natural and artificial thermoluminescence curves were determined for three meteorites of known age. The thermoluminescence age is in agreement for one of these but is low for the other two. The peaks of maximum intensity on the curves of artificial luminescence are shifted toward the lower temperature side with respect to the peaks for natural thermoluminescence. The shapes and areas beneath the curves are similar, however.—J.W.C.

- 191-49. Vinogradov, A. P., Zadorozhnyy, I. K., and Knoppe, K. G. Ob argone v meteoritakh [On argon in meteorites]: Akad. Nauk SSSR Meteoritika, no. 18, p. 92-97, 1960.

On the basis of the fact that the ratio Ar-36/Ar-38 in meteorites of all classes is different from that in the earth's atmosphere, and from a comparison of the absolute age of meteorites determined by their ratios Pb/U, Rb/Sr, and Ar/K with that determined from residual radioactive isotopes He-3/H-3 and Ar-38/Ar-39, information is sought on whether the intensity of cosmic irradiation for each meteorite during the period of its cosmic life is the same. On the assumption that the argon found in 6 iron meteorites studied is all of ter-

restrial origin, the age of 17 chondrites and 11 achondrites determined from the ratios Ar-36/Ar-38 and Ar-40/Ar-36 was found to range between 0.65 and 4.5 b.y. for chondrites, and between 0.56 and 4.4 b.y. for achondrites.—A.J.S.

- 191-50. Ceplecha, Zd. Note on the mass determination of the Přebam meteorites: Central Astron. Inst. Czechoslovakia Bull., v. 11, no. 4, p. 164, 1960.

From computations of the coordinates and brightness of 17 trails of the multiple meteorite fall at Přebam, the masses of the meteorites and their approximate impact locations were determined. The computed masses range from 100 kg to less than 10 g. One meteorite fragment of 420 g was found.—A.J.S.

- 191-51. Ceplecha, Zd. Multiple fall of Přebam meteorite photographed: Central Astron. Inst. Czechoslovakia Bull., v. 12, no. 2, p. 21-47, 1961.

This is a detailed determination of the Přebam multiple meteorite fall trajectories and of the position of impacts of individual meteorites. The results given in the preliminary paper (see Geophys. Abs. 191-50) were not confirmed, and the mass of the main meteorite was found uncertain. Four meteorites have been found and are described: Luhy, 4.48 kg; Velka I, 0.08 kg; Hojsin, 0.42 kg; and Drazkov, 104 g.—A.J.S.

- 191-52. Vronskiy, B. I. Meteorit El'ga [Elga meteorite]: Priroda, no. 9, p. 90-91, 1961.

The Elga iron meteorite was found near the Elga River, a tributary of the Indigirka River in eastern Siberia on August 28, 1959. Petrographic examination revealed chondrules of 1-5 mm that consist largely of potassium-sodium feldspar and monoclinic pyroxene. The meteorite was found in alluvium at a depth of 20 m. Its specific gravity is 6.2, and its total weight 28.8 kg.—A.J.S.

- 191-53. Fesnekov, V. G. O prirode komet i usloviyakh padeniya ikh na zemlyu [Nature of comets and the conditions of their fall on the earth]: Akad. Nauk SSSR Meteoritika, no. 21, p. 3-14, 1961.

The physical characteristics of comets are discussed, and the effect of their collision with the earth is indicated. The Tungus phenomenon is regarded as such a collision with a small comet. The intensity of the explosions, the anomalous luminescence in the night sky, and the absence of meteorite fragments are compelling evidence for this interpretation.—J.W.C.

- 191-54. Iddis, G. M., and Karyagina, Z. V. Okometnoy prirode Tungusskogo meteorita [The comet nature of the Tungus meteorite]: Akad. Nauk SSSR Meteoritika, no. 21, p. 32-43, 1961.

On a basis of the night sky luminescence, geomagnetic phenomena, and other observations, calculations are made as to the velocity, size, mass, and energy of the Tungus explosion. The mass is placed at  $10^6$  tons, and the energy at  $2 \times 10^{23}$  ergs.—J.W.C.

- 191-55. Ivanov, K. G. Ob energii vzryva Tungusskogo meteorita [Energy of explosion of the Tungus meteorite]: Akad. Nauk SSSR Meteoritika, no. 21, p. 44-45, 1961.

The time required for the shock wave of the Tungus explosion to reach the ionosphere at a height of 80 km and to induce a geomagnetic variation was 140 sec. Relating these values to the density and thickness of the atmosphere, the energy of the explosion is calculated to have been  $(3-5) \times 10^{23}$  ergs.—J.W.C.

- 191-56. Ivanov, K. G. Geomagnitnyye yavleniya, nablyudavshchiesya na Irkutskoy magnitnoy observatorii vsled za vzryvom Tungusskogo meteorita [Geomagnetic phenomena observed at the Irkutsk magnetic observatory after the Tungus meteorite]: Akad. Nauk SSSR Meteoritika, no. 21, p. 46-48, 1961.

Variations in the H, Z, and D components of the magnetic field of the earth were examined on the records of the Irkutsk observatory for the two-hour period following the Tungus explosion on June 30, 1908. The largest variation was in the H component. An increase in this component began 140 sec after the explosion and reached a value of 20 gammas within 20 min. A 12-min interval of no change followed, and then the value dropped 67 gammas during the next 54 min. The change in the Z component was similar but less intense. No variation was observed in D. The absence of any geomagnetic disturbance at the Sverdlovsk, Pavlov, and Tbilisi observatories indicates that the disturbance recorded at Irkutsk was due to the explosion.—J.W.C.

- 191-57. Obashev, S. O. O geomagnitnom effekte Tungusskogo meteorita [Geomagnetic effect of the Tungus meteorite]: Akad. Nauk SSSR Meteoritika, no. 21, p. 49-51, 1961.

The question as to whether the head or the tail of the comet caused the magnetic disturbance in connection with the Tungus explosion is discussed. The effect of the tail has been compared to that of a plasma stream coming from the sun. This explanation is little likely, however, because the onset time of the geomagnetic disturbance was 140 sec after the explosion. Assuming that explosion of the head of the comet produced a considerable volume of plasma, calculations are made of the lag in time between the explosion and the onset of a geomagnetic disturbance. A value of 3.9 min is obtained, which is of the correct order of magnitude.—J.W.C.

- 191-58. Plekhanov, G. F., Kovalevskiy, G. F., Zhuravlev, V. K., and Vasil'yev, N. V. O vliyanií vzryva tungusskogo meteorita na geomagnitnoye pole [The effect of the explosion of the Tungus meteorite on the geomagnetic field]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 6, p. 94-96, 1961.

From magnetograms of geomagnetic disturbances for the period from June 25 to July 5, 1908 obtained from 18 magnetic observatories throughout the world, only the observatory at Irkutsk in central Siberia nearest the Tungus meteorite locality (900 km) showed the effect of the meteorite explosion on the geomagnetic field. The disturbance due to this explosion was found to be similar to those due to the nuclear explosions over Johnston Island in the Pacific Ocean. The disturbances were marked by sudden commencements, by similar forms of H-curves and Z-curves (for Honolulu and Fenning), and by a local character (Guam observatory at 4,000 km from Johnston Island did not register any disturbance due to nuclear explosions). A geomagnetohydraulic phenomenon is proposed to explain the disturbances.—A.J.S.

- 191-59. Bronshten, V. A. K voprosu o dvizhenii v atmosfere Tungusskogo meteorita [On the problem of motion in the atmosphere of the Tungus meteorite]: Akad. Nauk SSSR Meteoritika, no. 20, p. 72-86, 1961.

Studies of the fall of the Sikhote-Alin meteorite have indicated that a meteorite cannot reach the surface of the earth if it approaches the earth with a velocity higher than 20 km/s, independently of the initial mass of the meteorite. The method used in the analysis of the fall of Sikhote-Alin meteorite is applied to the fall of the Tungus meteorite. The result shows that the initial mass of the Tungus meteorite was of the order of  $10^6$  tons, its initial velocity of entry into the atmosphere was 28-40 km/s, the velocity of impact was 16-30 km/s, and its impact mass  $(2-7) \times 10^4$  tons.—A.J.S.

- 191-60. Tsikulin, M. A. Priblizhennaya otsenka parametrov Tungusskogo meteorita 1908 g. po kartine razrusheniya lesnogo massiva [An approximate estimate of the parameters of the Tungus meteorite of 1908 according to the picture of destruction of the forest massif]: Akad. Nauk SSSR Meteoritika, no. 20, p. 89-94, 1961.

The parameters of the Tungus meteorite are estimated on a basis of field data (see Geophys. Abs. 184-106). The theory of cylindrical explosion was used; the length of the cylinder was taken to be 3-4 km. The energy of explosion is estimated at  $(1.0-1.6) \times 10^{17}$  ergs per cm and the total energy to be  $(2 \pm 0.5) \times 10^{23}$  ergs per cm. The diameter is calculated to have been 20-130 m, mass - 20,000-400,000 tons, density - 0.3-1.5 g per  $\text{cm}^3$ , and velocity - 10-50 km/s. — A.J.S.

- 191-61. D'yakonova, M. I., and Kharitonova, V. Ya. Khimicheskiy sostav 18 kamennykh meteoritov iz kolleksii Akademii nauk SSSR [Chemical composition of 18 stone meteorites from the collection of the Academy of Sciences of the U.S.S.R.]: Akad. Nauk SSSR Meteoritika, no. 21, p. 52-59, 1961.

This is a continuation of a study of the chemical composition of the meteorites in the collection of the Academy of Sciences of the U.S.S.R. (see Geophys. Abs. 183-58). Data on 17 chondrites and 1 achondrite are presented here. In addition to the 16 components usually reported, the content of CaS (oldhamite) was also determined. — J.W.C.

- 191-62. Vorob'yev, G. G., and Namnandorz, O. Spektrokhimicheskoye issledovaniye mongol'skogo meteorita Noyan-Bogdo [Spectrochemical investigation of the Mongolian meteorite Noyan-Bogdo]: Akad. Nauk SSSR Meteoritika, no. 21, p. 60-63, 1961.

Spectrochemical analysis of the Noyan-Bogdo meteorite, which fell in the Gobi Desert in 1933, places it in the relatively rare group IV of the chondrites. — J.W.C.

- 191-63. Nikolov, N. S. Meteority Bolgarii [Meteorites of Bulgaria]: Akad. Nauk SSSR Meteoritika, no. 21, p. 71-76, 1961.

The history of research on meteorites in Bulgaria is reviewed. The Rasgrad, Virba, Gumoshnik, and Kon'ovo meteorites are discussed from references in the literature. — J.W.C.

- 191-64. Yudin, I. A. O nakhozhdenii meteornoy pyli v rayone padeniya kamennogo meteoritnogo dozhdya Kunashak [On the finding of meteoritic dust in the region of fall of the Kunashak stone meteoritic shower]: Akad. Nauk SSSR Meteoritika, no. 18, p. 113-118, 1960.

Fifteen samples of ground were taken from the area of dispersion of the Kunashak meteoritic shower of 1949. The magnetic fraction was separated and investigated mineralogically. Several thousand magnetic grains were analyzed, but only three spherules and one elongated particle were found to correspond to the structure and mineralogical composition of the outer crust of melted stone meteorites. The four particles are considered to belong to the meteoritic dust blown off the surface of the meteorite during its flight. — A.J.S.

- 191-65. Safronov, V. S. Skol'ko kosmicheskogo veshchestva padayet na Zemlyu [How much cosmic matter falls on the earth]: Priroda, no. 1, p. 127-128, 1962.

Various approaches are presented for estimating the amount of cosmic matter that falls on the earth either sporadically in the form of meteorites or con-

tinuously as meteoric dust. It is estimated that bodies of 1-2 km in diameter fall on the earth once in 300,000 years.—A.J.S.

- 191-66. Taylor, S. R. Fusion of soil during meteorite impact, and the chemical composition of tektites: *Nature*, v. 195, no. 4836, p. 32-33, 1962.

Schwarcz's proposal that tektites result from fusion of soil (see *Geophys. Abs.* 189-59) is of value in directing attention to widespread surficial deposits as possible parent materials, but contains several inherent difficulties, which are discussed. It is suggested that loess is much closer in composition to tektites than other common terrestrial material and is a more likely source.—D.B.V.

- 191-67. Adams, Ernst W., and Huffaker, Robert M. Parent body hypothesis for origin of tektites: *Nature*, v. 195, no. 4842, p. 681-684, 1962.

Experiment and analysis show that button-type australites were derived by aerodynamic heating from initially cold glassy spheres which entered the atmosphere in a nearly horizontal direction with a velocity between 6.5 and 11.2 km/s. Trajectory analysis shows that terrestrial origin of the spheres is impossible. As according to ablation analysis the smallest known buttons must have entered at less than 7 km/s, extraterrestrial origin of such a cluster is impossible.

The existence of limited tektite-strewn fields can be explained if tektites were released as liquid droplets from the ablating surface of a hypothetical parent body in skipping flight through the earth's atmosphere. Ablation analysis shows that such a body must consist of a glassy substance which cannot be generated by fusion of siliceous stone due to aerodynamic heating. Terrestrial origin of such a parent body, even when the material is not in the liquid but in the solid state, would require a violent event of such magnitude as to be unlikely to have ever occurred.—D.B.V.

- 191-68. O'Keefe, John A., Lowman, Paul D., Jr., and Dunning, Kenneth L. Gases in tektite bubbles: *Science*, v. 137, no. 3525, p. 228, 1962.

Neon, helium, and oxygen have been identified, by spectroscopic analysis of light-produced electrodeless discharge, as the main gases in a tektite bubble. The neon and helium have probably diffused into the bubble from the atmosphere because of the high permeability of tektite glass for these gases. This explanation is probably not possible for the oxygen; if so, it may be atmospheric oxygen incorporated into the tektite during its formation.—D.B.V.

- 191-69. Firsoff, V[aldemar] A. *Surface of the Moon - Its structure and origin*: London, Hutchinson and Company, Ltd., 128 p., 1961.

One of the gaps in the understanding and presentation of many lunar problems has been the lack of a concise, comprehensive, and systematic work on the geology of the moon. The object of this book is to fill this gap. The book is divided into three parts as follows: structure of the lunar surface features, origin of the lunar surface features, and selenologia nova. A map and gazetteer of lunar key formations, photographic plates of lunar and terrestrial formations, a lunar tectonic grid map, and other illustrations are included.—V.S.N.

#### EARTH CURRENTS

- 191-70. Yokoyama, Izumi. Relations between the short period changes in geomagnetism and in telluric currents: *Hokkaido Univ., Fac. Sci. Jour.*, ser. 7 (Geophysics), v. 1, no. 5, p. 331-346, 1961.

The relation between changes in the geomagnetic field and in telluric currents with periods of a few scores of minutes is discussed on the basis of data observed at the Centre de Physique de Globe, Dourbes, Belgium. Particular emphasis is given to the anisotropic behavior of changes in the telluric currents in relation to changes in the vertical component of the geomagnetic field. Variations in earth-potential are found to take a strongly predominant direction in marked contrast to geomagnetic variations. Furthermore, analysis of the anomalous behavior of the short period variation of  $\Delta Z$  in relation to the anisotropic behavior of changes in telluric currents shows that the anomalous  $\Delta Z$  variation is closely related to anisotropy of earth conductivity. Brief comments are made also on observations of changes in telluric currents and on the direct measurement of the anisotropic distribution of surface resistivity on Miyake Island, Japan, where anomalous changes in the geomagnetic vertical component have been reported.— V.S.N.

- 191-71. Kebuladze, V. V., and Kiziriya, L. V. Ob ustoychivyykh korotkoperiodicheskikh kolebaniyakh polya zemnykh tokov [Steady short-period oscillations of the field of earth currents]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 86-89, 1962.

The basic characteristics of regular Pc's are examined using fast tellurograms (30 mm/min) of the Dusheti station in the Georgian S.S.R. Regular Pc variations are excited during daylight hours but are absent at night. The diurnal changes of the occurrence frequency of these variations is a function of local mean solar time. The number of hours during which regular Pc variations occur is much less in winter than in summer. The diurnal curve of the occurrence frequency of regular Pc's exhibits two maximums and one minimum, and these coincide with the maximums and the minimum of the diurnal curve of the potential gradient of the  $E_y$  component. The maximum number of starts of regular Pc's is observed during early morning hours. The regular Pc variations exhibit low amplitudes at Dusheti, and a broad range of periods is found.— J.W.C.

- 191-72. Vinogradov, P. A. K voprosu o radiuse deystriya blizhdayushchikh tokov na zapisi variatsiy elektrotelluricheskogo polya [On the problem of the radius of action of stray currents on records of variations of the electrotelluric field]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 2, p. 121-124, 1961.

Experimental data on the radius of action of stray currents due to an electrified section of the East Siberian railroad are discussed. A correlation has been found between the prevalent direction of the potential gradient of the stray currents and potential gradient of the electrotelluric field.— A.J.S.

- 191-73. Vinogradov, P. A. Nekotoryye dannyye o morfologii chastoty poyavleniya kolebaniya Ps i Pt elektromagnitnogo polya Zemli [Certain data on the morphology of the frequency of occurrence of variations of Ps and Pt of the electromagnetic field of the earth]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 7, p. 77-89, 1961.

The frequency and distribution of short period variations, Ps and Pt, of the earth's electromagnetic field are discussed. The data on such variation from 28 stations throughout the world are analyzed and interpreted with respect to morphology.— A.J.S.

- 191-74. Rokityanskiy, I. I. Krivaya glubinnogo magnetotelluricheskogo zondirovaniya (MTZ) po dannym observatorii Borok [Curve of deep magnetotelluric sounding (MTZ) according to data of the Borok Observatory]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 679-680, 1962.

Magnetotelluric studies of the geologic massif at Borok are described, and the results are reported. Diurnal runs of  $E_x$ ,  $E_y$ ,  $H$ ,  $D$ , and  $Z$  are given, and  $E_x/H_y$  and  $E_y/H_x$  values are tabulated for periods of 6-10, 10-30, 30-60, 60-120, 120-240, 720, and 1,440 min variation of  $T$ . The magnetotelluric sounding curve ( $\sqrt{T}$  versus apparent resistivity in ohms per m) is given on a bilogarithmic scale. It was found that the curve splits into two branches for  $T$  less than 3 min. Two possible causes of the splitting are (1) abyssal nonhomogeneity of electric conductivity; and (2) properties of the source of the field. The second variant is considered to be more probable, especially if the variations of ionospheric currents are the source of long-period magnetotelluric variations.—A.J.S.

- 191-75. Horton, C. W., and Hoffman, A. A. J. Power spectrum analysis of the telluric field at Tbilisi, U.S.S.R., for periods from 2.4 to 60 minutes: *Jour. Geophys. Research*, v. 67, no. 9, p. 3369-3371, 1962.

Power spectrums are computed for the east-west and north-south components of the telluric field at Tbilisi, U.S.S.R., over a frequency band corresponding to periods from 2.4 to 60 min. Ten-hour samples for each of four successive days and for each of four successive nights are analyzed, and curves of the average density of the power spectrum are presented. The results suggest that the average spectrum for the east-west component becomes smoother as the total length of the samples increases. On the other hand, the average spectrum for the north-south component shows numerous lines which are more clearly defined at night than at day.—Authors' abstract

- 191-76. Shabanov, B. A., and Gorelov, L. A. Rezul'taty oprobvaniya metoda telluricheskikh tokov v bortovoy zone Prikaspiyskoy vpadiny [Results of testing the method of telluric currents in the border zone of the Peri-Caspian depression]: *Geologiya Nefti i Gaza*, no. 6, p. 37-41, 1960.

Telluric current surveying has been shown to be suitable for study of the relief of the surface of the Permian evaporite deposits in the border zone of the Peri-Caspian depression. This method distinguished all structures that had been recognized by seismic surveying, even the very smallest which are not expressed on the gravity anomaly maps. In comparison with the seismic method the telluric current method has the advantage of tracing a single surface throughout the border zone. Other advantages are the high productivity and low cost. A telluric current party with two field laboratories can cover 2,000 sq km in six months with an average density of 1 point per 3 sq km. The cost of such work is many times less than that of seismic surveying. Several maps of average field intensity  $E$  are presented.—J.W.C.

#### EARTHQUAKES AND EARTHQUAKE WAVES

- 191-77. Kárník, Vít. Epicentre maps for Europe ( $I_0 \geq VI$ , 1901-1955) [with Russian summary]: *Československá Akad. Véd Studia Geophys. et Geod.*, v. 5, no. 2, p. 133-137, 1961.

Five maps are presented, four showing the epicenters of shallow earthquakes ( $h < 60$  km) that occurred in Europe and the Mediterranean area during 1901-55 with intensities of 6 ( $M=4$  to  $4\frac{3}{4}$ ), 7 ( $M=4.8$  to  $5.4$ ), 8 ( $M=5.5$  to  $6.2$ ), and 9 to 11 ( $M=6.3$  to  $8.3$ ); and the fifth showing the location of intermediate ( $h=60-300$  km) and deep-focus ( $h < 300$  km) earthquakes of intensities 6 to 11 during the same period. The principles of construction of the maps are discussed.—D.B.V.

- 191-78. Solonenko, V. P. Gobi-Altayskoye zemletryaseniye [The Gobi-Altay earthquake]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 2, p. 3-27, 1960.

The area of the Gobi-Altay earthquake of December 4, 1957 was studied by airborne and land expeditions. Schematic maps of seismogenetic and neotectonic structures of central Asia and of the seismicity of the Mongolian Peoples Republic are presented, and data on regional magnetic anomalies and on anomalies in the conventional zero-gravity points are given.— A.J.S.

- 191-79. Yoshiyama, Ryoichi. Earthquake near the National Park Hakusan on August 19th, 1961 [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 849-856, 1961.

An earthquake occurred on August 19, 1961 near Hakusan National Park, Honshu, Japan, at lat  $36^{\circ}05' N.$ , long  $136^{\circ}44' E.$  The depth of the hypocenter was  $30 \pm 10$  km, which places it probably at the M-discontinuity. The mechanism at the focus was of the cone rather than the quadrant type. The magnitude of the hypocentral region is estimated roughly from analysis of the time-distance curve and from the push-pull distribution.— V.S.N.

- 191-80. Kishinouye, Fuyuhiko, and Onda, Isao. Field studies of the Kita Mino earthquake on August 19, 1961 [with Japanese abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 857-868, 1961.

The Kita Mino earthquake occurred on August 19, 1961, near the border of Gifu, Fukui, and Ishikawa Prefectures. The magnitude of the earthquake is estimated as 7. Only a few earthquakes have been recorded in this mountainous area in the past, and it is characteristic of them that the number of felt aftershocks is small. The loss of life and property is small because of the rigidity of the structures. Aftershocks are discussed and tabulated and such affects as rockfalls, landslides, earth fissures, overturning and rotation of gravestones, changes in underground water, and disturbances to water in the reservoir are described.— V.S.N.

- 191-81. Osawa, Yutaka. On the damage to buildings during the Kita Mino earthquake of August 19, 1961 [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull. v. 39, pt. 4, p. 869-872, 1961.

The Kita Mino earthquake of August 19, 1961 occurred in a mountainous area of small population density and was not of high intensity; therefore, the damage to houses was comparatively slight. Two types of damage were observed: that produced directly from vibration due to ground motion and that caused by foundation failure which for the most part occurred in houses built on filled ground.— V.S.N.

- 191-82. Hagiwara, Takahiro, and Kayano, Ichiro. Seismological observations of the Kita Mino earthquake, August 19, 1961 and its aftershocks [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 873-879, 1961.

The following data are given for the Kita Mino earthquake of August 19, 1961 by the Japan Meteorological Agency and the U.S. Coast and Geodetic Survey, respectively: 05h33m32s, lat  $36.0^{\circ} N.$ , long  $136.8^{\circ} E.$ ,  $d=40$  km,  $M=7.2$ ; and 05h33m32s, lat  $36.0^{\circ} N.$ , long  $136.5^{\circ} E.$ ,  $d \approx 17$  km,  $M=7 \frac{1}{4}$ . Data on the initial motion plotted against traveltime curves suggest that the focal depth is small. The epicenter lies near the shot point of the Miboro explosion and data from this explosion are also in accord with a shallow focus. It is noted that records from Mount Tsukuba give the magnitude as  $6-6 \frac{1}{2}$  (see Geophys. 191-84). Aftershock observations were carried out at Kadohara and Hachiman.— V.S.N.

- 191-83. Omote, Syun'itiro; Karakama, Ikuo; Nakajima, Naoyoshi; Saito, Sadao; and Kayano, Ichiro. Aftershocks of the Kita Mino earthquake of August 19, 1961. Observations at the Kadohara and Hirugano stations [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 881-894, 1961.

Observations of aftershocks of the Kita Mino earthquake of August 19, 1961 were made from August 25 to September 20 at the temporary stations of Kadohara and Hirugano in cooperation with a third temporary station at Hachiman. Maximum frequencies of the P-S duration times are 1.0, 1.2, and 4 sec for the three stations, respectively. Difference-time methods were used for determining the focus of each shock. Twenty-five shocks are located and the distribution of their focuses is given on a map. The area covered by the epicenters is so small that it may be cited as a notable exception to the formula that defines the area of the aftershock from the magnitude of the main shock. No aftershock focus seems to have been located deeper than 15 km.—V.S.N.

- 191-84. Miyamura, Setumi; Hori, Minoru; Aki, Keiiti; Matumoto, Hideteru; and Ando, Seiichi. Observation of aftershocks of the Kita Mino earthquake, August 19, 1961 [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 895-908, 1961.

Observations of aftershocks of the Kita Mino earthquake, August 19, 1961 made at Hachiman, Gifu Prefecture, Japan, about 30 km southeast of the epicenter and one of three temporary stations (see also Geophys. Abs. 191-83) are reported. A block diagram of the instrumentation used and examples of seismograms and monitor records are given. The daily average number of aftershocks decreased smoothly without the appearance of the aftershocks of magnitude 1 or 2 grades less than the main shock that are common after big earthquakes. The frequency distribution of S-P times shows a sharp mode between 4 and 5.5 sec, indicating a narrow space concentration of aftershock activity. The method of determining the epicenters is discussed, and the aftershock field was determined to be at a depth of 0-25 km. Applying the formula that derives the area of the aftershock field from the magnitude of the main shock, it is found that the area of aftershocks should be 1,590 or 3,170 sq km for  $M=7.2$  or  $M=7.5$  as given by the Japan Meteorological Agency and Pasadena, respectively. The actual aftershock area estimated from observations is 600 sq km; this gives a value for  $M \leq 6.8$ . From data at Tsukuba Station,  $M$  is estimated to have been equal to 6.5 which suggests that the main shock had characteristics that should be investigated further. Several small local shocks were observed in azimuths other than the aftershock area. Whether these are part of the general seismicity of this region or some type of aftershock activity is not known.—V.S.N.

- 191-85. Murai, Isamu, and Tsuya, Hiromichi. Some notes on the geologic structure of the Kita Mino district [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 909-934, 1961.

A field survey of damage and topographic change, caused by the Kita Mino earthquake of August 19, 1961 is reported. The damage to buildings was rather slight and no trace of a new earthquake fault could be found in the epicentral area. Rock falls, landslides, and ground cracks were found in many places; most of these were distributed in a NNW-SSE direction from Ichinose in Ishikawa Prefecture to Shiratori in Gifu Prefecture and parallel to the trend of the north wing of the Neo (Midori) fault that formed during the Mino-Owari earthquake of 1891. This fault is a part of the major system in the Median Line of the Inner Zone of southwest Japan (Hida tectonic zone).—V.S.N.

- 191-86. Morimoto, Ryōhei, and Matsuda, Tokihiko. Geology of the area damaged by the Kita Mino earthquake. Part 1, The upper reaches of the Uchinami River and the Itoshiro River, Fukui and Gifu Prefectures, Japan [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 935-942, 1961.

The stratigraphy and major faults of the epicentral area of the Kita Mino earthquake are discussed. No new faults nor any renewed activity of old faults could be found. The strike of fissures opened by the earthquake is apparently dependent upon local topography.— V.S.N.

- 191-87. Kanai, Kiyoshi, and Osada, Kaio. Seismic characteristics in ground of mountainous formation (Observation of the after shocks of the Kita Mino earthquake) [with Japanese abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 943-951, 1961.

A study was made of the aftershocks in the epicentral area of the Kita Mino earthquake to investigate the relation between the earthquake motion and the seismic character of the ground in a mountainous area and the damage to various types of structures. A study of the maximum displacements, maximum accelerations, and the predominant periods of the aftershocks observed at 4 temporary stations leads to the conclusion that the larger the predominant period of the ground in a mountainous area (the softer or thicker the ground), the larger is the displacement of the earthquake motion; in contrast, the sense of acceleration is almost the reverse. The predominant period of the short period of earthquake motion in mountainous ground corresponds to the natural period of its thin weathered layer. It is verified that the empirical formula for the spectrum of strong earthquake motions is applicable to destructive earthquakes. The effect of this earthquake on structures and on human susceptibility has been accurately interpreted by using this formula.— V.S.N.

- 191-88. Asada, T[oshi], Steinhart, J. S., Rodríguez, B., Tuve, M. A., and Aldrich, L. T[homas]. The earth's crust—seismic studies: Carnegie Inst. Washington Year Book 60, p. 244-250, 1961; reprinted in Carnegie Inst. Dept. Terrestrial Magnetism Ann. Rept. Directory for 1960-61, 1961.

The cooperative work with colleagues in Peru, Bolivia, and Chile has continued for the purpose of local earthquake studies designed to examine the marked attenuation of seismic waves found in 1957, and to define the patterns of local earthquake activity. Sixteen short-period vertical sets for recording local shocks from a few kilometers up to 600-800 km distance have been installed, and 6 or 7 more sets will be installed before the end of 1961. Preliminary results of observations of relatively small local earthquakes at five stations in Peru are summarized.

Data from the 1960 series of explosions along two lines in Montana support the three-layer (or four-layer) model suggested by the first series in 1959. The model obtained has a closure time difference of less than 0.2 sec and a structure that is deeper under the great plains of central Montana than under the mountains.— V.S.N.

- 191-89. Shurbet, D. H. Note on use of a Sofar geophone to determine seismicity of regional oceanic areas: Seismol. Soc. America Bull., v. 52, no. 3, p. 689-691, 1962.

Daily Bermuda short period seismograms are compared with Sofar geophone records for a period of three years. Many short-period seismic signals were recorded on the geophone record that are not on the seismograms. Therefore, it is suggested that a geophone array could be most useful in de-

termining regional seismicity in oceanic areas. The large number of geophone signals recorded gives some indication that the advantages of the expected quiet of the ocean bottom may be somewhat offset.— Author's abstract

- 191-90. Kirov, K. T., and Grigorova, E. I. Seizmichno rayonirane na B<sup>1</sup>lgariya [Seismic regionalization of Bulgaria (in Bulgarian with English and Russian summaries)]: B<sup>1</sup>lgar. Akad. Nauk. Izv., Otdel. Fiz.-Mat. i Tekh. Nauki, Ser. Fiz., v. 6, p. 389-405, 1956.

Two maps of maximum isoseismal lines in Bulgaria, one with actual and the other with generalized contours, are drawn on the basis of macroseismic observations made for a century (1856-1955). The country is divided into nine seismic regions. The two most active areas are the western and central parts of east central Bulgaria and the western half of south Bulgaria; shocks of force 10-11 have been known here. Next most active are north central Bulgaria (up to force 7-8) and west central Bulgaria (up to force 9-10). Least active are northwestern Bulgaria and the eastern half of east central Bulgaria, where no shocks greater than force 6 have been recorded.— D.B.V.

- 191-91. Tamrazyan, G. P. O periodichnosti seysmicheskoy aktivnosti v techeniye poslednikh polutora-dvukh tysyach let (na primere Armenii) [Periodicity of seismic activity in the course of the last fifteen hundred to two thousand years (in the example of Armenia)]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 76-85, 1962.

A periodicity in the seismic activity of Armenia during the last 1,500 yr has been revealed. These periods last 90-140 yr and consist of active and passive half periods of approximately equal duration. Six such periods are distinguished from the eighth to the fourteenth century. Although seismic activity began to diminish after the fourteenth century, the periodicity is still recognizable. The year 1900 marked the beginning of a new half period of activity in which many earthquakes of 8 points intensity occurred. According to this regularity the next period of increased seismic activity in Armenia should occur in the years 2000-2060.— J.W.C.

- 191-92. Tskhakaya, A. D. O glubinakh kavkazskikh zemletryaseniy [On the depths of Caucasus earthquakes]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 577-584, 1962.

The depths of earthquake focuses in the Dzhavakhet Upland, Kazbek, east Georgian S.S.R., the Trialet Ridge, and the eastern regions of the Caucasus are critically evaluated from macroseismic data. Most Caucasus earthquakes originate at depths less than 10 km; only six earthquakes recorded from 1931 to 1961 had depths between 60 and 150 km. The conclusions of previous authors that earthquakes in the Caucasus region are confined to the lower part of the granitic layer are found doubtful.— A.J.S.

- 191-93. Makarova, S. D. O nekotorykh voprosakh seysmotektoniki Sredney Azii [Some problems of the seismotectonics of middle Asia]: Akad. Nauk Uzbek. SSR, Zapiski Uzbekistan. Otdel. Vses. Mineral. Obshch., no. 7, p. 135-149, 1955.

Central Asia is divided into two territories: the southeast which is mountainous and seismic, and the northwest which is a plain and aseismic. Shallow earthquakes with focal depths of 0-10 km correspond in area to large tectonic depressions. They occur at the contact between Paleozoic and Mesozoic sediments and also within Mesozoic and Cenozoic sediments.

Twelve young mountain systems are distinguished; these are marked by different degrees of seismicity and by different depths of focus. Five seismic zones are distinguished on the basis of depths of focus.— J.W.C.

- 191-94. Florensov, N. A. O neotektonike i seysmichnosti Mongolo-Baykal'skoy gornoy oblasti [On the neotectonics and seismicity of Mongol-Baikal mountain region]: Akad. Nauk SSSR, Siberskoye Otdeleniye, Geologiya i Geofizika, no. 1, p. 74-90, 1960

On a basis of seismic and neotectonic data for the Baikal region and the western part of the Mongolian Peoples Republic, a similarity is noted in the morphology and structure of the mountains. The seismicity of these regions evaluated by the paleoseismological method proposed here indicates a higher seismicity than is usually derived on the basis of records of historical earthquakes. (See also Geophys. Abs. 184-156.)—A.J.S.

- 191-95. Central Water and Power Research Station Poona. Seismological Investigations - Kopili dam project, Assam: India Ministry of Irrigation and Power Central Water and Power Research Sta. Poona Ann. Research Mem., 1961, p. 305-308, 1962.

A general investigation of the regional seismicity and geotectonic forces responsible for the acute seismicity of the northeast part of India was undertaken in order to evaluate the safety factor needed for a dam on the Kopili River, a tributary to the Brahmaputra River in Assam, India. From the distribution of isoseismals and other relevant data of the region, a horizontal acceleration of 0.22 g and a vertical acceleration of 0.15 g are suggested for a structure on compact and massive formations. These factors are based on the assumption that the structure will not be caught within the epicentral tracts of severe earthquakes of the region. The silting factor as a result of landslides following earthquakes is discussed also.—V.S.N.

- 191-96. Treskov, A. A. Pryamolineynyye epitsentrali [Straight-line epicentrals]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 1, p. 91-95, 1960.

A new method of construction of straight-line epicentrals is proposed and explained. The construction is based on absolute arrival times of longitudinal or shear waves from observations of three or four seismic stations. The epicentrals are obtained as the common chords (radical axes) of two circumferences whose centers are given and whose different radii  $a$  and  $r$  satisfy the equation,  $a^2 - r^2 = k^2$ , where  $k^2$  represents an equation of circumference with a given radius  $a$ . The method can be used for hyperbolic and linear traveltime curves.—A.J.S.

- 191-97. Vanek, I, Zátópek, A[lois], Kárník, V[ít], Kondorskaya, N. V., Rizenchenko, Yu. V., Savarenskiy, Ye. F., Solov'yev, S. L., and Shebalin, N. V. Standartizatsiya shkaly magnitud [Standardization of scales of magnitude]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 2, p. 153-158, 1962.

A standard method for determining the magnitude  $M$  of earthquakes is proposed. The basic formula is  $M = \log (A/T)_{\max} - \sigma(\Delta)$ , where  $A$  is the maximum displacement amplitude of the ground in microns,  $\Delta T$  is the corresponding period in sec, and  $\sigma(\Delta)$  is a calibrating function that expresses the change in the value of  $A/T$  with epicentral distance. The mean value of  $M$  is determined for each type of wave.—J.W.C.

- 191-98. Galanopoulos, A. G. On magnitude determination by using macroseismic data: Annali Geofisica, v. 14, no. 3, p. 225-253, 1961.

Using published data on 124 earthquakes in Greece and 36 in California, a simple formula is derived for the determination of earthquake magnitudes from macroseismic data. This formula can be applied directly to earthquakes of

any depth and probably to those at any place, and can also be used for magnitude determination from instrumental data.— D.B.V.

- 191-99. Gayskiy, V. N. O nekotorykh zakonmernostyakh seysmicheskogo protsessa na primere izucheniya zemletryaseniy Tadzhikistana [On certain regularities of the seismic process as exemplified by Tadzhikistan earthquakes]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 4, p. 574-577, 1961.

The formula derived previously for evaluation and comparison of seismic activity of different regions,  $\log N = \alpha + y \log E$  (see Geophys. Abs. 176-49), is evaluated with regard to the assumptions that the seismic regime is constant in time and that  $y$  (coefficient of seismic energy release) is the same for any region. It was found that  $y$  is not universal, and that the distribution of strong earthquakes in time appears to be statistically constant, following the Poisson's theoretical distribution of random events when the  $a$  parameter in the Gutenberg and Richter formula,  $\log N = a + b(8 - M)$  is constant.— A.J.S.

- 191-100. Solonenko, V. P. O neravnornosti raspredeleniya intensivnosti sotryaseniy na poverkhnosti Zemli pri zemletriyasiyakh [On irregularity of distribution of shock intensity of earthquakes on the surface of the earth]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 3, p. 122-126, 1960.

Investigation of an irregular distribution of earthquake intensities within the same area of Mongolia and Siberia showed that the isoseists extend across the strikes of the geologic structure and that earthquake intensities are strongly damped by deep crustal breaks. The disposition of deep breaks may produce seismic islands of low seismicity, and seismic antinodes of high seismicity.— A.J.S.

- 191-101. Stauder, William. S-wave studies of earthquakes of the north Pacific, Part I: Kamchatka: Seismol. Soc. America Bull., v. 52, no. 3, p. 527-550, 1962.

The polarization of S-waves at stations distributed azimuthally about the source is examined for each of 23 Kamchatka earthquakes of 1950-60. In 19 of these earthquakes the P- and S-wave data are in agreement with a double couple source as the point model of the focal mechanism. The S-waves indicate a uniform mechanism which repeats itself from earthquake to earthquake and from which it may be inferred that the axes of greatest and least stress at the foci tend to lie in a vertical plane normal to the trend of the Kamchatka-Kuriles Arc. The axis of least stress usually plunges almost vertically under the continent, but may also plunge less steeply at angles as low as 45°. At least two earthquakes may be represented by a single couple source.— Author's abstract

- 191-102. Furumoto, Augustine S. The use of ScS-wave data in focal mechanism determinations: Seismol. Soc. America Bull., v. 52, no. 3, p. 551-572, 1962.

In this paper the S-wave method of focal mechanism determination is extended to include the ScS wave. By the establishment of the quantitative relationship between the directions of vibration of the S and the ScS, ScS wave data can be reduced to a form of S-wave data usable for focal mechanism determinations. The new extension has been checked by reobtaining focal mechanism solutions for four earthquakes using ScS wave data. Results were consistent with previous solutions by the S-wave method or P-wave method.— Author's abstract

- 191-103. Ferraes, Sergio G. Note on the determination of the earthquake mechanism by S waves: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 683-688, 1962.

A direct computational technique for determination of the direction of the motion along an earthquake fault plane that is an analytical modification of Adams' technique (see *Geophys. Abs.* 174-50) is proposed. Equations are derived for computing the direction cosines of the "direction of motion" for a type I source (a couple of two equal and opposite forces with moment acting at the focus).—D.B.V.

- 191-104. Brune, James N. Correction of initial phase measurements for the southeast Alaska earthquake of July 10, 1958, and for certain nuclear explosions: *Jour. Geophys. Research*, v. 67, no. 9, p. 3643-3644, 1962.

Initial phase measurements given by Brune and others in earlier works (see *Geophys. Abs.* 181-118, 183-203, 189-110) need to be revised because of an error of  $\pi$  in correcting for the instrumental phase shift. The corrected pattern of initial phase for the Alaska earthquake of 1959 agrees approximately with a model of the fault as a right-lateral dipole of force which acts as a step function in time and travels from the epicenter northwestward along the strike of the fault for 200 km with a velocity of 3 kmps. In the initial paper it was not possible to propose a model that was consistent with all observations.

The initial phases implied by the various choices of phase velocity curves in the case of the nuclear explosions are also corrected. In the one set (*Geophys. Abs.* 181-118) the initial phases then appear to be about  $-\pi/2$ , corresponding theoretically to an explosive impulse or an upward impulse of force; in the high altitude explosions (*Geophys. Abs.* 183-203) the initial phase is  $\pi/2$ , corresponding theoretically to a downward impulse of force.—D.B.V.

- 191-105. Aki, Keiiti. Revision of some results obtained in the study of the source function of Rayleigh waves: *Jour. Geophys. Research*, v. 67, no. 9, p. 3645-3647, 1962.

The signs of all the source functions obtained for Rayleigh waves in three earlier papers by Aki (see *Geophys. Abs.* 181-111, 182-117, 184-172) must be reversed because of an error of  $\pi$  in the instrumental correction. In the first paper the reversal of sign means that the source mechanism will disagree with the mechanism obtained by Báth and Richter from body wave data (see *Geophys. Abs.* 173-69); this disagreement is attributed to an imperfect phase equalization with respect to the propagation of Rayleigh waves. In the second paper the revised conclusion on the earthquake mechanism is the same as the original as far as the shocks attributed to horizontal forces are concerned, but conclusions on the mechanism of dip-slip earthquakes must be revised. In the third paper the revised result seems to be in better agreement with the observed distribution of land uplift and depression that accompanied the main shock.—D.B.V.

- 191-106. Gurevich, G. I., Nersesov, I. L., and Kuznetsov, K. K. K istolkovaniyu zakona povtoryayemosti zemletryaseny [On interpretation of the law of earthquake frequency]: *Akad. Nauk Tadzhik. SSR Inst. Seysmostoykogo Stroitel'stva i Seysmologii Trudy*, v. 6, p. 39-88, 1960.

An analogy between the number and volume of fragments of crushed solid bodies on the one hand and the number and energy of local earthquakes on the other is investigated. Considering that the deformation process is of a discrete nature, the observed analogy can be explained if earthquakes are con-

sidered as a manifestation of this process. This leads to a correlation between frequency of earthquakes and the mean deformation characteristics within the seismoactive regions of the crust. The correlations obtained are found to be in general agreement with seismic observations.—A.J.S.

- 191-107. Gzovsky [Gzovskiy], M. V. Tectonophysics and earthquake forecasting: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 485-505, 1962.

Earthquake prediction in the U.S.S.R. based on maps of seismic regionalization compiled on a scale of  $10^{-6}$  and  $10^{-5}$ , is being developed according to the following concepts: (1) future earthquakes are to be expected with at least the same intensity where they have occurred in the past; (2) in a given area earthquakes of a given energy occur with a certain average frequency that diminishes with increasing energy; (3) the main parameters of the earthquake-frequency diagram can be computed for each region on the basis of tectonophysical interpretation of data on the deep structure, the history and mechanism of deformations, and recent tectonic movements; (4) prediction should be based on interpretation of seismostatistical and geological data; and (5) final appraisal of the earthquake risk at each building site includes an estimate of conditions of topography and the nature of the ground. A bibliography of 86 entries is appended.—D.B.V.

- 191-108. Petrushevskiy, B. A. *Zemletryaseniya i vozmozhnosti ikh predskazaniya* [Earthquakes and the possibility of their predictions]: Moscow, Izdatel'stvo "Znaniye," 48 p., 1961.

Various types of earthquakes are described, and the possibility of prediction is discussed briefly. Instrumental recording of earthquake intensity and energy is reviewed in connection with a description of destructive earthquakes that have occurred during the last few decades. The importance of seismic regionalization is emphasized. No dependable method for prediction of times of earthquakes has yet been developed. The latest world seismicity map is included in the text. (See also *Geophys. Abs.* 189-85.)—A.J.S.

- 191-109. Clough, R. W. Earthquake analysis by response spectrum superposition: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 647-660, 1962.

Although earthquake response spectra can be used to determine the maximum response of structures having one degree of freedom, they provide only an approximate indication of the maximum response in multi-degree systems. In this paper, two different methods of approximating the maximum response, both based on superposition of the response spectra, are compared with exact analyses, and the errors in the approximations are evaluated. Five different structures, each subjected to three different earthquake motions, are considered.—Author's abstract

- 191-110. Nazarov, A. G. *Metod inzhenernogo analiza seysmicheskikh sil* [The method of engineering analysis of seismic forces]: Yerevan, Akad. Nauk Armyan. SSR, 286 p., 1959.

A direct instrumental method of determining seismic forces is proposed and described. Multipendulum seismometers AIS-1 and AIS-2 are used for direct integration of the equations of ground movements, and a model of the behavior of an engineering construction during an earthquake is reproduced. Large-scale recording of destructive earthquakes is proposed by using maximum multipendulum seismometers without time recording. The data recorded are used for determining on a large scale the spectrums of seismic accelerations and seismic intensities, for seismic regionalization and microregionalization, and for estimates for seismic resistance. (See also *Geophys. Abs.* 178-51.)—A.J.S.

- 191-111. Nakamura, Kohei. Velocity of long gravity waves in the ocean: Tohoku Univ. Sci. Repts., Geophysics, ser. 5, v. 13, no. 3, p. 164-173, 1961.

Effects on the velocities of oceanic waves of compressibility of the sea water, elasticity of materials beneath the seabed, the Coriolis force, and curvature of the earth are examined particularly in the case of long period waves as tsunamis. Computation of the dispersion curves for the phase and group velocities reveals that the usual velocities of oceanic waves whose wavelengths fall within the range 100-1,000 km are reduced at most 1 percent owing to the above-mentioned effects.— Author's abstract

- 191-112. Kogan, S. Ya. Ob opredeleni koeffitsiyenta pogloshcheniya seismicheskikh voln [Determination of the coefficient of absorption of seismic waves]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1738-1748, 1961.

The variation of a seismic pulse due to absorption described by the law  $\alpha = k|\omega|^n$  with arbitrary values of  $k$  and  $n$  is investigated. Asymptotic formulas permitting determination of the absorption parameters  $k$  and  $n$  are obtained. From these formulas it follows that the pulse attenuation at great distances from the first instrument is subject to the law  $x^{-1}$  ( $1 > 0$ ) and not to any exponential law. Only in the immediate vicinity of the first instrument does the amplitude diminish linearly with distance. This may account for the fact that in practice a body-wave is traced a much greater distance than can be obtained on the assumption of exponential attenuation. To use these formulas in practice it is essential either to perform the observations with a monotypical apparatus or to develop a method that allows for distortion of the pulse by the seismic detector channel.— J.W.C.

- 191-113. Jeffreys, Harold. Deep foci and distribution of velocity: Royal Astron. Soc. Geophys. Jour., v. 6, no. 4, p. 550-552, 1962.

A numerical test has been applied to see whether study of deep-focus earthquakes can give information on velocities of P not provided by shallow ones. A layer is considered, beginning at a depth of  $0.03a$ , where the velocity is about 10 percent more or less than that above it. For the case of low velocity the traveltimes up to  $12^\circ$  can be made to agree closely with those for a uniform sphere by a suitable choice of origin time and focal depths; but a discrepancy would be revealed if distant observations also are available. For the case of high velocity, the agreement up to  $12^\circ$  cannot be made close, but comparison of direct and indirect waves would give all the information required.— Author's summary

- 191-114. Jeffreys, Harold. Some normal earthquakes: Royal Astron. Soc. Geophys. Jour., v. 6, no. 4, p. 493-508, 1962.

Normal earthquakes in Europe, central Asia, and eastern and western North America are discussed with reference to possible differences in P- and S-wave velocities at short distances. The results show that there is regional variation in P- and S-velocities. The lower P-wave velocity of about 7.8 kmps is right for Japan, the higher—about 8.1 kmps—is right for Europe, central Asia, and eastern North America, whereas western North America is probably intermediate. The S-wave velocities found at short distances for Europe, central Asia, and eastern North America are decidedly greater than those given in the 1940 traveltime tables, which depend on Japanese deep-focus earthquakes; but a search has not revealed any normal earthquakes in Japan capable of giving a local determination of the S-wave velocity.— D.B.V.

- 191-115. Kravtsov, G. S. Ob opredelenii srednikh skorostey po godografam prelomlennykh voln [On determination of mean velocities from

the travelttime curves of refracted waves]: Akad. Nauk SSSR, Sibirskoye Otdeleniya, Geologiya i Geofizika, no. 1, p. 109-111, 1961.

A rigorous solution of the problem of determination of mean velocities of refracted seismic waves by the points of intersection of their travelttime curves is given. A theoretical formula for  $\bar{V}_m(z)$  is derived for horizontal refraction boundaries, and a method for solution of the problem for plane non-horizontal boundaries is suggested.— A.J.S.

- 191-116. Bolt, Bruce A., and Marussi, Antonio. Eigenvibrations of the earth observed at Trieste: Royal Astron. Soc. Geophys. Jour., v. 6, no. 3, p. 299-311, 1962.

Earth oscillations following the Chilean earthquake of 1960 were clearly recorded by a sensitive tiltmeter installed near Trieste. Analysis of 85 hours of the N-S record and comparison with other recent observations of free oscillations and with theoretical values leads to the identification of 23 fundamental torsional eigenfrequencies ( $2 \leq f \leq 24$ ); on removal of the main semidiurnal tides there is an indication that the four lowest fundamental spheroidal modes were also recorded.

The tiltmeter and the method of analysis are described. The Trieste data agree significantly better with an earth model having Gutenberg shear velocities and Bullen A densities than with one having Jeffreys-Bullen shear velocities and Bullen B densities.— D.B.V.

- 191-117. Pěč, Karel. Phases Lg et Rg observées à Praha [Lg and Rg phases observed at Prague (with Russian summary)]: Československá Akad. Véd Studia Geophys. et Geod., v. 5, no. 3, p. 219-226, 1961.

Some preliminary results are presented concerning the velocities, amplitudes, and regional characteristics of Lg and Rg type waves observed at Prague. Records obtained with a Wiechert horizontal pendulum apparatus between 1933 and 1937 were analyzed statistically. A tabulation of the velocities of all of the Rg and Lg phases and of Li shows that some phases occur in most azimuthal groups whereas others appear only for a certain azimuthal interval. Both Lg1 and Lg2 are observed at Prague, but the latter is mainly Lg2'; the Lg2'' observed by Báth at Uppsala (see Geophys. Abs. 163-99) is almost lacking. Lg has a velocity of 3.2 km/s at all azimuths in the Prague records. Rg4 ( $v=3.0$  km/s) and Rg1 ( $v=2.8$  km/s) appear in all azimuthal groups and Rg4 ( $v=2.4$  km/s) in all but one. The clarity of Lg phases at Prague varies with the path. Mountains appear to afford no obstacle to their passage, however.

The Lg1 phase shows the normal decrease of amplitude with distance; Lg2, Rg5, and Rg6 show an abnormal amplitude decrease within the interval  $\Delta=12^\circ-20^\circ$ , and the Rg4 curve is almost the inverse of the Rg5. For this epicentral interval, practically all shocks recorded at Prague are from the azimuth of the Mediterranean area or Asia Minor, where structure is complicated and crustal thickness variable.— D.B.V.

- 191-118. Maisuradze, O. M. Ob osobennoy faze karakternoy dlya nekotorykh zemletryaseniy Gegechkorskogo rayona [On a particular phase characteristic of certain earthquakes of the Gegechkori region]: Akad. Nauk Gruzin. SSR Soobshch., v. 27, no. 3, p. 271-276, 1961.

An unusual seismic wave is investigated. The extraordinary phase  $x$  appears on the seismogram after phase  $\bar{p}$  and is much more intense than  $\bar{p}$ . Its vertical component is more intense than its horizontal component. The difference  $x-\bar{p}=1$  sec remains constant for different epicentral distances, and phase  $x$  has a period  $T_x=0.6$  sec that also remains constant for different epicentral distances. Phase  $x$  is recorded at the Gegechkori station only when  $\bar{s}-\bar{p}=3$  or 4 sec. It is found to be a longitudinal  $\bar{p}_1$  wave that originates by some peculiarity of the geologic structure of the region.— A.J.S.

- 191-119. Golenetskiy, S. I. O godografakh seysmicheskikh voln dlya Yuzhnogo Pribaykal'ya [On the traveltime curves of seismic waves for the South Baykal area]: Akad. Nauk SSSR, Sibirskoye Otdeleniya, Geologiya i Geofizika, no. 2, p. 124-136, 1960.

An attempt is made to determine seismic wave velocities in the region of South Baykal. Nineteen earthquakes that occurred in the area during 1952-56 are analyzed, and the maximums and minimums of the possible values of the fictitious waves S-P are determined. The approximate velocity of the longitudinal seismic waves was found to be  $6.6 \pm 0.3$  km/s, and that of the transverse waves  $3.7 \pm 0.2$  km/s.— A.J.S.

- 191-120. Ragimov, Sh. S. Ob odnoy osobennosti gruppykh skorostey voln Releya [About a peculiarity of the group velocities of Rayleigh waves]: Akad. Nauk Azerbaydzhan. SSR Doklady, v. 16, no. 2, p. 133-136, 1960.

From the results of 12 earthquakes recorded by the Shemakha, Kirovabad, and Goris seismic stations during 1957, a peculiar parallel shift of group velocity curves of Rayleigh waves is noted when epicenters  $n$  and  $k$  of the earthquakes are approximately at the same distance from the stations but their azimuths are noticeably different. These shifts are attributed to the structural differences of the crust along the traverses of the surface waves from the epicenters to the stations.— A.J.S.

- 191-121. Northrop, John. Evidence of dispersion in earthquake T phases: Jour. Geophys. Research, v. 67, no. 7, p. 2823-2830, 1962.

Spectrum analyses have been made of T-phases that have traveled from earthquakes and explosions in the Atlantic Ocean to a recording point over completely oceanic paths and over paths having a very short continental segment at the source end. Even with a completely oceanic path there are variations in the apparent velocity of T for earthquakes but not for explosions. These variations are due primarily to the T-phase arrival being dispersive. Only the higher frequencies (50-150 cycles per second) travel with the velocity of sound in water. The transformed energy received at a seismograph on land usually shows only a small part of the spectrum, so that the traveltime will depend on instrumental characteristics and sensitivity as well as on the path. The sound spectrograph records are symmetrical in time about the peak signal. The earliest T arrivals are abrupt when a proper broad-band instrument is used. They arrive with a velocity as high as 1.65 km/s, corresponding to possible transmission through the sediments. The large central spike containing the high-frequency arrivals has the velocity of sound in water in the Sofar channel ( $1.49 \pm 0.005$  km/s in the Atlantic); later arrivals are caused by later modes and reverberation.— D.B.V.

- 191-122. Cleary, J., and Doyle, H. [A.]. Application of a seismograph network and electronic computer in near earthquake studies: Seismol. Soc. America Bull., v. 52, no. 3, p. 673-682, 1962.

A description is given of the application of a close network of seismograph stations and of an IBM 650 computer program to the study of a sequence of near earthquakes in southeastern Australia. The epicenters, depths, and origin times of a moderate sized earthquake and its aftershocks were determined with unusual accuracy, revealing an interesting pattern of foci. The position and origin time of the main shock were then used to study arrivals at more distant stations;  $P_n$  arrivals were found to fit a linear traveltime equation closely to a distance of  $15^\circ$  with a surface velocity of  $8.16 \pm 0.03$  km/s. The  $S_n$  phase was not clear and gave an approximate velocity of  $4.7 \pm 0.2$  km/s. The possibility of a small velocity decrease in the upper mantle below eastern Australia is discussed.— Authors' abstract

- 191-123. DeBremaecker, J. Cl., Donoho, Paul, and Michel, J[ean] G. A direct digitizing seismograph: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 661-672, 1962.

A seismograph is described in which capacitance transducers on either side of the inertial reactor determine the frequencies of two Clapp oscillators. The oscillators are heterodyned and the resulting frequency, varying between 10 and 100 kc, is detected by a frequency or period counter and an analog output. The latter drives a self-balancing potentiometer through a cathode follower and an adjustable twin-T filter. It also drives a circuit with a very long time constant which keeps the boom centered through a coil and magnet transducer. The electronic noise corresponds to a boom displacement of less than 1.25  $m\mu$ . The sensitivity is about 400 cycles per second per micron. The dynamic range is about 100 db at constant resolution. The digital output is temporarily in the form of printed or punched tape. A special magnetic tape recorder is being built.— Authors' abstract

- 191-124. Savill, R. A., Carpenter, E. W., and Wright, J. K. The derivation and solution of indicator equations for seismometer-galvanometer combinations including the effect of seismometer inductance: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 4, p. 409-425, 1962.

The general differential equations for a seismometer-galvanometer system connected through an attenuator and including the terms due to the inductance of the transducer coil are derived. The solution of such equations relating to commercially available instruments using an analogue computer is illustrated and possible applications of the technique discussed.— Authors' summary

- 191-125. Fremd, V. M. P'yezoelektricheskiy seysmorpriyemnik dlya sil'nykh dvizheniy [Piezoelectric seismic pickup for strong movements]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 5, p. 630-638, 1962.

A device using a barium titanate ceramic for piezoelectric recording of earthquakes of intensity greater than 5 and seismic waves frequencies 0.5-20 cycles per second is described, and a simplified seismometer based on this method of recording is proposed. This design results in a family of curves  $P=P(R)$  ( $P$  is an inertial weight, and  $R$  is input resistance) for varied electric loads on the piezoelectric seismic receiver. Test of the seismometer on a vibroplatform confirmed the theoretical calculations.— A.J.S.

- 191-126. Skur'yat, A. N. Malogabaritnyy osvetitel' (MO) naklonomernoy i seysmicheskoy registratsii [A small size illuminator (MO) for tiltmetric and seismic recording]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 8, p. 1220-1222, 1960.

A miniature illuminator for use in optical and galvanometric recording of slow motions of the crust (tilts and deformations) and in seismic observations is proposed and described. The filament of the light bulb (Sts-79) can be focused for distances from 450-5,000 mm or more. At 5,000 mm the width of the filament image is 0.9 mm and at 8,000 mm the width is 1.5 mm.— A.J.S.

- 191-127. Kuznetsov, V. P., and Vaysman, G. I. Releynoye ustroystvo c sonicheskoy signalizatsiye dlya preduprezhdeniya o peregoranii lamp i istoshcheniiy akkumulyatorov [A relay for audible signals warning about burned out bulbs and exhausted storage batteries]: *Akad. Nauk Azerbaydzhan. SSR Doklady*, v. 7, no. 3, p. 227-228, 1961.

A relay signaling device is described which produces an audible signal warning about a faulty electric bulb in the seismograph collimator or an exhausted storage battery that feeds the bulb.— A.J.S.

- 191-128. Ye, Shi-Yan', Kirnos, D. P., and Solov'yev, V. N. Uproshchennaya registratsionnaya ustanovka dlya instrumental'nykh nablyudeniy v epitsentral'nykh zonakh sil'nykh zemletryasenyi [A simplified recording device for instrumental observations in the epicentral zones of strong earthquakes]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 5-11, 1961.

A simplified recording device, UAR, for optical and galvanometric seismic receivers is described. The purpose of the device is to serve as an auxiliary seismograph, several of which should be placed in zones of high seismic activity around a primary seismograph station. Schematic circuit diagrams of the device are given, and its theory is explained. Two dry cell batteries of 6 and 100 v provide current for a period up to one year.—A.J.S.

- 191-129. Borisevich, Ye. S., Zabelin, M. V., and Mosyagina, M. S. Ostsillograf seymicheskoy tipa OSB-IV [Seismic oscillograph of the type OSB-IV]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 12-18, 1961.

The OSB-IV oscillograph is designed for recording earthquakes during expeditions and at temporary seismic stations. It is a portable apparatus 550×340×285 mm in size and weighs 23 kg. It operates on d-c of 6 v of not more than 0.5 amps. The records are produced optically by mirror galvanometers on a sheet of photographic paper on a rotating drum. Circuit diagrams are given.—A.J.S.

- 191-130. Borisevich, Ye. S., Kastorskiy, S. A., and Mosyagina, M. S. Ostsillograf seymicheskoy tipa OSB-V [Seismic oscillograph of the type OSB-V]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 19-24, 1961.

This is an improved model of the type OSB-IV oscillograph (see Geophys. Abs. 191-129). A circuit diagram of the device and its optical operation are given.—A.J.S.

- 191-131. Kirnos, D. P., and Solov'yev, V. N. Seysmograf s opticheskoy registratsiyey dlya zapisi sil'nykh i razrushitel'nykh zemletryasenyi [Seismograph with optical registration for recording strong and destructive earthquakes]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 25-36, 1961.

A device for optical recording of earthquakes of intensity greater than 6 is described. The recording arrangement and its automatic control are discussed, and an electric circuit diagram is given. The initial lag in recording time is expected to be approximately 0.002-0.003 sec.—A.J.S.

- 191-132. Aronov, L. Ye. Fotoelektricheskiy avtomat dlya upravleniya zapis'yu elektricheskikh protsessov [Photoelectrical automatic device for controlling the recording of electrical processes]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 37-39, 1961.

A photoelectric device designed for automatic control of the light intensity of the illuminator in various models of magnetoelectric seismic oscillographs is described. A picture of its exterior appearance and a circuit diagram are given.—A.J.S.

- 191-133. Solov'yev, V. N. Avtomat upravleniya zapis'yu seysmografav Auz-I [Automatic device for controlling the recording of seismographs Auz-I]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 40-43, 1961.

A device for automatic control of optical recording is described. The automation arrangement, AUZ-I, is used for sound and light signals informing that an earthquake is taking place. A decrease or increase of the light source is recorded on a photo-tape or sheet according to the amplitude of the seismic oscillations. The optical system, electrical circuit diagrams, and a photograph of the instrument are given.—A.J.S.

- 191-134. Borisevich, Ye. S., Zhilevich, I. I., Aronov, L. Ye., Arshvila, S. V., and Zabelin, M. V. Seysmicheskii elektrograficheskiy ostsiograf SEO-I [Seismic electrographic oscillograph SEO-I]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 44-51, 1961.

The electrographic seismic oscillograph SEO-I is a memory device designed for automatic recording of earthquakes. Its record is observable and ready for analysis during an earthquake. The recording is made on a ring tape 120 mm wide and 1.2 m long. The oscillograph operates on frequencies up to 5 cycles per second at an amplitude of 15 mm. Recording is at a uniform speed during the initial stages of an earthquake, but then changes automatically to a lower speed (60 mm per min changes to 6 or 12 mm per min, and 120 mm per min changes to 12 or 24 mm per min). Alternating current of 127 or 220 v and of not more than 1 amp is used. The apparatus is 255×240×660 mm in size and weighs 29 kg. A circuit diagram is given.—A.J.S.

- 191-135. Vetchinkin, A. N., and Preobrazhenskiy, V. B. Avtomaticheskaya seysmicheskaya registriruyushchaya ustanovka s magnitnoy pamyat'yu [An automatic seismic recording device with magnetic memory]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 52-56, 1961.

A seismic apparatus utilizing the magnetic memory principle is described. The apparatus records continuously on a magnetic drum and automatically transfers an earthquake recording to a phototape by means of an electromagnetic oscillograph. The apparatus has 6 operating channels and 1 auxiliary. During the watching period the apparatus uses 4 watts and during the record transfer period it uses 50 watts from a d-c source of 12 v. The dimensions of the apparatus (without the oscillograph) are 470×470×525 mm, and its weight is 35.5 kg. A block diagram and a photograph of the apparatus are given.—A.J.S.

- 191-136. Borisevich, Ye. S., Gol'dfarb, M. L., and Mosyagina, M. S. Registriruyushchiy pribor s lyuminiscentnoy pamyat'yu [A recording device with luminescent memory]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 57-63, 1961.

The design of a seismic recorder operating on the principle of luminescent memory is described. The continuous watching recording is made using mirror galvanometers of a standard oscillograph type H-700 (POB-14M) on a ring paper tape 110 mm wide and 1,200 mm long. The record remains on the tape for the period of the drum revolution, fading to zero luminosity at the end of the revolution. The watching record can thus be made continuously on the same tape. A photographic tape is exposed to the ray of light when deflection is above the background noise, the record is thus placed on a permanent tape. The size of the recording device is 300×260×520 mm, and it weighs 17.6 kg. A schematic circuit diagram, a photograph of the apparatus, and a sample recording are given.—A.J.S.

- 191-137. Kolesnikov, Yu. A. Ustanovka dlya fotoopticheskoy registratsii zemletryaseniya metodom peremennoy shiriny i dlya posleduyushchego vosproizvedeniya seysmogramm [A device for photo-optical recording of earthquakes by the variable width method and for subsequent reproduction of seismograms]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 64-68, 1961.

An apparatus for recording earthquakes that uses the variable width of the stroke produced on a photographic film or paper by a slit illuminator of an optical recorder is described. If a seismic signal arrives with an amplitude higher than a preset value, the light source of the illuminator begins to operate within 0.005 sec and makes strokes across the film proportional to the instantaneous amplitude. A sequence of such closely spaced strokes represents the recording of the apparatus; this can be converted into electrical impulses to produce a conventional seismic oscillation curve. A schematic diagram of the instrument and examples of records are given.—A.J.S.

- 191-138. Borisevich, Ye. S., and Katyushkin, V. F. Gal'vanometry tipa GB k seymicheskim ostsilografam [Type GB galvanometers for seismic oscillographs]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 69-72, 1961.

The GB-III and GB-IV-M galvanometers used in magnetoelectric oscillographs are described, and diagrams of their construction are given. The parameters of 13 improved models of the GB-III galvanometer are listed in two tables, and those of the improved low frequency models of the GB-IV-M galvanometer are listed in another table.—A.J.S.

- 191-139. Borisevich, Ye. S., Gol'dfarb, M. L., Kastorskiy, S. A., and Preobrazhenskiy, V. B. Peropishushchiy seymicheskii registriruyushchiy pribor PSERP-I [Pen-writing seismic recording device PSERP-I]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 73-77, 1961.

A three-channel seismic device for continuous visible recording of seismic oscillations by three changeable ink or heat pens is described. The recording pen draws a helical seismic record on a ring tape or on a special tape for the heat pen. Frequencies up to 3 cycles per second and 20 mm double amplitude can be recorded. The weight of the apparatus is 33 kg, and its dimensions are 460×470×290 mm. Circuit diagrams are given.—A.J.S.

- 191-140. Gol'dfarb, M. L., and Preobrazhenskiy, V. B. Chetyrekhkanal'nyy peropishushchiy registriruyushchiy pribor [A four-channel pen-writing recording device]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 78-80, 1961.

A four-channel pen-writing device for recording oscillations is described. The record can be transformed into an electric current or voltage oscillations up to 30 cycles per second. The device records with changeable pen-writing magnetoelectric galvanometers, using either ink or a hot pen and special paper. The tape, 120 mm wide and 12 m long, is run at speeds of 4, 8, 16, 32, or 64 mm per sec. The dimensions of the instrument are 360×190×220 mm, and its weight is 11 kg. Circuit diagrams are given.—A.J.S.

- 191-141. Borisevich, Ye. S., Gol'dfarb, M. L., and Preobrazhenskiy, V. B. Smennyye peropishushchiye galvanometry [Changeable pen-writing galvanometers]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 81-85, 1961.

Two types of changeable pen-writing galvanometers, GPCh for recording by ink, and GPT for recording by a hot pen on special paper, are described in detail, and construction diagrams are given.—A.J.S.

- 191-142. Maksimov, L. S., and Tokmakov, V. A. Dstantsionnaya regulirovka dlinnoperiodnogo vibrodatchika [Remote control of a long-period vibration pickup]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 86-90, 1961.

The model VDTs-2N vibration pickup for periods of 1-100 cycles per second and amplitude range between 0 and  $1,000\mu$  is described, and the arrangement for its remote control and adjustment is discussed. The instrument is intended for vibration study of structures such as hydraulic aprons and dams.— A.J.S.

- 191-143. Kirnos, D. P., Moskvina, A. G., and Shebalin, N. V. O vybore ratsional'noy metodiki opredeleniya postoyannykh elektrodinamicheskikh seysmografov [On selection of an effective method for determination of constants of electrodynamic seismographs]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 91-112, 1961.

A method is given for obtaining a complete set of recording characteristics of a seismograph and the parameters that determine the electromagnetic and mechanical properties of its pendulum-galvanometer system. Methods of determining the period of the galvanometer and pendulum, their damping constants and magnification rate, the reduced pendulum length, and moments of inertia of both pendulum and galvanometer are analyzed, and probable errors in the seismograph parameters are discussed.— A.J.S.

- 191-144. Moskvina, A. G. Raschet osnovnykh postoyannykh seysmografa po vidu krivoy uvelicheniya [Calculation of the main constants of a seismograph from the shape of the magnification curve]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 113-121, 1961.

The method of calculating the main parameters of narrow band characteristics of an electrodynamic seismograph from the shape of the magnification curve is analyzed and discussed. An example is given using the seismograph of the Rakhov station. The observed and calculated curves were found to agree within 10 percent.— A.J.S.

- 191-145. Arkhangel'skiy, V. T. Metod izmeneniya yvelicheniya elektrodinamicheskogo seysmografa pri sokhraneni vida yego chastotnoy kharakteristiki [A method for changing the amplification of an electrodynamic seismograph preserving the shape of its frequency characteristic]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 122-129, 1961.

The theory of electrodynamic seismographs with galvanometric recording is analyzed, and a method is proposed for controlling the magnification of the apparatus while preserving the frequency characteristic. The method was applied to a SVK seismograph, and the maximum magnification was found to be 1,285.— A.J.S.

- 191-146. Aronovich, Z. I. O priblizhennom preobrazovani parametrov seysmografa [On an approximate transformation of seismograph parameters]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19 (186), p. 130-135, 1961.

A method is proposed for transformation of seismograph parameters in order to adjust the magnification of one electrodynamic seismograph to fit that of another instrument with a different frequency characteristic. The transformation formula is given.— A.J.S.

- 191-147. Shebalin, N. V. K raschetu variatsiy parametrov elektrodinamicheskogo seysmografa [On calculation of variations of parameters of electrodynamic seismographs]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 19, (186), p. 136-143, 1961.

A simplified method is proposed for exact graphic-analytical determination of the parameters of the system of an electrodynamic seismograph for

the coupling coefficient  $\sigma^2=0$ , and for determination of variations in the system of partial parameters for a constant frequency characteristic. Formulas of coupling coefficients  $\sigma^2$  are derived, and an example of a calculation is given.—A.J.S.

## ELASTICITY

- 191-148. Deresiewicz, H., and Rice, J. T. The effect of boundaries on wave propagation in a liquid-filled porous solid: III. Reflection of plane waves at a free plane boundary (general case): *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 595-625, 1962.

A general solution is derived of Biot's field equations governing small motions of a porous solid saturated with a viscous liquid. The solution is then employed to study some of the phenomena attendant upon the reflection from a plane, traction-free boundary of each of the three body waves predicted by the equations. The problem, though more complex, bears some similarity to that of electromagnetic waves in a conducting medium, in that some of the reflected waves are inhomogeneous, planes of constant amplitude not coinciding with planes of constant phase. Analytical expressions are displayed for the phase velocities, attenuation coefficients, angles of reflection, and the amplitude ratios; and explicit formulas are given for the limiting cases of low and high frequencies, representing first-order corrections for porosity of the solid and viscosity of the liquid, respectively. The paper concludes with a presentation of results of numerical calculations pertinent to a kerosene-saturated sandstone.—Authors' abstract

- 191-149. Deresiewicz, H. The effect of boundaries on wave propagation in a liquid-filled porous solid: IV. Surface waves in a half-space: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 627-638, 1962.

Dispersion and dissipation of Rayleigh-type surface waves in a porous, elastic half-space filled with a viscous liquid are studied within the framework of Biot's field equations. The algebraic secular equation turns out to be of the seventh degree, its (complex) coefficients being functions of a dimensionless frequency parameter. It is shown that for small and for large values of this parameter the wave is essentially non-dissipative. A numerical analysis of the secular equation pertaining to a kerosene-saturated sandstone reveals the existence of several values of the phase velocity, a skewed bell-shaped variation of the dissipation per cycle, and a high-frequency cutoff for the surface wave for certain values of the dynamical coefficients.—Author's abstract

- 191-150. Usami, Tatsuo, and Sato, Yasuo. Torsional oscillations of a homogeneous elastic spheroid: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 469-484, 1962.

There are several causes for the observations of splitting of the spectral peaks determined from the free oscillation of the earth. In this paper, the splitting due to the ellipticity is studied assuming a homogeneous earth described by oblate spheroidal coordinates. Ellipticity causes the  $iT_n$  mode to split into  $(n+1)$  modes, while the earth's rotation causes it to split into  $(2n+1)$  modes.  $1/297.0$  is adopted as the ellipticity of the earth. Numerical calculations are carried out for the fundamental mode ( $n=2,3,4$ ) and for the first higher harmonics ( $n=1$ ). The difference between the extreme frequencies for each value of  $n$  is 0.7 percent ( $n=2$ ), 0.5 percent ( $n=3$ ), and 0.4 percent ( $n=4$ ).—Authors' abstract

- 191-151. Sherwood, J. W. C., and Spencer, T. W. Signal-to-noise ratio and spectra of explosion-generated Rayleigh waves: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 573-594, 1962.

This preliminary theoretical study is basically concerned with the estimation of the depth of an explosive source from a knowledge of the radiated Ray-

leigh wave. Details are given of the dependence of the amplitude spectrum on the explosive yield, depth of burial, horizontal range, and the elastic parameters of the medium. It is assumed that the medium is a homogeneous and isotropic half space which, as far as the Rayleigh wave is concerned, possesses a mechanical quality factor, or  $Q$ , which is independent of frequency. Furthermore, it is assumed that the explosive shot has been effectively decoupled from the medium by locating it within a cavity of appropriate size. It is shown that changes in either shot depth or  $Q$  can produce an identical change in the Rayleigh wave spectrum. Hence a lack of knowledge of  $Q$  limits the accuracy with which source depth may be estimated. An additional inaccuracy may result from the ambient ground motion preventing the recovery of the Rayleigh wave spectrum. For this reason estimates are given of the theoretically anticipated Rayleigh signal-to-noise ratio per kiloton of explosive in a seismically quiet location. It is emphasized that the study is preliminary in nature. To be of significant practical use it is believed that the theory must be extended to take into account the effect of surface layering of the medium.— Authors' abstract

- 191-152. Deresiewicz, H. A note on Love waves in a homogeneous crust overlying an inhomogeneous substratum: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 639-645, 1962.

A secular equation is derived, governing the phase velocity of Love waves in a homogeneous elastic crust resting on an inhomogeneous elastic substratum, for a number of variations of shear modulus and density with depth.— Author's abstract

- 191-153. Anderson, Don L. Love wave dispersion in heterogeneous anisotropic media: *Geophysics*, v. 27, no. 4, p. 445-454, 1962.

An analysis is made of Love-wave propagation in a medium composed of transversely isotropic layers. This is the kind of anisotropy which most commonly occurs at the surface of the earth, and in particular is displayed by bedded sediments. The exact boundary value problem is solved for a simple layer and extended to multilayered media by a generalization of Haskell's technique. By a suitable redefinition of parameters, it is possible to cast the anisotropic problem into isotropic form so that existing programs, tables, and graphs can be used to determine the structure of layered anisotropic media. It can be shown that the Love-wave period equation expresses the condition of constructive interference between multireflected SH waves with directionally dependent velocities. Also, it is demonstrated analytically and numerically that a restricted form of the anisotropy considered here is the limit of a finely laminated solid as the laminations become much smaller than a wave length. For long wave lengths, a multilayered structure may be replaced by an equivalent single layer.— Author's abstract

- 191-154. Abubakar, Iya. Disturbance due to a line source in a semi-infinite transversely isotropic elastic medium: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 3, p. 337-359, 1962.

The disturbance due to a buried line source in a homogeneous elastic half space with hexagonal elastic symmetry is investigated using a combination of Fourier and Laplace transform technique. Following Cagniard's method a series of transformations is used to render the integrals invertible by inspection. The case of an impulsive line source is considered in detail. Exact closed algebraic expressions for the surface displacements as functions of time and horizontal distance valid for all epicentral distances are obtained.— Author's summary

- 191-155. Nag, K[anti] R[anjan]. Disturbance due to shearing-stress discontinuity in a semi-infinite elastic medium: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 4, p. 468-478, 1962.

The displacements at the free surface due to sudden introduction of shearing-stress discontinuity which expands or moves uniformly after creation inside a semi-infinite isotropic elastic medium have been obtained in exact forms for SH type of motion by the method due to Cagniard. Displacements at different points on the free surface have been calculated numerically, and results are shown graphically for two particular cases.— Author's summary

191-156. Hudson, J. A. The total internal reflection of SH waves: Royal Astron. Soc. Geophys. Jour., v. 6, no. 4, p. 509-532, 1962.

The first part of the paper discusses the reflection of simple harmonic plane SH waves at angles of incidence greater than the critical angle at the interface between two semi-infinite elastic mediums. The change of phase which occurs on reflection is related to the rate at which energy crosses the interface. Then the rate at which energy travels parallel to the interface in the inhomogeneous wave and its effect on the group velocity of Love waves are calculated.

The second part of the paper treats the total reflection of a plane SH pulse. The expression for the reflected pulse involves the use of allied functions. General results concerning the allied functions are drawn from a few conditions imposed on an otherwise general function. It is shown that the approximation of a plane pulse to a bounded plane pulse or spherical pulse is not valid for incident angles near  $\pi/2$  or near the critical angle. The pulse usually known as the head wave is not given by this approximation, but displacements that are forerunners of the reflected pulse and arrive ahead of the reflected pulse predicted by ray theory can be studied. A few special cases are given and deductions are made about the reflected wave when the incident pulse is symmetrical with a central maximum.— D.B.V.

191-157. Yamaguchi, Rinzo. Surface waves and layered structures. Part 1, Influence of a low velocity layer and some study on Lg and Rg waves [with Japanese abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, no. 4, p. 653-668, 1961.

The effect of a low velocity layer on surface waves and the nature of Lg and Rg phases in relation to crustal structure are discussed. The existence of a low velocity layer in the mantle has been verified recently by a comparison of the calculated dispersion curve of the mantle Rayleigh wave with that actually observed (see Geophys. Abs. 181-130). As further verification, the behavior of Love waves and Rayleigh waves propagated along the surface of a stratified medium containing a low velocity layer is calculated and the results are illustrated. These results are then applied to interpretation of Lg and Rg waves. It is concluded that the structure of the intermediate layer may be determined to some extent from the observed Lg and Rg waves. These phases appear when the intermediate layer (3.5-3.7 km/s) has a thickness as great as five or more times that of the upper layer. The existence or not of Lg waves with periods shorter than 2 sec at a distance is a clue to the existence of a low velocity layer. The appearance of the Lg phase suggests the presence of a sedimentary layer over the intermediate layer.— V.S.N.

191-158. Yamaguchi, Rinzo, and Kizawa, Takashi. Surface waves and layered structures. Part 2, Theoretical dispersion curves for suboceanic surface waves [with Japanese abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, no. 4, p. 669-809, 1961.

Theoretical calculations are presented for dispersion curves of surface waves in a two-layered structure including the water layer and covering a wide variation of crustal structure and topography. The cases treated are grouped, and the dispersion curves for Rayleigh waves are represented graphically in 49 figures; the values of the parameters in the respective groups and the calculated values for each case are tabulated. Calculations have been lim-

ited to the dispersion curve of the fundamental mode. Brief descriptions are given for each group of cases. Theoretically a water layer overlying a crust has no effect on the Love wave provided the water is a perfect fluid with no viscosity. In view of the utility in practical problems, the dispersion curves of Love waves for most of the above cases are calculated and shown graphically in 35 figures.— V.S.N.

191-159. Takahashi, Takehito. The dispersion of Love waves in heterogeneous half space overlain by a homogeneous layer: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 811-822, 1961.

The theory of Love wave propagation is discussed for the case of a homogeneous upper layer of thickness  $h$  and a heterogeneous lower layer, where rigidity and density are slowly varying functions of the depth. The equation of dispersion is calculated. An example is cited in which the distribution of shear velocity is given only numerically, and results are compared with calculations of dispersion of mantle Love waves by Kobayashi and Takeuchi (see Geophys. Abs. 186-263). The theory is found not to hold for extremely long waves.— V.S.N.

191-160. Takahashi, Takehito. Dispersion curves for the higher modes of surface waves in heterogeneous media: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 823-830, 1961.

As a continuation of previous papers (see Geophys. Abs. 165-91, 172-63) in which only the fundamental mode is treated in calculating the dispersion of surface waves in heterogeneous mediums, dispersion curves are calculated for the second mode of both Love and Rayleigh waves and for higher modes of Love waves in a medium having a low velocity zone. The changes necessary in the calculations to treat Rayleigh waves under the same assumptions are given also.— V.S.N.

191-161. Tazime, Kyozi. Ray-theoretical construction of dispersive Rayleigh waves (continued): Hokkaido Univ. Fac. Sci. Jour., ser. 7 (Geophysics), v. 1, no. 5, p. 347-365, 1961.

Following the principle developed in the first half of this paper (see Geophys. Abs. 179-125) in which reflecting coefficients on a solid-solid interface are expressed explicitly by matrices, general expressions are given for reflecting coefficients on the lower boundary of a superficial layer. Using these expressions, displacement potentials are given for dispersive Rayleigh waves as well as general expressions for the characteristic equations.— V.S.N.

191-162. Červený, Vlastislav, and Hron, František. Reflection coefficients for spherical waves (with Russian summary): Československá Akad. Věd. Studia Geophys. et Geod., v. 5, no. 2, p. 122-132, 1961.

Reflection coefficients are investigated mathematically for spherical waves. The potential of a reflected harmonic wave on a plane interface between two liquid mediums may be formally expressed by the equation  $\phi = A(e^{ikR}/R)$ , where  $R$  is the distance from the source and  $A$  is the modified reflection coefficient. The latter depends on the angle of incidence, on the parameters of both mediums, and also on the frequency, or wavelength, of the incident wave. With increasing frequency the modified reflection coefficient  $A$  approaches asymptotically the value of the reflection coefficient of plane waves  $A_0$ . This paper investigates the differences between  $A$  and  $A_0$ , particularly in the vicinity of the critical point.— D.B.V.

191-163. Osipov, I. O. Kharakter ismeneniya skorostey rasprostraneniya uprugikh voln v anizotropnykh sredakh [Character of variation of

velocities of propagation of elastic waves in anisotropic mediums]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 3-10, 1962.

The character of variation of velocity of propagation of elastic waves in solid anisotropic bodies with four elastic constants depending on the latter is discussed. Inequalities are obtained which impose on the elastic constants of actual anisotropic bodies more rigid conditions than the conditions for determination of elastic properties by a quadratic formula. This raises doubt as to the value of elastic constants of a large number of materials determined experimentally. Using the inequalities obtained here it is shown that the third case of surface waves of Rayleigh type cannot take place at the free boundary of an anisotropic halfspace.—J.W.C.

191-164. Zharkov, V. N. Sobstvennyye kolebaniya zemli. Zatkhaniye [Natural oscillations of the earth. Attenuation]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 2, p. 159-170, 1962.

A theory of the attenuation of torsional, radial, and basically spheroidal oscillations of an earth model is presented in the first part of the paper. It is assumed for this purpose that (1) the absorption is small (relative to the decrease in amplitude of oscillation for one period); (2) the attenuation of elastic oscillations due to dissipative processes can be calculated within the framework of linear theory; (3) the dissipative processes due to volume compressibility can be neglected; (4) the gradients of the quantities that affect attenuation are small; and (5) the problem of determining the frequency of the natural oscillations has been solved previously. In the second part of the paper a theory of attenuation of torsional oscillations is presented for a real earth model.—J.W.C.

191-165. Osipov, I. O. Dvizheniye seismicheskoy energii v anizotropnykh sredakh [Transfer of seismic energy in anisotropic media]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 2, p. 181-185, 1962.

The transfer of seismic energy in anisotropic mediums with three elastic constants is investigated. The direction of the energy flow of uniform waves of the first and second types in anisotropic mediums does not coincide with the normals to the wave fronts or to particle displacements, in contrast to their behavior in isotropic mediums. The property of the flow of energy of reflected and refracted plane elastic waves at the interface of mediums is examined. Relationships are obtained which characterize the distribution of energy of incident waves between reflected and refracted waves. Relationships are also established that express the principles of reversibility of elastic waves.—J.W.C.

191-166. Galperin, Ye. I. Ob izmenenii napravleniya smeshcheniy chastits pri prokhozhenii seismicheskikh voln cherez zonu malyykh skorostey [On the change of the displacement direction of particles during passage of seismic waves through a zone of low velocities]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 585-594, 1962.

Experimental studies were made of changes of the displacement direction of particles due to the passage of a seismic wave through a layer of low seismic velocity, the thickness of which is commensurate with the wavelength. A discontinuity in the velocity of the longitudinal waves may reach a ratio of 5-6 and cause a marked deviation of the seismic ray, even when the relief of the lower boundary of the layer is insignificant.—A.J.S.

191-167. Shamina, O. G., and Lebedeva, F. V. Ob obmennykh volnakh na modelyakh zemnoy kory i obolochki [On transformed waves on models of the crust and the mantle]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 610-619, 1962.

Reflected transformed waves were investigated directly on two-dimensional models of the crust made of vinylplast, plexiglas, and hetinox. The results of the investigation show that  $S_2P_1$  waves can be distinguished on the record when their velocity ratio in the crust and the mantle is 0.5-0.8.  $P_2S_1$  waves were not distinguished because of their low intensity and their interference with the subsequent phases of  $P_2P_1$  waves. The experimental results are presented in seismograms and traveltime curves for a single-layer and two-layer crust.—A.J.S.

191-168. Kun, V. V. Osobennosti seysmicheskikh voln v sredakh s vyklinivayushchimisya sloyami (po model'nym issledovaniyam) [Peculiarities of seismic waves in mediums with layers that pinch out (according to model experiments)]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1749-1767, 1961.

The dynamic characteristics of head and diffracted waves in a model of a layer that pinches out were investigated. In the region of the subsequent arrivals, several types of waves are distinguished that occur at the inclined boundary and exceed in intensity the waves recorded in the region of the first arrivals. The relative intensity of the converted wave increases with an increase in the differences between the velocities and densities at the inclined refracting boundary. The relative intensity of the diffracted waves increases with an increase in the thickness of the covering layer and the angle at which the diffraction takes place. The relative intensity of waves recorded in the region of the first arrivals beyond the line of pinch out is determined largely by the ratio of the velocities and the densities along the base of the pinching out layer. The head wave corresponding to the inclined boundary of the pinching out layer and generated at the lower line of pinch out is two to three times weaker than the ordinary head waves corresponding to this boundary.—J.W.C.

191-169. Osipov, I. O. Otrazheniye i prelomleniye ploskikh uprugikh voln na granitse zhidkosti i tverdogo anizotropnogo tela [Reflection and refraction of plane elastic waves at the boundary of a liquid and a solid anisotropic body]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1768-1783, 1961.

The problem of reflection and refraction of plane elastic waves at the interface between a compressible liquid medium and a solid anisotropic half space with four elastic constants is solved. The existence of surface waves of Rayleigh type is investigated for the two-dimensional case (see also Geophys. Abs. 186-253).—J.W.C.

191-170. Lossovskiy, Ye. K. Osobennosti amplitudnykh grafikov uprugikh ploskikh voln v sloistoy srede [Peculiarities of amplitude graphs of elastic plane waves in a layered medium]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1792-1798, 1961.

The behavior of reciprocal amplitude graphs of plane waves in a two-layered medium at a normal incidence of the waves at the interface are discussed. Equations that describe the ratio of the amplitudes of plane waves in a two-layered medium indicate that this ratio depends on the direction of the wave motion. When the wave passes from a medium which is acoustically less rigid into one that is more rigid, the magnitude of the amplitude jump of the displacement is larger than if the wave passes in the opposite direction. The effect of the directionality of the passage of the wave across the interface increases with an increase in the difference between the elastic parameters at the interface. If the location of the points of the source and receiver are interchanged, keeping the excitation constant, the energy of excitation as well as the form of the oscillations at connected points are equal, provided the wave incidence is normal.—J.W.C.

- 191-171. Zaytsev, L. P. O vyrozhdennykh golovnykh volnakh v uprugom srede s granitsej razdela [On degenerated head waves in an elastic medium with an interface]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1117-1123, 1960.

The axially symmetrical problem of forced oscillations in a medium consisting of two elastic halfspaces and having a plane interface is discussed. The physical nature of these oscillations has not yet been explained satisfactorily. The degenerated head waves possess several peculiarities which both help and complicate their observation. They should be encountered frequently during seismic observations because for their occurrence it is sufficient that one of the velocities in a medium with a source be higher than at least one of the wave velocities in the underlying layer. Strong damping of the oscillations with increasing distance of the source or of the observer from the interface may be compensated greatly by using low frequencies. The invariability of the form at all epicentral distances will undoubtedly help in identifying degenerated head waves.— J.W.C.

- 191-172. Shamina, O. G. Izucheniye dinamicheskikh kharakteristik prodol'nykh voln v sloyakh raznoy tolshchiny [Study of dynamic characteristics of longitudinal waves in layers of various thickness]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1135-1148, 1960.

The dynamic characteristics of longitudinal pulse waves in a free layer and in a layer immersed in water are investigated. It is shown that the velocity, form, predominant period, and amplitude attenuation of the sliding wave in the free layer and a head wave from a layer in water depend on the thickness of the layer. The thinner the layer, the shorter the distance from the radiator within which it can be considered as a plate. The behavior of the wave amplitude is the most dependable indication that a longitudinal wave which propagates through a layer with a velocity equal to that in the plate is fully formed.— Author's abstract, A.J.S.

- 191-173. Soluyan, S. I., and Khokhlov, P. V. Rasprostraneniye akusticheskikh voln konechnoy amplitudy v dessipativnoy srede [Propagation of acoustical waves of finite amplitude in a dissipative medium]: Moskov. Univ. Vestnik, no. 3, p. 52-61, 1961.

A system of equations of gas dynamics consisting of the equations of continuity, of motion, of heat transfer, and of state describes the propagation of disturbances of a finite amplitude in gas. Simplifying these equations for small initial disturbances and small dissipation of energy in a medium of arbitrary Reynolds number, the process of formation of front waves can be traced.— A.J.S.

- 191-174. Alekseyev, A. S., Babich, V. M., and Gel'chinskiy, B. Ya. Luchevoyy metod vychisleniya intensivnosti volnovykh frontov [The ray method of calculation of intensity of wave fronts] in Voprosy dinamicheskoy teorii rasprostraneniya seysmicheskikh voln: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 3-24, 1961.

The basic principles of the ray method of calculation of wave fronts in non-stationary problems for the wave equation and a system of dynamic equations of the theory of elasticity are outlined.— A.J.S.

- 191-175. Babich, V. M. O skhodimosti ryadov lucheвого metoda vychisleniya intensivnosti volnovykh frontov [Concerning convergence of series of the ray method for calculating wave front intensities] in Voprosy dinamicheskoy teorii rasprostraneniya seysmicheskikh voln: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 25-35, 1961.

The ray series developed in the previous paper (see Geophys. Abs. 191-174) is analyzed, and proofs are given that these series converge within the region of sensible limits. The proof is derived using Hadamard's monographs of 1902 and 1931 on wave propagation as a basis.—A.J.S.

- 191-176. Babich, V. M. Luchevoiy metod vychisleniya intensivnosti volnovykh frontov v sluchaye uprugoy neodnorodnoy anizotropnoy sredy [The ray method of calculation of intensity of wave fronts in the case of an elastic nonhomogeneous anisotropic medium] in Voprosy dinamicheskoy teorii rasprostraneniya seismicheskikh voln: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 36-46, 1961.

The fundamental equations of the ray method of calculating the intensity of wave fronts are generalized for the case of wave propagation through an elastic nonhomogeneous anisotropic medium. The fundamental formula for elastic energy distribution along the ray was found to be analogous to the energy distribution formula derived independently from the considerations of energetics.—A.J.S.

- 191-177. Gel'chinskiy, B. Ya. Formula dlya geometricheskogo rashkhozhdeniya [Formula for geometric divergence] in Voprosy dinamicheskoy teorii rasprostraneniya seismicheskikh voln: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 47-53, 1961.

A formula for the reduced geometric divergence of a seismic wave propagating with a variable velocity through a medium of arbitrary discontinuity boundaries is derived in this paper.—A.J.S.

- 191-178. Alekseyev, A. S., and Gel'chinskiy, B. Ya. Luchevoiy metod vychisleniya intensivnosti golovnykh voln [The ray method of calculation of head wave intensities] in Voprosy dinamicheskoy teorii rasprostraneniya seismicheskikh voln: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 54-72, 1961.

The problem of determining the terms of seismic ray dispersion for waves generated at an interface from incident waves of a specified ray dispersion is considered. The boundary conditions of a solid contact for partial amplitudes of K-th order, and the problem of determining the principal terms of ray dispersion for head waves is discussed in detail.—A.J.S.

- 191-179. Gazaryan, Yu. L. O geometro-akusticheskom priblizhenii polya v okresnosti neosobogo uchastka kaustiki [On a geometric-acoustic field approximation in the neighborhood of a nonsingular point of the caustic] in Voprosy dinamicheskoy teorii rasprostraneniya seismicheskikh voln: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 73-89, 1961.

Instead of an approximate integral representation of a sonic field in the neighborhood of its caustic, constructed asymptotically from the field frequency by one of the geometric-acoustical methods, a rigorous method of geometrical acoustics is proposed for calculating the sonic field parameters. As a result of the analysis, formulas for the values of pressure produced by waves coming to and departing from the caustic are derived, the sum of which represent the sonic field formula.—A.J.S.

- 191-180. Gazaryan, Yu. L. O rasprostraneni zvuka v neodnorodnykh sredakh [On propagation of sound in nonhomogeneous mediums] in Voprosy dinamicheskoy teorii rasprostraneniya seismicheskikh voln: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 90-114, 1961.

The method of geometrical acoustics (see Geophys. Abs. 191-179) is developed further and applied to study of sonic waves in nonhomogeneous mediums. The pressure density spectrum of the field is investigated, and formulas are derived for the sonic field in an elastic nonhomogeneous medium at different proximity to the caustic.—A.J.S.

- 191-181. Babich, V. M. Analiticheskiy karakter polya nestatsionarnoy volny v okrestnosti kaustiki [Analytic properties of the field of a nonstationary wave in the neighborhood of a caustic] in *Voprosy dinamicheskoy teorii rasprostraneniya seismicheskikh voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 115-144, 1961.

The analytical properties of the function which describes a nonstationary wave field in the neighborhood of its caustic are discussed. It is assumed that this function,  $u(x,y,t)$ , satisfies the wave equation  $(1/c^2)u_{tt} = \Delta u$ , where  $c=c(x,y)$ , and takes a form,  $u=A(x,y,t) (t-\tau-i0)^\lambda$ , where  $\tau=\tau(x,y)$ . The discontinuity line of the solution  $t=\tau(x,y)$  is, then, the wave front. The analytic properties of the function,  $u(x,y,t)$ , are derived for the neighborhood of the envelope of the sonic rays of the field studied.—A.J.S.

- 191-182. Babich, V. M. Analiticheskoye prodolzheniye resheniy volnovogo uravneniya v kompleksnuyu oblast' i kaustiki [Analytic extension of solutions of the wave equation into a complex region and the caustic] in *Voprosy dinamicheskoy teorii rasprostraneniya seismicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 145-152, 1961.

From a known ray expansion having a variable analytic coefficient before reaching the caustic, and taking into consideration the different types of discontinuity behind the caustic, the ray is extended analytically into a complex region to determine whether or not ray expansion behind the caustic is possible. By extending the elementary solution of the Cauchy problem analytically with the aid of the Poisson formula, it was found that ray expansion is possible behind the caustic.—A.J.S.

- 191-183. Buldyrev, V. S. Obobshcheniye metoda perevala na sluchay dvykh blizko raspolozhennykh sedlovykh tochek [Generalization of the pass method for the case of two approximate saddle points] in *Voprosy dinamicheskoy teorii rasprostraneniya seismicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 153-168, 1961.

This is a mathematical analysis and generalization of the solution of the contour line integral,  $J(p,\delta) = \int_i F(z) e^{p f(\delta, z)} dz$  for  $p \gg 1$  used in determination of the form of geologic bodies. Physical interpretation of different types of solution of the integral are given in the form of waves reflected and refracted at various types of interfaces.—A.J.S.

- 191-184. Tsepelev, N. V. Rasprostraneniye voln v akusticheskoy srede s perekhodnym sloyem [Propagation of waves in an acoustic medium having a transition layer] in *Voprosy dinamicheskoy teorii rasprostraneniya seismicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 169-205, 1961.

This is a mathematical analysis and solution of elastic wave propagation through a transition layer between two mediums of differing properties and with variable velocities  $V_s$  and  $V_p$ . The velocities  $V_s$  and  $V_p$  are assumed to vary exponentially. The reflected waves that produce a field in the transition layer are studied in detail.—A.J.S.

- 191-185. Molotkov, I. A. *Aşimptoticheskoje povedeniye nestatsionarnogo volnovogo polya v okrestnosti fronta soskal'zyvaniya v zadache diffraktsii na vypuklom tsilindre* [Asymptotic behavior of a nonstationary wave field in the neighborhood of the slip front in a diffraction problem on a convex cylinder] *in Voprosy dinamicheskoy teorii rasprostraneniya seysmicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 206-209, 1961.

Asymptotic expressions are derived for a nonstationary wave field in the neighborhood of a slip front from the convex surface of a cylinder similar to those obtained by the ray method. Analytical formulas are obtained which describe the transformation of the slip front into a regular wave front. — A.J.S.

- 191-186. Buldyrev, V. S. *Volnovoye pole v okrestnosti kaustik v nestatsionarnykh zadachakh diffraktsii v sluchaye sfericheskikh i tsilindricheskikh granitz razdela sred* [Wave field in the neighborhood of caustics in nonstationary diffraction problems in cases of spherical and cylindrical interfaces of the mediums] *in Voprosy dinamicheskoy teorii rasprostraneniya seysmicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 210-232, 1961.

Wave fields and their behavior in the neighborhood of caustics are investigated. The nonanalytical part of the field, which can be represented by a converging series whose coefficients are determined by the coefficient of asymptotic resolution for Mellin's integrals, is analyzed in the neighborhood of the cusps of the wave front on the surface of the caustic. Examples are given where spherical and cylindrical interfaces are present in the mediums. — A.J.S.

- 191-187. Molotkov, I. A. *Nekotoryye svoystva tsilindricheskikh funktsiy i ikh nuley* [Certain properties of cylindrical functions and of their zeros] *in Voprosy dinamicheskoy teorii rasprostraneniya seysmicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 233-239, 1961.

Nonstationary wave fields were investigated in the neighborhood of slip fronts (the surfaces of the first arrival of waves in the region of geometric shadow), and new properties of cylindrical functions and their zeros were established. These properties are: (1) new data on Hankel functions  $H_{-1\gamma}^{(j)}$  ( $i$ ),  $j=1,2$ , the imaginary unit, and their zeros on the complex plane,  $s$ ; (2) information on the number of zeros of Hankel functions on the plane of argument, depending on the complex index; and (3) data on the distribution of zeros of Bessel function  $J_p(z)$  on a  $p$ -plane when  $z$  is imaginary. — A.J.S.

- 191-188. Molotkov, L. A. *O rasprostraneni uprugikh voln v sredakh soderzhashchikh tonkiye plosko-parallel'nyye sloi* [On propagation of elastic waves in mediums containing thin plane-parallel layers] *in Voprosy dinamicheskoy teorii rasprostraneniya seysmicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 240-280, 1961.

Nonstationary interference phenomena in mediums consisting of plane-parallel elastic layers are analyzed and discussed in detail. Expressions in the double integral form for potentials of wave displacement fields are derived, and methods for solution of problems on propagation of elastic waves in mediums containing an arbitrary number of thin layers are given. — A.J.S.

- 191-189. Molotkov, L. A. *O rasprostraneni nizkochastotnykh kolebaniy v zhidkikh poluprostranstvakh razdelennykh uprugim tonkim sloyem*

[On propagation of low frequency oscillations in liquid halfspaces separated by a thin elastic layer] in *Voprosy dinamicheskoy teorii rasprostraneniya seysmicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 281-302, 1961.

Using a mathematical analysis of propagation of low frequency waves in liquid mediums separated by a thin elastic layer, the displacement fields according to the engineering theory of oscillation of plates and the elasticity theory are compared in order to determine the conditions under which the engineering theory can be applied.— A.J.S.

191-190. Molotkov, L. A. Ob inzhenernykh uravneniyakh kolebaniy plastin imeyushchikh sloistuyu strukturu [On engineering equations of oscillation of plates of layered structure] in *Voprosy dinamicheskoy teorii rasprostraneniya seysmicheskogo voln*: Leningrad, Izdatel'stvo Leningradskogo Universiteta, sbornik 5, p. 303-313, 1961.

A medium of free surfaces consisting of a finite number of plane-parallel elastic layers is studied, and equations analogous to the engineering equations for a single layer are derived for the low frequency part of displacements. It was found that the low frequency oscillations of a layered plate are subject to the same type of equations that are used in the study of low frequency oscillations of homogeneous elastic plates.— A.J.S.

Brune, James N. Correction of initial phase measurements for the southeast Alaska earthquake of July 10, 1958, and for certain nuclear explosions. See *Geophys. Abs.* 191-104.

Vinogradov, S. D. Experimental study of the distribution of the number of fractures according to energy during crushing of rocks. See *Geophys. Abs.* 191-652.

191-191. Davydova, N. I. Izucheniye na modelyakh zavisimosti dinamichekikh kharakteristik prodol'nykh golovnykh voln ot moshchnosti prelomlyayushchego sloya [Study on models of the dependence of dynamic characteristics of longitudinal head waves on the thickness of refracting layers]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 1, p. 11-22, 1962.

Solid-liquid models were used to study the trace, period, and amplitude damping with distance of longitudinal head waves corresponding to layers of different thickness,  $d$ . Amplitude damping is greatest when  $d/\lambda = 1$  (where  $\lambda$  is the wavelength in the layer); it is considerably less in very thin and thick layers. The change in amplitude damping with distance when the thickness of the sheet is varied indicates that caution should be used with respect to the hitherto current view that head waves associated with thin layers show anomalously high amplitude damping. With real mediums it is also possible that the maximum amplitude damping of longitudinal head waves occurs at certain intermediate values of thickness and not in the thin layers. Large changes in the damping of amplitude with distance may be due to changes in thickness as well as to changes in absorption properties.— J.W.C.

191-192. Voskresenskiy, Yu. N. Ob izuchenii seysmicheskikh otrazheniy ot nezerkal'nykh granits na trekhmernykh modelyakh [On the study of seismic reflections from nonspecular boundaries on three-dimensional models]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 5, p. 620-629, 1962.

Experiments on reflection of seismic waves from nonspecular boundaries in three-dimensional solid-liquid models are described, and the results obtained

using oriented reception of seismic waves are discussed. A special pickup using pi-form filters of upper and lower frequencies is proposed. A monodimensional boundary gives the same results as a two-dimensional boundary and permits separation of side waves of the second order. The formula which limits the formation of such waves is confirmed.—A.J.S.

- 191-193. Ivakin, B. N. Metody upravleniya plotnost'yu i uprugost'yu sredy pri dvmernom modelirovani seysmicheskikh voln [Methods of controlling the density and elasticity of a medium during two-dimensional modeling of seismic waves]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1149-1167, 1960.

For purposes of two-dimensional seismic modeling of wave phenomena, some methods are suggested for controlling the density and elasticity of thin plates (sheets) by means of a net of holes or projections as well as by using plates of different thickness. The effective wavelength  $\lambda$  in plates must satisfy the equation  $\lambda \geq (8/10)h_1$ , where  $h_1$  is the greatest spacing of the holes or projections and when the absorption and distortion of the wave form due to dispersion over nonuniformities is still insignificant. The decrease in wave velocity due to the holes can attain 60 percent. By varying the thickness of a plate, a threefold increase or decrease of the effective density at an interface is possible.—J.W.C.

- 191-194. Central Water and Power Research Station Poona. In-situ elasticity of rock in tunnels—New Bhira tunnel project: India Ministry of Irrigation and Power Central Water and Power Research Sta. Poona Annual Research Mem., 1961, p. 273-278, 1962.

Investigations were made to assess the in place values of Young's modulus of rocks exposed in the New Bhira Tunnel at Dongarwadi, Maharashtra State, India, primarily to determine the optimum thickness of the concrete lining for each section of the new tunnel. Using the compressive wave velocity determined from a measured seismic profile and the density determined on rock samples collected from the tunnel wall corresponding to each seismic profile length of 70 feet, Young's modulus was calculated assuming a Poisson's ratio of 0.33. Laboratory measurements were also made. Acceleration and strain measurements were carried out in the old tunnel to determine the safe charge for excavating some of the galleries in the new tunnel.—V.S.N.

- 191-195. Nicholls, Harry R. In situ determination of the dynamic elastic constants of rock, in International Symposium on Mining Research: New York, Pergamon Press, v. 2, p. 727-738, 1962.

This is virtually the same as the paper published in U.S. Bur. Mines Rept. Inv., no. 5888, 13 p., 1961 (see Geophys. Abs. 190-168).—V.S.N.

- 191-196. Vasil'yev, Yu. I. Dve svodki konstant zatukhaniya uprugikh kolebaniy v gornykh porodakh [Two sets of constants of attenuation of elastic oscillations in rocks]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 595-602, 1962.

The following two seismic problems are analyzed and discussed: (1) the dependence of attenuation decrements of elastic waves on oscillation frequency; and (2) the correlation between attenuation coefficients of longitudinal and transverse waves including surface waves. Experimental data on attenuation decrements of body and surface waves in granites and other crystalline rocks of the crust are summarized in a table. The decrement remains practically unchanged within the range of oscillation frequencies from 0.05 cycle per second to 1 megacycle per second. Data compiled in another table give values of  $V_S/V_P$  and ratios of attenuation coefficients  $\alpha_P/\alpha_S$  and  $\alpha_P/\alpha_R$  for various rocks and materials.—A.J.S.

- 191-197. Vanek, I., Klíma, K[arel], and Pros, Z[deněk]. Osobnosti metodiki izmereniya pogloshcheniya uprugikh voln v obraztsakh gornykh porod [Particulars of the method of measurement of absorption of elastic waves in rock samples]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 603-609, 1962.

The impulse method of measuring elastic wave absorption in rock samples is discussed. The methods of multiple reflection, profiling, and sounding with frequencies from 0.2 to 2.5 mc per sec are analyzed, and sources of possible error are pointed out. Determinations of the absorption coefficient on a basis of interpretation of the amplitude curve obtained by the impulse method are not unique. An empirical function is proposed that takes the divergence of the wave front and the absorption effects into account; these phenomena affect the amplitude curve with increasing distance.—A.J.S.

- 191-198. Kravets', V. V. Pro shvydkosti pruzhnykh kolyvan' ta anizotropiyu deyakikh metamorfichnykh porid [On the velocities of elastic oscillations and anisotropy of certain metamorphic rocks]: Akad. Nauk Ukrain. RSR Dopovīd', no. 3, p. 295-298, 1961.

Ultrasonic determination of elastic wave velocity and of anisotropy coefficients in metamorphic rocks is described. The anisotropy coefficient can vary considerably depending on the stratification of the medium and its internal structure. In cases where the coefficient became anomalous, the wave velocities along the strata are found to be lower than those in a transverse direction.—A.J.S.

- 191-199. Volarovich, M. P. Issledovaniye fiziko-mekhanicheskikh svoystv gornykh porod pri vysokikh davleniyakh [Investigation of physical-mechanical properties of rocks under high pressure]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 4, p. 13-21, 1961.

The methods and results of investigation of elastic parameters of rocks under confining pressures up to 4,000 kg per  $\text{cm}^2$  are reported. Velocities of longitudinal waves in granite, gabbro, gabbro-diorite, and quartzite under 4,000 kg per  $\text{cm}^2$  pressure (corresponding to a depth of 15 km) were found to be 5,850-6,120, 6,800, 6,520, and 6,000 m per sec, respectively, and 5,800-6,070, 6,730, 6,450, and 5,980 m per sec, respectively, when corrected for higher temperature (220°C) by Birch's formula (see Geophys. Abs. 177-245). The values of the elastic parameters  $V_p$ ,  $V_g$ ,  $\sigma$ ,  $E$ , and  $G$  were determined for marly and limy sandstone. The values obtained in the laboratory by the dynamic impulse ultrasonic method and by the bending and torsion method were found to be slightly lower than the values obtained for the same rocks and at corresponding pressures determined by the seismic logging method. The method of determining attenuation coefficients of elastic waves in cylindrical rock samples is also discussed. (See also Geophys. Abs. 183-195.)—A.J.S.

- 191-200. Konstantinova, A. G. Zavisimost' sovstvennoy chastoty kolebaniy obraztsov porod ot odnostoronnnego davleniya [Dependence of natural frequency of oscillations of specimens of rocks on unilateral pressure]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 23-29, 1962.

Laboratory investigations show that the natural frequency of oscillations of rock samples increases appreciably with application of unilateral pressure. The form and character of these frequency changes depend largely on the uniformity or heterogeneity of the rock samples. For very uniform rocks (talc-chlorite, white marble), the form of the natural oscillations of the flexural type is very close to that of a decaying sinusoidal oscillation. In samples with less uniform composition (coal, argillite), the natural oscillation processes

have a more complicated character and differ considerably from decaying sine waves. In samples where many cracks are present (coal), the oscillations have an even more erratic character.— J.W.C.

- 191-201. Aleksandrov, K. S., and Ryzhova, T. V. Uprugiye svoystva porodobrazuyushchikh mineralov. II. Sloistyie silikaty [Elastic properties of the rock-making minerals. Pt. 2. Phyllosilicates]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1799-1804, 1961.

Elastic wave velocities were measured in a number of phyllosilicates, and the elastic moduli of biotite, phlogopite, and muscovite were determined. These minerals are strongly anisotropic in their elastic properties due to anisotropy in bond strength. With increased bond strength between the layers, there is a systematic increase in the elastic constants normal to the layering and a similar diminution in the anisotropy of the elastic properties. On the other hand, because of the almost complete similarity of the micaceous structural units that make up all the phyllosilicates, the elastic constants along the layers of all crystals are practically constant and similar to corresponding values of these constants in the pyroxenes and amphiboles.— J.W.C.

- 191-202. Aleksandrov, K. S., and Ryzhova, T. V. Uprugiye svoystva porodobrazuyushchikh mineralov. III. Polevyie shpaty [Elastic properties of the rock-making minerals. Pt. 3. Feldspars]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 2, p. 186-189, 1962.

Elastic wave velocity was measured in several nonequivalent directions in crystals of microcline, oligoclase, and labradorite. The results are tabulated. All the crystals studied are very anisotropic in their elastic properties. In microcline, for example, the velocities of the elastic compressional waves traveling along the X and Y axes are 5.1 and 8.15 km/s, respectively. The velocities of the shear waves range widely from 2.14 to 4.96 km/s. In the plagioclase series the transition from oligoclase to labradorite is marked by a large increase in elastic wave velocity and in the moduli of elasticity of the crystals.

An unexpected fact is that the lowest value of the normal elastic modulus occurs in the direction (100), where no cleavage is present. It is suggested that the (Al, Si)-tetrahedron framework is the least rigid element of the feldspar structure.— J.W.C.

- 191-203. Volarovich, M. P., Sobolev, G. A., and Parkhomenko, E. I. P'yezoelektricheskiy effekt pegmatitovykh i kvartsevykh zhil [Piezoelectric effect of pegmatite and quartz veins]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 2, p. 145-152, 1962.

The piezoelectric effect in pegmatites generally exceeds that of a gneissic host rock by two to four orders of magnitude. Pegmatites that consist almost entirely of feldspar and contain but little quartz exhibit no piezoelectric effects. When the measuring instruments are located between the impact point and a quartz vein but not closer than 5 m to the vein, a piezoelectric effect is recorded in the host rock. As the vein is approached, the piezoelectric effect in the vein itself assumes a dominant role.— J.W.C.

- 191-204. Pounder, E. R., and Stalinsky, P. Elastic properties of Arctic sea ice (with French abstract), in General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub., no. 54, p. 35-39, 1961.

The speed of sound in ice was measured by observations of the velocities of longitudinal and transverse wave pulses in cylinders about 15 cm × 7.5 cm cut from sea-ice cores. Young's modulus and Poisson's ratio are found from these velocities, and an equation is derived to express the relationship between

Young's modulus and the salinity of the ice. The average value of Young's modulus is lower for the top and bottom layers where salinity is higher.— V.S.N.

- 191-205. Ahrens, Thomas J., and Katz, Samuel. An ultrasonic interferometer for high-pressure research: *Jour. Geophys. Research*, v. 67, no. 7, p. 2935-2944, 1962.

A new method in which ultrasonic interferometry is used to measure the pressure dependence of elastic constants and the density of solids has been applied to polycrystalline KCl to pressures of 36 kilobars. Simultaneous measurement of longitudinal and transverse wave velocities in a specimen of initial thickness of approximately 0.2 mm, compressed between two tungsten carbide anvils, yields the adiabatic pressure derivative of density, which is numerically integrated to give the pressure-density relation, permitting direct comparison with Bridgman's data. Densities obtained by the present method are within 0.7 percent of Bridgman's throughout the pressure range studied. The 19.7-kb phase transition of KCl is marked by a 6 and 12 percent increase in bulk and shear moduli, the former in good agreement with Bridgman. Extension of the present method to higher pressures and high temperatures to a variety of materials appears feasible.— Authors' abstract

Judd, W. R., and Huber, Carolyn. Correlation of rock properties by statistical methods. See *Geophys. Abs.* 191-641.

- 191-206. Jones, G. H. S. Transverse motion from repeated explosions: *Jour. Geophys. Research*, v. 67, no. 7, p. 2994-2997, 1962.

Attention is drawn to a recent series of investigations which, although not principally directed toward SH motion, fulfills some of the requirements of experiments suggested by Press and Archambeau concerning the pronounced transverse motion from underground detonations (see *Geophys. Abs.* 188-219). Explosive trials at Ralston, Alberta, involved surface detonations of hemispherical charges ranging from 8 to 200,000 lb of TNT, all on essentially the same ground. In all the seismograms obtained the radial, vertical, and transverse components are of similar magnitude, and they are similar in profile at a given distance from all shots; the amplitude, of course, changes with the depth of burial. It thus appears that the transverse motion in these surface waves can hardly be correlated with the release of tectonic strain or crack propagation in the immediate vicinity of the source, and the mechanism of formation is likely to be removed from the immediate crater itself. Nevertheless, the source mechanism is obviously contained within, at most, a few radii of the plastic zone, since strong SH motion has been obtained at 2,000 feet from a 200,000-lb charge which produced a plastic zone of several hundred feet radius. Evidence was obtained of a slow "relaxation" in the plastic zone surrounding the crater during a period of at least 7 days after the detonation. Permanent displacements measured for several of the larger charges do not show full radial symmetry with a uniformly decreasing displacement outward from the crater; both transverse displacements and displacements toward the center were observed.— D.B.V.

- 191-207. Leet, L. Don. The detection of underground explosions: *Sci. American*, v. 206, no. 6, p. 55-59, 1962.

Methods are discussed for detecting underground nuclear explosions and for distinguishing them from earthquakes on seismic records. The methods proposed depend on extracting a large body of information from an ensemble of records made at varying distances and directions from the explosion or earthquake. To identify underground explosions, records from stations up to 1,000 to 1,500 km from the suspected explosion location should be examined first for a reversal of the usual division of energy between P- and S-waves

(that is, for a preponderance of P over S). Possibly the records may show H- and C-waves, which are never found in earthquake records. At intermediate ranges out to 2,500 km a progressive loss of surface and shear waves should occur and, if this takes place, the final indication - lonesome P-waves - will be found on records of distant stations. The records of distant stations should also serve to locate the explosion accurately. — V.S.N.

- 191-208. Carpenter, E. W., Savill, R. A., and Wright, J. K. The dependence of seismic signal amplitudes on the size of underground explosions: Royal Astron. Soc. Geophys. Jour., v. 6, no. 4, p. 426-440, 1962.

The essence of this paper is the application of  $W^{1/3}$  scaling laws to predict the amplitude dependence of distant seismic signals on the size of underground explosions. Various hypothetical models for the ground motion near an underground explosion are discussed, and the appropriate amplitude-yield relationship is derived. For most practical applications it appears that a linear relationship can be used, although for very large charges (or high frequencies) the amplitude will increase less rapidly than charge size and may even decrease. The effect of the bandwidth of the recording instrument is shown to be significant, and a comparison is made between theoretical predictions and the results obtained from nuclear explosions. — Authors' summary

- 191-209. Lombard, David B., and Power, Dean V. Close-in shock studies: U.S. Atomic Energy Commission Plowshare Program, Project Gnome Prelim. Rept. PNE-104P, 23 p., 1962.

Measurements of shock parameters, including particle velocity profile and peak shock pressure, were attempted in the salt close to the Gnome nuclear explosion. The measurements were to be compared with results predicted by the UNEC code, which predicts quantities such as cavity size, shock arrival time, extent of cracking, and details of ground motion. Radiation-fogged film and damaged instruments nullified most of the measurements, but the experience gained will be valuable in designing instruments and techniques for similar experiments in the future. — V.S.N.

- 191-210. Swift, L. M. Intermediate range earth motion measurements: U.S. Atomic Energy Commission plowshare Program, Project Gnome Prelim. Rept. PNE-111P, 50 p., 1962.

Thirty-one gage channels were installed for ground motion measurements on the Gnome shot (5kt) exploded at a depth of 366 m in salt beds near Carlsbad, N. Mex. In general, the accelerations and peak particle velocities observed were similar to those predicted. The usual effect of the free surface in increasing particle motions was observed, although not universally. Spalling of surface formations was noted out to 805 m. It is estimated that the observed radial particle velocity at the Shell well (9.5 km from shot point) corresponded to a peak over-stress of about 14 psi in the formation. No damage was caused at this distance, and it is concluded that there were no damaging effects at greater ranges. — V.S.N.

Lehmann, I[nge]. The travel times of the longitudinal waves of the Logan and Blanca atomic explosions and their velocities in the upper mantle. See Geophys. Abs 191-408.

- 191-211. Oliver, Jack [E.], and Isacks, Bryan. Seismic waves coupled to sonic booms: Geophysics, v. 27, no. 4, p. 528-530, 1962.

Air-coupled seismic waves of low frequencies excited by aircraft-generated sonic booms were detected by a hydrophone at moderate depth and by a geophone on the sea floor on the continental shelf off New Jersey. This phenomenon merits study because under conditions favorable for coupling, waves of

damaging proportions might be generated in the earth and cause a problem that could become serious as supersonic air travel becomes routine; and also because it may be possible to generate seismic waves very efficiently through the proper application to the earth of controlled sonic booms.—D.B.V.

- 191-212. Bradner, Hugh. Pressure variations accompanying a plane wave propagated along the ocean bottom: Jour. Geophys. Research, v. 67, no. 9, p. 3631-3633, 1962.

The use of pressure transducers instead of seismographs on the ocean floor to detect small vertical bottom motions has been suggested. The ratio of pressure to velocity has been estimated in the limiting case of waves that are long compared with the water depth by considering that the water above a given section of the bottom rises and falls as a cylinder. It is shown here that the ratio can be estimated for other cases by looking at the solution for plane wave propagation in a uniform liquid layer above a semi-infinite uniform solid bottom. From a graph which is presented it can be concluded, for example, that a 3-sec-period Rayleigh wave of displacement amplitude  $10 \text{ m } \mu$  in water 3 km deep would produce water pressure variations of about  $3.2 \text{ d per cm}^2$ .

From some meager observational data it appears that the low-frequency acoustic pressures in calm sea conditions might all be accounted for by seismic motion. A large increase in sound pressure might be expected at heavy sea states due to bodily compressional waves generated by "slapping" at the surface. It will be interesting to investigate coherence between hydrophone and seismometer signals at multiple ocean-bottom stations and to determine whether the pressure signatures under heavy seas without extensive standing wave patterns show a strong peak at the microseism frequency.—D.B.V.

## ELECTRICAL EXPLORATION

- 191-213. Matveyev, B. K. Elektricheskoye pole tochechnogo istochnika v mnogosloynnoy srede s sharovym vklyucheniym [Electrical field of a point source in a multilayered medium with a spherical inclusion]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1784-1791, 1961.

A solution is given for the problem of electrical profiling above a spherical inclusion in the presence of detrital deposits. Some results of calculations are presented that show the possibility of detecting these inclusions. Vertical electrical sounding curves above a sphere embedded in a two-layered medium are illustrated. The right branches of these curves diverge from the grid two-layered curve of the same modulus most markedly when the dimensions of the sphere are greatest and it is closest to the surface. If the sphere is nonconducting, all the ordinates of the calculated curve are raised in the center, whereas the curves are lowered and smoothed over a conducting sphere.—J.W.C.

- 191-214. Zakharov, V. Kh. Zavisimost' anomalii ot napravleniya peresecheniya vertikal'nogo malomoshchnogo plasta pri dipol'nom elektromagnitnom profilirovani [Dependence of an anomaly on the direction of intersection of a vertical thin stratum in connection with dipole electromagnetic profiling]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1818-1822, 1961.

For a ZZ dipole layout the profile should extend across the strike of an ore body and the frames should be dispersed. Heterogeneity of the field should be taken into account in calculating anomalies for dipole layouts. A change in the direction of profiling relative to the ore body does not in practice affect the phase alteration of the secondary magnetic field.—J.W.C.

- 191-215. Svetov, B. S. O roli sposoba vzbuzhdeniya polya v nizkochastotnom induktivnom metode elektrorazvedki [Role of the procedure for exciting a field in the low-frequency inductive method of electrical prospecting]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1826-1831, 1961.

Results are reported of experimental electrical surveying in the south Urals where anomalous effects were observed above known ore deposits when an ungrounded loop was spread directly above part of a deposit or to the side of it. It was found that the frequency characteristics and phases of the secondary field depend greatly on the arrangement of the field source. Outside the loop only anomalies from very good conductors of isometric shape embedded in high-resistivity country rock behave in accordance with current theories. The shape of the anomalies are also dependent on the arrangement of the loop. Anomalies that are linear outside the loop commonly take on a shape characteristic of ring or bilinear currents inside the loop. Anomalies detected through the vertical component of the magnetic field outside the loop are quite large, whereas inside the loop they are reduced sharply in size.—J.W.C.

- 191-216. Pris, G. V. Vozmozhnosti kolichestvennoy interpretatsii induktivnykh anomalii na nizkoy chastote [Possibilities of quantitative interpretation of inductive anomalies at low frequencies]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 65-75, 1962.

Integral methods of induction surveying are considered. The complex moments of the cross section of a cylindrical conductor can be found using low frequencies. When the measurements are taken inside the loop, this method can be used to obtain the coordinates of the center of gravity of the cross section of a conductor and the effective radius of inertia; the latter characterizes the geometric properties of the section. When the measurements are taken outside the loop or in the field of the cable, the longitudinal conductivity and the coordinates of the center of gravity of the cross section can be determined.—J.W.C.

- 191-217. Shaub, Yu. B. O vliyani udel'nogo soprotivleniya vmeshchayushchey sredy na formu anomal'nykh krivyykh v aereoelktorazvedke [On the effect of the specific resistance of the country rock on the form of anomalistic curves in airborne electrical prospecting]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 652-658, 1962.

The generation of an electric dipole and the subsequent appearance of a corresponding secondary magnetic field are discussed for a spherical conducting body buried in country rock of finite resistivity. An improvement in the accuracy of calculating the secondary field is attained which permits an analysis of the characteristic changes in the anomalistic curves in terms of the resistivity of the country rock. Illustrative computations are made for the two variants of airborne electric prospecting: the method of measuring of the inclination angle of the polarization plane of the natural variable magnetic field (AFMAG), and for the method of an infinitely long cable.—A.J.S.

- 191-218. Polonskiy, A. M. K voprosu o vychislenii magnitnykh momentov [The calculation of magnetic moments]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 726-730, 1962.

A formula derived in a previous paper (see Geophys. Abs. 187-495) for the calculation of magnetic moments using the vertical field component  $Z$  is transformed. The new formulas can be applied for the calculation of moments of buried bodies having the form of vertical cylinders with an arbitrary cross section and with a lower edge receding practically to infinity. They can be used also for inclined magnetization.—W.S.J.

- 191-219. Priz, G. V. Perekhodnyye protsessy v tsilindricheskom provodnike posle vyklyucheniya vneshnego magnitnogo polya. I [The transient processes in a cylindrical conductor after an external magnetic field is switched off. 1]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 736-743, 1962.

Based on study of the transient secondary magnetic field for  $t \rightarrow \infty$  by the "method of field establishment" (method of transient processes), a definition of a "parameter of the source of anomaly" is suggested. This method must be distinguished from the "field establishment method" for determining the thickness and depth of a layer. An approximate formula for such a parameter for the case of a cylindrical conductor having an elliptical cross section is  $\alpha \approx ((a+b)/2a)(1/\mu\gamma ab)$  where  $a$  and  $b$  are semiaxes,  $\mu$  is permeability, and  $\gamma$  is the specific conductivity. For a circular cylinder the formula yields an exact expression of the parameter.—W.S.J.

- 191-220. Priz, G. V. Opredeleniye parametrov rudnykh vklyucheniya po krivoy perekhodnogo protsessa v metode stanovleniya. II [Determination of the parameters of ore inclusions from the transient process curve in the method of field establishment. 2]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 744-749, 1962.

The method of transient processes for study of the asymptotic behavior of a secondary magnetic field for  $t \rightarrow 0$  and  $t \rightarrow \infty$  makes it possible to define parameters of anomalous objects (see Geophys. Abs. 191-219). These parameters  $\alpha_0, \alpha_1, \alpha_2$ , and  $\alpha_\infty$  defined by their mathematical expressions can be determined from the curve representing the transient process. However, the characteristics of the last three parameters have not yet been studied. The transient process curve yields also the parameters used in the inductive method. Practical methods of interpretation in prospecting could be based on the formulas obtained.—W.S.J.

- 191-221. Plokhikh, N. A. Resheniye nekotorykh ploskikh zadach elektrorazvedki postoyannym tokom [The solution of some plane problems in d-c electrical prospecting]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 750-757, 1962.

The method of inversion with respect to a circle is used for solving several problems in electrical prospecting. The fields of a linear source located at the earth's surface are investigated for the case of a buried conducting circular and semicircular cylinder, for a buried infinitely thin plate, for a nonconducting or conducting circular cylinder at the plane of vertical contact of two mediums, and for a nonconducting circular cylinder at the surface. The linear source is always assumed to be parallel to the strike.—W.S.J.

- 191-222. Glyuzman, A. M. K teorii elektrorazvedki pogrebennykh struktur. I [The theory of electric surveying of buried structures. 1]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 758-770, 1962.

Several boundary value problems important for interpretation in electrical surveying are discussed. The observed field in electrical surveying is assumed to be the field of an electric current measured at the boundary of a half space. The theory is based on exact solutions of problems concerning potential distribution due to a current in the presence of some assigned structures. A brief review is given of special systems of curvilinear coordinates which can be used for the solution of such problems in cases where the interfaces have the shape of surfaces of the second order. The solution of a boundary value problem is then sought in coordinates associated with interfaces. A solution is obtained for the field of a point source located at the boundary of a half space in the presence of a buried hyperboloidal dome (see Geophys. Abs. 186-296,

-301). The method of curvilinear coordinates is also used to account for the effect of the shape of the free surface.— W.S.J.

191-223. Kaufman, A. A. Tri sposoba vzbuzhdeniya polya v nizkochastotnoy elektrorazvedke rudnykh mestorozhdeniy [Three methods of field excitation in low-frequency electrical prospecting of ore deposits]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 5, p. 19-30, 1961.

Using a sphere embedded in a medium of infinite resistivity as an example, low frequency electrical prospecting at the earth-atmosphere interface is considered. The anomaly is determined either by the potential of the field or by eddies in the field, depending on the method of excitation and the frequency used.— A.J.S.

191-224. Belash, V. A. O nekotorykh sposobakh interpretatsii rezul'tatov nablyudeniya po metodu vyzvannoy polarizatsii [On some methods of interpretation of results of observations by the method of induced polarization]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 7, p. 90-95, 1961.

Methods of induced electrical polarization proposed by various authors are discussed, and formulas are derived for calculating theoretical curves of apparent polarizability of a two-layer horizontally stratified medium and for a thin vertical layer.— A.J.S.

191-225. Levadnyy, V. T. Vertikal'noye elektricheskoye zondirovaniye nad sistemoy trekh plastov zalegayushchikh na gorizonta'lnom osnovanii [Vertical electric sounding over a system of three layers lying on a horizontal basement]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 3, p. 126-128, 1960.

The problem of the distribution of electrical potential on the earth's surface for the case of three layers lying on the same basement of infinitely great or infinitely small resistivity is treated mathematically. Formulas for apparent electrical resistivities of the layers are derived for possible application to calculation of theoretical curves of vertical electrical sounding.— A.J.S.

191-226. Orellana [Silva], Ernesto. Criterios erróneos en la interpretación de sondeos eléctricos [Erroneous criteria in the interpretation of electric soundings (with English summary)]: Rev. Geofísica, v. 20, no. 79, p. 207-227, 1961.

Two conflicting schools of thought have arisen in the field of electrical prospecting, the "empirical" and the "scientific." Different rules found in the literature for interpreting the results of vertical resistivity sounding are described. The development of these methods is outlined, and the advantages and disadvantages of each are explained. The results of the empirical and scientific methods are incompatible. Practical examples are given to show that the empirical rules should be abandoned.— D.B.V.

191-227. Kolbenheyer, Tibor. O pryamoy zadacha elektrorazvedki dlya sloistogo trekosnogo ellipsoida [On the boundary problem of electrical surveying for a layered triaxial ellipsoid (with German summary)]: Československá Akad. Věd Studia Geophys. et-Geod., v. 4, no. 3, p. 250-255, 1960.

A triaxial ellipsoid that is divided by a number of confocal ellipsoid surfaces into a finite number of homogeneous and isotropically conducting layers is examined in the field of a constant direct-current point source lying either in one of the layers or outside. The potential of the stationary field inside

each layer is expressed as the sum of the primary and supplementary potential. The supplementary potential as a harmonic function of each layer can be written as an infinite series of Lamé's functions. A corresponding development has already been given by the author for the primary potential (see Geophys. Abs. 181-186). The unknown coefficients appearing in the potential expressions can be determined by solution of a system of linear equations obtained from the boundary conditions. In conclusion, the corresponding telluric problem is solved for a layered ellipsoid, and its solution is reduced to elliptical integrals of the first and second order.— Author's summary, D.B.V.

- 191-228. Umezu, Naganori, and Ando, Kiyomi. Electrical prospecting method by three phase alternating current (3). Potentials due to a buried conducting and insulating sphere: Kyushu Inst. Technology Bull., no. 12, p. 25-29, 1962.

Expressions are derived for the potentials due to a buried conducting and insulating sphere by use of the 2d approximation, and a study is made of the expressions  $\rho_{ao}/\rho_1$  and  $\rho_{a_{in}}/\rho_1$  ( $\rho_1$  is resistivity of ground,  $\rho_{ao}$  and  $\rho_{a_{in}}$  are the effective resistivity due to a buried conducting and insulating sphere), which are necessary to find the standard curves for electrical prospecting by the 3-phase alternating current method. (See also Geophys. Abs. 187-176, -177:)— V.S.N.

- 191-229. Unz, M. Linear approximation of apparent resistivity functions: Geophysics, v. 27, no. 1, p. 100-108, 1962.

Linear expressions are sufficient for the approximation of resistivity functions, if the trend of the resistivity contrasts is taken into account. The maximum error in two-layer systems has been determined. Application to more than two layers and interpretation methods are investigated. Three-layer examples are discussed.— Author's abstract

- 191-230. Negi, Janardan G. Diffraction of electromagnetic waves by an inhomogeneous sphere: Geophysics, v. 27, no. 4, p. 480-492, 1962.

The electromagnetic response of an inhomogeneous conducting sphere (having radial conductivity distribution) embedded in an infinite homogeneous medium is investigated. The effect of linear conductivity variation and magnetic contrast between the two media is discussed in detail and relevant curves are presented. Analytical results are further extended to a more general situation in which this sphere is located in a half-space, and the influence of air-earth boundary is calculated. These results may be applied to geoelectrical interpretation.— Author's abstract

- 191-231. Wiedurwilt, W. Gordon. Interpretation techniques for a single frequency airborne electromagnetic device: Geophysics, v. 27, no. 4, p. 493-506, 1962.

An airborne electromagnetic device, designed to measure electromagnetic anomalies in a manner that readily lends itself to the interpretation of conductivity and type-body, led to the Aero-Newmont vertical coaxial coil EM system. This mining prospecting device, applicable chiefly in Canadian-type mineral environment, is rigidly mounted on an S-55 helicopter. Continued studies in the theory of interpretation for such a device, plus an accumulation of over five years of field experience, have provided a knowledge of the limitations which compliment the interpretation procedure to produce a surprisingly accurate and useful exploration tool.— Author's abstract

- 191-232. Praus, Oldřich. A contribution to the asymptotic expression of the electromagnetic field of an electric dipole: Československá Akad. Věd Studia Geophys. et Geod., v. 4, no. 2, p. 153-157, 1960.

A relatively simple method can be used to find the solution for the electromagnetic field of an electrical dipole on the surface of a half space formed of plane-parallel horizontal layers having different electrical parameters, at distances much greater than the wavelength corresponding to the frequency of the exciting alternating field (wave zone). The expressions for an electrical field in the wave zone can be regarded as the principal terms of the expansion of the corresponding functions of the field with respect to the distance  $r$  from the field source.

In order to judge under what conditions the field may be replaced by its asymptotic expression, the influence of the other terms of the expansion must be known, and the conditions under which the higher terms may be neglected must be determined. This is done in this paper. A graph of the electrical field amplitude for various values of  $v_1=r/h_1$ , for example, shows that for parameters  $v_1 > 8$  the curve approaches the asymptote.— D.B.V.

- 191-233. Khomenyuk, Yu. V. Metod dvoynogo vrashchayushchegosya polya [Method of double rotating field]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1823-1825, 1961.

Currents of two frequencies, a working frequency and a fairly low auxiliary frequency, are passed through the generating frames, thus creating two rotating fields with identical configuration in a nonconducting medium. By establishing a predetermined ratio between the currents of the working and the auxiliary frequencies in the generating frames and by regulating the sensitivity of the receiving apparatus to the working and the auxiliary frequencies, identical rectified voltages can be obtained in the working and auxiliary frequency channels. Such an arrangement eliminates false anomalies due to disturbance of coaxiality between the generating and receiving frames. Ore bodies with high conductivity create anomalies at the working frequencies but practically no anomaly at the low auxiliary frequencies.— J.W.C.

- 191-234. Dmitriyev, V. I. Difraktsiya elektromagnitnykh voln na provodyashchey plastine, raspolozhenoy v provodyashchem prostranstve [Diffraction of electromagnetic waves at a conducting plate in a conducting medium]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 731-735, 1962.

The mathematical problem for an anomalous field due to the presence of a conducting plate in a layered medium is reduced to a Fredholm equation of second kind. A vertical plate in a homogeneous half space covered by a horizontal conducting layer is considered, and approximate boundary conditions at the plate surface are used.— W.S.J.

- 191-235. Kozulin, Yu. N. K teorii chastotnogo elektromagnitnogo zondirovaniya mnogosloynnykh struktur [On the theory of frequency electromagnetic sounding of multi-layered structures]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 8, p. 1204-1212, 1960.

Existing methods of computing electromagnetic fields in layered mediums are either formal solutions from which no physical information can be derived, or they require high-speed computers. A convenient approximate method is proposed here in which the actual field excited in a layered half space is compared with the field in a hypothetical homogeneous half space that has a frequency-dependent conductivity.— J.W.C.

- 191-236. Paterson, Norman R. Helicopter E. M. test, Mobrun orebody, Noranda: Canadian Mining Jour., v. 82, no. 11, p. 53-58, 1961.

An airborne test survey was made over the Mobrun sulfide deposit at Noranda, Quebec, using a new combination electromagnetic and magnetometer installation with helicopter transport. The instruments, with the exception of

control consoles, are installed in a bird suspended 100 feet below the helicopter. To obtain better penetration over earlier E. M. instruments, the separation between transmitting and receiving coils was increased from 20 to 30 feet. A decrease in weight of the new E. M. instrument was achieved that made it possible to carry the Gulf fluxgate magnetometer in the same bird. The various recording devices and control consoles are located in the helicopter. The total weight of the bird and associated equipment is 100 lbs. Results of a test survey with the bird 100 feet above ground are illustrated with maps and compared with results from ground electromagnetic and magnetometer surveys. The test shows that this new E. M.-magnetometer combination for helicopter operates within acceptable tolerances.—V.S.N.

- 191-237. Kamenetskiy, F. M., and Kovalenko, V. F. Nekotoryye rezul'taty oprobovaniya MPP [Some results of testing MPP]: *Razvedka i Okhrana Nedr*, no. 7, p. 35-38, 1962.

The method of transition processes (MPP) is based on study of the magnetic field of eddy currents induced in various geologic bodies at the time of removal of a primary magnetic field created by an ungrounded d-c fed loop. The method has been successfully field tested, and illustrative case histories are given. Advantages of the method are as follows: Only anomalous components of the field are recorded because the reading is made after the primary field has been cut out. Exploration is possible in regions of thick, good-conducting overburden where surveying by other induction methods is hampered by strong absorption of the field.—J.W.C.

- 191-238. Kelly, Sherwin F. Geophysical exploration for water by electrical resistivity: *New England Water Works Assoc. Jour.*, v. 76, no. 2, p. 118-189, 1962.

The electrical resistivity method of exploration for ground water is discussed in detail. The principles and techniques are reviewed and some examples of application described. Case histories are cited to illustrate application of the principles to representative types of field problems—areas of concealed structures, glacial and nonglacial overburden, tropical and semi-tropical lands, desert wash, subsurface basins, arid lands, gravel aquifers on clay bedrock, and the like. A reference list of 33 items is included.—V.S.N.

- 191-239. Petrucci, [Giuseppe], and Coppolino, S. Alcune esperienze su formazioni acquifere con i metodi della polarizzazione indotta e della resistenza adoperando un dispositivo di misura bipolare [Some tests on water-bearing formations with the induced polarization and resistivity methods, using a bipolar measuring set-up (with English summary)]: *Annali Geofisica*, v. 14, no. 3, p. 255-266, 1961.

The induced polarization method described by Orilia and Petrucci (see *Geophys. Abs.* 167-94) was tested in different areas in Italy where the nature of the subsoil was known from apparent resistivity measurements or well data. The results confirm the usefulness of this electrochemical method in ground water prospecting. The aquifers tested are in Eocene clays that crop out at the surface, in alluvium overlying Eocene clays, and in calcareous tuffs overlying clays.

The relative merits of the bipolar and quadrupolar (Wenner-like) arrangements are discussed. Theoretically at least, the former (used in these tests) has the advantages that it measures the entire response to the polarizing current (and therefore requires less current) and penetrates deeper; furthermore, by using a third electrode with the bipolar method, parasite polarizations at the electrodes and variations in emf due to superficial inhomogeneities can be eliminated.—D.B.V.

- 191-240. Rao, H. N. Ramachandra, and Chetty, T. Nookiah. A method of correlation of measured and calculated resistance of grounding systems: A single driven rod: [India] Irrigation and Power Jour., v. 19, no. 3, p. 197-206, 1962.

In electrical exploration it is essential to determine the approximate resistance of the grounding arrangement before actual installation because the resistivity value used for the calculation of resistance is often the source of large error. The resistivity value obtained is a function of probe spacing, and the problem is to choose a value such that the calculated resistance will be approximately equal to the measured resistance. A solution is given for a grounding system consisting of a single driven rod. From results of field tests it is concluded that if the probe spacing corresponds to length of the driven rod, the calculated resistance will be approximately equal to the measured resistance. The average value of resistivity to various depths was explored at three different places by expanding the probe spacing.— V.S.N.

- 191-241. Bondarenko, V. M., Kovalenko, N. D., and Tarkhov, A. G. Geofizicheskiye issledovaniya uranovykh mestorozhdeniy metodom radiovolnovogo prosvechivaniya [Geophysical investigations of uranium deposits by the method of radiowave transparency]: Vyssh. Ucheb. Zavedeniye Izv., Geologiya i Razvedka, no. 2, p. 71-82, 1962.

The content of uranium-bearing minerals in a uranium deposit is usually so small that it does not affect the physical properties of the ore zone and therefore is not readily detectable by the usual geophysical methods. This paper reports the results of tests applying the radiowave method of electromagnetic surveying to models and to two uranium deposits known through mining operations. It was found that the coefficient of radiowave absorption is 2 to 3 times greater over ore than over barren rock (quartz porphyry).— D.B.V.

- 191-242. Mizyuk, L. Ya., and Kotyuk, A. F. Metody aereoel'ektorazvedky [Methods of airborne electrical prospecting]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 6, p. 83-93, 1961.

Airborne methods of electrical prospecting are reviewed with respect to three groups: (1) methods using fixed sources of an electromagnetic field on the surface of the earth; (2) methods using the field source on a plane or helicopter; and (3) methods using the natural electromagnetic fields of sonic and infrasonic frequencies.— A.J.S.

- 191-243. Verbyts'kyy, T. Z. Vyprominyuvannya ramochnoi anteny v elektrovidnomy seredovyschi [Radiation of a loop antenna in electrically conductive medium]: Akad. Nauk Ukrain. RSR Dopolvidi, no. 9, p. 1165-1168, 1961.

It is shown mathematically that the radiation intensity of a loop antenna made of thinly insulated wire increases with an increase of electrical conductivity and magnetic permeability of the medium, and decreases with an increase of electromagnetic oscillation frequency generated by the antenna. A simple method of using alternating current is proposed to increase the depth of electric prospecting.— A.J.S.

- 191-244. Tokmagambetov, G. A. Plotnost' i poristost' l'da, firna i snega Maloal'matinskikh lednikov [Density and porosity of the ice, firn and snow of the Lesser Almatinskiy glaciers (with English abstract)], in Glyatsiologicheskie Issledovaniya v Period MGG, no. 2: Alma-Ata, Akad. Nauk Kazakh SSR, p. 90-98, 1962.

Electrical resistivity measurements were made in boreholes on the Central Tuyuksuysky Glacier to study the structural heterogeneity of the glacier. It was found that the specific electric resistance of the ice is directly dependent on the density and inversely dependent on the porosity. The results of determination of the volumetric weight of the ice and firn in the laboratory on borehole specimen are discussed also.— V.S.N.

- 191-245. Borovinsky, B. A. On the question of the researches of the glaciers by the methods of the electrical prospect [with French abstract], in General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub., no. 54, p. 492-499, 1961.

The experience gained in explorations of glaciers in the Kazakh S.S.R. by electrical methods is discussed, and the advantages of electrical over electromagnetic and seismic methods for this type of investigation are described. The many difficult problems in the use of electrical methods are outlined, and some recommendations are made for field methods to be used. Electrical data from surveys of the Tuyuksu and Shumsei glaciers are in good agreement with seismic results.— V.S.N.

- 191-246. Levadnyy, V. T. O mikroanizotropii otlozheniy mezokaynozoya yuga Zapadno-Sibirskoy nizmennosti [On microanisotropy of Meso-Cenozoic deposits of the south of the West Siberian Lowland]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 3, p. 109-114, 1960.

The coefficient of microanisotropy of Meso-Cenozoic deposits in the south part of the West Siberian Lowland is investigated by comparing the parametric curves of electric sounding with laterolog curves. This coefficient was found to be very small, probably less than 1.05-1.1.— A.J.S.

#### ELECTRICAL LOGGING

- 191-247. Buchheim, Wolfgang. Theoretische Grundlagen für die Messung von elektrischem Gesteinswiderstand und Gesteins-D.-K. in Bohrlochern durch Induktion nach dem Rückwirkungsverfahren [Theoretical principles of the measurement of electrical resistivity and dielectric constants of rocks in boreholes by induction according to the reaction method]: Freiburger Forschungshefte, C 62, 67 p., 1959.

Certain difficulties inherent in present electrical logging methods could be fundamentally eliminated if the electromagnetic eddy current effect were measured according to the induction principle, thus avoiding individual galvanic contacts. In this way the dimensions of the sonde could be kept quite small. The effect of flushing would not enter in, and measurements could be made in unflushed or dry holes. The possibilities of such a method are investigated theoretically. The cases of an infinite cylindrical coil set in a homogeneous semiconductor and of a dipole oscillator in a spherical cavity within a homogeneous semiconductor are examined.

The alternating current resistivity is estimated for a coil and for an infinitely long cylindrical capacitor. An approximate theory of the inductive and capacitive reaction borehole sonde is treated.

It is concluded that in the low frequency range, only inductive methods using coils with strongly magnetized cores are feasible, but in the high frequency range capacitive sondes (rod-shaped) can also be considered. Generally, the coil sonde is more suitable for measurements on rocks of low resistivity ( $\rho < 10^3$  ohm-cm) and the condenser sonde for those of higher resistivity. With low frequencies, all measurements in the  $10-10^5$  ohm-cm resistivity range are practically independent of the dielectric constant ( $\epsilon$ ) of the surroundings,

but at high frequencies, high values of  $\epsilon$  can introduce an error. In the meter or centimeter wave range, however, the relations are reversed; for  $\rho > 10^2 - 10^3$  ohm-cm, the reaction effect practically depends only on  $\epsilon$  for both types of sonde.

The practical possibilities of purely dielectric logging are limited by the slight penetration (for example, at a frequency of  $10^8$  cycles per second, penetration is only 6-7 cm for  $\rho = 10^3$  ohm-cm in the range  $\epsilon = 2-20$ ). The effect of flushing then can enter in significantly.—D.B.V.

- 191-248. Duesterhoeft, W. C., Jr., and Smith, H. W. Propagation effects on radial response in induction logging: *Geophysics*, v. 27, no. 4, p. 463-469, 1962.

This paper considers the problem of the field of an alternating magnetic dipole on the axis of cylindrical boundaries separating isotropic conductive formations. The study accounts for attenuation, phase shift, and reflection in the conducting formations. Numerical results are presented for the voltage induced in a separated coaxial receiver coil. The results are applicable directly to induction logging theory.—Authors' abstract

- 191-249. Johnson, Hamilton M. A history of well logging: *Geophysics*, v. 27, no. 4, p. 507-527, 1962.

The science of well logging was begun by Conrad Schlumberger in 1927 as an application of his work on resistivity measurements of the earth in surface exploration. From the early measurements of electrical properties by means of normal and lateral resistivity curves, modern logging has progressed through such changes as the introduction of wall-contacting micro-spacing devices, focused devices, dipmeters, and conductive and inductive techniques. Parameters other than electrical have been utilized, such as the radioactive properties of rocks both inherent and as a result of bombardment by both low- and high-energy neutrons; the measurement of acoustic properties; the physical recovery of rock and fluid samples by wire-line, and others. A chronological listing of these developmental steps of formation evaluation by down-hole measurement is presented, and the earlier ones are discussed in considerable detail. Each relates to a certain phase of development and is the answer to a certain need for evaluation of a specific zone or to overcome limitations of a prior method.—D.B.V.

- 191-250. Logovskaya, G. K., and Agamaliyev, G. M. Opredeleniye koeffitsiyenta poristosti kollektorov i gorizonta produktivnoy tolshchi mestorozhdeniy Prikurinskoy nizmennosti po geofizicheskim dannym [Determination of the coefficient of porosity of reservoirs and horizons of producing beds of oilfields of the Pri-Kura depression according to geophysical data]: *Vyssh. Ucheb. Zavedeniye Izv., Neft i Gaz*, no. 2, p. 11-14, 1962.

A method of determining porosity of a layer is outlined. The presence of permeable layers is established on the basis of electrical logging data and caliper measurements. Their  $\rho_k/\rho_s$  ratio is calculated, and from this the  $\rho\Delta/\rho_s$  ratio of the layer being investigated is determined by use of a template. Then the apparent resistivity of the layer is calculated according to formulas that are given, and from the curve showing the dependence of apparent resistivity on porosity, the porosity of the layer can be determined. The method is applied to reservoir horizon 1 of the Mishovdag field. It is recommended that the method be applied to other oilfields of the Pri-Kura depression and to other producing horizons to test the possible use of the  $R_k=f(K_n)$  curves obtained under actual physical-geological conditions.—D.B.V.

- 191-251. Kaufman, A. A. O priblizhennoy teorii induktsionnogo karotazha [On an approximate theory of induction logging]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 4, p. 117-127, 1961.

Doll's theory of induction logging (see Geophys. Abs. 139-11592) is analyzed. Vertical and radial characteristics of two- and four-coil sondes are obtained on the basis of the theory examined, and the application of the theory is evaluated. It was found that in Doll's method the amplitude of induced currents is determined by the primary field only, and interactions between the currents in the medium that surrounds the probe are neglected. An ability to detect thin layers of somewhat higher conductivity is considered an advantage of Doll's theory of induction logging.—A.J.S.

- 191-252. Boyarov, A. T. Sposob opredeleniya udel'noy poverkhnosti po promyslovo-geofizicheskim dannym [Method of determination of the specific surface according to geophysical logging data]: Geologiya Nefti i Gaza, no. 7, p. 39-41, 1960.

Determination of the specific surface of reservoir rock by the conventional formula relating the specific surface of the pores, the permeability, and the porosity is modified by introduction of a coefficient that reflects the morphology of the pore space. This coefficient is the ratio between the structural index of real ground and that of ideal ground.—J.W.C.

- 191-253. Anpilogov, A. P. K voprosu kolichestvennoy otsenki kollektorskiykh svoystv terrigennykh porod po diagrammam PS [Problem of quantitative estimation of reservoir properties of terrigenous rocks according to SP logs]: Geologiya Nefti i Gaza, no. 7, p. 42-49, 1960.

Porosity was determined on sandstones of the Tuymazy oilfield using 7 different methods of analyzing SP logs. The results were then compared with porosity data determined in the laboratory. Deviations from the laboratory values are from 7 to 38 percent. Quantitative estimates of porosity of individual lithologic varieties can be made more reliably from SP logs when average values and limits of variation are first established by core analysis.—J.W.C.

- 191-254. Goryunov, I. I. Izucheniye treshinovatosti porod po dannym elektricheskogo karotazha [The study of rock fracturing from electrical logging data]: Akad.Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 3, p. 94-102, 1960.

A new method of statistical processing of standard electrical logs is proposed and discussed. The contours of mean equal resistivities are drawn for the area investigated, and rose diagrams of the fracturing are determined from the density and direction of the iso-ohmic curves. This method may also be used in determining the most probable routes of petroleum migration.—A.J.S.

- 191-255. Turcan, A. N., Jr. Estimating water quality from electrical logs: U.S. Geol. Survey Prof. Paper 450-C, Art. 116, p. C135-C136, 1962.

Resistivity readings from electrical logs provide an empirical method for calculating the field formation resistivity factor and the chloride content of formation waters. This method eliminates the need for determining the porosity and cementation factor of the aquifer.—Author's abstract

- 191-256. Kozlov, I. G., Yastrebova, T. A., Purtova, S. I., and Serabryakova, Z. D. Opornyye skvazhiny SSSR. Khanty-Mansiyskaya opornaya

skvazhina (Tyumenskaya oblast') [Research drill holes of the USSR. Khanty-Mansiysk research drill hole (Tyumen Region)]: Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy, no. 176, 76 p., 1961.

The Khanty-Mansiysk research drill hole is located near the confluence of the Ob and Tobol Rivers in Siberia. It penetrated Tertiary and Cretaceous sediments to bottom at 2,180 m. The resistivity log is reproduced.—J.W.C.

191-257. Alferov, B. A., Purtova, S. I., Serabryakova, Z. D., and Yastrebova, T. A. Opornyye skvazhiny SSSR. Uvatskaya opornaya skvazhina (Tyumenskaya oblast') [Research drill holes of the USSR. Uvat research drill hole (Tyumen Region)]: Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy, no. 178, 92 p., 1961.

A detailed description is given of the section of the Uvat research drill hole, which is one of several such boreholes in the West Siberian Lowland. The resistivity log is reproduced for the entire section, which extended to a depth of 2,983 m. The base of the Paleocene occurs at a depth of 766 m, and the base of the Cretaceous at 2,755 m; the hole bottomed in Jurassic.—J.W.C.

191-258. Stankevich, L. I. Opornyye skvazhiny SSSR. Pestovskaya opornaya skvazhina (Novgorodskaya oblast') [Research drill holes of the USSR. Pestovo research well (Novgorod Region)]: Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy, no. 182, 92 p., 1961.

Drilling of the Pestovo research drill hole increased considerably the knowledge of the geology of the northwest regions of the Russian platform. The well bottomed in the crystalline basement after penetrating 1,602 m of Cambrian, Ordovician, Devonian, and Carboniferous sediments. The resistivity log is reproduced.—J.W.C.

191-259. Poyarkova, Z. N. Opornyye skvazhiny SSSR. Chulymskaya opornaya skvazhina (Tomskaya oblast') [Research drill holes of the USSR. Chulym research drill hole (Tomsk Region)]: Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy, no. 183, 138 p., 1961.

The Chulym research drill hole was put down to furnish stratigraphic and lithologic information for an area where magnetic and electrical surveys had previously furnished data on the configuration of the surface of the basement. The well bottomed at 3,001 m in Carboniferous sediments after having passed through a thick section of Cretaceous and Jurassic sediments. The resistivity log is reproduced.—J.W.C.

191-260. Ayzenshtadt, G. Ye.-A., and Pinchuk, I. A. Opornyye skvazhiny SSSR. Yuzhno-Embenskaya 2 i Tugarakchanskaya 5 opornyye skvazhiny [Research drill holes of the USSR. Yuzhno-Emba 2 and Tugarakchan 5 research drill holes]: Vses. Neft. Nauchno-Issled. Geol.-Razved. Inst. Trudy, no. 184, 294 p., 1961.

These two research boreholes were drilled in the area of the South Emba gravity maximum to aid in clarifying the stratigraphy and structure. Both penetrated largely Mesozoic rocks. The resistivity logs are given for each hole.—J.W.C.

Tuparev, P., Doykov, Zh., and Avramchev, L. Preliminary results of the complex geological and geophysical survey and exploration of blind ore bodies in the "Gramatikovo" deposit, "Keremidoto" sector. See Geophys. Abs. 191-629.

## ELECTRICAL PROPERTIES

- 191-261. Sarma, V. V. Jagannadha, and Rao, V. Bhaskara. Variation of electrical resistivity of river sands, calcite, and quartz powders with water content: *Geophysics*, v. 27, no. 4, p. 470-479, 1962.

Electrical resistivity variations of samples of graded river sands, calcite, and quartz powders are studied for different moisture contents of varying salinities. The variations exhibit a general hyperbolic trend. For the same grain size, the critical saturation index of a sample is constant and independent of the salinity of moisture content. The smaller the grain size, the larger the saturation index. The critical saturation index of a sample is correlated with its retentive capacity, and it is shown from studies of the quartz samples that for grain sizes of the order of clay particles, the critical moisture would reach 100 percent.— Authors' abstract

- 191-262. Rush, Stanley. Methods of measuring the resistivities of anisotropic conducting media in situ; *U.S. Natl. Bur. Standards Jour. Research*, v. 66C, no. 3, p. 217-222, 1962.

Solutions for several static boundary value problems involving anisotropic media are given, and the results are applied to simple electrode configurations to obtain formulas for in place determinations of the resistivities of anisotropic conducting media. The results may be used for measurement of electrical properties of earth formations and semiconductors and of dielectric constants of uniaxial crystals.— V.S.N.

- 191-263. Hill, Patrick Arthur, and Green, Ronald. Thermoelectricity and resistivity of pyrite from Renison Bell and Mt. Bischoff, Tasmania: *Econ. Geology*, v. 57, no. 4, p. 579-586, 1962.

Pyrite cubes from many different environments at Renison Bell appear thermoelectrically to be all of the same generation and to have formed at a lower temperature than pyrite from Mount Bischoff. Slight thermoelectric differences, unattributable to tarnish, exist between polished and unpolished samples. Resistivity measurements obtained using a 4-probe method show that (1) low resistivity is related at room temperature to positive thermoelectricity, and (2) pyrite at the base of pyrrhotite "sills" may have formed at higher temperatures than pyrite within the sills. Spectrographic analyses indicate a tentative correlation between copper and (or) molybdenum content and high resistivity.— Authors' abstract

## EXPLORATION SUMMARIES AND STATISTICS

- 191-264. Woollard, George P[rior]. The land of the Antarctic: *Sci. American*, v. 207, no. 3, p. 151-166, 1962.

The form and extent of the Antarctic continent beneath the icecap as determined by gravity and seismic surveys conducted during the International Geophysical Year by United States, British, and U.S.S.R. parties are discussed. The principles of gravity and seismic surveying and the instrumental techniques and methods of interpretation of results applicable to the Antarctic are described.

Rock profiles that show the archipelago character of west Antarctica in the vicinity of Byrd Station and the plateau character of central and east Antarctica are illustrated. Contour maps are included to show (1) the surface of the land mass and (2) the depth to basement of the land mass. The latter map also gives figures for crustal thickness. Large contrasts in crustal thickness are found between east and west Antarctica and, consequently, a difference in the amount of crustal depression by the ice. The velocity dispersion of earthquake

surface waves has confirmed this contrast and shows a mean crustal thickness of 40 km for east Antarctica and 30 km for west Antarctica. Airborne magnetometer measurements have been a valuable supplement to gravity and seismic measurements for determining depths to basement and for charting tectonic trends. The shift in the position of the Magnetic Pole over the past 50 years and the possibility of continental drift are discussed also.—V.S.N.

- 191-265. Behrendt, J[ohn]C., Laudon, T. S., and Wold, R. J. Results of a geophysical traverse from Mount Murphy to the Hudson Mountains, Antarctica: *Jour. Geophys. Research*, v. 67, no. 10, p. 3973-3980, 1962.

During the 1960-61 field season in Antarctica an airborne geophysical traverse party made investigations along a profile from Mount Murphy to the Hudson Mountains. The bedrock is about 1,000 m below sea level as shown by seismic soundings, which also demonstrate that a branch of the trough extending into Marie Byrd Land from the Ross Sea continues through to the Amundsen Sea. The rough bottom beneath the ice probably determines the irregularities of the upper surface of the ice. Bouguer anomalies indicate an approximate depth to the M-discontinuity of 30 to 31 km, which is consistent with other continental margin areas of Antarctica. Aeromagnetic data have shown the absence of a thick sedimentary section beneath the ice along the profile. A broad magnetic anomaly has been shown to be caused by lithologic change at an approximate depth of 25 km.—Authors' abstract

- 191-266. Weihaupt, John G. Geophysical studies in Victoria Land, Antarctica: *Wisconsin Univ. Geophys. and Polar Research Center Research Rept.*, no. 1, 123 p., 1961.

The results of seismic, gravity, and magnetic measurements made during the Victoria Land traverse of 1959-60 are presented with final interpretations and conclusions (see *Geophys. Abs.* 182-230). The Arctic Institute Range and Rennick Glacier, major geographical discoveries made during the traverse, are located and described. Results show that a vast ice thickness, in many cases exceeding 2.0 km, covers Victoria Land and conceals a major subglacial depression. Comparison of seismic and altimetric results indicates that the subglacial topography affects the relief of the ice surface. A prolonged seismic surface noise is attributed to low temperature phenomena.—V.S.N.

- 191-267. Robin, Gordon de Q. The ice of the Antarctic: *Sci. American*, v. 207, no. 3, p. 132-146, 1962.

Studies of the Antarctic icecap include thickness determinations by seismic surveys and gravity measurements, glacial flow and equilibrium studies, isotope studies as measures of variation in precipitation for the past 1,000 years or more and possibly as indicators of "fossil" temperatures, carbon-14 age determinations, and physical properties studies of the ice as a possible key to behavior of the crust and mantle rocks. Detailed studies of the forces governing the thickness and spread of the Antarctic ice shelves have indicated that the same kind of force could make the continents wander over the face of the earth.—V.S.N.

- 191-268. Borovinskiy, B. A. Geofizicheskiye issledovaniya na Glavnem Bol'shealmatinskom Lednike [Geophysical investigations on the Glavnny Bol'shealmatinskiy Glacier]: *Akad. Nauk Kazakh. SSR Vestnik*, no. 16(11), p. 108-109, 1960.

Seismic, electric, and magnetic methods were used to determine ice thickness of the Glavnny Bol'shealmatinskiy Glacier in the southeast Alma-Atin Region in 1960. The results of determinations of thickness and of the physi-

comechanical properties of the ice from seismic data are given, and Poisson coefficient, modulus of movement, and Young's modulus are calculated. The possibility of using geophysical methods to compute the volume of water conserved in the glacier is discussed.— V.S.N.

- 191-269. Mel'kanovitskiy, I. M. Geologicheskaya interpretatsiya materialov glubinnikh geofizicheskikh issledovaniy zakrytoy chasti Pritashkentskogo rayona [Geological interpretation of data of deep geophysical investigations in the closed part of the Tashkent region]: *Uzbek. Geol. Zhur.*, no. 1, p. 16-25, 1962.

Results are reported of gravity, magnetic, and seismic surveys in the Turanian plate of central Asia.— A.J.S.

- 191-270. Volodarskiy, R. F. Strukturno-tektonicheskaya skhema Amursko-Zeyaskoy depressii po geofizicheskim dannym [Structural plan of the Amur-Zeya depression according to geophysical data]: *Sovetskaya Geologiya*, no. 5, p. 131-135, 1962.

The depth, configuration, and probable structures of the Paleozoic basement in the Amur-Zeya basin in the U.S.S.R. have been mapped on the basis of gravity and magnetic surveys. The  $\Delta g$  profile through Zavitinsk and Klimovka is compared with a seismic profile obtained in 1960; the gravity minimum corresponds to a graben revealed in the seismic profile, and the thickness of the Mesozoic sediments as calculated from the gravity and magnetic data agrees with the 1,300-1,400 m maximum obtained by the seismic survey. Over individual basement highs the Mesozoic thickness is 400-500 m or less. Some details of the structure are discussed.— D.B.V.

- 191-271. Desio, Ardito; Marussi, Antonio; and Caputo, Michele. Glaciological research of the Italian Karakorum expedition, 1953-55, in General Assembly of Helsinki, 1960, Snow and Ice Commission: *Internat. Assoc. Sci. Hydrology Pub.*, no. 54, p. 224-232, 1961.

The glaciological work of the Italian Karakorum expedition, 1953-55, is reported. Descriptive data were collected on the majority of the glaciers existing within the territory visited by the expedition, and detailed geophysical investigations were made of two glaciers - the Baltoro and the Kuthiah. For the latter investigation, photogrammetric surveys were made to determine the topographic features of the glacial valley, the relief of the glacier itself, and the superficial flow velocity of the glacier. Somigliana's method was used to determine the bottom profile of the glacier (assumed to be cylindrical) by means of the distribution of velocities on the surface, and gravity surveys were made to determine the depth and shape of a cross section of the glacier bed.— V.S.N.

- 191-272. Central Water and Power Research Station Poona. Geophysical investigations: I. Dudhganga project sites. II. Godavari anicut at Dowlaiswaram: India Ministry of Irrigation and Power Central Water and Power Research Sta. Poona Annual Research Mem., 1961, p. 257-273, 1962.

The results of seismic surveys of three alternative dam sites along the Dudhganga River, India, and of electrical resistivity surveys of the irrigation dam across the Godavari River at Dowlaiswaram, India, to locate cavities under the thick masonry structure are described and illustrated.— V.S.N.

## GENERAL

- 191-273. Matalas, N. C., and Langbein, W. B. Information content of the mean: *Jour. Geophys. Research*, v. 67, no. 9, p. 3441-3448, 1962.

The amount of information given by a statistical estimate is defined as the reciprocal of the variance of the estimate. In this study, a random series is adopted as the standard of information content. The relative information content of the mean for various types of hydrologic series is defined as the ratio of the variance of the mean for a random series to the variance of the mean for given types of series. Beyond the well-known fact that the sequential correlation in hydrologic series reduces the effective length of the series, the sequential correlation tends to impair the effectiveness of cross-correlations between series. There are limits, therefore, upon increasing the information content of a mean by utilizing the information contained in a related series. Moreover, cross-correlation tends to decrease the effective length of series for computing regional means.— Authors' abstract

- 191-274. Roy, Amalendu. Ambiguity in geophysical interpretation: Geophysics, v. 27, no. 1, p. 90-99, 1962.

The question of uniqueness or otherwise of the various geophysical methods has been looked into from a general point of view. A method is theoretically determinate or indeterminate according as the totality of unknowns is smaller or greater than that of the independent measurables. While all natural field methods fall in the latter category, all applied field methods do not necessarily come under the former. Actual interpretations, however, cannot make any use of the theoretical uniqueness even where it exists and must depend on simplifying but permissible hypotheses based on extraneous information. These hypotheses are found to be surprisingly similar in all geophysical methods.— Author's abstract

- 191-275. Woods, J. P. Exploration in a changing world: Geophysics, v. 27, no. 1, p. 1-3, 1962.

There have been and will be many changes in the instruments and methods used in mineral exploration, and the changes are now coming faster than ever before. The forces of world economics and world politics will cause many changes. It is hoped that such changes will be in the direction of international cooperation rather than otherwise.— D.B.V.

- 191-276. Dobrin, [Milton] B. Exploration Geophysics—today and tomorrow: geophysics, v. 27, no. 1, p. 109-110, 1962.

This is an introduction to a Society of Exploration Geophysicists' sectional conference on exploration geophysics held at Calgary, Alberta on February 27, 1961. The purpose of the conference was to analyze current trends in exploration geophysics, particularly the problems brought about by the current decline in exploration activity within the oil and mineral industries.— V.S.N.

- 191-277. McLarty, D. M. E. Geonomics, in Exploration geophysics -- today and tomorrow: Geophysics, v. 27, no. 1, p. 110-113, 1962.

Neither in Canada nor the United States is the oil industry dependent on exploration to supply future crude oil requirements. Finding oil by increased recovery methods is successfully replacing exploration as a source of crude; moreover there are the potential 1.5 trillion barrels of shale oil reserves in the United States and the Athabaska tar sands in Canada. Suggestions are made for the organization of an exploration department that will make exploration competitive by modernizing business management practices and reducing costs of exploration through quantitative planning and objective organization.— V.S.N.

- 191-278. Newfarmer, Leo R. Geophysics' share of the exploration dollar in the U.S.A. and Canada, in Exploration geophysics -- today and tomorrow: Geophysics, v. 27, no. 1, p. 113-120, 1962.

This is virtually the same paper as previously published in *Oil in Canada*, v. 13, no. 32, p. 33-35, 1961 (see *Geophys. Abs.* 186-327).— V.S.N.

191-279. Lyons, Paul L. Economics of geophysics in oil exploration, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 121-127, 1962.

Data on costs and on the finding rate for oil and gas in the United States and Canada by the use of geophysics are summarized on graphs; these data indicate that a leveling off of costs and successes has developed which moves back indefinitely the day when application of geophysics to the oil industry will no longer be economic. Methods and instruments are available to produce better results and to increase efficiency, and the profitable way is not to shut down but to increase the success ratio of geophysics and the magnitude of geophysical finds.— V.S.N.

191-280. Moore, C. M., Jr. Problems of the geophysical contractor, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 127-130, 1962.

The importance of research in cutting costs in geophysical exploration is emphasized. Diversification on the part of the geophysical contractor not only will aid his business but will improve his techniques of exploration. Improving techniques infers a controlled obsolescence of current methods and instruments that might be termed "creative destruction".— V.S.N.

191-281. Link, Theodore A. Feast or famine in the oil and gas producing industry, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 130-133, 1962.

The "overproduction" of professional geologists and geophysicists is suggested as one of the causes of the current economic dilemma in geophysical exploration. It may be necessary for many trained specialists to change into other fields of endeavor. In Canada, it is believed that the large scale exportation of gas from Western Canada will alleviate conditions in that area earlier than elsewhere. Government subsidies as an aid to the oil and gas producing industry should be avoided, and pertinent tax relief only should be considered.— V.S.N.

191-282. Born, W. T. Technical limitations of present geophysical tools, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 133-137, 1962.

Six factors that limit the usefulness of geophysical methods are discussed - the indirect approach, instrumental, range (depth) of investigation, noise, limited resolving power, and ignorance.— V.S.N.

191-283. Paterson, Norman R. Trends and prospects in mining geophysics, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 140-143, 1962.

Statistics show that each million dollars spent on geophysical exploration and properly supported by geology in the mining industry results in one new mine with a gross value of about 200 million dollars. However, as it costs about 4 million dollars to prove a new mineral deposit, few small companies can raise the capital. The economic, technical, and personnel factors involved in maintaining a vigorous geophysical exploration business are examined in a discussion of present trends in geophysics. Government participation in exploration, research, education, and tax reduction is recommended as the most important item for a healthy geophysical industry in Canada.— V.S.N.

- 191-284. Campbell, Colin. Statistics on employment of exploration geophysicists, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 143-148, 1962.

The results of an employment survey of SEG members are summarized in tables and graphs. It is concluded that most of the technically trained crew members affected by the drop in geophysical activity of recent years have been absorbed in other positions by their companies. The ones who have suffered most are the drillers, shooters, surveyors, and helpers, none of whom belong to SEG and thus were not reached in this survey.— V.S.N.

- 191-285. Jones, D. C. Alternative employment for geophysicists in the oil industry, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 148-152, 1962.

Virtually no type of work in the production and exploration segments of the oil industry is beyond the scope of scientifically and technically trained geophysicists. Four such areas -- well log interpretation, design and installation of automatic equipment intended to reduce the number of manual operations involved in producing oil and gas, corrosion control, and computer programming -- appear to offer the opportunity to use past training and experience to a maximum and at a professional level with satisfactory compensation.— V.S.N.

- 191-286. Hollister, John C. The effect of the present slump on geophysical education, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 152-156, 1962.

The decline in students specializing in geophysics is analyzed, and suggestions are made to encourage enrollment that include improvements in curriculums to raise and broaden the level of training.— V.S.N.

- 191-287. Woods, J. P. How can geophysicists meet the present situation?, in *Exploration geophysics -- today and tomorrow: Geophysics*, v. 27, no. 1, p. 156-161, 1962.

Statistics for oil exploration costs, crew months, production, reserves, and future needs in the United States, Canada, and the world are discussed, compared, and illustrated in charts and graphs. It is concluded that discovery need is much greater now than the actual discovery rate, and the rapid rise of the curve of discovery need shows that great demands will be made of exploration geophysics in the years just ahead. These demands will come at a time when valuable men have left exploration and when colleges have few students in geology and geophysics.— V.S.N.

- 191-288. Brant, A[rthur] A. Beneath the surface: *Geophysics*, v. 27, no. 1, p. 162-167, 1962.

This is the text of a talk presented at the Mining Luncheon at the 31st annual meeting of the Society of Economic Geologists on November 8, 1961, in Denver, Colo. It is not concerned with exploration, but is a plea to "look critically beneath the surface of verbiage" to rediscover the principles of free enterprise that led to American greatness.— D.B.V.

- 191-289. Hoy, R. B., and Foose, R. M. Earth deformation from a nuclear detonation in salt: U.S. Atomic Energy Commission Plowshare Program, Project Gnome Prelim. Rept. PNE-109P, 54 p., 1962.

The maximum permanent surface displacement caused by the Gnome explosion was confined to an area within 100 m of surface ground zero. The surface above ground zero remained permanently raised to 0.3-0.5 m after an initial displacement estimated to be 1.5 m. The area of permanent deformation is

characterized by fractures with offsets up to 0.2 m. Abundant hair-line fractures occur out to 300 m and occasional fractures as far as 1,000 m from surface ground zero. Fractures and spalling occurred underground, and there are indications that a stable cavity 40 m high was formed.— V.S.N.

- 191-290. Gieseck, Alberto. El Instituto Geofísico del Perú [The Geophysical Institute of Peru]: *Ciencia Interamericana*, v. 3, no. 3, p. 3-9, 1962.

The history of the Geophysical Institute of Peru is summarized briefly. The objectives, organization, scientific activities, and equipment of the observatories are outlined. The program of the observatories includes the observation, reduction and publication of data on meteorology, seismology, magnetism, and ionospheric and solar activity.— V.S.N.

- 191-291. Zátpek, Alois. The development of Czechoslovak geophysics from 1945 to 1960: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 4, no. 2, p. 102-110, 1960.

The development of geophysics in Czechoslovakia since 1945 is reviewed. A geophysics curriculum was established at Charles University in 1950. In 1953 the Geophysical Institute of the Czechoslovakian Academy of Sciences was founded, an outgrowth of the geophysical sector of the Central Institute of Physics, with gravimetric, seismic, geomagnetic, geoelectric (and later radiometric, ionospheric, and development) departments and a geomagnetic and seismic observatory at Průhonice; still later a meteorological sector was incorporated in the institute. Basic academic research is carried on by the institute and by the Geophysical Laboratory of the Slovak Academy of Sciences in Bratislava, which also operates the Hurbanovo Observatory and the Skalnaté Pleso seismic station. Geophysical prospecting was carried on by various ministries or their economic production units, with very uneven results. In 1959 the Institute of Applied Geophysics was opened in Brno (with a branch in Prague) under the Central Geological Office to do research in applied geophysics. Two new journals appeared, the annual *Geofyzikální Sborník* in 1953 and the quarterly *Studia Geophysica et Geodetica* in 1957. Research in the immediate future will deal more and more with the deep structure of the crust.— D.B.V.

- 191-292. Klushin, I. G., and Tolstikhin, I. N. Vydeleniye lineynykh tektonicheskikh dislokatsiy na geofizicheskikh kartakh [Distinguishing linear tectonic dislocations on geophysical maps]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 6, p. 98-103, 1961.

A method is proposed and master chart designed for determining linear geologic zones of deep tectonic dislocations from the data on geophysical and structural maps. The frequency of orientation of isolines is measured; local topographic and regional interferences are eliminated statistically.— A.J.S.

- 191-293. N'yuton [Newton] R., and Round, G. F. Diffuziya geliya v osadochnykh porodakh [Diffusion of helium in sedimentary rocks (with English summary)]: *Geokhimiya*, no. 4, p. 332-353, 1961.

This is a Russian translation of the paper published originally in *Geochim. et Cosmochim. Acta*, v. 22, no. 2/4, p. 106-132, 1961 (see *Geophys. Abs.* 189-236).— D.B.V.

GEODESY

- 191-294. Bursa, Milan. Teoriya opredeleniya neparallelnostey maloy osi referents-ellipsoida polyarnoy osi inertsii Zemli i ploskostey iskhodnogo astronomicheskogo i geodezicheskogo meridianov po nab-

lyudenyam iskusstvennykh sputnikov Zemli [Theory of the determination of the nonparallelism of the minor axis of the reference ellipsoid with the polar axis of inertia of the earth, and of the plane of the astronomic prime meridian with that of the geodetic prime meridian according to observations of artificial earth satellites (with German summary)]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 6, no. 3, p. 209-214, 1962.

The fundamental relationships of geodetic and astronomic values are based on the preliminary conditions that the minor axis of the reference ellipsoid be parallel with the axis of rotation of the earth and that the plane of the geodetic prime meridian be parallel with the Greenwich astronomic prime meridian; however, these conditions are generally not fulfilled. Artificial satellites now afford a means of checking the nonparallelism of the planes in question, and a method of doing so is proposed here. If the geodetic coordinates, quasi-geoid heights, and normal heights are known at several geodetic stations, and if the geocentric equatorial coordinates, or geocentric distance, are also known for the time of the observations, the values of six independent elements of the orientation of the reference ellipsoid can be derived. For example, the coordinates of the center point with reference to the earth's center of gravity and the three angles determining the direction of its axes can be determined. The nonparallelism values sought can then be calculated from these values.—D.B.V.

191-295. Burša, Milan. K opredeleniyu krivizny poverkhnosti, predstavlyayushchey figuru Zemli, po astronomo-geodezicheskim i gravimetriceskim dannym [On the determination of the curvature of the surface representing the figure of the earth according to astrogeodetic and gravimetric data (with German summary)]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 5, no. 2, p. 95-107, 1961.

Exact expressions are derived for the mean and total K curvature of the surface Q representing the real figure of the earth, assuming that their partial derivatives of the first and second order are fixed. These expressions are then applied to the case where Q is the potential surface  $W_0$  to which astronomic, geodetic, and gravimetric measurements are reduced. The expressions are in such form that they contain the values of the altitude (h), and of the components  $\xi$  and  $\eta$  of the deflection of the vertical and their gradients in the direction of the meridian and of the first vertical. The expressions can be simplified by neglecting the terms  $J\xi^3$  and  $K\xi^3$ . These formulas can aid in determining the dimensions of the earth ellipsoid and in expressing the vertical gradient of gravity.—D.B.V.

191-296. Pick, Miloš. Projektive Methode zur Transformation drei-achsiger Ellipsoide mit nicht parallelen Achsen [Projective method for the transformation of a triaxial ellipsoid with nonparallel axes (with Russian summary)]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 5, no. 3, p. 191-210, 1961.

This paper approaches the problem of transforming one reference ellipsoid into another in a more general way than hitherto attempted, treating the case of two different triaxial ellipsoids that have been displaced and twisted with respect to each other, and finding a transformation such that the projection of all points on the surface of one ellipsoid along normals to its surface gives another ellipsoid.—D.B.V.

191-297. Burša, Milan. Theorie der Lösung der grundlegenden geodätische Aufgabe und der Bildung eines einheitlichen geodätischen Weltsystems auf Grund der Beobachtungen künstlicher Erdsatelliten [Theory of the solution of the fundamental geodetic problem and the building of a uniform world geodetic system on the basis of arti-

cial earth satellite observations (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 5, no. 3, p. 264-269, 1961.

The possibilities of solving geometric problems of geodesy by use of satellite data have not been investigated as thoroughly as have those of the dynamic (physical) problems. This paper deals with the application of satellite data to two tasks: the formation of a uniform world geodetic system and—the fundamental task of geodesy—the derivation of the parameters of the mean earth ellipsoid. Expressions that have been derived for the geocentric coordinates of observation points on the basis of determinations of the topocentric equatorial coordinates of the moon are here adapted to artificial satellites.—D.B.V.

191-298. Pick, Miloš. Einfluss eines der systematischen Fehler bei der geographischen Breitebestimmung auf die Form des Geoides [Effect of one of the systematic errors in geographic latitude determination on the form of the geoid (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 4, no. 3, p. 205-216, 1960.

It is shown what error can be tolerated in calculation of absolute heights and absolute deflections of the vertical, if the effects of inaccuracies of orientation, size, and shape of the reference ellipsoid are neglected. Expressions for  $\Delta N$ ,  $\Delta \epsilon$ , and  $\Delta \eta$ , obtained by the translative and projective methods and by changing the reference surface, and the mean value of normal gravity for the area of integration  $\omega$ , are given.—D.B.V.

191-299. Rýsavý, Josef. Le développement de la géodésie et cartographie tchécoslovaque de 1945 a 1960 [The development of Czechoslovak geodesy and cartography from 1945 to 1960 (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 4, no. 2, p. 119-129, 1960.

This is a review of the geodetic and cartographic activities of the Czechoslovakian Academy of Sciences, education in these fields in Czechoslovakia, and the work of the State Geodetic Survey, with a list of pertinent Czech publications.—D.B.V.

## GEOTECTONICS

191-300. Barnett, C. H. A suggested reconstruction of the land masses of the earth as a complete crust: *Nature*, v. 195, no. 4840, p. 447-448, 1962.

Jeffreys, Harold. A suggested reconstruction of the land masses of the earth as a complete crust: *ibid.*, p. 448, 1962.

The outlines of the continents, each with its continental shelf to the 1,000-fathom isobath, were transferred by Barnett to thin sheets of rubber from a 4 1/2-in. globe, cut out, and then marked on a 3-in. ball. Despite the crude method used the masses fitted together reasonably well. It is difficult for Barnett to believe that chance alone can explain this fit; therefore, support for the expanding earth hypothesis is indicated.

Jeffreys comments that the fit is better than he should have expected and should give rise to much discussion; however, apart from explaining how the earth's volume can have increased threefold, it will probably take some time for structural geologists, paleontologists, meteorologists, and magneticians to agree about whether the separation of continents occurred soon after formation of the earth, in the Paleozoic, or at the end of the Cretaceous. It is pointed out that the fit obtained by Barnett must depend on the distribution of stretching of the rubber; hence the suggestion that the only alternative to the reconstruction is chance cannot be accepted.—D.B.V.

- 191-301. Shimazu, Yasuo. Thermodynamics of tectogenesis [with Japanese abstract]: *Earth Sci.* [Chikyu Kagaku], no. 58, p. 1-10, 1962.

Various features of tectogenesis are analyzed and a physicochemical model is presented. Abnormal heat flow from the mantle toward the crust is concluded to be the energy source for tectogenesis. The heat flow is inferred to be directly related to the generation and upward transfer of basaltic magmas within the mantle. The model is a type of heat engine in which coupling exists between tectonic process, magma transfer, and metamorphism. The efficiency (work done/supplied heat) of the engine is of the order of 0.1. Two hypotheses for tectogenesis, in which horizontal deformation and vertical movement of the crust respectively are of primary significance, are critically tested for efficiency. It is shown that horizontal deformation can not be disregarded if only the crust is subjected to vertical movements. Thickening and vertical movement of the crust are assumed to be caused either by plastic buckling or by phase transition at the Moho. Variations in thickness and temperature of the respective layers within the earth are computed.

Sequences of sinking (geosyncline formation) and uplifting (mountain building) stages that proceed at the rate of  $10^8$  and  $10^7$  yr, respectively, are deduced from the model. Igneous activities accompanying tectogenesis are discussed also.—V.S.N.

- 191-302. Lyustikh, E. [Ye.] N. Some investigations of isostasy and earth's contraction: *Annali Geofisica*, v. 14, no. 1, p. 79-86, 1961.

The contraction hypothesis is investigated from the geological, gravimetric, mechanical, and geothermal points of view and found to be untenable from all. The role of isostasy in geotectonic evolution is considered. Topographic anomalies (Bouguer with terrain correction) are most suitable for tectonic interpretation, not only because they are affected by all density anomalies, but particularly because they give almost directly the approximate relief of the base of the crust, whereas isostatic anomalies require complicated calculations. Isostasy is not a leading factor in crustal evolution because it is passive; tectonic movements often go against it. However, the greater the tectonic disturbance the greater the isostatic compensation, and the latter sets a limit for the former; thus no isostatic anomaly greater than  $\pm 300$  mgal is observed. Tectonic forces as a rule change sign many times; if such oscillation is gradually weakened and damped, the movements have to stop at the position of isostasy.—D.B.V.

- 191-303. Popov, V. I. Nekotoryye osnovnyye polozeniya yadernoy teorii razvitiya zemnoy kory [Some principal aspects of the nuclear theory of development of the crust]: *Akad. Nauk Uzbek. SSR, Zapiski Uzbekistan Otdel. Vses. Mineral Obshch.*, no. 7, p. 5-90, 1955.

The nuclear theory of development of continents is discussed comprehensively. According to this idea the continents expand gradually from a nucleus by growth of the sialic crust due to selective radioactive remelting of the lithosphere. The places of most abundant formation of sialic magma are the most active nuclei of this growth. Characteristics of nuclear areas are given, and examples are cited.—J.W.C.

- 191-304. Popov, V. I., and Filin, T. D. Materikovyye bloki (provintsi), yadernyye i mezhduduyadernyye uchastki Sredney Azii i Yuzhnogo Kazakhstana [Continental blocks (provinces), nuclear and internuclear areas of central Asia and south Kazakhstan]: *Akad. Nauk Uzbek. SSR, Zapiski Uzbekistan Otdel. Vses. Mineral Obshch.*, no. 7, p. 91-133, 1955.

Crustal structure in central Asia is discussed from the standpoint of the nuclei of the continent. Various nuclei are described, and their disposition with respect to the general structure is discussed.— J.W.C.

- 191-305. Girdler, R. W. Initiation of continental drift: *Nature*, v. 194, no. 4828, p. 521-524, 1962.

Study of the worldwide ridge-rift system gives observational support to the theory of continental drift recently proposed by Runcorn (see *Geophys. Abs.* 189-248), which invokes a worldwide pattern of convection currents in the mantle. The system satisfies such a convection pattern; moreover, the presence of a possibly new current under the East Pacific Rise suggests a recently changing pattern, as there a rising current is close to an Alpine fold-mountain belt. If convection is also used to explain fold mountains, then the pattern must have changed within the past  $3 \times 10^7$  yr. Further, it is tentatively suggested that the regions where the ridge-rift system intersects the continents may show how continental drift is initiated, with the formation of new oceanic crust depending on the degree of extension.— D.B.V.

- 191-306. Mohr, Paul A. The Ethiopian rift system: *Addis Ababa Univ. Coll. Geophys. Observatory Bull.*, v. 3, no. 1, p. 33-62, 1962.

A detailed descriptive account of the Ethiopian Rift System is given that includes much new information based on field observations, air flights, and aerial photography. The faulting of the system is shown to be intimately although not coincidentally related to the preceding uplift of the Arabo-Ethiopian swell. The age of the faulting and some of the more interesting Quaternary tectonic and volcanic features are listed.

At present there are virtually no concrete data on the crustal and sub-crustal structure of the Arabo-Ethiopian swell, but surficial data examined in the light of data on ocean swells or ridges allow a tentative cause for the swell to be suggested. The crest of the Arabo-Ethiopian swell traversed by the Rift system is marked by high seismicity, high heat flow, active vulcanicity, and low shear-wave sub-crustal velocities. The presence of large quantities of basaltic lava and differentiates from it indicates that the subcrustal portion of the swell is largely occupied by basaltic rocks beneath a thin crust of silicic Precambrian basement. The depth and form of the M-discontinuity below the swell is not yet known, but it is probable that a phase-transition of basalt-eclogite occurs at some depth below this discontinuity and that accumulation of excessive radiogenic heat above the transition line has lowered the boundary and caused isostatic raising of the lithosphere. Because of the lack of basic field work the geographical plan of the Ethiopian Rift system cannot be explained as yet, but it is probably the world's most fruitful region for further research into the causes of graben and horst formation.— V.S.N.

- 191-307. Menard, H[enry] W. Correlation between length and offset on very large wrench faults: *Jour. Geophys. Research*, v. 67, no. 10, p. 4096-4098, 1962.

A clue to the probable offset on very large wrench faults exists in the correlation between offset and length. Both the length and the offset increase during the active life of such a fault, and it seems reasonable that the offset at any time may be proportional to the length. A tabulation of offsets and lengths of 15 large wrench faults (measured by offset of rock for continental faults and by offset of seafloor magnetic anomalies or bathymetry for submarine faults) suggests that offset of wrench faults less than 600 km long is about one-seventh of the length, and on longer faults about one-third of the length. This correlation has already demonstrated its utility in the case of the Murray fracture zone.— D.B.V.

- 191-308. Wilson, [J.] Tuzo. Cabot fault, an Appalachian equivalent of the San Andreas and Great Glen faults and some implications for continental displacement: *Nature*, v. 195, no. 4837, p. 135-138, 1962.

The narrow belt of large faults extending from north Newfoundland across Nova Scotia and the Bay of Fundy to Massachusetts and Rhode Island is a continuous dislocation, here called the Cabot fault. When maps of Newfoundland and the British Isles are juxtaposed it is apparent that the Cabot and Great Glen faults are opposite to one another and have the same orientation. As both are the same age (Late Devonian and Early Carboniferous), are transcurrent, are large, are perhaps sinistral, and cut rocks well known to be similar, it is reasonable to speculate that, if drift occurred, they are the two ends of the same fault.

Three points are offered that may make the concept of continental drift more acceptable. First, the protocontinents Pangaea and Laurentia need not have all been confined in neat packets before Carboniferous time; continents and fragments of continents may always have had a random distribution and motion and may have grown along their leading edges. Second, the crust should be considered to move as a result of convection currents in the mantle rather than as a result of dynamic forces. Third, if convection currents rise under mid-ocean ridges and sink under continental mountains, the approximate flow patterns can be plotted on a globe. The possible pattern for the Tertiary is straightforward, but since then a change appears to have occurred in the Pacific. Changes in the thermal state of the earth could from time to time produce changes in mode, each corresponding to one major worldwide orogenic cycle; the intervening periods of stable modes would correspond with times of fixed patterns of mountain building. Converging currents approaching continental mountains from different directions might produce shear faults such as the Cabot fault.—D.B.V.

- 191-309. Gilliland, William N. Possible continental continuation of the Mendocino fracture zone: *Science*, v. 137, no. 3531, p. 685-686, 1962.

The Mendocino fracture zone may continue through or below North America near 40° N. lat. This is suggested by instances of left-lateral movement, location of basin deeps, sedimentation patterns, interruption of a major magnetic anomaly, and inflection of major structural trends. A major segmentation of middle North America results.—Author's summary

- 191-310. Shul'ts, S. S. Osnovnyye geostrukturnyye oblasti Zemli po dannym noveyshey tektoniki SSSR [Fundamental geostructural elements of the earth according to data on recent tectonics of the U.S.S.R.]: *Sovetskaya Geologiya*, no. 5, p. 18-32, 1962.

A map is presented and discussed that shows the distribution and main features of the geostructural regions formed during the Neogene and Quaternary development of the U.S.S.R. The continental platforms are divided into shield areas, areas of recent uplift or depression, and areas of thick Neogene to Quaternary sedimentation; the probable boundaries of oceanic platforms are shown; geosynclinal areas are subdivided into areas of recent intensive uplift or subsidence and regions of thick Neogene-Quaternary sedimentation; areas of mountain building are mapped according to intensity of movement and location with respect to older orogenic belts; and the location of young volcanoes and widespread volcanics or intrusives are also shown.

The map shows that the territory of the U.S.S.R. lies in the following structural areas: the Eurasian continental platform (comprising the East European, Central Siberian, West Siberian, and Turano-Skif meganticlises and the Baltic, Ukrainian, Kazakh, Anabar, and Aldan shields); the Kolyma and Amur continental platforms; the Pacific and Arctic oceanic platforms; the Kurile-Kamchatka geosyncline; and the Caucasus, Tian Shan, Altay, Baikal, Sikhote-Alin, Verkhoyan, Ural, Byrranga, and Yenesei orogenic areas.—D.B.V.

- 191-311. Popov, V. I. O svyazi zemletryaseniy sredney Azii s prodolzhayushchimsya veshchestvennym razvitiyem zemnoy kory [Relationship of the earthquakes of central Asia to the continuing development of the crust]: Akad. Nauk Uzbek. SSR, Zapiski Uzbekistan Otdel. Vses. Mineral Obshch., no. 7, p. 150-175, 1955.

Mechanical seismotectonic deformation, manifest in the upper portion of the lithosphere and crust in the form of intimately related orotectonic and seismic phenomena, has its origin in deeper horizons of the rigid crust as a result of physical-chemical changes in the material making up these lower layers. These processes lead to gradual growth of the continental sialic crust and to its orotectonic uplift. An expression of this continued development is the Pamir zone and adjacent area. — J.W.C.

- 191-312. Allen, J. R. L., and Wells, J. W. Holocene coral banks and subsidence in the Niger Delta: Jour. Geology, v. 70, no. 4, p. 381-397, 1962.

The present thermal structure of the Nigerian seas suggests that the narrow coral thickets that overlie the Holocene marine sands and crop out for 300 miles along the Nigerian continental shelf were localized by a horizontal thermocline layer. Each group of banks represents brief stillstands of sea level during progressive relative deepening. Radiocarbon dates suggest stillstands terminating about 3,900 yr B. P. and 2,900 yr B. P. The present variation in depth of the coral banks indicates that differential subsidence of the continental margin accompanied the relative deepening, which is itself largely the result of downwarping. An axis of relative stability is inferred to cross the shelf in the area just east of Lagos. Deposits of the Niger delta are concentrated in a downwarped region bounded on the west and north by this axis and on the east by the physiographic-structural barrier of the Cameroon Mountains, Fernando Poo, and Sao Tomé. — V.S.N.

## GLACIERS

- 191-313. Hofmann, Walther. Tellurometer measurements on the Greenland Ice Cap during the International Glaciological Greenland Expedition (EGIG) summer 1959 [with French abstract], in General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub., no. 54, p. 469-473, 1961.

Profiles of fixed points on the Greenland Ice Cap were established during the summer of 1959 by distance measurements with a tellurometer. A repetition of these measurements is planned in 4 to 5 or 8 to 10 years. However, the high accuracy of the tellurometer measurements made it possible to measure differential movement of a section of the west-east profile near the west coast in 1959. This 35 km section shows a total expansion of 9.10 m in 3 months. — V.S.N.

- 191-314. Mälzer, Hermann, and Möller, Dietrich. Das Nivellement bei der Expedition Glaciologique Internationale au Groenland (EGIG)—Sommer-Kampagne 1959 [Leveling by the International Glaciological Greenland Expedition (EGIG)—Summer campaign 1959 (with English abstract)], in General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub., no. 54, p. 474-483, 1961.

In order to determine vertical ice movements, two parallel lines of geometric leveling were carried out along a west-east profile from Disko Bay by way of EGIG Camp VI, Milcent, and Station Centrale across to Station Jarl-Joset in the summer of 1959 by the International Glaciological Expedition to Greenland. Altitudes were determined along the profile at 65 points. Auto-

matic leveling instruments and invar staffs were used for the observations. The geometrical leveling proved highly efficient; the differences in altitude between bench marks approximately 12 km apart were determined with an accuracy of 4 to 6 cm.—V.S.N.

- 191-315. Shreve, Ronald L. The borehole experiment on Blue Glacier, Washington, in General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub., no. 54, p. 530-531, 1961.

The borehole experiment on Blue Glacier, Mount Olympus, Wash., followed the established technique of drilling several deep holes vertically into the glacier, simultaneously emplacing aluminum pipes (5 cm diameter), and making inclinometer surveys of the pipes each year to measure the deformation. Assuming that the deformation of the pipes is the same as that of the surrounding ice, it is possible to determine the relationship between shear stress and strain rate for comparison with theory and experiment. Data collected from two of three holes fit a power law relationship. For shear stress ranging from 0.5-0.8 bars, corresponding to depths of 70-100 m, the curve fits quite closely; for smaller stresses and smaller depths, the scatter increases considerably.—V.S.N.

- 191-316. Haefeli, R[obert]. Zur Rheologie von Eisschildern der Arktis und Antarktis [On the rheology of ice shields in the Arctic and Antarctic (with English and French summaries)], in General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub., no. 54, p. 547-561, 1961.

This is a German version of the paper published in English in the Jour. Glaciology, v. 3, no. 30, p. 1133-1151, 1961 (see Geophys. Abs. 187-270).—V.S.N.

- 191-317. Glen, J. W. Measurement of the strain of a glacier snout, in General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub., no. 54, p. 562-567, 1961.

Measurements made on the snout of Austerdalsbreen Glacier, Norway, show that the glacier is undergoing compressional strain even in the last 20 m of its length. The ice velocity at the actual ice edge is about 10 m per yr, and due to compressional strain-rate this increases to 30 m per yr at a distance 220 m up-glacier. Although it retreated 37 m between 1958 and 1959, the glacier was moving faster in 1959 than it had been in 1958. The longitudinal strain-rate varies markedly over the region; the only correlation that can be found is between it and the vertical velocity of the ice, a result which suggests that the strain-rate variations are of the same sign throughout the thickness. A measurement of the surface strain-rate tensor using a square of stakes did not give a very accurate result owing to the marked variations of strain-rate with distance, even within the 18 m dimensions of the square. The largest principal strain-rate was compressive and of magnitude  $0.19 \pm 0.02$  per yr, corresponding to a maximum principal stress of  $0.81 \pm 0.07$  bars.—Author's abstract

- 191-318. Millecamps, R. Sur une nouvelle methode d'investigation en glaciologie [On a new method of glaciological investigation (with English abstract)], in General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub., no. 54, p. 568-573, 1961.

Terrestrial photogrammetry measurements made over the period 1954-56 at the rate of one pair of pictures every 6 hours show that it is possible to observe 12-hour micromovements and surface deformations of a section of a glacier. Similar measurements were made in 3 dimensions by determining

the time-lapse of waves propagated between ceramic tiles buried in the ice. The principles and preliminary results of a series of such experiments on the Mer de Glace Glacier since 1957 are discussed.— V.S.N.

- 191-319. Swithinbank, Charles. Ice movement inland, in Norwegian-British-Swedish Antarctic Expedition, 1949-52, Sci. Results, v. 3, pt. F, p. 145-159: Oslo, Norsk Polarinstitut, 1960.

Measurements of ice movement were made at four places in Antarctica near lat 73° S. and long 3° W., and at one point on the inland margin of the Maudheim Ice Shelf. Results agree with rough figures derived from mass balance calculation. Most of the inland ice sheets moves 10-100 m per yr; ice streams move much faster. Velocities evidently vary according to local patterns of slope, the depth of ice, and the distance from nunataks. A velocity of 15 m per yr is probably typical of larger snow fields between nunataks. The lowest figure obtained, 7 cm per yr, is associated with an almost level and very limited ablation area close to a nunatak.— V.S.N.

- 191-320. Makarevich, K. G. K voprosy o dinamike Tsentral'nogo Tuyuksuyskogo lednika v posledniye desyatiletnya [Concerning the dynamics of the Central Tuyuksuysky Glacier in the last decade (with English abstract)], in Glyatsiologicheskkiye issledovaniy v period MGG, no. 2: Alma-Ata, Akad. Nauk Kazakh. SSR, p. 24-38, 1962.

This is primarily a study of the retreat of the Central Tuyuksuysky Glacier since its period of maximum advance, 1902-22. A comparison is made between its size and extent today and that of 1922. From a study of the glacier tongue a direct relationship is found to exist between glacier thickness and speed of motion. From 1908 to 1922 the glacier had a velocity near the end of its tongue of more than 47 m per yr or 13.5 cm per day. Today the velocity is 0.3-0.6 cm per day. The volume of ice lost from 1923 to 1959 is more than 29 million m<sup>3</sup>.— V.S.N.

- 191-321. Barvenko, H. Ya. Poverkhnostnoye dvizheniye l'da na Maloalmatinskikh lednikakh khrebt Zailiyskiy Alatau [Surface ice movement of the Lesser Almatinsky glaciers of the Zailiyskiy Altay range (with English abstract)], in Glyatsiologicheskkiye issledovaniya v period MGG, no. 2: Alma-Ata, Akad. Nauk Kazakh. S.S.R., p. 66-71, 1962.

The results of measurements of velocities of the small glaciers in the Lesser Almatinsky group obtained during the International Geophysical Year are tabulated. Brief descriptions are given of the glaciers.— V.S.N.

- 191-322. Cherkasov, P. A. Tayaniye lednikov i ikh rol' v pitanii reki Baskan khrebt Dzhungarskiy Alatau [Glacier ablation and its role in feeding the Baskan River of the Dzhungarsky Altay Range (with English abstract)], in Glyatsiologicheskkiye issledovaniy v period MGG, no. 2: Alma-Ata, Akad. Nauk Kazakh. SSR, p. 160-196, 1962.

The significance of the investigation of glacial flow and methods of observation of ice and snow melting are discussed in the first part of this report. The second part treats problems of calculating glacial flow. The part that glaciers play in supplying the Baskan River both at its source and at its exit from the mountains under various weather conditions during the ablation period is discussed also. Data are tabulated.— V.S.N.

- 191-323. Svatkov, N. M. Dvizhenie l'da v lednike Shokal'skogo [Ice movement in Shokalskiy Glacier]: Akad. Nauk SSSR Mezhdudved. Komit. Proved. Mezhdunarod. Geofiz. Godu, Sbornik Statey, IX Razdel Programmi Mezhdunarod. Geofiz. Godu (Glyatsiologiya), no. 5, p. 56-71, 1960.

Measurements made from February to May 1958 on Shokalskiy Glacier on Novaya Zemlya indicate that the annual movement of the glacier is approximately 150 m. This rapid movement is the result of the high temperature of the ice, the high gradient of the bed, and the funnel shape of the cirque. Data on ice movement at various times during 1958 near the glacier's front are tabulated.— V.S.N.

## GRAVITY

191-324. Dicke, R. H. The Eötvös experiment: *Sci. American*, v. 205, no. 6, p. 84-94, 1961.

The extraordinarily precise experiments made by Eötvös between 1889 and 1908 to test the constancy of gravitational acceleration are described and illustrated, and Einstein's application of the meaning of the results to show that the units of length and time are the same everywhere in the universe is discussed. For various reasons having to do with the theory of relativity it seemed important to repeat the Eötvös work. The experiment was redesigned to contain its own built-in control measurement. The new experiment depends on the acceleration of the earth - and earthbound objects - toward the sun. Three weights are suspended at the same height from the corners of an equilateral triangle; all are about the same mass, and two are copper and one is lead chloride. This configuration of weights and the small size of the triangle (about 5 cm on a side) minimizes gravitational gradients. Multiple-wall thermal radiation shields are employed to reduce the instruments's sensitivity to temperature, and the freely suspended parts are sealed in a high vacuum to reduce convection difficulties. Two magnetometers were installed next to the apparatus to monitor continuously the two horizontal components of the earth's magnetic field and thus to determine the magnitude of torques produced by magnetic disturbances. The human observer is eliminated by the use of a combined electrooptical system that monitors the rotation angle of the suspended triangle and is able to determine (over an observation period of 10 sec) any rotation amounting to about  $10^{-7}$  degree of arc. A feedback control system prevents the apparatus from rotating. The whole apparatus is mounted in a pit 12 feet deep sealed by a four-foot plug of thermal insulation when an experiment is in progress. With all the modern techniques, however, the improvement on the accuracy of the Eötvös results is only by a factor of 50. With an accuracy of about one part in  $10^{10}$  it can be said that the gravitational acceleration of lead and copper are equal; it is hoped to extend this accuracy by another factor of 10.— V.S.N.

191-325. Gamow, George. *Gravity*: Garden City, N. Y., Doubleday and Company, Inc., 157 p., 1962.

The history of man's understanding of gravity is centered about the work of three men -- Galileo Galilei, Isaac Newton, and Albert Einstein. In this book one chapter is devoted to Galileo's pioneering work, six chapters to Newton's ideas of gravity as a universal force and their subsequent development, one chapter to Einstein's theory that gravity is curvature of the four-dimensional space-time continuum, and one chapter to post-Einsteinian speculations concerning the relation between gravity and other physical phenomena. Chapter 3 is a discussion of the elementary principles of calculus, the branch of mathematics developed by Newton to meet the problems raised by his theory. (See also *Geophys. Abs.* 186-387.)— V.S.N.

191-326. Lamar, Donald L. Comments on paper by W. H. Munk and G. F. J. MacDonald, "Continentality and the gravitational field of the earth": *Jour. Geophys. Research*, v. 67, no. 9, p. 3641-3642, 1962.

Munk and MacDonald (see *Geophys. Abs.* 182-282) have shown that the departure of the zonal harmonics of the earth's gravitational field from the hy-

drostatic values cannot be explained by the distribution of continents and reasonable assumptions about the density of the crust and upper mantle. Lamar points out that isostatic compensation may be regarded as a balance of mass or as a balance of pressure. The difference is important if one attempts to explain the gravity potential of the earth by a distribution of density in the mantle; therefore, it is important to determine which form of isostasy should be assumed. An argument supporting the balance of pressure model is presented. This model implies that a relatively small mass at the boundary of the core could balance an area the size of a continent at the earth's surface. Actually, if the depth of compensation were this great, the surface load would be largely balanced by the resistance of the mantle to deformation.—D.B.V.

- 191-327. Caputo, Michele. Deformazioni di un modello della terra causate da distribuzioni superficiali di masse gravitanti [Deformation of a model of the earth caused by superficial distribution of gravitational mass (with English abstract)]: Associazione Geofisica Italiana Atti del X Convegno Annuale, Roma, 1960, p. 157-165, 1960.

This is an Italian version of essentially the same paper that was published in *Jour. Geophys. Research*, v. 67, no. 4, p. 1611-1616, 1962 (see *Geophys. Abs.* 189-240).—V.S.N.

- 191-328. Kazinskiy, V. A. Approksimatsiya ukloneniy otvesnykh liniy, nablyudayemykh v gravitatsionnom pole zemli [Approximation of the deflection of plumb lines observed in the gravity field of the earth]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 1, p. 95-104, 1962.

An analytical method is described for calculating the deflection of the vertical. As this method is based on assumptions developed in the theory of approximations by polynomials, it can be called the method of polynomials. The method is very flexible and simple mathematically.—J.W.C.

- 191-329. Cook, G. E. Luni-solar perturbations of the orbit of an earth satellite: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 3, p. 271-291, 1962.

The effects of the gravitational attractions of the sun and moon on the orbital elements of an earth satellite are investigated using Lagrange's planetary equations. Expressions are obtained for the change in the elements during one revolution of the satellite and for the rates of change of these elements. Corresponding expressions are obtained for the effects of solar radiation pressure, including the effect of the earth's shadow.—Author's summary

- 191-330. Smith, D. E. Determination of the earth's gravitational potential from satellite orbits: *Planet. and Space Sci.*, v. 8, no. 1, p. 43-48, 1961.

From the motions of the orbital planes of four satellites, values for the second, fourth, and sixth harmonics in the earth's gravitational potential have been obtained. Allowance is made for atmospheric, lunar, and solar perturbations, and the results are compared with those of other authors.—Author's abstract

- 191-331. Smith, D. E. An evaluation of the odd harmonics in the earth's gravitational field: *Planet. and Space Sci.*, v. 9, p. 93-94, 1962.

Analysis of orbits of Vanguard I, Transit 1B, and Transit 2A satellites has shown that they are considerably affected by asymmetry about the equator of the earth's gravitational field. Preliminary results are given for this effect on the orbits of Explorer VIII, XI, and Tiros II satellites together with values for the odd harmonics,  $J_3$  and  $J_5$ , in the earth's potential function.—V.S.N.

- 191-332. Sehnal, L. The effect of the equatorial ellipticity of the earth's gravitational field on the motion of a close satellite: Central Astron. Inst. Czechoslovakia Bull., v. 11, no. 3, p. 90-93, 1960.

The perturbations of a close artificial satellite due to the equatorial ellipticity of the earth are analyzed on the basis of the external gravitational field of the earth expressed by the formula developed by Zhongolovich in 1957, and compared with the values of calculations by O'Keefe and Batchelor. The variations of the mode, inclination, and the perigee distance were determined by the method of variation of the constants. The perturbation of the amplitude of the short period terms was found to be about  $20''$  of arc (slightly greater than the O'Keefe and Batchelor determination), and the long period perturbation (due to the velocities of the earth's rotation and of the satellite's revolution being commensurate) was found to be higher by approximately one order.—A.J.S.

- 191-333. Kolbenheyer, Tibor. K teorii gravitacionnykh poley odnorodnykh i neodnorodnykh beskonechnykh prizm [On the theory of the gravitational field of homogeneous and nonhomogeneous infinite prisms (with German summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 5, no. 2, p. 108-121, 1961.

It is shown that the known double integrals that represent the gravitational potential, the field components, and the second and higher derivatives of the potential of an arbitrary infinite homogeneous prism can be transformed rather easily into linear integrals and expressed in closed form by elementary functions. In this way formulas for the potential, the field components, the second derivative of the potential, and the third vertical derivative can be derived for a prism having any cross-section. The formulas are obtained in a general form, whereby the subsidiary quantities appearing in them can very easily be determined graphically. It is shown further that this same method can also be used to calculate the gravity field of a nonhomogeneous prism.

In conclusion, the vertical component  $Z$  of the field of an arbitrary horizontal infinite prism is calculated for the case of a density distribution  $\sigma = (1 + \beta z)^{-2}$ , where  $z$  is depth and  $\beta$  is an arbitrary positive constant. Solutions are given for a homogeneous prism and for a model in which density varies steadily and uniformly with depth and asymptotically approaches a given boundary value.—D.B.V.

- 191-334. Kolbenheyer, Tibor. Gravitacionnoye pole odnorodnogo kruglogo tsilindra [The gravitational field of a homogeneous circular cylinder (with German summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 5, no. 3, p. 211-218, 1962.

It is shown that the components of the gravitational field of a finite homogeneous upright circular cylinder can be expressed in closed form by means of complete elliptical normal integrals of first, second, and third type, whereby the parameters  $k$  and  $\lambda$  of these integrals depend on the dimensions of the cylinder and on the position of the top point. The method is based on repeated application of the Gauss law, as it is shown that the calculation of the component parallel to the  $Z$ -axis can be referred to the determination of the potential of two homogeneous circular disks, which in turn can be calculated by appropriate application of the same law to the plane problem involved. The radial component  $X$  is first expressed by a plane integral extending over the mantle of the cylinder, which can be reduced without particular difficulty to the three complete elliptical normal integrals. As tables are available for the elliptical integrals appearing in the final formulas, these formulas are very suitable for numerical calculations.—Author's summary, D.B.V.

- 191-335. Bulakh, Ye. G., and Yevsikova, L. G. Ob odnom integral'nom sposome interpretatsii gravitacionnykh i magnitnykh anomaly [An integral method of interpreting gravity and magnetic anomalies]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 90-94, 1962.

A method of integral grids is proposed for solution of the direct problem in interpreting gravity and magnetic anomalies. This method has some advantage over using polar grids. It is possible to introduce corrections into the geologic scheme until the integral criterion is satisfied.— J.W.C.

191-336. Yun'kov, A. A. Opredeleniye glubiny i razmerov trekhmernogo tela po anomalii  $\Delta g$  [Determination of the depth and dimensions of a three-dimensional body by the  $\Delta g$  anomaly]: *Geofiz. Razvedka*, no. 5, p. 3-15, 1961.

A procedure for interpretation of  $\Delta g$  anomalies over three-dimensional geologic bodies is discussed. It permits separation of a local anomaly from the regional one.— A.J.S.

191-337. Afanas'yev, N. L. Interpretatsiya anomalii  $V_{SZ}$  pryamym metodom [Interpretation of  $V_{SZ}$  anomalies by the direct method]: *Geofiz. Razvedka*, no. 5, p. 15-27, 1961.

A method is presented for interpreting  $V_{SZ}$  anomalies from anomalistic integrals of final limits without the necessity of evaluating the residue. This eliminates a source of considerable error. The cases of evaluation of effective masses and the horizontal and vertical coordinates of the center of gravity of two- and three-dimensional disturbing bodies are considered, and formulas are derived for both cases. The accuracy of the evaluation was found to depend mainly on the correct choice of integration limits of the observed values of  $V_{xz}$  and  $V_{yz}$ .— A.J.S.

191-338. Kivioja, L[assi] [A.]. Development of gravity Bouguer anomalies of state of Ohio and the isostatic anomalies of north Atlantic in Fourier series: *Ohio State Univ. Inst. Geodesy, Photogrammetry and Cartography*, Rept. no. 22, 13 p., 1962.

On the basis of developments in Fourier series of gravity anomalies for two test areas,  $2^\circ \times 3^\circ$  in Ohio and  $10^\circ \times 35^\circ$  in the Atlantic Ocean, mean gravity anomalies were estimated for  $10' \times 10'$  and  $1^\circ \times 1^\circ$  squares, respectively. For comparison, another method was used in which the original values were plotted on a transparent sheet placed over a topographic or bathymetric map, isoanomaly contours were drawn just on the basis of the original anomaly values and topography, and mean gravity anomalies were estimated for the same squares. This second manual method proved to have smaller standard errors than the Fourier series method. It is more accurate, faster, and can better use all available material regardless of whether the gravity points are along profiles or scattered over a wide area. A combination of analytic and topographic methods will obviously bring best results.— D.B.V.

191-339. Kane, M. F. A comprehensive system of terrain corrections using a digital computer: *Geophysics*, v. 27, no. 4, p. 455-462, 1962.

The system of terrain corrections uses an electronic digital computer for much of the calculation. A new method using a desk calculator is suggested for terrain effects arising from close-in topography. The present system covers a square area 40 km by 40 km, with the station at the center. A selected group of corrections that were compared with conventionally computed ones agree within 0.1 mgal. The speed of the operation using the Datatron 220 computer is considerably faster than the conventional method of computing. [See also *Geophys. Abs.* 183-363.]— Author's abstract

191-340. Berezkin, V. M. Uchet vliyaniya rel'yefa mestnosti na pokazaniya gravimetrov po znacheniyu otnositel'nykh vysot v opredelennykh tochkakh [Accounting for the effect of the relief of a locality on the gravimeter readings according to the values of relative alti-

tudes at certain points]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 10, p. 102-109, 1960.

A method is formulated for accounting for the effect of local relief on gravimeter readings by determining the values of relative altitudes at certain points on rays emerging from the observation points. Examples of its application are explained.—A.J.S.

191-341. Berezkin, V. M. Nomogrammy dlya ucheta vliyaniya relyefana pokazateli gravimetrov po znacheniyu otnositel'nykh vysot v kharakternykh tochkakh [Nomograms for calculating the effect of relief on gravimeter readings according to the values of relative altitudes at characteristic points]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 11, p. 116-122, 1960.

This is a supplement to Berezkin's preceding paper (see Geophys. Abs. 191-340). Special nomograms are developed to aid in calculating the functions needed for determining corrections of gravimetric observations for the relief of the terrain.—A.J.S.

191-342. Carrozzo, M. T., and Mosetti, F. Sulle combinazioni lineari dei dati di osservazione per la riduzione di talune mappe geofisiche [On the linear combination of observational data for the reduction of certain maps]: Boll. Geofisica Teor. ed Appl., v. 3, no. 10, p. 103-120, 1961.

Certain properties of linear combinations adaptable to interpretation of geophysical anomalies are analyzed and discussed. A critical evaluation of other systems of calculation of the regional gravimetric field led to interesting analogies in the calculation of the second derivatives of the field, and the application of these analogies to the further development of the linear combinations method is proposed.—A.J.S.

191-343. Shvank, O. A. Vychisleniye pervoy i vtoroy vertikal'mykh proizvodnykh anomalii sily tyazhesti [Calculation of the first and second derivatives of gravity anomalies]: Prikladnaya Geofizika, no. 27, p. 131-142, 1960.

The procedure for calculating the first derivative proposed by Veselov (see Geophys. Abs. 164-162) and of the second derivative proposed by Rosenbach (see Geophys. Abs. 155-14811) of gravity are followed through and analyzed. The comparative accuracy of the approximate formulas obtained for the above derivatives is discussed and illustrated by computing the values of the first and the second vertical derivatives of gravity anomalies ( $W_{ZZ}$  and  $W_{ZZZ}$ ).—A.J.S.

191-344. Yun'kov, Ya. A. Obchislennyya anomalii g nad trymirnymy tilamy paletkoyu dvomirnogo tila [Calculations of g anomalies of three-dimensional bodies with a master chart of two-dimensional bodies]: Akad. Nauk Ukrain. RSR Dopovidī, no. 2, p. 181-182, 1961.

A method of using master charts of two-dimensional bodies for interpretation of gravity anomalies over three-dimensional bodies of arbitrary shape is discussed. The method permits determination of the configuration of the body in the  $xoz$  and  $yoz$  planes, its surface area, and its position in space relative to a given point.—A.J.S.

191-345. Yun'kov, Ya. A. Obchislennyya anomalii  $V_{ZZ}$  nad trymirnymy tilamy paletkoyu dvomirnogo tila [Calculation of anomalies  $V_{ZZ}$  over three-dimensional bodies with the master-chart of two-dimensional bodies]: Akad. Nauk Ukrain. RSR Dopovidī, no. 4, p. 483-485, 1961.

A method of using a two-dimensional master-chart for interpretation of anomalies of the second derivative of gravity potential of three-dimensional bodies of any shape is discussed.— A.J.S.

- 191-346. Tyapkin, K. F. Pro vrakhuvannya bokovykh vplyviv pri interpretatsii ploskikh gravitatsiynykh anomalii pryamyym sposobom [On accounting for lateral effects in the interpretation of plane gravity anomalies by the direct method]: Akad. Nauk Ukrain. RSR Dopovidī, no. 11, p. 1462-1466, 1961.

A method is proposed for taking into account the effect of two or more geologic bodies on their common anomaly as observed on the surface of the earth. This is accomplished by replacing the plane anomalistic bodies by equivalent horizontal cylindrical bodies, the parameters of which are determined by the method of successive approximations to fit the observed anomalistic curve.— A.J.S.

- 191-347. Bulakh, Ye. G. Uzagal'nennyya deyakikh kryteriiv dlya perevirky interpretatsiy gravitatsiynykh anomalii [Generalization of certain criteria for verification of interpretation of gravity anomalies]: Akad. Nauk Ukrain. RSR Dopovidī, no. 5, p. 630-633, 1960.

Physical-mathematical criteria for verification of interpretation of gravity anomalies  $\Delta g = -\partial V / \partial (\xi; \eta; 0)$ , and  $V_{\xi\xi}$  are analyzed, and their application to three-dimensional bodies of arbitrary shapes are discussed.— A.J.S.

- 191-348. Tyapkin, K. F. Pro vykorystannya formul ploskoi zadachi dlya interpretatsii gravitatsiynykh anomalii, zumovlenykh konechnymy po prostyagannyyu geologichnymy ob'yektamy [On utilization of formulas of the plane problem for interpretation of gravity anomalies due to geological objects of finite length]: Akad. Nauk Ukrain. RSR Dopovidī, no. 8, p. 1070-1073, 1960.

Plane problem formulas are applied to interpretation of gravity anomalies produced by three-dimensional bodies, and general mathematical expressions for the components of the field intensities due to two- and three-dimensional bodies are analyzed and compared. A preliminary summation of the measured gravity elements along lines parallel to the strike of a three-dimensional disturbing body is proposed for the interpretation of anomalies of a plane gravity field.— A.J.S.

- 191-349. Klushin, I. G. Metodika sovместnoy interpretatsii geofizicheskikh dannykh s tsel'yu izucheniya plotnosti glubinnykh sloev zemnoy kory [Methods of combined interpretation of geophysical data for the purpose of studying the density of deep layers of the crust]: Akad. Nauk SSSR, Sibirskoye Otdeleniyya, Geologiya i Geofizika, no. 11, p. 97-107, 1961.

Methods and results of combined interpretation of gravimetric surveys and deep seismic soundings are discussed. An analysis of several hundred versions of density distribution with the depth was carried out with subsequent elimination of the least reliable reading; this led to a value of 2.82 as the normal density of the crust. It was found from investigations of the density of deep crustal layers that areas with thicker sedimentary strata are compensated with denser basalts beneath.— A.J.S.

- 191-350. Tyapkin, K. F. Graficheskiye sposoby vychisleniyya anomalii  $g$  obuslovlennykh konechnymy po prostiraniyyu geologicheskimi ob'yektami [Graphical methods of calculation of anomalies of  $\Delta g$  due to geologic objects of finite length]: Geofiz. Razvedka, no. 5, p. 27-38, 1961.

Master charts for calculating  $\Delta g$  anomalies due to geologic bodies of finite length are presented (see also Geophys. Abs. 177-120). In this variant of master charts the equivalent effect element in the form of a paralleliped in the cross-section of the plane  $xOz$  is adopted, instead of the elements being formed by the intersection of radial planes and coaxial cylinders.— A.J.S.

- 191-351. Ladynin, A. B. Obrabotka gravimetricheskikh nablyudeniy s vvedeniyem popravki za nul'-punkt po krivolineynomu zakonu sposobom priblizheniya [Processing of gravimetric observations by introducing the zero-point correction according to nonlinear law by the successive approximation method]: Geofiz. Razvedka, no. 5, p. 39-45, 1961.

Considering that the rate of zero-point variation due to change of temperature and external mechanical effects on the system of a GAK-4M type gravimeter is essentially nonlinear, a method of zero-point determination by a nonlinear law of the variation is proposed. The first zero-point determination is made by one of the usual linear formulas, and the average of gravity increments obtained for all traverses is taken as the first approximation in the process. Using these first approximation values of  $\Delta g$ , graphs of the zero-point for each traverse are drawn as the variation rate of the zero-point for the traverse, and further processing is continued in the usual manner. The base network established by the 9/60 Astrakhan expedition, recalculated according to the process proposed, showed a probable error of  $\pm 0.06$  mgal against 0.11 mgal obtained by the linear correction method.— A.J.S.

- 191-352. de Visintini, G. More selectivity in residuation: Boll. Geofisica Teor. ed Appl., v. 3, no. 12, p. 331-337, 1961.

A template with three concentric circles of radii  $r_1$ ,  $r_2$ , and  $r_3$ , is discussed as a means of residual gravity determination in the separation of a significant gravity anomaly from components superimposed due to overburden effects or to uncertainty in the local density of the ground. The value of  $r_1$  is selected to be close to a half wavelength of the anomaly, and the other two according to the relationship,  $r_i = (a_i^2 + b_i^2)^{1/2}$ , where  $a_i$  and  $b_i$  are whole numbers. The residual gravity is then determined as a linear combination of the average Bouguer value along the three circles according to the formula,  $\Delta g = \bar{g}(r_1 + \bar{g}(r_2) - \bar{g}(r_3))$ .— A.J.S.

- 191-353. Glicken, Milton. Eötvös corrections for a moving gravity meter: Geophysics, v. 27, no. 4, p. 531-533, 1962.

When making gravity measurements with a moving meter, the Eötvös correction is often the limiting factor in the precision of the entire system. Nomograms are presented showing the error to be expected in the Eötvös correction for errors of various sizes in the determination of ground speed, heading, and latitude of the vehicle.— Author's abstract

- 191-354. Popov, Ye. I. Otsenka tochnosti izmereniy uskoreniya sily tyazhesti na more gravimetrami [Evaluation of the accuracy of measurements of the acceleration of gravity at sea by gravimeters]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 30-53, 1962.

The accuracy of marine gravity measurements is limited at present by errors in determining coordinates, currents, and depths of the sea rather than by instrumental errors. Measurements by "Gal" gravimeters in a submarine are characterized by the following mean square errors: (1) anomalies in the Faye reduction averaging 3-4 mgal for the observation point; (2) anomalies in the Bouguer reduction averaging 4-5 mgal at the observation point and up to 15 mgal in regions of great depth of water. The instrumental error does not exceed 1.4 mgal. Accuracy is limited by errors due to inability to allow for cur-

rents (up to 4 mgal), errors in determining position at the time when the observations were made (up to 5 mgal), and errors in determining the depth of the sea (10-15 mgal). By using 5-8 "Gal" gravimeters, it is possible to make submarine measurements of variations in the acceleration of gravity within the range of 1,500-2,000 mgal over a period of 3-4 months.— J.W.C.

Strakhov, V. N. Construction of quadrature formulas with almost equal coefficients. See *Geophys. Abs.* 191-495.

Strakhov, V. N. Approximations of functions on a half-axis and application of similar approximations to calculation of integrals used in interpretation of magnetic and gravity anomalies. See *Geophys. Abs.* 191-494.

191-355. Schulze, Reinhard. Automation of the sea gravimeter Gss2: *Jour. Geophys. Research*, v. 67, no. 9, p. 3397-3401, 1962.

The latest improvement in the sea gravimeter after Graf led to a servo control for setting the measuring spring so that the measuring boom is always held in the zero position over an average period of time. The setting of the measuring spring is recorded by means of a potentiometer, the recorder, and a counter. Thus, the direct measuring range is extended to approximately 7,000 mgal. Lags in recording caused by the extreme heavy damping, as well as reductions in the gravity amplitudes of interest, have been almost entirely eliminated with the automatic servo control. In addition, considerable simplification in operation and data evaluation has been achieved, with a possibility for electronic data reduction.— Author's abstract

191-356. Krasnov, B. A. Opyt raboty gravimetrami-vysotometrami GVP-1 [Experience in operating the GVP-1 gravimeter-altimeter]: *Geofiz. Razvedka*, no. 5, p. 46-53, 1961.

The construction, design, and performance of the model GVP-1 portable gravimeter-altimeter are described, and the results of 97 traverses and 1,186 observations during the period from June 1959 to March 1960 are discussed. It was found that this model has many advantages over the preceding model, the GV-52. The new apparatus has proved to be the best of its kind for areal two-milligal gravimetric surveys when the required accuracy is  $\pm 0.8$  mgal.— A.J.S.

191-357. Grushinskiy, N. P. Opyt primeneniya gravimetra na nadvodnom korable [Experiment in the use of a gravimeter on a surface ship], in *Morskiye gravimetricheskiye issledovaniya: Moskov. Univ. Sbornik*, no. 1, p. 69-76, 1961.

The first experimental gravity measurements during the Second Russian Antarctic Expedition of 1957 carried out aboard the ship *Ob'* are described. It was found that gravity measurements with a gravimeter aboard a rolling ship do not require such rigorous conditions of observations as are necessary in measurements with pendulum instruments; however, the accuracy is inferior ( $\pm 10$  mgal). Gravimetric measurement can be used at auxiliary points between pendulum bases.— A.J.S.

191-358. Aleksandrov, S. Ye., Sukhodol'skiy, V. V., and Izmaylov, Y. P. Novyy mayatnikovyy pribor dlya opredeleniya sily tyazhesti na more [New pendulum device for gravity determination at sea]: *Akad. Nauk SSSR Inst. Fiziki Zemli Trudy*, no. 8, (175), p. 3-24, 1959.

A marine pendulum gravimeter is described. It has 6 quartz pendulums arranged in groups of 3 in 2 parallel planes and is provided with a set of special pendulums for measuring tilts and accelerations. Brief data are given on the results of tests at sea.— Authors' abstract, A.J.S.

- 191-359. Tulin, V. A. Kvaritsevyey chasy dlya mayatnikovoykh opredeleniy sily tyazhesti na more [Quartz clock for gravity determinations at sea]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 8 (175), p. 25-31, 1959.

A portable quartz clock for gravimetric pendulum measurements is described, and methods for adjusting separate units and for operating the device as a whole are given. Performance curves for the clock under laboratory and field conditions are provided.— Author's abstract, A.J.S.

- 191-360. Popov, Ye. I. Kvaritsevy gravimetr dlya morskikh nablyudeny [Quartz gravimeter for observations at sea]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 8 (175), p. 32-41, 1959.

A quartz gravimeter with photo-recording is described. The highly damped elastic system of the gravimeter makes observations possible on a moving base, provided the device is supported in a Cardan joint. The laboratory and sea tests showed that the accuracy of individual measurements are within 10-15 mgal for perturbing accelerations not higher than 10-15 gal. In observations carried out on board of a moored ship, an accuracy of 6 mgal was obtained. The gradation value of the device is 12 mgal per mm on the average.— A.J.S.

- 191-361. Sukhodol'skiy, V. V. Pribor PNU dlya issledovaniy naklonov i uskorenny, deystvuyushchikh pri gravimetricheskikh opredeleniyakh na more [The PNU device for investigation of tilts and accelerations in gravity determinations at sea]: Akad. Nauk SSSR, Inst. Fiziki Zemli Trudy, no. 8 (175), p. 42-53, 1959.

A device is described that records tilts and accelerations at sea and permits galvanometric recording of vibrations after their transformation into electric oscillations by appropriate pick-ups. Data on the character of perturbing vibrations, tilts, and accelerations effective aboard the ship "Mikhail Lomonosov" are given. (See also Geophys. Abs. 181-269.)— A.J.S.

- 191-362. Bulanzhe, Yu. D. Sokachaniye shtativa kvartsevykh gravimetrov s gorizonta'l'noy krutil'noy nit'yu [Co-oscillation of the support of quartz gravimeters having a horizontal torsion filament]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 8 (175), p. 54-60, 1959.

This is virtually the same as the paper published in Československá Akad. Věd Studia Geophys. et Geod., v. 3, no. 1, p. 25-32, 1959 (see Geophys. Abs. 177-206).— A.J.S.

- 191-363. Romanyuk, V. A. Vliyaniye sokachaniya shtatina na period kolebaniya mayatnika [The effect of co-oscillation of the support on the period of pendulum oscillation]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 8 (175), p. 61-67, 1959.

The effect of co-oscillation of the support of pendulum gravimeters due to oscillation of the pendulum and the corresponding change of the center of mass of the system is discussed and analyzed mathematically. It was found that the Schmekl's formulas used for calculating the residual effect of such a co-oscillation are not sufficiently accurate, and accurate correction formulas are derived.— A.J.S.

- 191-364. Kuzivanov, V. A. Opredeleniye sily tyazhesti gravimetrom na dvizhushchemsya osnovanii [Gravity determination by a gravimeter on a moving base]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 8, (175), p. 68-71, 1959.

The terms of the differential equation of motion of a horizontal overdamped gravimeter pendulum installed on a moving support are estimated. A formula is derived for calculation of the gravity increment according to the gravimeter readings of long- and short-period pendulums.—Author's abstract, A.J.S.

191-365. Berezin, E. M., and Kuzivanov, V. A. Nomogrammy dlya opredeleniya popravok na amplitudu, temperaturu, glubinu pogruzheniya, popravki za effekt Etvessa i dlya opredeleniya sokachaniya pri mayatni-kovykh nablyudenyakh na more [Nomograms for determination of corrections for the amplitude, temperature, submersion depth, correction for Eötvös effect, and for determination of the co-oscillation coefficient in pendulum observations at sea]: Akad. Nauk SSSR Inst. Fiziki Zemli Trudy, no. 8 (175), p. 72-79, 1959.

The following nomograms for processing pendulum observations at sea are presented and discussed: (1) nomogram for determination of the amplitude correction; (2) nomogram for calculating a correction for temperature variation; (3) graph for calculating a correction for the submersion depth; (4) nomogram for calculating a correction for the Eötvös effect; and (5) nomogram for determination of the co-oscillation coefficient.—A.J.S.

191-366. Morelli, C[arlo], Gantar, C., Inghilleri, G[iuseppe], and Solaini, L[uigi]. Misure con gravimetri lungo la linea di taratura Europea tra Bad Harzburg e l'Osservatorio Etneo [Gravimeter measurements along the European calibration line between Bad Harzburg and the Etna Observatory]: Osservatorio Geofisico Sperimentale Trieste Pubblicazioni, new ser., no. 117 B, 1961.

Gravimeter observations made by the Observatory of Experimental Geophysics of Trieste and the Institute of Geophysics, Topography, and Photogrammetry of the Milan School of Engineering during the establishment of the Italian part of the European calibration line for gravimeters are discussed. The selection of the stations, the gravimeters used, the work of the two institutes, and the results obtained are described. It is concluded that the accuracy of the Italian part of the European calibration line compares well with that of other parts. The least satisfactory results were obtained in areas of great elevation differences such as Brenner Pass, Cisa Pass, and around Mount Etna.—V.S.N.

191-367. Gantar, C., and Zampieri, L. Nuove misure gravimetriche di collegamento agli aeroporti italiani di Roma e Catania [New gravimetric measurements connecting the airports of Rome and Catania]: Boll. Geofisica Teor. ed Appl., v. 3, no. 11, p. 193-196, 1961.

Gravimetric measurements made with a Worden gravimeter connecting the new Fiumicino airport in Rome with the Italian gravity network, the Fontanarossa airport in Catania, and the station at the Sigonella airport are reported.—A.J.S.

191-368. Morelli, C[arlo], and Lozano, L. Enlace Roma - Barcelona de la Red Gravimetrica Europea [The Rome-Barcelona tie with the European gravimetric net]: Osservatorio Geofisico Sperimentale Pubblicazioni, new ser., no. 113 B, 1961.

Three Worden gravimeters were used to establish the Rome to Barcelona tie to the European gravimetric net in June 1960. Measurements show good agreement for the three instruments. The weighted mean for the difference between the two stations is computed as Rome (Ciampino)=Barcelona (Muntadas)+26.16 mgal  $\pm 0.01$ ; the definitive mean adopted is Rome (Ciampino)=Barcelona (Muntadas)  $\pm 26.145$  mgal.—V.S.N.

- 191-369. Behrendt, J[ohn] C., Wold, R. J., and Laudon, T. S. Gravity base stations in Antarctica: Royal Astron. Soc. Geophys. Jour., v. 6, no. 3, p. 400-404, 1962.

Gravity base stations established in Antarctica during the austral summer of 1960-61 are presented and compared with previous results by various observers. The use of two geodetic gravimeters, a LaCoste-Romberg and a Worden, has increased the accuracy and resolved several discrepancies. Ties were made between Christchurch, New Zealand and the United States Antarctic Stations at McMurdo Sound, South Pole, Byrd, and Hallett, as well as satellite stations in West Antarctica and the New Zealand Scott Base at McMurdo Sound. Station descriptions and observed gravity values are presented.—Authors' summary

- 191-370. Ostenso, Ned A., and Holmes, G. William. Gravimetric determinations of ice thickness of Jarvis Glacier, Alaska: U.S. Geol. Survey Prof. Paper 450-C, Art. 94, p. C93-C96, 1962.

A gravimetric survey of this small glacier revealed a maximum thickness of 1,055 feet, a U-shaped cross section, and a rock threshold or sill bounding the cirque basin. Possible causes of the overdeepened cirque are discussed briefly. Qualitative support is given to Nye's relation of surface slope to ice thickness.—Authors' abstract

Steenland, Nelson C. Gravity and aeromagnetic exploration in the Paradox Basin. See Geophys. Abs. 191-543.

- 191-371. McLean, Adam C. A gravity survey of the Sanguhar coalfield: Royal Soc. Edinburgh Proc., sec. B, v. 68, pt. 2, p. 112-127, 1960-61 [1962].

Results are discussed of a gravity survey made of the Sanguhar district coal basin where relatively light Upper Carboniferous rocks overlie a denser basement of Ordovician greywackes. The residual Bouguer anomalies reflect the structure of the Carboniferous rocks and in the southeast part of the basin agree closely with the calculated effect produced by the known thicknesses, structure, and density contrast. Westward from Kirkconnel, however, an increasing discrepancy between observed and theoretical anomalies indicates the presence of an additional mass of light rock. The structure and thickness of this mass is discussed. It is concluded that the strata concealed by the known Coal Measures are stratigraphically significant because they indicate the existence of a pre-Wesphalian basin trending northwest-southeast which was antecedent to the Hercynian fold; they also suggest that pre-Hercynian movements took place along a fault near Kirkconnel that trends northeast-southwest across the basin.—V.S.N.

- 191-372. McLean, Adam C. Density measurements of rocks in south-west Scotland: Royal Soc. Edinburgh Proc., sec. B, v. 68, pt. 2, p. 103-111, 1960-61 [1962].

A large number of density measurements were made on the more important rock types exposed at the surface in Ayrshire and certain neighboring areas to provide information for the interpretation of gravity measurements. Laboratory measurements were made on 600 specimens of the common rock types of the lower and upper Paleozoic systems and their associated igneous rocks, and gravimeter measurements were made in four mine shafts to cover the Carboniferous succession in south Ayrshire. The results are summarized and their reliabilities discussed. Density contrasts of regional importance occur in the sedimentary succession of south Ayrshire at the plane of unconformity between upper and lower Old Red Sandstone and between lower Old Red Sandstone and the lower Paleozoic greywackes. A contrast of local importance oc-

curs between the Permian sandstones of the Mauchline Basin and the underlying lavas and Carboniferous rocks. In north Ayrshire the most important contrast is between the upper Paleozoic sediments and associated dense igneous rocks.—V.S.N.

- 191-373. Gantar, C., Morelli, C[arlo], Segre, A. G., and Zampieri, L. Studio gravimetrico e considerazioni geologiche sull'isola di Pantelleria [Gravimetric studies and geological considerations of Pantelleria Island]: *Boll. Geofisica Teor. ed Appl.*, v. 3, no. 12, p. 267-287, 1961.

A gravity survey of Pantelleria Island (48 measurements) and adjacent offshore areas (20 measurements) is reported. Data on the gravimetric regional relief are presented in tabular form and in the maps of Bouguer isoanomalies at 2 mgal for densities of 2.30 and 2.50.—A.J.S.

- 191-374. Renner, J. Gravity research in Hungary in the years 1957 through 1959: *Acad. Sci. Hungaricae Acta Tech., ser. Geod. et Geophys.*, v. 2, no. 1/2, 1960.

From 1957 to 1959 a detailed gravimeter survey was made in Hungary at 12,842 points over an area of 11,280 sq km; a torsion balance was used at an additional 625 points covering 910 sqkm. Bouguer anomalies and second vertical derivatives were determined for all gravimeter points. Gravimeter and torsion balance measurements are compared for plains areas. The undulation of the geoid is computed, and the gravimetrically and astrogeodetically determined deflections of the vertical are compared for one Laplace station. Results are reported of a study of the relation of the astrogeodetically determined deflections of the vertical for 17 Laplace stations throughout the country to the Bouguer and isostatic anomalies. Gravimetric determination of the remaining Laplace stations is expected to yield results in general agreement with astrogeodetic results. Deflections of the vertical computed by astrogeodetic methods and from curvature values of the torsion-balance measurements are plotted on a chart for the 17 Laplace stations.—V.S.N.

- 191-375. Artem'yev, M. E., and Tarakanov, Yu. A. Gravimetricheskiye nabljudeniya v odnoy iz shakhtkrivorozhskogo basseyna [Gravimetric observations in one of the mines of the Krivoy Rog basin]: *Razvedochnaya i Promyslovaya Geofizika*, v. 38, p. 18-23, 1960.

Experimental work in one of the iron mines of Krivoy Rog shows that gravimetric observations are of practical value in mines provided that a sufficient density contrast exists in the adjacent rocks. The observations add to the accuracy of knowledge of the geologic structure and provide density data that is useful for surface surveys. Gravity observations to determine approximate locations of ore bodies are much quicker and less cumbersome than electrical surveys; however, due to the greater accuracy of the electrical surveys, gravitationally anomalous zones should be surveyed in detail by electrical methods.—J.S.W.

- 191-376. Lebedev, T. S., and Sobakar, G. T. Deyaki novi dani pro shchil'nist' osadochykh porid pivdennykh okrain Donbasu [Certain new data on the density of sedimentary rocks of the southern margin of the Donets Basin (with English summary)]: *Akad. Nauk Ukrayin. RSR Dopovidi*, no. 12, p. 1601-1605, 1961.

The results of determination of the densities of sedimentary rocks in 16 boreholes in the territory between the Mius and Grushevka Rivers on the southern boundary of the Donets Basin are synthesized, and the weighed average values were found to be 2.66, 1.91, and 1.73 for the Middle Carboniferous, Upper Cretaceous, and Paleogene rocks, respectively. The local

gravity anomalies may be due to relief of the Carboniferous basement or to differences in structural and lithological characteristics.— A.J.S.

- 191-377. Tal'-Virskiy, B. B., and Fomin, V. M. O prirode magnitnykh i gravitatsionnykh anomalii Bukhara-Khivinskoy neftegazonosnoy oblasti i Kyzylkumov [Nature of the magnetic and gravity anomalies of the Bukhara-Khivin oil-gas area and of Kyzyl-Kum]: *Uzbek. Geol. Zhur.*, no. 3, p. 22-26, 1961.

The values of the gravity and magnetic anomalies in the Bukhara-Khivin and Kyzyl-Kum areas of the Uzbek S.S.R. decrease in a southeast direction. On this background there are many maximums and minimums, as well as sharp changes in the gravity field which produce the so-called gravity steps. The intensities of the anomalies in the northwest part of the Bukhara-Khivin area reach tens of milligals, and their dimensions are measured in hundreds of kilometers. They have a clear northwest trend. Large gravity maximums in central Kyzyl-Kum correspond to exposures of Paleozoic sediments in the cores of individual horsts. The gravity anomalies in the southeast part of the Bukhara-Khivin area are small. Clear, positive magnetic anomalies correspond to the large gravity anomalies of the northwest part of the Bukhara-Khivin area. There are no significant magnetic anomalies in the southeast.— J.W.C.

- 191-378. Vol'vovskiy, I. S., Ryaboy, V. Z., and Shraybman, V. I. O prirode regional'nykh gravitatsionnykh anomalii Bukhara-Khivinskoy provintsii i sopredel'nykh rayonov [On the nature of the regional gravity anomalies of the Bukhara-Khivin province and adjoining regions]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 5, p. 644-651, 1962.

Gravity and deep seismic sounding data indicate a crustal structure in the Bukhara-Khivin province of central Asia that stands in contrast to the character of the regional gravity anomalies. The nonuniform deep structure of the territory is manifested by an intensive  $\Delta g$ , whose transition from a maximum to a minimum corresponds to the zone of the most intensive dislocations. The confinement of the linear magnetic anomalies to the area of the greatest gradients of  $\Delta g$  indicates that the dislocations in Bukhara-Khivin province are due to a zonal series of deep ruptures.— A.J.S.

Berzon, I. S., Pak, V. A., Yakovlev, V. N., and Leontiyev, I. Y. Seismic sounding of the Fedchenko Glacier. Gravimetric observations on the Fedchenko Glacier. See *Geophys. Abs.* 191-635.

- 191-379. Pegum, D. M. Gravity survey of the Willunga basin: South Australia Dept. Mines Mining Rev., no. 113, p. 74-76, 1962.

Results of a gravity survey over the Willunga basin, an area of Eocene to Recent sediments overlying a Cambrian and Precambrian basement about 25 miles south of Adelaide, indicate the thickness of the sediments. The deepest part of the basin is 600 to 900 feet below sea level. A Bouguer gravity sketch map is included.— V.S.N.

- 191-380. Mumme, I. A. Gravimetric investigations - Eden fault zone, Glen Osmond, Beaumont and Rosslyn Park areas: South Australia Dept. Mines Mining Rev., no. 113, p. 82-85, 1962.

Gravity investigations in the Glen Osmond, Beaumont, and Rosslyn Park areas clearly delineated the Eden fault zone. Longitudinal profiles of the Bouguer anomaly characterizing the zone are given for each of the three areas.— V.S.N.

- 191-381. Grushinskiy, N. P. Morskiye opredeleniya sily tyazhesti v Antarktike v 1956-1957 gg [Marine gravity measurements in the Antarctic during 1956-1957], in Morskiye gravimetricheskiye issledovaniya: Moskov. Univ. Sbornik, no. 1, p. 41-62, 1961.

Gravimetric measurements in Antarctic waters and the Indian Ocean with Fechner-Sorokin modernized four-pendulum (quartz-metallic) and Cambridge three-pendulum (brass) instruments mounted in Cardan joints carried out aboard the ship "Ob." during 1956-57 are described. Long and short period pendulums were employed in measuring the inclination and vertical and horizontal accelerations of the gravimeters, and a GAISH quartz clock was used for timing. The accuracy was found to be  $\pm 8.0$  to  $\pm 8.4$  mgal.—A.J.S.

- 191-382. Zommer, I. E., and Gayanov, A. J. Metodika i rezul'taty opredeleniy sily tyazhesti v Antarktide [Methods and results of gravity measurements in the Antarctic], in Morskiye gravimetricheskiye issledovaniya: Moskov. Univ. Sbornik, no. 1, p. 63-68, 1961.

Measurements of gravity at four bases situated along the coast of Antarctica at intervals of 500-700 km from Mirnyy performed with GAISH four-pendulum instruments are described. The pendulum measurements were accurate to 2.0 mgal, and those made with an aircraft using a gravimeter GAK-3M contained probable errors from 3.2 mgal on pack ice to 10-15 mgal on the continental glaciers. The physical properties of 10 rock samples from the Antarctic are tabulated. A considerable deflection of the plumbline was noticed over these parts of the Antarctic.—A.J.S.

- 191-383. Lazarev, G. Ye., and Shumskiy, P. A. Predvaritel'nyye rezul'taty gravimetricheskikh opredeleniy tolshchiny lednikovogo pokrova [Preliminary results of gravimetric investigations of thickness of the ice sheet]: Sovetskaya Antarkt. Exped. Inf. Byull., no. 10, p. 96-100, 1960.

The gravimetric measurements carried out during the International Geophysical Year by U.S.S.R. investigators at 215 stations in east Antarctica are discussed. Measurements are based on the difference between the density of the ice and of the underlying ground and on comparison of gravity anomalies (see Geophys. Abs. 178-247). The methods and equipment used are described.—V.S.N.

#### HEAT AND HEAT FLOW

- 191-384. Donaldson, I. G. Temperature gradients in the upper layers of the earth's crust due to convective water flows: Jour. Geophys. Research, v. 67, no. 9, p. 3449-3459, 1962.

The temperature and flow patterns that would be set up in a single, permeable layer bounded above and below by impervious conducting sheets and in a two-layer system consisting of an upper saturated permeable layer and an underlying layer of impermeable basement rock are determined approximately for planar water flows of convective type. For the single-layer system only simple circulatory flows are considered, but for the two-layer system two types of flow are treated, purely circulatory flows and flows incorporating a closed circulation of underground water combined with a circulation in which water enters the ground surface at some places and rises to be lost as the surface runoff in other places. It is found that flows of the order of  $2 \times 10^{-7} \text{ cm}^3 / \text{ cm}^2 \text{ sec}$  may occur in a layer 3,000 m thick. Simple circulatory flows of this order can cause the surface heat flux to differ by a factor of 9 between regions of upward and downward flow. This surface heat flux difference is more extreme when discharge and recharge are included; in recharge regions the tem-

perature gradient may be almost zero for a considerable depth. Such convective circulations create a local "hot spot" beneath the region of upward flow at the interface between basement rocks and the permeable layer.—D.B.V.

- 191-385. Valle, P. E. Sull'andamento della temperatura nell'interno della Terra [On the behavior of the temperature in the earth's interior (with English abstract)]: *Annali Geofisica*, v. 13, no. 3-4, p. 387-392, 1960.

The temperature distribution in the earth's interior is calculated on the assumption that the whole planet is in adiabatic equilibrium. The upper limit of temperature is also calculated for different depths in the mantle and core. For a depth of 2,898 km (core-mantle boundary) the maximum temperature is 4,083°K.—D.B.V.

- 191-386. Mongelli, F., and Morelli, C[arlo]. Contributi alla prospezione geotermica [Contributions to geothermal prospecting]: *Boll. Geofisica Teor. ed Appl.*, v. 3, no. 12, p. 294-306, 1961.

The use of surface temperature measurements (1.5 m deep) for determining deep thermal anomalies in the crust is discussed. It is demonstrated that this method is valid when appropriate corrections are applied to the surface thermal data. The theoretical considerations for the correspondence of surface and subsurface (25-30 mi) temperatures are given. The methods of measurements are described, the causes of error analyzed, and the validity of the surface geothermy demonstrated for the region of Colli Euganei, Italy, by comparing deep and surface geothermal measurements.—A.J.S.

- 191-387. Lubimova, H. A. [Lyubimova, Ye. A.]. On the processes of heat transfer in earth's mantle: *Annali Geofisica*, v. 14, no. 1, p. 65-78, 1961.

This paper, read at the Helsinki assembly of the International Union of Geodesy and Geophysics in 1960, has also been published in English in *Jour. Physics of Earth* [Tokyo], v. 8, no. 2, p. 11-16, 1960 (see *Geophys. Abs.* 187-338).—D.B.V.

- 191-388. Zans, V. A. Bath Springs, St. Thomas - Their history and development: *Geonotes*; v. 4, pts. 3/4, p. 47-70, 1961.

The history and development of the thermal springs of Bath in St. Thomas, Jamaica, since their discovery about 1695 are discussed. Chemical analyses of both hot and cold springs in the area show that the same type of groundwater supplies both types of springs. The heat of the thermal springs is probably derived from localized deep circulation of the groundwater; such deeply circulating waters could acquire heat from volcanic sources or from exothermic reactions such as from decomposition of sulfides. No evidence has been found of a juvenile or connate origin for these thermal springs. Discharge measurements - elevation, temperature, volume of flow - are tabulated.—V.S.N.

- 191-389. Beck, A. E. Terrestrial flow of heat near Flin Flon, Manitoba: *Nature*, v. 195, no. 4839, p. 368-369, 1962.

Preliminary measurements of underground temperatures and thermal conductivity have been made in the Coronation Mine near Flin Flon, Manitoba. The geothermal gradient was found to be  $15.3 \pm 0.8^\circ\text{C}$  per km down to 600 feet, then changed to  $11.7 \pm 1.2^\circ\text{C}$  per km from 600 to 1,350 feet. Corresponding heat flow values are  $0.9-1.2 \mu$  cal per sq cm per sec from 150 to 600 feet, and  $0.7-0.9 \mu$  cal per sq cm per sec from 600 to 1,350 feet.—D.B.V.

- 191-390. Tsuruyants, A. B., and Gadzhziyeva, T. A. O geotermicheskoy stupeni v neftegazonosnykh rayonakh Azerbaydzhana [On the geothermal step in the oil-gas regions of Azerbaijan]: *Geologiya Nefti i Gaza*, no. 7, p. 59-62, 1960.

The calculated geothermal step in the Karadag gas field is 33 m per °C, whereas the actual value proves to be 56.08 m per °C. Conventional formulas for determining geothermal step using the mean annual temperature of the region are applicable in this region to depths of 800 m. Below this level the geothermal step increases.—J.W.C.

- 191-391. Klimentov, P. P. Hidrogeologicheskiye issledovaniya pri burenii na termal'nyye vody [Hydrogeologic investigations in boring for thermal waters]: *Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka*, no. 9, p. 94-107, 1961.

In the U.S.S.R., the Kurile-Kamchatka region should offer some possibilities of development of geothermal power and thermal waters. Exploratory drilling affords an opportunity for geophysical investigation of the layers pierced as well as study of the hydrogeological properties. The geophysical investigations possible include standard electrical logging procedures both during and after drilling; inclinometer measurements; measurements of borehole configuration by caliper log, resistivity meter, and electrothermometer; study of permeability of the core by gas and water; neutron and gamma logging; acoustic logging; water inflow measurements using resistivity meter and electrothermometer in cases where drilling must stop more than three times a day; and, 12-15 days after completion of the hole, determinations of geothermal gradient and temperature anomalies.—D.B.V.

- 191-392. Fukutomi, Takaharu. Rates of discharge of heat energy from the principal hot spring localities in Hokkaido, Japan: *Hokkaido Univ. Fac. Sci. Jour.*, ser 7 (Geophysics), v. 1, no. 5, p. 315-330, 1961.

The total discharge rate of heat energy  $Q$  from a hot spring locality is the sum of the discharge rate of heat energy  $Q_1$  flowing out as hot water from orifices and of heat energy  $Q_2$  emitted from the ground surface by heat conduction. The method of estimating the latter is discussed. The heat energy  $Q$  generated from the principal and some small Hokkaido hot spring localities in Japan is estimated to range from  $0.3 \times 10^7$  to  $120 \times 10^7$  cal per min; the data upon which this is based are tabulated. In order to classify hot springs areas by their heat energy a "heat energy index" of 8 classes (0 through VII) is presented in which each class represents a range in heat energy values. Using this index a presumption is made of the amount of heat energy in uninvestigated localities, and the total sum of heat energy per unit time from all of the hot spring localities in Hokkaido is estimated to be  $5.5 \times 10^9$  cal per min. The heat energy generated from other hot spring localities in Japan and other countries is discussed also. It is concluded that energy generated from an average hot spring locality ranges from  $<10^{6.5}$  to  $10^{10}$  cal per min.—V.S.N.

- 191-393. LeMarne, A. E., and Sass, J. H. Heat flow at Cobar, New South Wales: *Jour. Geophys. Research*, v. 67, no. 10, p. 3981-3983, 1962.

From temperature measurements in two deep drill holes at Cobar, N.S.W., the mean geothermal gradient was calculated as  $(0.63 \pm 0.03)^\circ\text{C}/100$  feet, with a mean extrapolated surface temperature of  $(21.5 \pm 1.0)^\circ\text{C}$ . Determination of thermal conductivity on 16 sections of drill cores from the same holes gave a mean of  $(10.6 \pm 1.1)$  mcal/sec cm °C. The geothermal flux was  $(2.18 \pm 0.33)$   $\mu\text{cal}/\text{cm}^2$  sec.—Author's abstract

- 191-394. Schmidt, Richard A. Temperatures of mineral formation in the Miami-Picher district as indicated by liquid inclusions: *Econ. Geology*, v. 57, no. 1, p. 1-20, 1962.

A study by the visual method of liquid-inclusion geothermometry of samples of two generations of sphalerite, pink dolomite, and calcite from ten mines of the Miami-Picher district of Oklahoma and Kansas indicates that the minerals were deposited at temperatures of 120°C to 52°C uncorrected for pressure. The temperatures are consistent with geological data for the deposits, which suggest deposition at shallow depths and low temperatures. The temperature data indicate that mineralization took place from two successive surges of warm ore solutions, each of which cooled as deposition progressed. Higher ranges of inclusion temperatures were found for minerals collected near the Miami Trough graben, and lower ranges for those farther from this fault zone. Therefore, the warm ore solutions appear to have entered from the fault zone and cooled as they spread farther into the country rocks. The Miami-Picher ores are considered of "hydrothermal" origin in that they apparently developed from warm aqueous solutions.— V.S.N.

- 191-395. Arnold, R. G. Equilibrium relations between pyrrhotite and pyrite from 325° to 743°C: *Econ. Geology*, v. 57, no. 1, p. 72-90, 1962.

The pyrrhotite solvus that represents the compositions of pyrrhotite coexisting in equilibrium with pyrite was determined in the temperature range 325°C to 743°C by experiments conducted in sealed, evacuated, silica glass capsules and at pressures equal to that of the vapor in equilibrium with the condensed phases. Experiments demonstrate that confining pressures of 2,000 bars do not measurably affect the position of the solvus below 670°C.

Temperatures of crystallization of ten natural pyrrhotite-pyrite assemblages are estimated using the pyrrhotite solvus. The temperature of crystallization of sphalerite coexisting with pyrrhotite and pyrite in four of these samples was also measured; the estimates obtained from the two methods, with few exceptions, agree well within the experimental error.— V.S.N.

- 191-396. Kalliokoski, J[orma]. Temperatures of formation and origin of the Nigadoo and Brunswick Mining and Smelting No. 6 deposits, New Brunswick, Canada: *Econ. Geology*, v. 56, no. 8, p. 1446-1455, 1961.

The iron content of sphalerite from the Nigadoo deposit suggests a temperature of formation of 670°C, which contrasts with the obviously low metamorphic rank of the wall-rocks. That from the B.M. and S. No. 6 deposit suggests a maximum temperature of formation near 480°C, which exceeds the suggested upper limit of the greenschist wall rocks by about 250°C. The temperature data thus indicates that both deposits are of epigenetic origin. It is not known why the high temperatures obtained during the formation of the mineral deposits are not reflected in the mineralogy of the wall rocks.— V.S.N.

#### INTERNAL CONSTITUTION OF THE EARTH

- 191-397. Lomnitz, C[inna]. Stresses and strains in the interior of a non-evolutive planet [in Spanish and English]: *Geoffisica Internac.*, v. 1, no. 2, p. 21-26, 1961.

The case of a hypothetical planet with an initial structure and density distribution similar to the present earth is analyzed. Bullen's and Gutenberg's values for the densities and velocities in the interior are assumed; then gravity force is "turned on." Values for the radial and tangential stresses and strains are calculated following derivations by Lamé and Love. The radial strains are contractional in the interior and extensional in an outer shell of 800 km thickness. The deviatoric stress is of the order of 170,000 atmospheres near the

surface and 600,000 atmospheres near the core boundary. The pressure at the center of the planet, assuming a liquid core, would be about 14 million atmospheres. The influence of the assumed method of formation of the earth on the stress-strain distribution is discussed.— Author's abstract

- 191-398. Vinogradov, A. P. O proiskhodenii veshchestva zemnoy kory. So-obshcheniye 1 [On the origin of the matter of the earth's crust. Part 1 (with English summary)]: *Geokhimiya*, no. 1, p. 3-29, 1961.

It is assumed that the mantle consists of material having a composition comparable to that of stony meteorites. The various phases of meteoritic material—silicate, iron sulfide (troilite), chromite, and others—are described. Under crustal conditions the minerals constituting these phases form ore bodies. The possibility of the transformation and interaction of these phases in the mantle are considered. Zonal melting of meteoritic silicates brings about differentiation into basaltic glass and dunite; during this process the chemical elements become distributed between the refractory (dunite) and fusible phases, with fewer elements in the former. In such manner the earth's crust -- the fraction of fusible and volatile materials -- is formed by differentiation of meteoritic material. Calculations show that the mantle is smelted and outgassed to at least the depth of deep-focus earthquakes. In general the character and thickness of the crust of the planets is a function of their radius. The transition between the nickel-iron and dunite phases is considered; the  $\text{Ni}_2\text{SiO}_4$  of dunite is thermally stable compared to  $\text{Fe}_2\text{SiO}_4$ . The composition of chrome spinels in an iron meteorite is determined as  $(\text{Mg,Fe})\text{Cr}_2\text{O}_4$ , of those in a stony meteorite and in nonmetalliferous dunites as  $(\text{Mg,Fe})(\text{Cr,Al})_2\text{O}_4$ , and of those in ore chromites as  $(\text{Mg,Fe})(\text{Cr,Al,Fe})_2\text{O}_4$ . The process of chrome spinel transformation is considered.— D.B.V.

- 191-399. Bullen, K. E. Oscillations of the earth and the earth's deep internal structure: *Australian Jour. Sci.*, v. 24, no. 7, p. 303-307, 1962.

After an outline of the background theory of natural periods of vibration of the earth, some details of observational results obtained from the Chilean earthquakes are given. The observational results are compared with five different earth models ( $\alpha$  and  $\beta$ , Bullard I and II, Bullen B). The artificially simplified  $\alpha$  and  $\beta$  models fit significantly less well with the observations than the other three. Bullard II gives slightly, but significantly inferior agreement than do Bullard I and Bullen B. Bullard I (based largely on Bullen A) gives just as good agreement as Bullen B with the spheroidal observations for which  $n \leq 2$ , but fails to give a period for  $n=0$ . Bullen B fits the whole set of observations within experimental error; therefore, no large-scale amendment to this model is likely.

In several cases the observations include two periods close together where theory predicts only one. This has tentatively been attributed to the earth's rotation and departures from spherical symmetry within the earth. The point is being investigated mathematically.— D.B.V.

- 191-400. Lyustikh, Ye. N., and Saltykovskiy, A. Ya. K voprosu ob obràzovanii granitnogo sloya zemnoy kory [On the problem of the formation of the granitic layer of the earth's crust (with English summary)]: *Geokhimiya*, no. 4, p. 293-297, 1961.

It is calculated that in order to produce the present crust by granitization of a primary crust, about  $5 \times 10^{18}$  tons of  $\text{SiO}_2$  and  $\text{Al}_2\text{O}_3$  would have had to be introduced by water vapor and other volatiles. As the total mass of the hydrosphere is only  $1.4 \times 10^{18}$  tons, the hypothesis is hardly probable. It is believed that the granitic layer is growing at the expense of juvenile granitic magma rising to the surface of the mantle.— D.B.V.

Bunce, Elizabeth T., and Fahlquist, Davis A. Geophysical investigations of the Puerto Rico trench and outer ridge. See Geophys. Abs. 191-619.

191-401. Tryggvason, Eysteinn. Crustal thickness in Fennoscandia from phase velocity of Rayleigh waves: *Annali Geofisica*, v. 14, no. 3, p. 267-293, 1961.

The phase velocity method of determining crustal thickness is applied to Fennoscandia, using data on two earthquakes as recorded at 8 stations in Fennoscandia. In the first shock (Mexico, July 28, 1957) wave propagation was perpendicular to the west coast of Norway; in the second (Kurile Islands, November 6, 1958) wave propagation was parallel to the Norwegian coast. Deformation of the wave fronts due to heterogeneity of the wave paths is taken into account. Comparison of the direction of wave fronts, as determined from arrival times at the different stations, with horizontal particle movements of the same waves at Kiruna and Uppsala reveals considerable deviation. New phase-velocity curves are calculated on the basis of observed group velocities across Africa. Crustal thickness in Fennoscandia is found to be nearly uniform and about 35 km.—D.B.V.

191-402. Bichevina, V. N. K voprosu o moshchnosti zemnoy kory Ostrovnogo rayona Dal'nego Vostoka SSSR [On the problem of the thickness of the crust in the insular region of the Far East of the USSR]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 1, p. 96-106, 1960.

Two methods of determining the thickness of the crust are proposed: the teleseismic method based on the traveltime difference of the seismic waves,  $pP-pP^*$ , reflected from the upper and lower boundaries of the crust; and the method based on the traveltime difference of the seismic waves,  $SP^1-S$ , reflected near the observatory from the lower boundary of the crust. The thickness of the crust was determined at 23 places in the Far East Region. Some of these values are as follows: 55-58 (granite 22) km for Sakhalin Island; 50 (granite 22) km for the Sea of Okhotsk, 40-45 (granite 18) km for the Kuriles region, and 30 km in the adjoining Pacific Ocean.—A.J.S.

191-403. Santo, Tetsuo [kima]. Division of the south-western Pacific area into several regions in each of which Rayleigh waves have the same dispersion characters [with Japanese abstract]: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 39, pt. 4, p. 603-630, 1961.

Using dispersion data obtained along 32 paths for Tsukuba Station, Japan, and along 13 paths for stations at Hongkong, Honolulu, and Suva, the complex oceanic area west of the Andesite Line is divided into four regions of characteristic dispersion curves of Rayleigh waves -- purely oceanic, sub-oceanic, sub-continental, and purely continental. Group velocities of Rayleigh waves across these regions are calculated by the least squares method to check the results.

In general, the crustal structure west of the Andesite Line is more continental than to the east of it; purely oceanic crust on the western side is limited to regions where the ocean depth is greater than 6 km. The East China Sea (Borneo Sea) has a purely continental dispersion character, and the central South China Sea and small parts of the Celebes Sea show a sub-ocean character. Comparison of the four types of dispersion curves with theoretical curves demonstrates that the shift in dispersion character from oceanic to continental can be explained by decreasing the compressional wave velocity in the crust from 6.9 to 5.0 km/s and by increasing the thickness of the crust from 5 to 20 km (see also Geophys. Abs. 187-366, 188-371, -372.)—V.S.N.

- 191-404. Santo, Tetsuo A[kima]. Dispersion of Love waves along various paths to Japan (Part 1) [with Japanese abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 631-651, 1961.

The dispersion characteristics of Love waves along both oceanic and continental paths to Japan are investigated and classified using seismograms recorded by Columbia-type ultra-long period seismographs at Tsukuba Station, Japan. In the central and northern Pacific, Love waves show a purely- and nearly-oceanic dispersion character, but as they enter the Micronesia region and the paths shift to the west, they show an increasingly continental character. Love wave propagation is much disturbed along paths crossing the Mariana Sea, but waves from earthquakes in the Tongas, Kermadecs, Solomons, and New Hebrides transmit in clear, dispersive long trains. The dispersive character of waves from the Sumatra region to Japan is as continental as that from Outer Mongolia or the Sinkiang region to Japan. Love waves that pass in or around the Tibetan region show a remarkable decrease in maximum group velocity that is probably explained by the special conditions in both the crust and the upper mantle beneath this high mountain region.— V.S.N.

- 191-405. Bentley, Charles R., and Ostenso, Ned A. On the paper by F. F. Evison, C. E. Ingham, R. H. Orr, and L. H. LeFort, "Thickness of the earth's crust in Antarctica and the surrounding oceans": Royal Astron. Soc. Geophys. Jour., v. 6, no. 3, p. 292-298, 1962.

Evison and others (see Geophys. Abs. 185-364) recently concluded from analysis of Love and Rayleigh wave dispersion along four complex wave paths that the crust is about 25 km thick under Marie Byrd Land. Gravity and surface elevation evidence, however, indicate a thickness of about 30 km. It is believed that agreement between these methods can be improved by a more realistic choice of crustal velocities by Evison and others.— D.B.V.

- Asada, T[oshi], Steinhart, J. S., Rodriguez, B., Tuve, M. A., and Aldrich, L. T[homas]. The earth's crust—seismic studies. See Geophys. Abs. 191-88.

- 191-406. Hodgson, J[ohn] H. The Upper Mantle Project: The Canadian Surveyor, v. 16, no. 3, p. 149-159, 1962.

The Canadian organization and program for the Upper Mantle Project, a three-year research program sponsored by the International Union of Geodesy and Geophysics, are outlined. Canada embarked on an expanded seismological program in 1959, and one of the major contributions to the Upper Mantle Project will be to speed up installation of the network of seismic stations for detailed crustal studies by explosion seismology. The general nature of these studies and cooperative plans with the United States are discussed. At each of the seismograph stations a hole will be drilled for heat-flow studies. A set of magnetic variometers will be operated also in various parts of Canada to search for areas of high magnetic variation. Areas in Canada where it may be possible to drill to the mantle within a short distance are discussed, and one of these, the large circular feature along the eastern shore of Hudson Bay thought to be a meteor crater, will be drilled. If this large feature is a meteor scar, its fractured zone should extend into the mantle which would give an opportunity for mantle rocks to well up into the crater and form its floor.— V.S.N.

- 191-407. Uffen, Robert J. Some Canadian contributions to the International Upper Mantle Project: Canadian Mining Metall. Bull., v. 55, no. 603, p. 473-476, 1962.

This paper covers approximately the same material as that in the paper by Hodgson published in The Canadian Surveyor, v. 16, no. 3, p. 149-159, 1962 (see Geophys. Abs. 191-406).— V.S.N.

- 191-408. Lehmann, I[ng]. The travel times of the longitudinal waves of the Logan and Blanca atomic explosions and their velocities in the upper mantle: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 519-526, 1962.

The P traveltimes of the Logan and Blanca atomic explosions are found to be consistent with an upper mantle structure having a discontinuity surface at about 215 km depth at which the velocity and the velocity gradient increase abruptly while the velocity varies only slightly or is constant above this depth.—Author's abstract

- 191-409. Gutenberg, B[eno]. The asthenosphere low-velocity layer: *Annali Geofisica*, v. 12, no. 4, p. 439-460, 1959.

The existence of a worldwide low-velocity asthenosphere channel is practically proved. Under continents the channel begins at the M-discontinuity, with velocities that are smaller the greater the depth of the discontinuity. The decrease in velocity immediately below the M-discontinuity is, on the average, greater than the critical rate for formation of shadow zones. There is no indication of a discontinuity in the upper mantle. Poisson's ratio is nearly constant (0.26) down to 80 km and increases in the asthenosphere channel to almost 0.29; below that it does not decrease again to 0.26, but remains between 0.28 and 0.30 in the rest of the mantle.—D.B.V.

- 191-410. Anderson, Don L. The plastic layer of the earth's mantle: *Sci. American*, v. 207, no. 1, p. 52-59, 1962.

Recent data strongly support Gutenberg's concept (1926) of a low-velocity, low-rigidity layer in the mantle. Gutenberg's premise was based on the decrease in amplitude of compressional waves that reach the surface at a distance between 100 and 1,000 km from an earthquake. Controlled tests made possible by underground nuclear explosions have confirmed his conclusions. Independent evidence includes that from surface waves and from analysis of frequencies of free vibrations resulting from the Chilean earthquake of May 1960. Both of these demonstrate that the layer is a world-wide phenomenon. A model of the earth constructed to fit current seismic data indicates that the low-velocity zone transmits horizontal and vertical vibrations in shear waves at different speeds; a crystalline material in which crystal grains are aligned in one direction would behave in this way. Deflections of the earth's surface under variations in atmospheric pressure and various earthquake and volcanic phenomena also attest to lowered rigidity of material near the top of the mantle. Most of the activity responsible for the broad-scale features of the earth's surface probably takes place in this low-velocity or plastic layer at the top of the asthenosphere, extending roughly from 60 to 250 km in depth. The existence of such a plastic layer makes the idea of continental drift much more plausible than before.—V.S.N.

- 191-411. Ringwood, A. E. Mineralogical constitution of the deep mantle: *Jour. Geophys. Research*, v. 67, no. 10, p. 4005-4010, 1962.

The nature of the transition zone in the mantle between about 300 and 900 km is reviewed in the light of recent high-pressure experimental results. It is found that pyroxene in the mantle will break down to olivine + stishovite around 400 km, olivine will invert to the spinel structure at about 600 km, and spinel will break down between 900 and 1,050 km into denser, closer packed phases that persist to the core boundary at 2,900 km. Two transformations are possible: spinel periclase + stishovite, or spinel periclase +  $MgSiO_3$  (corundum structure); the second is considered more probable. The total increase in density between 400 and 1,000 km is  $0.6-0.7 \text{ g/cm}^3$  (referred to zero pressure). Less abundant components in the mantle such as  $FeO$ ,  $Al_2O_3$ ,  $CaO$ , and  $Na_2O$  form solid solutions with the principal phases: this causes each of

the principal phase transitions to be spread over a substantial depth range, so that the increase in density between 400 and 900 km is continuous. These results verify Birch's hypothesis on the constitution of the mantle (see Geophys. Abs. 149-13682) and are in close agreement with the Bullen A model density distribution.—D.B.V.

- 191-412. Pekeris, C. L., Alterman, Z., and Jarosch, H. Effect of the rigidity of the inner core on the fundamental oscillation of the earth: [U.S.] Natl. Acad. Sci. Proc., v. 48, no. 4, p. 592-595, 1962.

The Bullen B and Gutenberg earth models previously studied (see Geophys. Abs. 184-189) gave periods for the spheroidal oscillation  $n=2$  of 53.70 and 53.52 min, respectively, as against the average observed gravity and seismic values of 53.9 min. In order to explain the discrepancy, the effect on the period of an assumed rigidity of the inner core ( $r < 1,250$ ) has been investigated. It is found that the period of core oscillation of about 101 min diminishes rapidly with increasing rigidity ( $\mu$ ) of the inner core, reaching an asymptotic value of about 53.8 min at large  $\mu$ , while simultaneously the amplitude spreads into the mantle and eventually assumes the pattern of a normal oscillation at the asymptotic period. The observed period of 53.9 min corresponds to a value of  $\mu = .5 \times 10^{12} \text{d/cm}^2$ , and within observational error fits into the range  $= 1.5-4 \times 10^{12} \text{d/cm}^2$  inferred by Bullen on the basis of seismic data.—D.B.V.

- 191-413. Bradley, R. S. Thermodynamic calculations on phase equilibria involving fused salts. Part II. Solid solutions and application to the olivines: Am. Jour. Sci., v. 260, no. 7, p. 550-554, 1962.

A theory is developed for ideal solutions of ionic salts giving Roozeboom Type I phase diagrams, based on the assumption that the mole fraction of an ion in a phase is equal to the number of specified ions present divided by the total number of ions of all species in the phase. When applied to solid solutions of fayalite and forsterite the theory predicts for the components heats of fusion of 25,200 and 29,300 cal mole<sup>-1</sup>, respectively. When applied to solid solutions of  $\text{Mg}_2\text{SiO}_4$  and  $\text{Mg}_2\text{GeO}_4$ , where there is a common cation, the theory predicts that ideal solution theory for undissociated molecules may be used. The data of Ringwood (1956) (see also Geophys. Abs. 173-241, 175-242) for this system show, however, practically no separation between liquidus and solidus, and do not admit of the calculation of heats of fusion. The behavior of the system  $\text{Mg}_2\text{GeO}_4 + \text{Fe}_2\text{SiO}_4$  with no common ion is predicted.  $\text{Mg}_2\text{SiO}_4$  and  $\text{Mn}_2\text{SiO}_4$  with a common anion, behave like forsterite and fayalite.—V.S.N.

- 191-414. Trubitsyn, V. P. Properties of matter at high pressures: Annali Geofisica, v. 14, no. 1, p. 103-106, 1961.

Equations of state for metals at high pressures are significant in studies of the physics of the earth's core. In this paper, a modified statistical method is proposed for calculation of the equation of state for ionic crystals and metals. The equation of state for metals is obtained in analytical form and illustrated on Mg and MgO.—D.B.V.

## ISOTOPE GEOLOGY

- 191-415. Doe, Bruce R. Relationships of lead isotopes among granites, pegmatites, and sulfide ores near Balmat, New York: Jour. Geophys. Research, v. 67, no. 7, p. 2895-2906, 1962.

The isotopic composition of lead in galenas from the Balmat, N. Y., sulfide deposits is compared with that of lead from potassium feldspar in nearby pegmatites and granite. The lead in the feldspars is slightly more radiogenic than that in the galenas, suggesting that the ores were not derived from the igneous

rocks. Rb-Sr and K-Ar age determinations indicate a metamorphism at approximately 1,100 m.y., and the lead model ages are in fair agreement with this figure.— E.J.C.

- 191-416. Gorai, Masao. Ultimate origin of granite [with Japanese abstract]: Earth Sci. [Chikyu Kagaku], no. 52, p. 1-8, 1960.

The role of magma is emphasized in the origin of both intrusive and migmatitic types of granite, with the ultimate source of the granite believed to be from "primary" granitic magma derived through partial refusion of the upper mantle under relatively high pressure conditions. A lead isotope method is proposed to determine whether a granite of a particular orogen is a consolidation product from a primary granitic magma or from a palingenic one. The current values of the Pb-206/204 ratios in chondritic meteorites and terrestrial ultrabasics are analyzed and both found to be near 19 - a value believed to have evolved during geologic time from a certain initial value of 9.5. Supposing that the age of the earth is 5.0 b.y., the evolutionary trend of the Pb-206/Pb-204 ratio in the upper mantle during the earth's history is calculated. Granitic magma derived from the upper mantle will have a similar Pb-206/Pb-204 ratio curve with time, whereas a palingenic granite will have a Pb-206/Pb-204 ratio curve that increases much more rapidly than that of mantle material over the same period of time because of its higher U/Pb ratio value. All examples of granites cited in this paper have Pb-206/Pb-204 ratio values very similar to those of mantle material. No data have been found to suggest a palingenic origin; however, all granites examined have been of Precambrian age, and more recent ones should be examined to test the validity of the concept.— V.S.N.

- 191-417. Lawrence, L. J., and Rafter, T. A. Sulfur isotope distribution in sulfides and sulfates from Broken Hill South, New South Wales: Econ. Geology, v. 57, no. 2, p. 217-225, 1962.

The Broken Hill orebody of western New South Wales is of conformable type, the origin of which is claimed by some to be syngenetic and by others to be epigenetic. Sphalerite and galena are the dominant primary ore minerals, and both these sulfides occur in minor amounts as supergene sulfides, especially at Broken Hill South. Isotope values for the primary sulfides  $\delta S_{34}$  range from 0 to +1.7. Secondary sulfates of the same metals (anglesite and goslarite) follow these figures very closely. The sphalerite and galena of supergene origin are among the highest  $\delta S_{34}$  values yet recorded, averaging -43.3 and reaching -51.9. This is considered due to near optimum conditions of freedom of circulation of the downward moving ground waters and thus to maximum availability of the two sulfur isotopes.— Authors' abstract

- 191-418. Jacobshagen, V. Die Isotopenzusammensetzung natürlicher Wässer und ihre Änderungen im Wasserkreislauf [The isotopic composition of natural waters and their changes during the water cycle]: Geol. Rundschau, v. 51, no. 1, p. 281-290, 1961 (1962).

This is a review of knowledge dealing with the change in isotopic composition of natural waters during the water cycle. The ranges of fluctuation in deuterium and in O-18 in different phases of the cycle (sea, rain, snow, rivers and lakes) are shown diagrammatically; ground water is not included because of paucity of data. This diagram reveals that natural waters show specific and measurable differences in isotopic composition that correspond to their geochemical environment and history.— D.B.V.

- 191-419. Uklonskiy, A. S. Predvaritel'nyye issledovaniya izotopnogo slostava poverkhnostnykh i podzemnykh vod Uzbekistana [Preliminary investigations of the isotopic composition of surface and ground wa-

ters of Uzbekistan]: Akad. Nauk Uzbek. SSR, Zapiski Uzbekistan. Otdel. Vses. Mineral. Obshch., no. 6, p. 47-62, 1953.

Results are presented of hydrogen and oxygen isotope analyses of 211 water samples from various localities in the Uzbek S.S.R. Absolute determinations of H-1, H-2, O-16, and O-18 were not made; rather these quantities are presented as ratios with respect to a standard sample. The Tashkent waters are lighter than the standard, and the variation in the isotopic composition is small. The isotopic composition of waters of the trunk rivers is close to that of the standard, which is also close to that of the Volga, Dnieper, and Ob but different from that of the snow-fed Angara. — J.W.C.

## MAGNETIC FIELD OF THE EARTH

191-420. Goldberg, R. A., and Schmerling, E. R. The distribution of electrons near the magnetic equator; Jour. Geophys. Research, v. 67, no. 10, p. 3813-3815, 1962.

It is shown that simple arguments based on the diffusion of electrons can explain qualitatively the more striking effects seen in the electron distribution near the magnetic equator. The assumption of constant electron density along a field line, though apparently giving a fairly good description of the variation of electron density with dip angle below the  $F_2$  peak, is not soundly based and leads to difficulties above the  $F_2$  peak. Examination of the limiting case of diffusive equilibrium indicates the direction in which an electron distribution is perturbed by diffusion and gives results above the  $F_2$  peak that do not conflict with the meager information available. — Authors' abstract

191-421. Beard, David B., and Jenkins, Edward B. The magnetic effects of magnetosphere surface currents: Jour. Geophys. Research, v. 67, no. 9, p. 3361-3367, 1962.

The electrical currents on the interface separating the geomagnetic field from the solar corona create a magnetic field everywhere interior to the interface. This surface current magnetic field has been computed in the meridian plane on the sunlit side of the earth by integration over the surface currents on the interface. It was found that apart from polar regions the surface current magnetic field increases linearly with altitude. At the subsolar point the increase is from  $14\gamma$  at the earth's surface to  $35\gamma$  at the edge of the magnetosphere during normal solar activity when the altitude of the magnetosphere is at 10 earth radii. If abnormal solar activity lowered the altitude of the interface to 5 earth radii, the magnetic field at the surface of the earth would increase by  $135\gamma$ . A sudden change in interface altitude of 2 earth radii would cause a sudden change in magnetic field at the earth's surface of about  $16\gamma$ . Such a change has been observed. — Authors' abstract

191-422. Axford, W. I. The interaction between the solar wind and the earth's magnetosphere: Jour. Geophys. Research, v. 67, no. 10, p. 3791-3796, 1962.

It is argued in this note that the interplanetary gas can usefully be treated as a continuum as far as the interaction between the solar wind and the terrestrial magnetosphere is concerned. On this basis, since the solar wind is highly supersonic near the earth, a collision-free bow shock wave should be a permanent feature of interplanetary space on the sunward side of the magnetosphere. Other features of the solar wind flow pattern and the shape of the magnetosphere are also considered, and it is suggested that certain ionospheric phenomena are the direct result of linkage to the exterior surface of the magnetosphere via geomagnetic lines of force. — Author's abstract

- 191-423. Chang, C. C. Outer Van Allen belts and neutral points on interface between solar wind and geomagnetic field: *Nature*, v. 194, no. 4827, p. 424-426, 1962.

A physical model of the mechanism of trapping high-energy particles from solar wind in the outer Van Allen belts is suggested.—D.B.V.

- 191-424. Harrison, E. R. An experiment to determine the nature of the earth's distant magnetic field: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 4, p. 462-467, 1962.

It is proposed that an alkaline-earth element, such as barium, is (i) released in a gaseous state from a space vehicle at a distance of several earth radii and is then subsequently ionized by the solar radiation, or (ii) the release occurs at an altitude of 300 km or greater at a latitude above the auroral zones and is accompanied by a small A-bomb burst. In both cases the ions can be detected by resonance scattering of the solar radiation as they map out the distant geomagnetic field. [See also *Geophys. Abs.* 188-391.]—Author's summary

- 191-425. Harrison, E. R. The earth's distant magnetic field: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 4, p. 479-492, 1962.

When the corpuscular radiation is subsonic the magnetosphere - the region about the earth in which the geomagnetic field is confined - is approximately spherical. In the case of hypersonic corpuscular radiation it is highly asymmetrical, in the shape of a tear drop with the tail pointing away from the sun. Within the framework of an asymmetric magnetosphere there are mechanisms for accelerating protons to an energy of 100 Kev and electrons to an energy of the order of 100 ev. The outstanding feature of these mechanisms is that the energetic particles are only available on the night side of the earth in the auroral zones. It is argued that the gegenschein and auroral displays on the night side are evidence of an asymmetric magnetosphere.—D.B.V.

- 191-426. Kellogg, P. J. Flow of plasma around the earth: *Jour. Geophys. Research*, v. 67, no. 10, p. 3805-3811, 1962.

The interplanetary plasma flow measured by means of Explorer 10 is supersonic in the sense that the flow speed is greater than the Alfvén speed. It is shown that this has some of the same implications as supersonic flow does in ordinary fluid flow theory, and possible consequences are discussed. The position of the shock that would develop if the interplanetary plasma were a perfect gas with a short mean free path is calculated and is shown to be well outside the orbit of Explorer 10 so that it would not have been seen. Speculations on the possible structure of the shock in collisionless plasma are given, and it is shown that this structure may account for the turbulent character of the distant magnetic field.—Author's abstract

- 191-427. Wait, James R. The electromagnetic fields of a dipole in the presence of a thin plasma sheet: *Appl. Sci. Research, Sec. B*, v. 8, no. 5-6, p. 397-417, 1960.

The problem of electric and magnetic dipoles located near a very thin planar slab or sheet of ionized material (such as the ionosphere) is considered. Expressions are obtained for the electric fields resulting when a constant and uniform magnetic field is impressed on the slab. As a result of the anisotropy of the sheet the fields are elliptically polarized in general. The far fields may be split into "radiation" and "surface wave" components. The dependence of the radiation pattern and surface wave characteristics on electron density, collision frequency, and the impressed magnetic field is illustrated. This idealization is expected to be of practical use only when the thickness of the

sheet is very small compared to other significant dimensions; nevertheless, the behavior of the solution brings to light many interesting features which could be present in situations where waves propagate along interfaces between isotropic and anisotropic mediums.— D.B.V.

- 191-428. Beard, David B. Self-consistent calculation of the ring current: Jour. Geophys. Research, v. 67, no. 9, p. 3615-3617, 1962.

It is shown that an approximate self-consistent calculation of the magnetic effects of the ring current can be undertaken in which the ring current is computed in the presence of the ambient field (that is, the geomagnetic field plus the major part of the field created in the vicinity of the ring current by the magnetic consequences of the ring current particle motion).— D.B.V.

- 191-429. Akasofu, Syun-Ichi. On a self-consistent calculation of the ring current field: Jour. Geophys. Research, v. 67, no. 9, p. 3617-3618, 1962.

The rigorous formulation of a self-consistent ring current is discussed. It is shown that the word "self-consistent" should be used only for solutions that take into account the terms  $[(H \cdot \nabla)H]_n$  and  $p_S$ ; although Beard (see Geophys. Abs. 191-428) showed that their effects are small, they cannot be assumed to be zero.— D.B.V.

- 191-430. Spreiter, John R., and Briggs, Benjamin R. Analysis of the effect of a ring current on whistlers: Jour. Geophys. Research, v. 67, no. 10, p. 3779-3790, 1962.

Results of a theoretical study to determine the effect of a ring current on the properties of whistlers are presented. It is concluded that it would be very difficult to deduce the properties of a possible ring current from the usual ground-based whistler data, but that the uncertainty in the latitude of the propagation field line might be removed if the data were acquired above the reflecting level of the ionosphere.— D.B.V.

- 191-431. Bonnet, G. Les possibilités nouvelles des magnétomètres à protons (II) [New possibilities of proton magnetometers (2)]: Annales Géophysique, v. 18, no. 2, p. 150-178, 1962.

The discussion on new possibilities in proton magnetometers is continued (see Geophys. Abs. 190-384). The problems that result from the use of the recently designed instruments are of two sorts: (1) those that concern the utilization of an absolute magnetometer in which it is possible by choice of a convenient arrangement to reduce the static error to a very acceptable value (the surest method of attaining this appears to be by polarization of the nuclei and by setting up oscillators with nuclear filters), and (2) those that associate the study of the field frequency transformation with that of the restitution of the frequency of signal in an observable form.— V.S.N.

- 191-432. Jaeschke, Rudolf. Ein Horizontalvectograph zur Registrierung erdmagnetischer Pulsationen: Aufbau und erste Auswertung [A horizontal vectograph for the registration of geomagnetic pulsations: construction and first utilization]: Akad. Wiss Göttingen Abh. Math.-Phys. Kl., no. 8, 50 p., 1962.

The horizontal vectograph for recording geomagnetic pulsations used at Göttingen, Germany, is described. The apparatus uses Grenet-type induction variometers, which have several advantages over normal variometers including greater sensitivity. Distortion due to the dependence of sensitivity on frequency and to phase shift is minimized by appropriate astatization of the magne-

tometer and by use of a suitable galvanometer. The first records were obtained with this apparatus in May-July 1960, a period of little or medium disturbance.

Analysis of the vectograms shows different types of disturbance in the course of a day. From early morning to noon pc's are recorded, describing irregular loops without preferred orientation or preferred direction of rotation. From noon to toward evening there are linear disturbances with a definite orientation, apparently in the direction corresponding to that of the linear deflections. At night on quiet days the recording point is only slightly deflected; two kinds of effects are distinguished: pt's and nighttime loops. The pt's are hardly uniform and are difficult to identify; their azimuth changes from 0° to 180° between 18:00 and 24:00 hr, and wherever their direction of rotation could be determined it was positive. The loop disturbances have periods of 5 to 20 min, they appear mostly as closed ellipses, their azimuth increases in the course of the night, and their direction of rotation is variable, being predominantly negative in the early evening and positive after 22:00 hr.—D.B.V.

- 191-433. Yegorov, Yu. M. K voprosu o registratsii variatsiy geomagnitnogo polya v diapazone chastot 0.0-10.0 gts [On the problem of recording geomagnetic field variations in the frequency range of 0.0-10.0 cycles per second]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 5, p. 677-678, 1962.

A recorder for geomagnetic field variations of 0.0-10 sec is described. Such variations are difficult to record because of the low amplitudes of the geomagnetic field in this range of periods. A block diagram of the apparatus and a sample of a microvariation record of the  $H_x$  component of the magnetic field are given.—A.J.S.

- 191-434. Mayaud, Pierre-Noël. Mesures de l'indice "K" à Addis Ababa - Janvier 1958 à Juin 1961 [Measurement of the "K" index at Addis Ababa - January 1958 to June 1961 (with English abstract)]: Addis Ababa Univ. Coll. Geophys. Observatory Bull., v. 3, no. 1, p. 1-8, 1962.

The magnetic K-indices for the period from January 1958 to June 1961 are the first in the series of the K-indices for Addis Ababa. The base chosen for the lower limit of  $K=9$  is  $300\gamma$ , which is low for an equatorial station but has the advantage of differentiating the periods of lower magnetic activity. Data are tabulated.—V.S.N.

- 191-435. Gouin, [Pierre], and Cambron, E. Geomagnetic activity at Addis Ababa - January-June 1960: Addis Ababa Univ. Coll. Geophys. Observatory Bull., v. 3, no. 1, p. 9-31, 1962.

Magnetic data for the period January-June 1960 are presented in graphic or tabular form as follows: base-line and scale values; mean hourly values and daily ranges of H, of D, and of Z; and daily mean and extreme values of H, of D, and Z. The installation, instrumentation, control, and reduction of the magnetograms are summarized briefly.—V.S.N.

- 191-436. Kakioka Magnetic Observatory. Report of the geomagnetic and geoelectric observations, 1959-60: Kakioka Magnetic Observatory Rept., no. 2, 177 p., 1962.

Tabulated results are presented from observations by the Kakioka Magnetic Observatory in 1959-60 as a part of the world cooperative program of observations during the year following the International Geophysical Year. Some results from the branch observatories at Memambetsu and Kanoya are included also. Part 1 of this report tabulates the results of observations of rapid var-

iations as defined by Committee 10 of IAGA. Part 2 contains reproductions of some records from the induction magnetograms and rapid-run tellurograms.— V.S.N.

- 191-437. Parkinson, W[ilfred] D., and Curedale, R. G. Isomagnetic maps of Australia for the epoch 1957.5. Pt. 2—Central and western Australia; Australia Bur. Mineral Resources, Geology and Geophysics Rept., no. 62, 25 p., 1961.

Isomagnetic maps of central and western Australia (South Australia, Northern Territory, and Western Australia) are presented to complete the summary begun in Part 1 (see Geophys. Abs. 185-414) of all magnetic field observations in Australia since 1910. Five magnetic elements reduced to epoch 1957.5 are shown; inset maps indicate the rate of secular change for each element. Observed and corrected values for each element are tabulated for every magnetic station.— V.S.N.

- 191-438. Molina, F., and Battelli, O. Sulla posizione del fuoco del sistema di correnti Sq [On the position of the focus of the system of Sq currents (with English abstract)]: Associazione Geofisica Italiana Atti del X Convegno Annuale, Roma, p. 85-93, 1960.

The position of the focus of the Sq overhead current system has been determined from the diurnal variation of the horizontal component of the earth's magnetic field recorded at Asiago, L'Aquila, and Gibilmanna between June 1958 and December 1959. It is concluded that during March through May the focus is north of Gibilmanna on 90 percent of the quiet days, and, on the average, drifts toward lower latitudes from summer to winter. Results are compared with Japanese and American studies, and the above conclusions are found to be valid for European and American regions but not for the Far East.— V.S.N.

- 191-439. Simeon, G., and Sposito, A. Rapporto preliminare su alcune particolarità nella variazione de c. m. t. [Preliminary report on a peculiarity in the variations of the earth's magnetic field]: Associazione Geofisica Italiana Atti del X Convegno Annuale, Roma, p. 223-230, 1960.

Records from the observatory on Ponza Island recorded in 1957 (spring) show that a parallelism exists during some intervals between the H and Z components of the earth's magnetic field. Magnetograms recorded at Koror Island, Palau Islands, during the International Geophysical Year show the same phenomenon. An experimental pattern is proposed for further study.— V.S.N.

- 191-440. Parkinson, W. D. The influence of continents and oceans on geomagnetic variations: Royal Astron. Soc. Geophys. Jour., v. 6, no. 4, p. 441-449, 1962.

During bays and similar magnetic variations the vectors representing changes in the geomagnetic field tend to lie close to a plane, the orientation of which varies from one observatory to another. At coastal observatories it almost invariably tilts upward toward the nearest deep ocean. The connection between the direction of magnetic variations and the edge of the nearest continental shelf is too definite to be accidental. One possibility, which cannot be immediately dismissed, is that the effect can be explained by electromagnetic induction in the ocean water. Another is that conductivity in the mantle may be systematically higher (because it is hotter?) below oceans than below continents.— D.B.V.

- 191-441. Hill, M[aurice] N[éville], and Mason, C. S. Diurnal variation of the earth's magnetic field at sea: Nature, v. 195, no. 4839, p. 365-366, 1962.

Total force measurements of the geomagnetic field were made in four positions on and at the foot of the continental slope about 120 miles southwest of Land's End, Cornwall, using a recording proton precession magnetometer in an anchored buoy. A similar instrument was operated during the same period at Ivybridge, near Plymouth. The results show that when conditions are not magnetically disturbed, the daily range is conspicuously greater (by a factor of 2) at sea than on shore; on magnetically stormy days, however, the difference is less conspicuous.

When the shore observations are subtracted from the buoy observations without adjustment for local time differences, the resulting curves show a component of change which is probably caused by induced electric currents in the sea resulting from the tidal motion of the water in the earth's magnetic field. Theoretical and model studies of this effect are now in progress. No screening effect due to the electrical conductivity of sea water was observed either with the normal solar daily variation or with shorter-period (1/2 to 2 hr) magnetic storm variations; but the effect may exist undetected at periods shorter than about 10 min.—D.B.V.

191-442. Vozoff, K[eeva], Ellis, R. M., and Garland, G. D. Composition of "pearls": *Nature*, v. 194, no. 4828, p. 539-541, 1962.

Records of geomagnetic micropulsations at times exhibit "pearls" which appear to result from mixing two sinusoidally varying magnetic fields having slightly different frequencies and roughly equivalent amplitudes. A record containing about one hour of impure pearls, obtained near Edmonton, Alberta, on September 27, 1961, was analyzed. It is concluded that (1) the changes in time of the relative amplitudes and orientations of the two major bands imply that the source oscillations can be excited independently, and (2) the relative amplitude and orientation changes arise at the sources. There is a suggestion that the oscillations are of the trapped V-type predicted by MacDonald (see *Geophys. Abs.* 187-440), possibly excited by the free-mode disturbances of the same type.—D.B.V.

191-443. Jacobs, J. A., and Jolley, E. J. Geomagnetic micropulsations with periods of 0.3-3 sec ("pearls"): *Nature*, v. 194, no. 4829, p. 641-643, 1962.

"Pearls" — geomagnetic micropulsations of nearly sinusoidal shape with periods ranging from about 0.3-3 sec — were recorded at several stations in Canada, the United States, Iceland, Sweden, Japan, and Peru during a combined operation in the summer of 1960. Analysis of the records suggests that the onset of pearls depends entirely on local time. The comparative rarity of pearls indicates that the ionosphere is an opaque shield for waves of this frequency most of the time. The conditions that make the ionosphere transparent to these waves is not clearly understood. Only rarely do they exist for more than one rotation of the earth, although they may occur on successive days. No relationship was found between pearls and other ionospheric phenomena.—D.B.V.

191-444. Hutton, [V.] Rosemary [S.]. Equatorial micropulsations and ionospheric disturbance currents: *Nature*, v. 195, no. 4838, p. 269-270, 1962.

It has been considered for some time that the evening maximum of pc activity must be associated in some way with other known equatorial disturbance phenomena, but previous attempts to correlate pc occurrence at Legon, Ghana, with ionospheric parameters from a neighboring station have been unfruitful. In this paper the disturbance daily variation ( $S_D$ ) of earth currents is compared with pc activity, using records obtained at Legon between April 1958 and March 1959. A correlation between the commencement of pc activity and increase in ionospheric disturbance currents is well established for this equatorial station

and agrees well with auroral zone studies by Campbell and Matsushita (see *Geophys. Abs.* 188-403). However, the estimation of the extent to which the movement of the  $S_D$  current may account for the midday maximum of pc activity at midlatitude stations and the evening maximum at the equator requires examination of more data from a wide network of stations.—D.B.V.

- 191-445. Wright, R. W. Effect of magnetic disturbances on the equatorial ionospheric jet current: *Nature*, v. 194, no. 4834, p. 1169-1170, 1962.

Examination of magnetic data obtained during the International Geophysical Year at Ibadan, Nigeria ( $3^\circ$  south of the magnetic equator, on the edge of the equatorial jet current), reveals two points of interest: (1) a 40 percent reduction in range of diurnal variation of  $Z$  on magnetically disturbed days, with no corresponding effect in the diurnal range of  $H$ ; and (2) an overall depression of  $H$  by about 30% with no corresponding change in  $Z$ . The latter effect is well known, but the former does not appear to have been noted before. One explanation might be that on disturbed days the anomalous behavior leading to the belt of high conductivity is reduced, so that the current is much less channeled into a jet. Another is based on the fact that Ibadan is very close to the region where the diurnal range of  $Z$  is at a maximum; therefore, if the exact position of the jet current moves erratically and is most affected on disturbed days, the effect will be a reduction in the average diurnal range of  $Z$ .—D.B.V.

- 191-446. Bol'shakova, O. V. Nekotoryye zakonomernosti poyavleniya regul'yarnykh kolebaniy geomagnitnogo polya s periodom 3-7 min na pol'yarnoy stantsii Lovozero [Some features of the appearance of regular pulsations of the geomagnetic field with a period of 3-7 min at the Lovozero polar station]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 12, p. 1816-1817, 1961.

Regular pulsations with periods of 3-7 min were recorded at the Lovozero polar station on traces of the vertical component of the geomagnetic field. Diurnal variations were determined for a period of 280 days. The pulsations exhibit a clearly defined diurnal distribution in which the maximum frequency occurs at 12:00 hours u.t. The period of these pulsations is normally between 3 and 7 min sustained correct in each case to 1-2 min; however, there are examples where the pulsations are absolutely regular and the period is maintained correct to a few seconds.—J.W.C.

- 191-447. Westphal, K. O., and Jacobs, J. A. Oscillations of the earth's outer atmosphere and micropulsations: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 3, p. 360-376, 1962.

The equations of small hydromagnetic oscillations are derived in cylindrical coordinates with the main magnetic field lying in the plane perpendicular to the axis of the cylinder. As the structure of the equations in this system is simpler than in spherical polar coordinates, it is possible to obtain the eigenperiods of toroidal oscillations as a function of co-latitude without making any approximations. Using an electronic computer it is possible to extend the calculations to the case of a nonuniform plasma density distribution.

Because recent studies suggest that the geomagnetic field does not extend as far into space as was assumed but to a first approximation is confined to a cavity, the equation of toroidal oscillations is applied to a compressed dipole field. Assuming both a constant and a variable plasma density distribution, the eigenperiods of the deformed magnetic lines of force are obtained.—D.B.V.

- 191-448. Pěčová, Jana. Sur les variations rapides du champ électrotellurique à Budkov (Tchécoslovaquie) [On the rapid variations of the electrotelluric field at Budkov (Czechoslovakia) (with Russian summary)]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 4, no. 2, p. 158-166, 1960.

Pc and Pt pulsations observed at Budkov during the International Geophysical Year are similar to those observed in the U.S.S.R., but the diurnal curves of both pc and pt are displaced from 3-4 hr, especially at their maximum, with respect to the Russian results. The appearance of both types apparently depends on local time. Comparison of the graph of critical frequencies of the E<sub>1</sub> and F<sub>2</sub> ionospheric layers with the graph of diurnal maximums of pc suggests that the appearance of pc is indirectly influenced by direct solar radiation on the ionosphere.—D.B.V.

- 191-449. Konečný, Mojmir. Some types of geomagnetic pulsations studied at the fast-recording observatory Budkov with an inductive magnetometer (with Russian summary): Československa Akad. Věd Studia Geophys. et Geod., v. 5, no. 3, p. 273-277, 1961.

Some particular examples of geomagnetic pulsations recorded in the period January 1, 1959-September 30, 1960 at the Budkov observatory in Czechoslovakia were examined. Among the Pc type pulsations there were a number of exceptions to the rule, in which the amplitude did not increase gradually to a maximum; instead, after an initial constant course lasting 1-2 min there was a relatively abrupt increase to the maximum, followed by a gradual decrease. Another interesting phenomenon found in three records is the superposition of higher harmonics on the basic frequency of the Pc pulsation in the disturbed interval; this phenomenon was observed only in periods of increased magnetic activity. The initial phase of Pt pulsations was distinguished in nearly all cases by an exponential course and the decaying phase by considerable attenuation. Pulsations with 2-6 sec period and amplitudes of fractions of  $\gamma$  frequently accompanied the initial stage of Pt. "Pearls" were observed on July 14 and 18, 1960.—D.B.V.

- 191-450. Křivský, Ladislav. Anomalous D-region during X-emission from flares and geomagnetic activity: Československá Akad. Věd Studia Geophys. et Geod., v. 6, no. 3, p. 242-249, 1962.

The interval between a solar flare maximum and the maximum of the SEA effect (sudden enhancement of atmospherics), previously accepted as  $\Delta t=6-7$  min, has been redetermined on the basis of analysis of a great number of flares recorded at the Ondrejov Observatory in Czechoslovakia, using a new method. The average value is found to be  $\Delta t=2.4$  min, and the most frequent value  $\Delta t=1.0$  min. These values are near those of the time lag of geomagnetic bay maximums, 2-3 min. It is suggested that the system of electric currents giving rise to magnetic bays during a flare can be located at the same level at which anomalous diffraction of long waves may give rise to SEA effects, in other words at the height of the anomalous D-region produced by the X-emissions of the flare. The various theories that have arisen from the supposed difference between the time lag of bay maximums and SEA maximums are unfounded.—D.B.V.

- 191-451. Mariani, F., and Molina, F. Perturbazione geomagnetiche, auro-rali, ionosferiche e dei raggi cosmici: interdipendenze e relazioni con l'attività solare. 4. Le perturbazioni dei raggi cosmici [Geomagnetic, auroral, ionospheric, and cosmic ray perturbations: interdependence and relations with solar activity. 4. The cosmic ray perturbations (with English abstract)]: Annali Geofisica, v. 13, no. 2, p. 135-229, 1960.

This survey of the geophysical and solar aspects of cosmic radiation continues the series on solar-terrestrial relationships (see Geophys. Abs. 182-393, -394, 183-448). As primary cosmic radiation is constituted principally by charged particles (positive), their motion in the geomagnetic field is not rectilinear. There are two geomagnetic effects: variations in intensity with

latitude and longitude, and variations in intensity depending on the direction of incidence with respect to the vertical and to the azimuth.

Forbush decreases (the principal perturbations in cosmic ray intensity) are almost always associated with geomagnetic storms, but geomagnetic storms are not necessarily associated with Forbush decreases. Cosmic ray flux is enhanced during certain solar flares. Soft cosmic radiation at high geomagnetic latitudes exhibits some correlation with auroral phenomena. A bibliography of 170 entries is given. — D.B.V.

- 191-452. Akasofu, Syun-Ichi, Cain, Joseph C., and Chapman, Sydney. The magnetic field of the quiet-time proton belt: *Jour. Geophys. Research*, v. 67, no. 7, p. 2645-2647, 1962.

The distortion of the earth's magnetic field produced by the proton belt is discussed. The magnetic field is calculated numerically, to a first approximation, for an analogous model belt in a steady state. It is estimated that in the equatorial plane at the earth's surface the magnetic field produced by this belt is of the order of  $38\gamma$ . It is directed southward. The maximum field reduction is of the order of  $72\gamma$  at  $4.1a$  ( $a$ =earth's radius); this is 15.5 percent of the dipole field intensity at this point. Beyond  $6.7a$ , the belt increases the earth's field. — Authors' abstract

- 191-453. Berishvili, G. P. K voprosu izucheniya variatsiy geomagnitnogo polya [On the problem of study of variations of the geomagnetic field]: *Akad. Nauk Gruzin. SSR Soobshch.*, v. 22, no. 6, p. 671-674, 1959.

A study of geomagnetic variations due to diurnal solar variations for the solar activity cycle of 1933-45 is presented. Geomagnetic disturbances (time and frequency) may follow the intensity of solar activity during one 11 year cycle and become opposite in phase in the following cycle. — A.J.S.

- 191-454. Uyeda, Seiya. An interpretation of the transient geomagnetic variations accompanying the volcanic activities at Volcano Mihara, Oshima Island, Japan [with Japanese abstract]: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 39, pt. 4, p. 579-591, 1961.

The reversible change in the geomagnetic declination accompanying the major activities of Volcano Mihara, Oshima Island, has been interpreted as being due to heating and cooling, or demagnetization and remagnetization of a subterranean mass at a depth of a few km. In the present paper, an alternative way of interpreting the observation is proposed. In the new model, the heat region is assumed to be a cylinder ( $r=430$  m) extending from the depths to the surface crater. It is shown that the gradual heating of the cylinder from beneath would produce the apparently reversible change in the declination, without requiring any rapid cooling which has been the difficulty in the classical model. Even in the new model, the transfer of heat both in the heating and cooling of the cylinder would need some process such as convective transfer, which is much more effective than the ordinary conductive one. — Author's abstract

- Plekhanov, G. F., Kovalevskiy, G. F., Zhuravlev, V. K., and Vasil'yev, N. V. The effect of the explosion of the Tungus meteorite on the geomagnetic field. See *Geophys. Abs.* 191-58.

- Ivanov, K. G. Geomagnetic phenomena observed at the Irkutsk magnetic observatory after the Tungus meteorite. See *Geophys. Abs.* 191-56.

- 191-455. Winckler, J. R., Bhavsar, P. D., and Anderson, K. A. A study of the precipitation of energetic electrons from the geomagnetic field during magnetic storms: *Jour. Geophys. Research*, v. 67, no. 10, p. 3717-3736, 1962.

The precipitation of energy during magnetic storms was observed by scintillation counters carried on balloons launched simultaneously at four sites between Waterloo, Iowa, and Flin Flon, Manitoba. It was found that precipitation comes in bursts of very large amplitude with time constants of about 0.1 sec, and that these bursts have a periodic tendency related to the bounce time of the electrons. The relationship between these periodic phenomena and periodic phenomena in the geomagnetic field constitutes a subject of prime importance for the understanding of the dynamics of the outer radiation belt.—D.B.V.

- 191-456. Kern, J[ohn] W. A note on the generation of the main-phase ring current of a geomagnetic storm: *Jour. Geophys. Research*, v. 67, no. 10, p. 3737-3751, 1962.

A model is described which permits an approximate calculation of the effects of repeated hydromagnetic shock waves on particles trapped in the magnetosphere. It is shown that an existing trapped plasma might be accelerated to yield an energetic particle distribution with the characteristics of a ring current. The change in magnetic moment  $\Delta M$  of such a ring current is calculated approximately as a function of the number  $n$  of hydromagnetic shock events. The approximate change in magnetic field  $\Delta H$  at the earth is also calculated as a function of  $n$ . Observed time variations of  $\Delta M$  and  $\Delta H$  are compared with the behavior of the model. The implications of the mechanism relative to other geomagnetic disturbances and to auroras are also discussed.—Author's abstract

- 191-457. Matsushita, S. On geomagnetic sudden commencements, sudden impulses, and storm durations: *Jour. Geophys. Research*, v. 67, no. 10, p. 3753-3777, 1962.

After a study of the morphology of geomagnetic sudden commencements during the International Geophysical Year, their accompanying phenomena (such as sudden increases of cosmic noise absorption, bursts of bremsstrahlung X-rays, and commencements of geomagnetic micropulsations) are examined. Geomagnetic sudden impulses observed during the same period are then examined in similar manner. Four types of the latter are found, three of which are completely analogous to corresponding types of sudden commencements. The average duration of storm time depression of the horizontal geomagnetic field, usually attributed to the ring current, is also studied; it is found that storms in years of great solar activity are about three times longer than those in years of little solar activity. The spectrum of storm durations shows that even sudden impulses belong to the family of storms. Possible causes of all these related phenomena are discussed.—D.B.V.

- 191-458. Bednářova-Nováková, Bohumila. Une note sur la question de l'origine des orages géomagnétiques [A note on the question of the origin of geomagnetic storms (with Russian summary)]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 4, no. 2, p. 167-171, 1960.

It is found that the sudden commencement of a geomagnetic storm depends on the position of the active solar region and of the solar eruption with respect to the central solar meridian. Eruptions are not always followed by geomagnetic storms, however. In the case of eruptions occurring outside the central meridian, a relation can always be found between the origin of a geomagnetic storm and the passage to the central meridian of part of the region in which filaments have developed.—D.B.V.

- 191-459. Bouška, Jan. Research into short-periodic variations of the earth's electromagnetic field at the observatory of Budkov: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 4, no. 3, p. 280-284, 1960.

The instrumentation for research on geomagnetic pulsations and earth currents at the Budkov observatory of the Geophysical Institute of the Czechoslovakian Academy of Sciences is described. Emphasis is on the pulsation character of the various phases of geomagnetic storms. Pulsations during solar flare effects, between solar flares and sudden commencements, around and during sudden commencements, and in storms with gradual commencements are investigated separately; those during the main phases and final phases of storms are also being studied. Some results to date are reviewed.—D.B.V.

- 191-460. Chapman, Sydney. Magnetic storms: their geometrical and physical analysis, and their classification (with Russian summary): Československá Akad. Věd Studia Geophys. et Geod., v. 5, no. 1, p. 30-50, 1961.

This review of the problem of magnetic storms discusses the study of the D-field and its geometric analysis into Dst and DS; D equipotential charts and possible current lines; solar streams and their interaction with the geomagnetic field; the DCF (corpuscular flux) part of the D-field; the DP part of the D field generated in the polar regions; the DR (ring current) part of the D field; the time development of DCF, DP, and DR; the development of magnetic storms and the pre-storm belts; the physical classification of magnetic storms; and some particular magnetic storms (with reproductions of magnetograms from different observatories).—D.B.V.

- 191-461. Bednářová-Nováková, Bohumila. Connection between geomagnetic storms in IGY and IGC and occurrence of some kinds of filaments (with Russian summary): Československá Akad. Věd Studia Geophys. et Geod., v. 5, no. 2, p. 138-163, 1961.

On the basis of observations made from 1957 to 1959, the relationship between geomagnetic storms and different kinds of solar filaments is investigated, using a graphic method. It is found that all central meridional filaments were followed by geomagnetic storms. Smaller geomagnetic disturbances, and some times storms, followed the passage of noncentral meridional filaments in 80 percent of the cases. Storms also followed the passage of other filaments (such as parallel filaments) when they occurred on the center of the visible solar disk. The time interval between a solar disturbance and the sudden commencement of a geomagnetic storm depends on the degree of solar activity, which evidently governs the velocity of the corpuscular stream. The mean values of the time intervals for filaments of high, medium, and low degree of activity are 28, 38, and 51 hr, respectively, corresponding to corpuscular velocities of 1,500, 1,100, and 800 kmps.

Surges were sometimes followed by an increase and sometimes by a decrease in geomagnetic activity, indicating that the position and dimensions of the effect and the coronal formations corresponding to it determine whether corpuscular streams will reach the earth. Thus, the geometry of the filament, together with its character, may give information on the origin of a geomagnetic storm. In a period of greater solar activity only a small percentage of the rays reach the earth's upper atmosphere. Only in a period of minimum corona can it be assumed that most of the corpuscular rays leaving the sun cause geomagnetic storms; this seems to explain the relatively large number of storms in a period of sunspot minimum.—D.B.V.

- 191-462. Bouška, Jan. Research into the pulsation characteristics of the different phases of geomagnetic storms with particular regard to sudden commencements (with Russian summary): Československa Akad. Věd Studia Geophys. et Geod., v. 5, no. 2, p. 179-183, 1961.

Rapid-run records obtained with LaCour type apparatus at the Budkov observatory in Czechoslovakia during 1958-60 show the fine structure of sudden commencements of geomagnetic storms. An ssc, defined as the moment at

which the sudden change starts on the record, is immediately followed by a short interval *Isc*, in which the sudden change in the geomagnetic field takes place, often accompanied by pulsations. The length of the interval *Isc* is not the same for all storms but depends for example on the magnitude of the sudden change denoted by *Asc*. The commencement of the *Isc* is given by the instant of the *ssc*, but its end is less clear.

The length of the *Isc* for different storms in 1958-60 and the dependence of the pulsation period in the *Isc* interval on the daily period were investigated. The *Isc* interval is sometimes very simple, sometimes very complicated. The record for September 4, 1960, shows an *Isc* lasting 6 min in which 3 kinds of pulsations occurred: one train with a 10-sec period followed by one with a 35-sec period with short-period (3-5 sec) pulsations superposed on the whole. In general the periods are longer in daytime than at night.

The *Isc* is followed by a period of calm lasting from a few minutes to several hours; this transition phase is marked by smaller disturbances with irregular periods and amplitudes of only a few  $\gamma$ . Then the main phase (*cmp*) begins. The complexity of the fine structure of the main phase in the records obtained by highly sensitive rapid-run apparatus is a detriment to their systematic evaluation.—D.B.V.

- 191-463. Halenka, Jaroslav. Geomagnetic activity after large chromospheric flares (with Russian summary): *Československá Akad. Ved Studia Geophys. et Geod.*, v. 5, no. 3, p. 237-255, 1961.

The effect of large solar chromospheric flares on geomagnetic activity has been studied statistically and compared with earlier works on the subject. It is found that the geomagnetic effect of flares depends markedly on their distance from the central meridian of the sun and on their intensity. Direct geomagnetic activity occurs only after flares of intensity 3 in the interval  $9^{\circ}$  E.- $9^{\circ}$  W., but other flares may have an indirect effect. The time interval between flares and geomagnetic activity is greater for flares of smaller intensity and for weaker geomagnetic storms.—D.B.V.

#### MAGNETIC PROPERTIES AND PALEOMAGNETISM

- 191-464. Sanford, Raymond L., and Cooter, Irvin L. Basic magnetic quantities and the measurement of the magnetic properties of materials: *U.S. Natl. Bur. Standards Mon.* 47, 36 p., 1962.

General information is given concerning the two basic quantities, magnetic induction and magnetizing force, and for the magnetic constant  $\mu$ . The magnetic properties of various materials are discussed, and methods and apparatus commonly used in the Magnetic Measurements Section of the National Bureau of Standards for measuring these properties by means of reversed direct current or alternating currents of low frequency are described. The rationalized mksa system of units is included as well as the classical cgs electromagnetic system.—V.S.N.

- 191-465. Howell, Lynn, G. Chemical and crystal controlled magnetization of rocks: *Am. Jour. Sci.*, v. 260, no. 7, p. 539-549, 1962.

The importance of chemical magnetization as one of the principal processes by which rocks become magnetized is discussed, and the role of hematite in controlling the direction of remanent magnetization in the case of single crystals and in the case of preferred crystallographic orientation of mineral assemblages of crystals is pointed out. It is shown that hematite crystals can grow in some cases without control of orientation by the earth's magnetic field.—V.S.N.

- 191-466. Lotgering, F. K. Paramagnetic susceptibilities of  $\text{Fe}^{2+}$  and  $\text{Ni}^{2+}$  ions at tetrahedral or octahedral sites of oxides: *Jour. Physics Chemistry Solids*, v. 23, p. 1153-1167, 1962.

Susceptibility measurements were performed at temperatures from 90°K to 1,000-1,200°K on  $\text{Fe}_{0.2}\text{Mg}_{0.8}\text{O}$ ,  $\text{Fe}_{1-x}\text{Mg}_x\text{Al}_2\text{O}_4$  ( $x=1.0$  and  $0.3$ ),  $\text{Ni}_{0.2}\text{Mg}_{0.8}\text{O}$ , and  $\text{Ni}_x\text{Mg}_{1-x}\text{Al}_2\text{O}_4$  ( $x=0, 0.25, 0.50,$  and  $0.75$ ), and the results were compared with values calculated from spin-orbit coupling constants and crystalline field parameters given in the literature. The equations for the susceptibilities of the  $\text{Fe}^{2+}$  ion in an octahedral crystalline field and the  $\text{Ni}^{2+}$  ion in a tetrahedral field are extended to account for the 2d order energies of the spin-orbit interactions. In most cases agreement within a few percent is found between the experimental and calculated susceptibilities.— Author's abstract

- 191-467. Zvoys'kiy, V. M., and Krutikhovskaya, Z. A. Pro vplyv anizotropii magnitnoi spryynyatlyvosti zrazkiv na tochnist' vymiryvannya zalishkovoi namagnichenosti [On the effect of anisotropy of magnetic susceptibility on the accuracy of residual magnetization measurements]: Akad. Nauk Ukrain. RSR Dopovidi, no. 6, p. 736-739, 1961.

The accuracy of measurement of remanent magnetization depends on the anisotropy of the magnetic susceptibility in the sample. An approximate formula is derived for a sample in the shape of an ellipsoid, the errors due to the anisotropy of the susceptibility are estimated, and the method of eliminating these errors in measuring the remanent magnetization of the sample is suggested.— A.J.S.

- 191-468. Brodskaya, S. Yu., and Grabovskiy, M. A. Magnitnaya stabil'nost' odnokomponentnykh i dvukhkomponentnykh iskusstvennykh sistem [Magnetic stability of one-component and two-component artificial systems]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 1, p. 54-66, 1962.

The stability of the intensity of isothermic remanent magnetization was studied for one- and two-component systems with respect to the concentration of ferromagnetic components. The ferromagnetic components of the specimens were represented by powders of magnetite and pyrrhotite and two types of synthetic ferrites. Kaolin was used as the nonferromagnetic filler. The coercive force of specimens with a concentration of ferromagnetic components exceeding 6 percent in the case of a two-component system depends on the concentration in all fields. In the case of a one-component system this force depends on the concentration in fields weaker than saturation fields. The size of the disruptive field at normal magnetization depends on the concentration and properties of the components, but the shape of the curves of demagnetization by a permanent field does not reflect these factors. In contrast to the permanent field, the value of the demagnetizing alternating field at normal magnetization depends only on the magnetizing field and not on the concentration or properties of the components.— J.W.C.

- 191-469. Yanovskiy, B. M., Sholpo, L. E., and Gorshkov, E. S. O nekotorykh osobennostyakh vyzkoi namagnichennosti [Some features of viscous magnetization]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 719-725, 1962.

The properties of viscous magnetization of rocks are investigated from the viewpoint of the theory of single domain grains. The viscous magnetization  $I_r(t)$  is defined as a particular type of remanent magnetization  $I_r$ . It differs in energetic state from the isothermal remanent magnetization of equal magnitude of the ferromagnetic material. The relationship between the temporal stability of the remanent magnetization and its stability with respect to an acting magnetic field varies for different types of magnetization. The results of experiments with basaltic lavas are in conformity with Neel's theory.— W.S.J.

- 191-470. Bol'shakov, A. S. Razdeleniye termoostatochnoy i normal'noy komponent namagnichennosti temperaturnym metodom [Separation of

thermoremanent and normal magnetization components by the temperature method]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1805-1815, 1961.

Heating can be used to separate the thermoremanent and normal magnetization components that exist simultaneously in the same specimen. The relative errors in determination of  $I_{rt}$  and  $I_r$  do not exceed 4 and 25 percent, respectively, and the directions of the vectors can be calculated accurately to within  $10^\circ$ , provided the normal magnetization is not less than 3 percent and not greater than 40 percent of the thermoremanent magnetization. Only the order of magnitude of  $I_r$  can be established when  $I_r/I_{rt}$  is less than 3 percent.—J.W.C.

191-471. Andreyev, V. I. Ob uchete nekotorykh razmagnichivayushchikh faktorov pri interpretatsii magnitometricheskikh dannyykh [Taking account of certain demagnetizing factors in interpretation of magnetometric data]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 11, p. 113-115, 1960.

The total magnetization vector  $I_s = \bar{I}_r + \bar{K}'H$ , consisting of the remanent magnetization  $\bar{I}_r$  and the magnetization  $\bar{K}'H$  induced in iron ores of an apparent magnetic susceptibility  $K'$  by the geomagnetic field  $H$ , was determined from the average effective magnetization intensity and found to agree with borehole data, in spite of the fact that neither external nor internal demagnetization factors were taken into account. This contradiction is explained by the presence of skarns and nonmagnetic inclusions in the magnetic ore body, which compensated for disregarding the demagnetization factors.—A.J.S.

191-472. Cox, Allan, and Doell, Richard R. Magnetic properties of the basalt in hole EM 7, Mohole project: Jour. Geophys. Research, v. 67, no. 10, p. 3997-4004, 1962.

The average direction of the remanent magnetization of the basalt layer at the bottom of hole EM 7 is  $36^\circ$  up, indicating reverse magnetization. Detailed demagnetization experiments with alternating magnetic fields to 800 oersteds peak intensity indicate that drilling did not remagnetize the basalt. The natural magnetization is extremely stable and is probably thermoremanent magnetization acquired as the basalt cooled through its Curie temperature of  $355^\circ\text{C}$ . The average intensity of the natural remanent magnetization is  $0.0054 \text{ emu/cm}^3$ , and that of the induced magnetization is less than 5 percent of that. The ratio of remanent to induced magnetization decreases markedly with depth below the upper flow surface and emphasizes the danger of determining this ratio from material recovered only from the upper surfaces of submarine layers.—D.B.V.

191-473. Wilson, R. L. The palaeomagnetic history of a doubly-baked rock: Royal Astron. Soc. Geophys. Jour., v. 6, no. 3, p. 397-399, 1962.

The technique of thermal demagnetization of the natural moment has allowed the separation of partial thermoremanences induced consecutively in a laterite by a lava and a dyke, and has shown that the lava baked the laterite to a higher temperature ( $>670^\circ\text{C}$ ) than did the dyke ( $\sim 550^\circ\text{C}$ ). The evidence, along with other evidence previously presented, strongly suggests that the earth's magnetic field was reversed when both bakings took place in Tertiary times.—Author's summary

191-474. Everitt, C. W. F., and Clegg, J. A. A field test of palaeomagnetic stability: Royal Astron. Soc. Geophys. Jour., v. 6, no. 3, p. 312-319, 1962.

A field test of paleomagnetic stability is described, based on a comparison of the magnetizations in mineralogically identical baked and unbaked sedimen-

tary rocks. If successful, the test demonstrates the stability of the magnetization acquired during baking. Two instances are given of its actual application, one of which has led to a reinterpretation of the paleomagnetism of certain Carboniferous formations. The test is compared with the three main field tests in common use.— Authors' summary

- 191-475. Gross, W[illiam] H., and Strangway, D. W. Remanent magnetism and the origin of hard hematites in Precambrian banded iron formation: *Econ. Geology*, v. 56, no. 8, p. 1345-1362, 1961.

Because of the relatively stable magnetic properties of hematite, it is possible that an analysis of the directions of remanent magnetism may be useful in determining the origin of hematite ore bodies. To test this possibility the remanent magnetic directions were determined from samples of two ore bodies that occur in a highly deformed Precambrian iron formation at Fort Gouraud, Mauritania. The results suggest that one ore body was formed in Precambrian time when the iron formation was horizontal and the other was formed by surface leaching with at least some of the solution and redeposition of the hematite occurring in recent time. These origins are consistent with geologic field relations.— V.S.N.

- 191-476. Mikhaylova, N. P. O yestestvennoy namagnichennosti gabbro-piroksenitov Oktyabr'skogo shchelochnogo massiva [On the natural magnetization of gabbro-pyroxenites of the Oktyabr'skiy alkaline massif]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 11, p. 1599-1606, 1961.

The results of determination of the natural magnetization of ultrabasic rocks of the Oktyabr'skiy alkaline massif in Ukrainian S.S.R. are discussed. A systematic variation of the Q-factor, and the absolute value and the inclination of the  $I_n$ -vector within the same massif of rocks of identical age were established. This finding makes these values unsuitable for age determinations of crystalline rocks, although the Q-factor may be considered as the stability measure of the rock when the quantitative value of Q is determined experimentally for each particular case.— A.J.S.

- 191-477. Dudarev, A. N. O magnitnykh svoystvakh gornyykh porod i rud Altaye-Sayanskoy oblasti [On the magnetic properties of rocks and ores of the Altay-Sayan Region]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 1, p. 117-122, 1960.

The general magnetic characteristics of rocks and ores of the Altay-Sayan Region are synthesized on a basis of statistical processing of more than 10,000 determinations taken from numerous industrial reports and the literature. The rocks and ores are categorized as sedimentary, effusive, intrusive, basic intrusive, metamorphic, and iron ores. Magnetic susceptibilities are given for 18 varieties of rocks and 5 varieties of iron ores.— A.J.S.

- 191-478. Yaskawa, Katsumi. Paramagnetism of some kinds of crystalline schists: *Kyoto Univ. Coll. Sci. Mem.*, ser. B, v. 28, no. 4, p. 485-488, 1962.

With few exceptions, samples of Sambagawa crystalline schist in southwest Japan give no indication of the presence of ferromagnetic or ferrimagnetic minerals. The samples are paramagnetic in nature, their susceptibility being nearly inversely proportional to temperature in the range from 0°C to 600°C. The susceptibility is found to be anisotropic, however, in that susceptibility measured parallel to lineation of the schist differs from that measured perpendicular to lineation.— V.S.N.

- 191-479. Kang, Yong-ho. Role of pyrrhotite in rock magnetism: *Kyoto Univ. Coll. Sci. Mem.*, ser. B, v. 28, no. 4, p. 489-526, 1962.

The natural occurrence of pyrrhotite is described for two iron sulfide mines in Japan - the Besshi Mine of Ehime Prefecture and the Yanahara Mine of Okayama Prefecture. Measurements of remanent and saturation magnetization were made on 107 mine samples, and the results from 88 of these are tabulated. The magnetic properties of pyrrhotites synthesized under conditions of high pressure and temperature are discussed also, and the results applied to the difference in magnetization found in the two mines. To determine the role of pyrrhotite in magnetism of sedimentary rocks, the natural remanent magnetization of several black shales and red sandstones in Japan was measured; results are tabulated. It is concluded from these data that in red beds the remanent magnetic vector due to iron oxides is more important to paleomagnetic investigations than that due to pyrrhotite, whereas in black shales the opposite is true.— V.S.N.

191-480. Fuller, M. D. A magnetic fabric in till: *Geol. Mag.*, v. 99, no. 3, p. 233-237, 1962.

The magnetic susceptibility anisotropy of specimens of a glacial till is described and used to define a magnetic fabric. This is compared with the fabric established by small particle and stone orientation, and the maximum susceptibility direction is shown to be similar to the preferred direction of the long axes of particles and stones. Hence magnetic susceptibility anisotropy in glacial tills could prove a useful tool to indicate the direction of flow in the parent ice sheet or glacier.— V.S.N.

191-481. Larionov, V. A. K voprosu ob opredelenii v polevykh usloviyakh velichiny otnosheniya ostatochnogo magnetizma k induktivnomu [A contribution to the problem of determination of the value of the ratio of remanent to inductive magnetization under field conditions]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 4, p. 107-109, 1961.

A method is proposed for determining the ratio of remanent to induced magnetization from the variation  $\delta Z$  of the vertical component of an anomaly at its epicenter. The ratio  $I_r/\kappa Z_n$  was found to be equal to  $(\delta Z_n Z_a - \delta Z_n Z_n + \delta Z_n Z_n^n)/(\delta Z Z_n - \delta Z_n Z_n)$  where  $\delta Z_n$  is the normal variation of the vertical component in the normal geomagnetic field,  $Z_a$  is the value of the vertical component of the anomaly at its epicenter,  $I$  is the remanent magnetization, and  $\kappa$  is the magnetic susceptibility of the rock.— A.J.S.

191-482. Kuzhelov, G. K., and Krutikhovskaya, Z. A. Obrazovaniye ostatochnogo namagnicheniya i yego raspredeleniye v gornyykh porodakh [Formation of remanent magnetization and its distribution in rocks]: *Sovetskaya Geologiya*, no. 2, p. 125-139, 1960.

The remanent magnetization of gabbros of the Volyn anomaly and of ferruginous quartzites of the Kremenchug anomaly of the Ukrainian shield was investigated. The thermoremanent magnetization of rocks that contain ferromagnetic minerals is commensurate with the value of the induced magnetization, and the ratio  $I_r:d_i$  decreases with increasing susceptibility. As a consequence of their layered solidification the thermomagnetization of igneous rocks is necessarily subject to the law of the magnetization of a thin bed. At each point in a geologic body the direction of the thermoremanent magnetization is determined by the position of the surface of cooling (Curie surface) relative to the magnetizing field ( $\theta$ ) and by the magnetic susceptibility of the rock at the Curie point. For rocks that have a magnetic susceptibility at the Curie point considerably greater than their magnetic susceptibility at normal temperatures, the direction of thermoremanent magnetization should not correspond to the direction of the earth's magnetic field either in azimuth or in the vertical plane. Such correspondence takes place only where  $\theta=0^\circ$  or  $90^\circ$ . The greater the value of the thermoremanent magnetization, the greater its

direction deviates from the direction of the earth's field. With a constant direction of the earth's field, rocks of the same age and even individual parts of the same geologic body may have different directions of thermoremanent magnetization. Conversely, rocks of different age with different directions of the earth's field have the same direction of thermoremanent magnetization. Therefore, it is not possible to determine the direction of the earth's field in various geologic epochs according to the direction of the thermoremanent magnetization of rocks of different ages.—J.W.C.

- 191-483. Evison, F. F. Rock magnetism and low-angle faulting: *Nature*, v. 194, no. 4829, p. 644-646, 1962.  
Norris, D. K., and Black, R. F. Rock magnetism and low-angle faulting: *ibid.*, p. 646, 1962.

Evison questions whether the remanence vectors in the Lewis thrust plate could have been effectively preserved in view of the possibility that it may have undergone plastic flow. In his view, discrepancies indicated by rock magnetism are due to plastic flow in the rock after it became magnetized, rather than to continental drift. The direction of such plastic flow in the Lewis thrust plate inferred from the paleomagnetic data of Norris and Black (see *Geophys. Abs.* 188-434), agrees with the direction indicated by the geological evidence.

In the view of Norris and Black, the rocks of the Lewis thrust plate have not undergone significant plastic flow, and the remanence vectors maintained a common Precambrian pole position before, during, and after the movement history of the plate. The plate was transported as a coherent but flexible mass, not as an extruded flow sheet.—D.B.V.

- 191-484. Creer, K. M. The dispersion of the geomagnetic field due to secular variation and its determination for remote times from paleomagnetic data: *Jour. Geophys. Research*, v. 67, no. 9, p. 3461-3476, 1962.

In studies of the paleosecular variation the situation often arises that although a number of spot readings of the paleogeomagnetic field have been deduced from the paleomagnetism of a formation, their stratigraphic sequence is unknown. In this paper methods are discussed for deducing the amount of dispersion produced by paleosecular variation in the magnetization of a formation against the background of noise due to experimental errors, partial remagnetization, subsequent tectonic movement, and other factors. Models are considered by means of which the full range of dispersion of the geomagnetic field in time may be estimated. Angular dispersion factors are defined and are calculated for three models; they are found to be of the same magnitude as those calculated from various rock formations. Other calculations for these models predict that the secular variation dispersion depends on latitude; data from several igneous formations confirm this prediction. It is not possible, however, to use the large body of paleomagnetic data tabulated by various authors to calculate the dispersion due to paleosecular variation, as these data have been computed in different ways.—D.B.V.

- 191-485. Burlatskaya, S. P., and Petrova, G. N. Arkheomagnitnyy metod izucheniya geomagnitnogo polya v proshlom [The archeomagnetic method of study of the geomagnetic field in the past]: *Akad. Nauk SSSR Geomagnetism i Aeronomiya*, v. 1, p. 111-119, 1961.

Paleomagnetic studies of variations in the earth's magnetic field during the last 2,000-3,000 yr from bricks and ceramics of historic and prehistoric cultures are discussed. By analysis of the remanent magnetic inclination and declination measured in such samples it was concluded that the archeomagnetic method of paleomagnetic investigation has a dating accuracy of 50 yr.—A.J.S.

- 191-486. Hilten, D. van. A deviating Permian pole from rocks in northern Italy: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 3, p. 377-390, 1962.

The magnetization of effusives near Bolzano in the southern Alps indicates a lower Permian pole at lat 51.4° N., long 118.2° W., a position that diverges strongly from other European Permian poles found up to now. Alpine orogenic displacements are held responsible, although quantitatively most estimates offered by orogenic hypotheses appear to be too small to explain the divergence satisfactorily. The divergent character of this magnetization is illustrated by a new isocline method of presenting paleomagnetic data.— D.B.V.

- 191-487. Bucha, Václav. Palaeomagnetic pole positions in the Pre-Cambrian and Palaeozoic periods investigated from Czechoslovak rocks (preliminary report) (with Russian summary): *Československá Akad. Věd Studia Geophys. et Geod.*, v. 5, no. 3, p. 269-273, 1961.

Pole positions have been determined from paleomagnetic measurements on 3 Precambrian, 6 Cambrian, 6 Ordovician, 1 Silurian, 2 Devonian, 1 Carboniferous, and 2 Permian rocks from Czechoslovakia. Results are tabulated. The pole positions describe a comparatively continuous curve, starting from the region of Central America in Precambrian and moving through South Africa in Lower Cambrian, through East Africa to Saudi Arabia in Lower Ordovician, to Indonesia in Upper Ordovician, toward Japan in Silurian, and to eastern Siberia in Carboniferous and Permian. Reversals of the geomagnetic field occurred in Precambrian and Cambrian times. The pole positions for Precambrian, Silurian, and younger rocks correspond approximately with published values, but the polar wanderings in Cambrian and Ordovician time indicate a west-east progress where westward movement has heretofore been assumed.

Comparison with pole positions for North America suggests that in Precambrian time North America was nearly connected with Europe and since Cambrian time has been drifting westward relative to Europe.— D.B.V.

- 191-488. Janovsky [Yanovskiy], B. M. Probleme des Palaeomagnetismus in der UdSSR [Problems of paleomagnetism in the U.S.S.R.]: *Freiberger Forschungshefte*, C 100, p. 56-85, 1961.

Paleomagnetic work in the U.S.S.R. is reviewed, and pole positions determined for different epochs by Russian and by west European authors are compared on a map. The theoretical basis of magnetic stability is discussed in some detail, and experiments on stability and on inverse magnetization are described. A bibliography of 60 entries is given.— D.B.V.

- 191-489. Valiyev, A. A. Opredeleniye polozeniya polyusov Zemli v tretichnoye vremiya na osnovanii izucheniya ostatnochnoy namagnichenosti gornykh porod nekotorykh rayonov Severnoy Fergany [Determination of the earth's poles positions during the Tertiary period on a basis of study of the remanent magnetization of rocks of several regions of north Fergana]: *Akad. Nauk SSSR Izv. Ser. Geofiz.*, no. 8, p. 1213-1219, 1960.

The coordinates of the earth's north pole during the Miocene and Pliocene are determined on a basis of the remanent magnetization of sedimentary rocks of the Chustpap anticline in north Fergana. Oriented rock samples (5x5x5 cm) were taken at 25-30 m interval at Sumsar and at Marguzar. The pole coordinates determined by the samples from Sumsar were found to be 71° and 222° for Oligocene and Miocene, 71° and 257° for Middle Pliocene, and 75° and 248° for Upper Pliocene. The Marguzar samples gave 66° and 259° for Middle Pliocene and 69° and 238° for Upper Pliocene. It is considered that the earth's magnetic pole positions were near the geographic poles during its entire geological history.— A.J.S.

- 191-490. Takeshita, Hisashi; Saito, Yutaka; and Momose, Kanichi. Paleomagnetisms and volcanic geology of the Shigarami formation [in Japanese with English abstract]: *Earth Sci. [Chikyu Kagaku]*, no. 49, p. 26-36, 1960.

On the basis of paleomagnetic data the volcanic rocks - ejecta, lava flows, and intrusives - of the Shigarami district, Nagano Prefecture, Japan, are classified into four stages extending from late Miocene to Pliocene or possibly into Plio-Pleistocene time. Paleomagnetism is thus shown to be a useful tool for geologic correlation despite the fact that the essential problem of the causes of paleomagnetic variation is unresolved.— V.S.N.

- 191-491. Mumme, W. G. A note on the mixed polarity of magnetization in Cainozoic basalts in Victoria, Australia: Royal Astron. Soc. Geophys. Jour., v. 6, no. 4, p. 546-549, 1962.

The mixed polarity of magnetization observed in Cenozoic volcanics is shown, by the use of a-c demagnetization techniques, to be due to a temporary unstable component of magnetization superimposed on a stable reversed direction.— Author's summary

- 191-492. Bull, C., Irving, E., and Willis, I. Further palaeomagnetic results from South Victoria Land, Antarctica: Royal Astron. Soc. Geophys. Jour., v. 6, no. 3, p. 320-336, 1962.

The directions of natural remanent magnetization are approximately uniform throughout a 5,000-ft section in South Victoria Land that includes granites, sediments, and hypabyssal intrusives of Mesozoic, Paleozoic, and possibly Precambrian ages. Small and apparently real differences in direction between some units are probably due to the presence of unstable components, the stable components being parallel in all the units studied. This uniformity is believed to be due to reheating of the whole area during the intrusion of the Ferrar dolerites in Mesozoic time.

Variations in magnetic properties through the Ferrar dolerite sheets throw light on their emplacement and differentiation.— D.B.V.

- 191-493. Khomenko, V. I. Pro mozhlivost' vykorystannya namagnichennosti girs'kykh porid pri tektonichnomu rayonuvanni [On the feasibility of using magnetization of rocks for tectonic regionalization]: Akad. Nauk Ukrayin. RSR Dopovīdī, no. 10, p. 1307-1310, 1961.

Tectonic zones in the Transcarpathian region determined on a basis of magnetometric data agree satisfactorily with zones based on geological data.— A.J.S.

#### MAGNETIC SURVEYS

- 191-494. Strakhov, V. N. Ob approksimatsiyakh funktsiy na poluosi i o primeneniі podobnykh approksimatsiy k vychisleniyu integralov, u potrebyayemykh pri interpretatsii magnitnykh i gravitatsionnykh anomalii [Approximations of functions on a half-axis and application of similar approximations to calculation of integrals used in interpretation of magnetic and gravity anomalies]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1726-1737, 1961.

Function approximation on a half-axis using exponential polynomials is investigated. A method is developed for obtaining quadrature formulas for integration on a half-axis according to an arbitrary weighting function, which is effective when the Laplace transform of this function is known. Quadrature formulas are obtained for weighting functions used in magnetic and gravity surveying.— Author's abstract, J.W.C.

- 191-495. Strakhov, V. N. O postroyeniі kvadraturnykh formul s pochti ravnymi koeffitsiyentami [Construction of quadrature formulas with almost equal coefficients]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 12, p. 1713-1725, 1961.

Problems of approximation of functions by "generalized" Bernstein polynomials are investigated. These polynomials are used to obtain quadrature formulas with almost equal coefficients; these can then be used to advantage in integration of empirical functions.— Author's abstract, J.W.C.

- 191-496. Shalayev, S. V. *Primeneniye funktsiy kompleksnogo peremennogo pri geologicheskoy istolkovanii gravitatsionnykh i magnitnykh danykh* [Application of the function of a complex variable to geological interpretation of gravity and magnetic data]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 3-14, 1961.

Based on Andreyev's investigation of the application of complex variables to determination of critical points of potential fields in geological interpretation of gravity and magnetic anomalies (see Geophys. Abs. 139-11605), a method of analytical extension of the potential function into the lower half-plane is discussed. This method permits a determination of the location of edge points of certain two-dimensional bodies of constant density or intensity of magnetization. The complex potential and its derivatives, and the application of the method to geological interpretations are discussed.— A.J.S.

- 191-497. Solov'yev, O. A. *Sposob interpretatsii magnitnykh anomalii po vertikal'nom i gorizonta'lnom gradiyentu  $Z_a$*  [Method of interpretation of magnetic anomalies from their vertical and horizontal gradient  $Z_a$ ]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 15-20, 1961.

Euler's theorem of homogeneous functions for determination of the poles of disturbing bodies of regular geometric shape is used for the calculation of the distance  $|F|$  from the point of observation to the disturbing pole of the ore body investigated. From several observed values of vertical and horizontal gradients the value of  $|F|$  can be determined within 6 percent accuracy, and the method proposed can be applied to obliquely magnetized bodies and to bodies in areas of strong relief.— A.J.S.

- 191-498. Solov'yev, O. A. *Sposob opredeleniya otnosheniya  $I/\sigma$  koso namagnichennykh tel proizvol'noy formy po znacheniyam  $Z_a$  and  $V_{zx}$*  [The method of determination of the ratio  $I/\sigma$  of obliquely magnetized bodies of arbitrary forms according to the values of  $Z_a$  and  $V_{zx}$ ]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 21-24, 1961.

A method of determining the value of  $I/\sigma$  from values of  $Z_a$  and  $V_{zx}$  (or  $\partial\Delta g/\partial x$ ) is worked out theoretically for obliquely magnetized bodies of arbitrary shape. A working formula,  $I^2/\sigma^2 = k^2 \int_{-\infty}^{+\infty} Z_a^2 dx / \int_{-\infty}^{+\infty} V_{zx}^2 dx$  is developed in which the remainder integrals can be disregarded because the squares of the values of  $Z_a$  and  $V_{zx}$  decrease with distance from the center of the anomaly approximately as  $1/x^4$ .— A.J.S.

- 191-499. Pyatnitskiy, V. K. *Opredeleniye glubin zaleganiya namagnichennykh tel po kharakternym tochkam krivoy  $Z_a$  ili  $\Delta T$*  [Determination of the depth of occurrence of magnetized bodies by characteristic points of the curve  $Z_a$  or  $\Delta T$ ]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 25-30, 1961.

The depth  $h$  to the upper side of a magnetized body is determined by a method in which the vertical dimension  $l$  of the body has little effect. The dependence of the form of the  $Z$ -curve on the horizontal dimension  $b$  and on  $l$  of a vertical layer of infinite strike is investigated, and formulas are derived for calculation of  $h$  from the observed curves  $Z_a$  and  $\Delta T$  with an accuracy of 12 percent.— A.J.S.

- 191-500. Gel'fand, N. I. K interpretatsii geofizicheskikh anomalii metodom kasatel'nykh [On interpretation of geophysical anomalies by the method of tangents]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 31-44, 1961.

A variant of the method of geological interpretation of magnetic anomalies by two tangents (one to the inflection point and one to the maximum point on the anomalous curve) (see Geophys. Abs. 174-87) is proposed, analyzed, and applied to the following anomalies: a single pole (vertical stock), a line of poles, an infinite horizontal cylinder, a sphere, a semisphere, an infinite parabolic cylinder, a vertical layer of infinite strike and dip, a paraboloid of revolution, a vertical fault scarp (bench), and a thin layer of limited extent down dip. The method permits interpretations of an anomaly by one tangent line only, disregarding the maximum point of the anomaly which is difficult to determine. The method is extended to interpretation of gravity anomalies.—A.J.S.

- 191-501. Gel'fand, N. I. K interpretatsii geofizicheskikh anomalii vysshikh proizvodnykh magnitnogo potentsiala [On interpretation of geophysical anomalies of higher derivatives of magnetic potential]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 45-54, 1961.

The interpretation of local magnetic anomalies by separating them from each other and from the regional anomaly according to their horizontal gradients  $Z_x$  and  $H_x$  and the vertical gradient  $Z_z$  using readings on the same level, is discussed (see also Geophys. Abs. 164-162). Instead of the usual two tangents (one to the inflection point and one to the maximum point on the curve) (see Geophys. Abs. 191-500), the ratio  $\Delta x = y/(\delta y/\delta x)$  is used where  $y=f(x)$ . Examples of interpretation of  $Z_z$ ,  $Z_x$ , and  $H_x$  for various geologic bodies of simple geometry are given.—A.J.S.

- 191-502. Simonenko, T. N. Vychisleniye proizvodnykh "psevdogravitatsionnogo" polya po dannym magnitnoy s'emki dlya sluchaya ploskoy zadachi [Calculation of derivatives of the "pseudogravitational" field according to magnetic survey data for the case of a plane problem]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 55-58, 1961.

A method of recalculation of  $Z_a$  and  $H_a$  curves of magnetic anomalies of obliquely magnetized geologic bodies into  $Z_a^*$  and  $H_a^*$  corresponding to the vertical magnetization of the same bodies is discussed. These pseudogravitometric anomalies (see Geophys. Abs. 169-241), treated according to the well known Poisson's theorem, lead to a mathematical expression that permits the magnetic potential and the component  $Z_a^*$  corresponding to the vertical magnetization of anomalous bodies of arbitrary forms to be found when the distribution of the potential on the observation plane is given. It is expected that an analysis of  $Z_a^*$  curves drawn from  $\Delta T$  data will simplify interpretation of airborne magnetic data, especially in the lower magnetic latitudes.—A.J.S.

- 191-503. Mikov, B. D. Uskorennyy sposob opredeleniya elementov magnitnogo polya dlya nekotorykh tel pravil'noy formy [A rapid method of determination of the elements of a magnetic field for certain bodies of regular shape]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 59-68, 1961.

A method is proposed for rapid determination of the elements of the magnetic field due to disturbing bodies such as horizontal and dipping layers, thin vertical layers and stocks, horizontal circular cylinders, and vertically magnetized spheres. Tables and nomograms are given for calculation of  $Z$ ,  $H$ , and  $T$  values of the anomalous field.—A.J.S.

- 191-504. Mikov, B. D. Uravneniya napryazhennosti magnitnogo polya dlya nekotorykh tel pravil'noy formy pri naklonnoy linii nablyudeniya [Equations of magnetic field intensity for certain bodies of regular shape when the line of observation is inclined]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 69-94, 1961.

Intensities of anomalous magnetic fields due to disturbing bodies of regular shape are considered for the conditions of irregular terrain, and equations are derived for the fields observed from a sloping plane. A formula for a horizontal plane is also developed. Analysis of the equations obtained here shows that the curves of magnetic anomalies observed from a sloping line differ considerably from the shape of those obtained for the same bodies from a horizontal line.—A.J.S.

- 191-505. Larionov, V. A. Raschety magnitnogo polya v vertical'noy ploskosti dlya nekotorykh prostykh tel [Calculations of the magnetic field in a vertical plane for certain simple bodies]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 95-114, 1961.

The problem of interpretation of magnetic field structure due to disturbing geologic bodies of simple vertical form is discussed. Theoretical formulas are derived and master charts constructed for stocks, spheres, and thin layers of infinite vertical extension into depth and for horizontal cylinders for determination of  $Z_a=f(h)$ . The method and basic analysis presented are applicable also to electrical and gravitational potential field anomalies on the surface and in boreholes. The upper edge of a disturbing body or its center at depth can be determined from the spatial distribution of  $Z_a$ , and the vertical cross sectional form of the body can be found.—A.J.S.

- 191-506. Provodnikov, L. Ya. Paletki dlya utocheniya nulevogo urovnya polya anomalii poslednego poryadka [Master charts for a more precise definition of zero-level of the field of anomalies of the last order]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 115-122, 1961.

A method of preparation of master charts for determination of the edge of vertically and uniformly magnetized geologic bodies from the form of their anomalous  $Z$  or  $\Delta T$  curves is discussed. The master charts are constructed for bodies of simple geometry such as a vertical layer of considerable depth and length and of small width, a horizontal circular cylinder, a sphere, spheroids of revolution, and a vertical stock of considerable depth. The method permits a differentiation of higher order anomalies from those of lower order, and separation of local terrain effects from those produced by the magnetic body investigated.—A.J.S.

- 191-507. Provodnikov, L. Ya. K voprosu opredeleniya glubiny zaleganiya verkhney chasti poverkhnosti namagnichennykh tel vida shara i gorizontalnogo tsilindra [On the problem of determination of the depth of occurrence of the upper part of the surface of magnetized bodies in the form of a sphere and of a horizontal cylinder]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 123-126, 1961.

This is a development of Provodnikov's preceding paper (see Geophys. Abs. 191-506) and is devoted to depth determination of the upper surface of anomalous geologic bodies in the shape of a sphere or a horizontal cylinder. By selecting the form coefficient  $k$  for the sphere or the cylinder in the formula  $h=kx_{0.5} \cos\alpha$ , where  $\alpha$  is the angle between the profile investigated and the strike of the body, and  $x_{0.5}$  is the half-maximum abscissa, the depth  $h$  is found with an approximation from 7 to 30 percent.—A.J.S.

- 191-508. Provodnikov, L. Ya. Opredeleniye glubiny zaleganiya namagnichennykh tel s uchetom oshibki za vybor normal'nogo polya [Determination of the depth of occurrence of magnetized bodies taking into account error in selection of the normal field]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 127-136, 1961.

The method proposed in Provodnikov's previous paper (see Geophys. Abs. 191-50?) is developed further by preparing two sets of master charts, one for gradual change of the magnetic field to which the local anomaly of the highest order is referred, and a second for an approximate interpretation of the anomalous field when the reference field is of a complex nature. The error of determination of the depth to the upper surface of the anomalous bodies is 10-20 percent.—A.J.S.

- 191-509. Timofeyev, A. N. Ob interpretatsii magnitnykh anomalii v sluchaye izmenyayushchey magnitnoy vospriimchivosti gornyykh porod [On interpretation of magnetic anomalies in the case of variable magnetic susceptibility of rocks]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 137-146, 1961.

This is a study of the changes in the magnetization of a geologic massif and of the magnetic field it produces when the magnetic susceptibility of the massif changes gradually in a horizontal plane due to changes in mineralogical composition (for example, titanium magnetite-chromite granites to granite porphyry to pegmatites to quartz veins). Assuming for the effective magnetic susceptibility  $\kappa$  in a plane parallel to the plane of measurement a change according to  $\kappa = \kappa_0 / (1 + \alpha^2 x^2)$ , where  $\kappa$  is the magnetic susceptibility that has a maximum at  $x=0$ , and  $\alpha$  is a constant which characterizes the change in magnetic susceptibility in the direction of  $x$  normal to the linear disturbing structure, a formula is derived that shows that the anomaly in  $Z_a$  of the magnetic field under a layer with variable susceptibility differs substantially from the anomaly of the same layer when  $\alpha=0$ . In further analysis, formulas are given to account for the variability in the value of susceptibility along a horizontal plane.—A.J.S.

- 191-510. Bugaylo, V. A. Opyt interpretatsii magnitnykh i gravitatsionnykh anomalii na Urale i Zaural'ye logarifmicheskimi paletkami [An experience in interpreting magnetic and gravity anomalies in the Urals and Trans-Urals with the aid of logarithmic master charts]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 147-150, 1961.

Progress in introducing mono- and bi-logarithmic master charts proposed and developed by Bugaylo in 1944 for interpretation of magnetic, electrical, and gravity anomalies is reported, and the geophysical parameters that can be determined with the aid of these master charts are discussed. Depths to the center of gravity of a disturbing body can be determined with an accuracy of 5-10 percent, and effective magnetic susceptibility to 10-30 percent. These master charts are recommended for determining the geophysical parameters of geologic bodies from their anomalous curves of the  $Z$  and  $H$  components of the magnetic field, from  $V_{SZ}$  and  $\Delta V$  of gravity anomalies, and from  $U$  and  $\partial u / \partial r$  in electric prospecting.—A.J.S.

- 191-511. Kuznetsov, G. F. K voprosu ob interpretatsii magnitnykh anomalii paletkami OVKA dlya vertikal'nykh plastov [On the problem of interpretation of magnetic anomalies with the aid of OVKA master charts for vertical layers]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Voprosy Razved. Geofiziki, no. 1, p. 151-153, 1961.

An analysis of Ivanov's master charts for interpretation of magnetic anomalies due to vertical layers showed errors in the auxiliary master chart of the

graph  $f=\phi(h/c)$ , and in the formula for determination of the magnetization intensity  $Z_a^m$ . Corrections are introduced and the percent errors between the 0.2, 0.5, 0.7, and 0.9 values of the ratio of the depth of the upper surface of the layer to its thickness are shown to be 14, 40, 65, and 35, respectively.—A.J.S.

- 191-512. Larionov, V. A. Metod vertikal'nogo magnitnogo zondirovaniya [Method of vertical magnetic sounding]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 1, p. 105-114, 1960.

A method is developed for determining the vertical magnetic field component  $Z_a$  for disturbing bodies in the shape of a stock, a thin vertical layer of infinite depth, a sphere, and a horizontal circular cylinder. The observations are made with the aid of special ladders from air balloons, helicopters, or in drill holes and can be used for approximate determination of the shape and depth of magnetized geologic bodies.—A.J.S.

- 191-513. Simonenko, T. N. K voprosu ob opredelenii napravleniya namagnichennosti tel v ikh yestestvennom zaleganii [On the problem of determination of the direction of magnetization of bodies in their natural occurrence]: Akad. Nauk SSSR Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 2, p. 137-141, 1960.

The possibility in theory of determining the magnetic vector of a buried intrusion from the magnetic anomaly is demonstrated, and methods which can be used in such determinations are reviewed briefly. A method of combined gravity and magnetic interpretation is suggested. The investigation is aimed at separating the induced and remanent components of magnetic anomalies.—A.J.S.

- 191-514. Gusev, Yu. M. K voprosu o metodike interpretatsii nesimmetrichnykh anomalii  $\Delta T$  [On the problem of methods of interpretation of asymmetric  $\Delta T$  anomalies]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 8, p. 90-99, 1960.

The feasibility of one of the possible methods of determining the depth to the upper boundary of vertically or obliquely magnetized bodies from the measured values of their  $\Delta T$  is analyzed and discussed. Formulas are derived for the depth  $h$  to a single pole, a line of poles, a thick vertical layer of infinite strike, a spherical body, and an infinite cylinder.—A.J.S.

- 191-515. Serbulenko, M. G. Korrelyatsionnyy metod interpretatsii dvukhmernykh potencial'nykh poley [Correlation method of interpretation of two-dimensional potential fields]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 11, p. 109-113, 1960.

An attempt is made to develop a method of interpretation of anomalous magnetic and (or) gravity potential fields that is independent of the physical nature of the potential field but is a function of the shape of the body. A brief theory of the method is given. It is based on the proved mathematical theorem that the normalized self-correlation function of an arbitrary component of a two-dimensional magnetic field is independent of the selection of the component and of the magnetization angle with regard to the plane to which the determined component is referred as soon as the shape of the body is given. Normalized correlation functions for the curves  $\Delta g$ ,  $V_z x$ ,  $Z$ , and  $H$  are calculated as a demonstration.—A.J.S.

- 191-516. Solov'yev, O. A. Nekotoryye voprosy transformatsii krivykh nablyudennykh znacheniy proizvodnykh magnitnogo potentsiala [Some problems of transformation of curves of observed values of magnetic potential derivatives]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 1, p. 112-113, 1961.

Hankel's integral transformation for three-dimensional bodies that are symmetrical with respect to the vertical axis is proposed for the transformation of curves of observed values of the magnetic potential derivatives of such bodies. The curves of Hankel's transformation  $\bar{Z}(\lambda)$ , where  $\lambda$  is the variable of transformation, are obtained for  $Z(a)$  of a thin vertical column, a sphere, a paraboloid of revolution, and a vertical column of radius  $a$ , all of which are vertically magnetized. Formulas for magnetic moments of such bodies are given in terms of  $\lambda$  and  $h$  (depth to the disturbing pole) for the first three bodies, and in terms of  $\lambda$ ,  $h$ , and  $J_1(\lambda, a)$  (the Bessel function of the first order) for the column of radius  $a$ . — A.J.S.

191-517. Serbuleiko, M. G. O korrelyatsionnoy interpretatsii vysshykh proizvodnykh dvukhmernykh potentsial'nykh poley [On correlation interpretation of higher derivatives of two-dimensional potential fields]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 4, p. 109-110, 1961.

To facilitate the process of normalization of self-correlation functions, it is suggested that the instrumental data be differentiated, and that the changes introduced into the self-correlation function of two-dimensional potential fields be investigated. A formula is derived for the self-correlation function of higher derivatives for a circular cylinder. — A.J.S.

191-518. Konstantinov, G. N., Konstantinova, L. S., and Filatov, V. A. K vo-prosu opredeleniya nulevogo urovnya magnitnykh anomalii [On the problem of determination of the zero level of magnetic anomalies]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 5, p. 91-92, 1961.

A simple method of determining the zero level of observed magnetic anomalies for two-dimensional cases is discussed. The method is based on the expression for the horizontal gradient of the magnetic potential at a certain point using the distribution of the field's vertical gradient  $Z$  on the horizontal line of observation. The method proposed can be applied to analysis of other potential functions. — A.J.S.

191-519. Solov'yev, O. A. Ispol'zovaniye dvukhmernogo integral'nogo pre-obrazovaniya Fur'ye dlya interpretatsii magnitnykh anomalii [Application of the two-dimensional integral transformation of Fourier for interpretation of magnetic anomalies]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 5, p. 92-93, 1961.

The two-dimensional Fourier integral transformation is proposed for use in interpretation of three-dimensional fields, and the mathematics of the process is discussed. Hankel's transformation is proposed for disturbing bodies that are symmetrical to the vertical axis. — A.J.S.

191-520. Mikov, D. S. Opredeleniye glubiny zaleganiya geologicheskikh tel po otnosheniyu ploshchadi anomal'nykh grafikov i maksimal'nykh napryazheniyam [Determination of the depth of occurrence of geologic bodies using the ratio of the area of the anomalistic graphs to the maximum intensities]: Geofiz. Razvedka, no. 3, p. 62-69, 1961.

The depth of occurrence,  $h$ , of geologic bodies is determined by the formula  $h=kP/Z_m$  where  $P$  is the positive area limited by the anomalistic curve and the abscissa,  $Z_m$  is the maximum intensity of the anomaly, and  $k$  is a certain coefficient depending on the shape of the body. Examples of calculations are given for a vertical layer and stock, a horizontal circular cylinder, and a sphere that are vertically magnetized. A table of coefficients,  $k$ , for bodies of other shapes is also given. — A.J.S.

- 191-521. Fedorova, N. A. Nomogrammy dlya vychisleniya  $H$  and  $Z$  nad paraboloidom vrashcheniya [Nomograms for calculation of  $H$  and  $Z$  over a paraboloid of revolution]: Geofiz. Razvedka, no. 5, p. 54-61, 1961.

A nomogram for determining numerical values of  $H$  over a paraboloid of revolution inclined by an angle  $\alpha$  to and in the plane of the  $X$  axis of rectangular coordinates  $X, Y, Z$  is discussed. An equation is derived for computing the nomogram parameters from given values of  $\alpha, X/f, P/f$ , and vertical magnetization intensity  $I=(200/3)$ , where  $f$  is the depth of focus of the paraboloid, and  $P$  is the parameter of the parabola which forms the paraboloid. Nomograms for determination of  $H$  and  $Z$  are given.—A.J.S.

- 191-522. Nassonov, V. A. Pereschet magnitnykh anomalii slozhnoy formy na zadannuyu vysotu [Extension of magnetic anomalies of complicated shape to a given altitude]: Geofiz. Razvedka, no. 5, p. 61-66, 1962.

Construction of a new master chart for extending magnetic anomalies of complex form to a given altitude is discussed. The master charts proposed by Andreyev (see Geophys. Abs. 158-17) are shown to be inadequate for such extensions. Satisfactory results using the new master charts on anomalies in the Ina region of the Altay are reported.—A.J.S.

- 191-523. Nepomnyashchikh, A. A. K teorii interpretatsii magnitnykh anomalii [On the theory of interpretation of magnetic anomalies]: Vyssh. Ucheb. Zavedeniy Izv., Geologiya i Razvedka, no. 1, p. 94-113, 1962.

In the interpretation of magnetic anomalies it has very often been assumed that the geologic bodies are magnetized vertically by the geomagnetic field, but the conditions of vertical magnetization have not been fully studied, nor has the effect of the form and position of objects in space on their magnetization been examined in sufficient detail. Remanent magnetization also is not often taken into account because of a lack of data on its intensity and direction. All these factors can lead to considerable error in interpretation of magnetic survey data. Detailed study of magnetic properties of rocks and ores also demands more complete information on the effect of demagnetizing factors and of remanent magnetization on the effective magnetization.

The influence of these various factors on magnetization of bodies is examined theoretically in this paper, and interpretations that take them into account are illustrated by examples.—D.B.V.

- 191-524. Tyapkin, K. F. Do pytannya vyznachennya vertykal'noi koordynaty tsentra vagy dvomirnykh ob'yektiv za rezul'tatamy magnitnykh sposterzhen' [On the problem of determination of the vertical coordinate of the gravity center of two-dimensional bodies from magnetic observational data]: Akad. Nauk Ukrayin. RSR Dopovidī, no. 7, p. 888-891, 1960.

A graphical method is proposed for calculation of the vertical coordinate of the center of gravity of two-dimensional bodies, which uses the asymptotic values of magnetometric functions  $\phi=-X^2Z_0$  and  $\Psi=-X^3H_0$ , where  $Z_0$  and  $H_0$  are the vertical and the horizontal components of a vertically magnetized body. By a reduction of uniformly magnetized two-dimensional bodies to the vertical orientation of their magnetization, the vertical coordinate of their centers of gravity can be determined for any direction of magnetization.—A.J.S.

- 191-525. Carrozzo, M. T., and Morelli, C[ar]lo. Reticoli per l'interpretazione magnetica [Master charts for magnetic interpretation]: Boll. Geofisica Teor. ed Appl., v. 3, no. 11, p. 183-192, 1961.

By equating the effect of a single magnetic layer and a double magnetic layer, master charts are prepared for interpretation of magnetic anomalies with the aid of Coutini's magnetic tables. Errors due to the difference between the single and double magnetic layers are accounted for in preparation of the master charts for calculating magnetic anomalies of two- and three-dimensional masses of finite and infinite extents. Curves of magnetic anomalies for parallelepipeds, 1,000×500×1,000 m, 1,000×1,000×1,000 m, and 1,000×1,500×1,000 m, with their centers at a depth of 1,500 m, are calculated and drawn.—A.J.S.

Bulakh, Ye. G., and Yevsikova, L. G. An integral method of interpreting gravity and magnetic anomalies. See *Geophys. Abs.* 191-335.

191-526. Orlov, V. P. Neobychno bol'shiye izmeneniya velichin vekovogo khoda geomagnitnogo polya [Unusually large changes in the values of secular variations of the geomagnetic field]: *Geofiz. Razvedka*, no. 3, p. 81-85, 1961.

Changes in the rate of secular variation of the total magnetic field,  $T$ , and their effect on the accuracy of magnetic maps of 1:200,000 and 1:1,000,000 scales are discussed. Examples are given for sudden changes in the rate of variation of the geomagnetic field during the period of 1949-59. Graphs of the mean-annual values of the rate of secular variation and a schematic map of isoporic lines over the territory of the U.S.S.R. are given.—A.J.S.

191-527. Fermandzhiev, I. I. Relefnii vliyaniya v' rkhuzemnoto magnitno pole [Effect of relief on the magnetic field of the earth (in Bulgarian with English and Russian summaries)]: *B'lgar. Akad. Nauk. Izv., Otdel. Fiz.-Mat. i Tekh. Nauki, Ser. Fiz.*, v. 6, p. 367-387, 1956 (1957).

The effect of relief on the distribution of the geomagnetic field can be appreciable above iron ore deposits. When the country rock has a magnetic susceptibility close to that of the ore formation, the effect of relief must be removed before reliable interpretation of magnetic measurements on the orebody can be made. Investigations on three hematite deposits show how the presence of valleys not only reduces the anomaly but may even produce negative instead of positive  $\Delta Z$  anomalies over the ore.

Quantitative calculations of the effect of relief are made for a vertical cylinder and for rectangular and parabolic horizontal troughs. By correcting for the effect of relief it is possible not only to obtain the true anomaly but also to determine to what extent it is due to the ore body and to what extent to a surface layer of high magnetic susceptibility.—D.B.V.

191-528. Hervás Burgos, Pablo. Localización de un filón magnético [Location of a magnetic vein]: *Rev. Geofísica*, v. 20, no. 77, p. 9-14, 1961.

The field of a buried, dipping magnetic dipole is discussed. The calculation from the anomaly field of the position of the deeper pole, the mass of the body, the dip of the dipole, and its position and length are illustrated.—D.B.V.

191-529. Ramaswamy, G. Discussion of "An evaluation of basement depth determination from airborne magnetometer data" by Peter Jacobson, Jr.: *Geophysics*, v. 27, no. 1, p. 162, 1962.

Airborne magnetic surveying does not have one of the advantages of ground surveys, that of simultaneous gravity observations. The absence of concurrent information on gravity has been a real handicap with aeromagnetic interpretation in reliably locating basement features in the early stages of exploration. In large unexplored sedimentary areas the gravity data are as valuable, sometimes more, to the interpretation of magnetic data as a knowledge of the mag-

netic properties of any outcropping rocks. The improvement of the present aerial gravimeter instrumentation so that simultaneous gravity and magnetic surveys can be made from the air is greatly to be desired.

In current practice, the value of the aeromagnetic data too often ceases when the basement depth map is prepared and seismic-gravity surveys are begun, but aeromagnetic reviews and re-interpretations can be of value to seismic surveys as a program guide; this point is illustrated by reference to Jacobsen's paper (see *Geophys. Abs.* 184-500, 185-475).—D.B.V.

- 191-530. Logačev [Logachev], A. A. Der gegenwärtige Stand und die Möglichkeiten der Verbesserung einer geologischen Deutung von magnetischer Messung [The present state and possibilities of improvement of a geologic interpretation of magnetic measurement]: *Freiberger Forschungshefte*, C 100, p. 95-101, 1961.

Present methods of interpreting magnetic survey data are reviewed. In the U.S.S.R., magnetic maps of particular areas or of individual formations are supplemented by schemes of the geologic structure, profiles, and studies of the magnetic properties of the rocks, and in some cases also by theoretically calculated examples appropriate to the individual case. Illustration of structure brought out by magnetic anomalies is shown for three examples: a plateau uplifted along a local fault, a trap plateau bounded on one side by Mesozoic sediments and on the other by a steep slope, and a lava plateau with deeply incised valleys. Such pictures can be constructed only by professionals who have surveyed the area and know the geologic and geophysical material.—D.B.V.

- 191-531. Belevtsev, Y. N. Poiskovyie kriterii zheleznykh rud magnitnykh anomalii [The prospecting criteria of iron ores of magnetic anomalies]: *Kiev, Akad. Nauk Ukrain. SSR*, 44 p., 1954.

Basic geologic features of iron ore deposits are discussed, and such ores of the Kursk and Krivoy Rog magnetic anomalies are described. Stratigraphic, mineralogic-petrographic, structural-tectonic, magmatogenic, and geochemical criteria for iron ore deposits in the fields of these anomalies are given. The methods of prospecting for such iron ores are discussed.—A.J.S.

- 191-532. Bromery, R[andolph] W. Aeromagnetic map of the Grand Lake Sebobeis Quadrangle, Aroostook and Penobscot Counties, Maine: U.S. Geol. Survey Geophys. Inv. Map GP-288, 1962.

This aeromagnetic map shows by contour lines the total intensity at about 500 feet above ground level for the Grand Lake Sebobeis quadrangle, Aroostook and Penobscot Counties, Maine.—W.L.G.

- 191-533. Balsley, J[ames] R. Aeromagnetic maps of Maine: U.S. Geol. Survey Geophys. Inv. Map GP-289 and GP-290, 1962.

Aeromagnetic maps have been published at a scale of 1:62,500 (1 inch=about 1 mile) for the following: GP-289, Oxbow quadrangle, Aroostook and Penobscot Counties; and GP-290, Howe Brook quadrangle, Aroostook County.—W.L.G.

- 191-534. Henderson, John R., Jr. Aeromagnetic map of the Bridgewater quadrangle, Aroostook County, Maine: U.S. Geol. Survey Geophys. Inv. Map GP-291, 1962.

An aeromagnetic map has been published at a scale of 1:62,500 (1 inch=about 1 mile) for the Bridgewater quadrangle, Aroostook County, Maine.—W.L.G.

- 191-535. Bromery, R[andolph] W. Aeromagnetic map of part of the Shin Pond quadrangle, Penobscot County, Maine: U.S. Geol. Survey Geophys. Inv. Map GP-292, 1962.

An aeromagnetic map has been published at a scale of 1:62,500 (1 inch=about 1 mile) for part of the Shin Pond quadrangle, Penobscot County, Maine.—W.L.G.

- 191-536. Dempsey, W[illiam] J. Aeromagnetic maps of Maine: U.S. Geol. Survey Geophys. Inv. Maps GP-293, GP-294, GP-295, 1962.

Aeromagnetic maps have been published at a scale of 1:62,500 (1 inch=about 1 mile) for the following: GP-293, Island Falls quadrangle, Aroostook and Penobscot Counties; 294, Smyrna Mills quadrangle, Aroostook County; and 295, Houlton quadrangle, Aroostook County, Maine.—W.L.G.

- 191-537. Bromery, Randolph W., and Gilbert, Francis P. Aeromagnetic map of the Skinner and parts of the Attean and Sandy Bay quadrangles, Somerset and Franklin Counties, Maine: U.S. Geol. Survey Geophys. Inv. Map GP-310, 1962.

This is an aeromagnetic map at a scale of 1:62,500 (1 inch=about 1 mile) for the Skinner and parts of the Attean and Sandy Bay quadrangles, Somerset and Franklin Counties, Maine.—W.L.G.

- 191-538. Meuschke, J[ack] L., Petty, A[rley] J., and Gilbert, F[rancis] P. Aeromagnetic maps of New Hampshire and Vermont: U.S. Geol. Survey Geophys. Inv. Maps GP-296, GP-298, GP-299, GP-300, GP-301, and GP-302, 1962.

Aeromagnetic maps have been published at a scale of 1:62,500 (1 inch=about 1 mile) for the following: 296, Strafford quadrangle, Orange and Windsor Counties, Vermont; 298, Hanover quadrangle, Grafton and Sullivan Counties, New Hampshire, and Windsor County, Vermont; 299, Mascoma quadrangle and part of the Cardigan quadrangle, Grafton Merrimack, and Sullivan Counties, New Hampshire, and Windsor County, Vermont; 300, Claremont quadrangle, Sullivan County, New Hampshire, and Windsor County, Vermont; 301, part of the Sunapee quadrangle, Merrimack and Sullivan Counties, New Hampshire; and 302, Bellows Falls quadrangle and part of the Lovewell Mountain quadrangle, Cheshire and Sullivan Counties, New Hampshire, and Windham and Windsor Counties, Vermont.—W.L.G.

- 191-539. Bromery, R[andolph] W., and Gilbert, F[rancis] P. Aeromagnetic map of the Mt. Cube quadrangle and part of the Rumney quadrangle, Grafton County, New Hampshire, and Orange and Windsor Counties, Vermont: U.S. Geol. Survey Geophys. Inv. Map GP-297, 1962.

An aeromagnetic map of the Mount Cube quadrangle and part of the Rumney quadrangle, Grafton County, New Hampshire, and Orange and Windsor Counties, Vermont has been published at a scale of 1:62,500 (1 inch=about 1 mile).—W.L.G.

- 191-540. Meuschke, J[ack] L., Petty, A[rley] J., and McCaslin, W[illiam] E. Aeromagnetic map of the Keene quadrangle and parts of the Brattleboro and Monadnock quadrangles, Cheshire County, New Hampshire, and Windham County, Vermont: U.S. Geol. Survey Geophys. Inv. Map GP-303, 1962.

An aeromagnetic map has been published at a scale of 1:62,500 (1 inch=about 1 mile) for the Keene quadrangle and parts of the Brattleboro and Monadnock quadrangles, Cheshire County, New Hampshire, and Windham County, Vermont.—W.L.G.

- 191-541. Watkins, Joel S. Precambrian basement structure and lithology inferred from aeromagnetic and gravity data in eastern Tennessee and southern Kentucky: U.S. Geol. Survey Prof. Paper 450-C, Art. 69, p. C25-C28, 1962.

Precambrian lithologic units inferred from aeromagnetic and gravity anomalies trend more northerly than do Paleozoic units. There is no evidence that Paleozoic thrust faults of the Valley and Ridge province extend into the basement, although one major fault was identified in the basement.— Author's abstract

- 191-542. Balsley, J[ames] R., Meuschke, J[ack] L., and Blanchett, Jean. Aeromagnetic map of the Eagle Harbor quadrangle, Keweenaw County, Michigan: U.S. Geol. Survey Geophys. Inv. Map GP-314, 1962.

An aeromagnetic map has been published at a scale of 1:24,000 (1 inch=2,000 feet) for the Eagle Harbor quadrangle, Keweenaw County, Michigan.— W.L.G.

- 191-543. Steenland, Nelson C. Gravity and aeromagnetic exploration in the Paradox Basin: *Geophysics*, v. 27, no. 1, p 73-89, 1962.

Analysis of aeromagnetic data obtained in the eastern Paradox Basin of Utah and Colorado, principally in the vicinity of the Gypsum and Dolores structures, shows that the Precambrian surface is uplifted several thousand feet on the southwestern flanks of the surface structures and that the uplifted Precambrian blocks are strongly mineralized ferromagnetically. It is postulated that this mineralization is contemporaneous with deformation which, in turn, resulted in the formation of the "salt anticlines" in the adjacent deep basement areas to the northeast. Gravity anomalies in the area are minimal and attributable to the masses of the salt "bulges" within the surface anticlines. Once the residual is correctly obtained, the gravity anomalies are very effective in determining the thicknesses of salt and, conversely, the position of the Lower Paleozoic and Precambrian rocks.— D.B.V.

- 191-544. Bromery, R[andolph] W. Geologic interpretation of the aeromagnetic map of the Lebanon quadrangle, Linn and Marion Counties, Oregon: U.S. Geol. Survey Geophys. Inv. Map GP-212, 1962.

This aeromagnetic map published at a scale of 1:62,500 (1 inch=about 1 mile) shows a pronounced magnetic gradient believed to be associated with the edge of a buried magnetic unit that probably influenced the present course of the South Santiam River. A linear magnetic feature traced for 4 miles in the south part of the quadrangle suggests the presence of a fault.— W.L.G.

- 191-545. Canada Geological Survey. Aeromagnetic maps of Ontario: Canada Geol. Survey, Dept. of Mines and Tech. Surveys, Geophys. Papers 1140G-1157G, 1961; *ibid.* 1174G-1194G, 1962.

Aeromagnetic maps that show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following: 1140G, Lac La Croix, Rainy River District; 1141G, Beaverhouse Lake; 1142G, Manion Lake; 1143G, Pekagoning Lake; 1144G, Stormy Lake; 1145G, Dymont, Kenora District; 1146G, Sandybeach Lake; 1147G, Hudson, Kenora Dist.; 1148G, Lac Seul, Kenora District; 1149G, Namakan Lake; 1150G, Seine Bay; 1151G, Little Turtle Lake; 1152G, Entwine Lake; 1153G, Upper Manitou Lake; 1154G, Wabigoon, Kenora District; 1155G, Dryden, Kenora District; 1156G, Route Lake; 1157G, McIntyre Bay; 1174G, Sleeman, 1175G, Arbor Vitae, Rainy River District; 1176G, Morson, Kenora and Rainy River Districts; 1177G, Sioux Narrows, 1178G, Longbow Lake, 1179G, Kenora, Kenora District; 1180G, Lount Lake; 1181G, Lennan Lake; 1182G, Rainy River; 1183G, Four Mile Bay; 1184G, Big Island; 1185G, Falcon Island; 1186G, Clearwater Bay; 1187G, Keewatin, Kenora District; 1188G, Whitedog Lake; 1189G, Umfreville Lake; 1190G, Berry Point; 1191G, Waugh, Kenora District; 1192G, Caddy Lake; 1193G, Crowduck Lake; and 1194G, Ryerson Lake.— W.L.G.

- 191-546. Canada Geological Survey. Aeromagnetic maps of Manitoba: Canada Geol. Survey, Dept. of Mines and Tech. Surveys, Geophys. Papers 1045G, 1046G, 1051G-1054G, 1059G-1063G, 1066G-1071G, and 1074G-1076G, 1961.

Aeromagnetic maps that show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles: 1045G, Melvin Lake; 1046G, Dunsheath Lake; 1051G, Brisebois Lake; 1052G, Le Clair Lake; 1053G, Jordan Lake; 1054G, Eyrie Lake; 1059G, Attridge Lake; 1060G, Kustra Lake; 1061G, Chartrand Lake; 1062G, Ducharme Lake; 1063G, Easton Lake; 1066G, Fagman Lake; 1067G, Morrow Lake; 1068G, Fergus River; 1069G, Pangman Lake; 1070G, Paulson Lake; 1071G, Chipewyan Falls; 1074G, Rutledge Lake; 1075G, Chatwin Lake; and 1076G, Dean Lake.—W.L.G.

- 191-547. Canada Geological Survey. Aeromagnetic maps of Saskatchewan: Canada Geol. Survey, Dept. of Mines and Tech. Surveys, Geophys. Papers 1204G-1262G, 1962.

Aeromagnetic maps that show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following: 1204G, Maurice Bay; 1205G, Cracklingstone; 1206G, Goldfields; 1207G, Forget Lake; 1208G, Uranium City; 1209G, Thluicho Lake; 1210G, Harper Lake; 1211G, Thainka Lake; 1212G, Zin Bay; 1213G, Burchnell Lake; 1214G, Ena Lake; 1215G, Riou Lake; 1216G, Engler Lake; 1217G, Richards Lake; 1218G, Helmer Lake; 1219G, Isle Brochet; 1220G, Fond-Du-Lac; 1221G, Lowe Lake; 1222G, Wiley Lake; 1223G, Fontaine Lake; 1224G, Oman Lake; 1225G, Forsyth Lake; 1226G, Nevins Lake; 1227G, Dardier Lake; 1228G, Carcoux Lakes; 1229G, Chappuis Lakes; 1230G, Scott Lake; 1231G, Cyprian Lake; 1232G, Perching Lake; 1233G, Fir Island; 1234G, Elizabeth Falls; 1235G, Clut Lakes; 1236G, Lytle Lake; 1237G, Higginson Lake; 1238G, Pinkham Lake; 1239G, Herbert Lake; 1240G, Young Lake; 1241G, Chambeuil Lake; 1242G, Astrolabe Lake; 1243G, Dodge Lake; 1244G, Seguin Lake; 1245G, Gaste Lake; 1246G, Offset Lake; 1247G, Hara Lake; 1248G, Eynew Lake; 1249G, Bickerton Lake; 1250G, Misekumaw Lake; 1251G, Walker Lake; 1252G, Franklin Lake; 1253G, Hutcherson Lake; 1254G, Nunim Lake; 1255G, Dutton Lake; 1256G, Emerson Lake; 1257G, Battleford Lake; 1258G, Sakwaw Lake; 1259G, Wayow Lake; 1260G, Bailey Lake; 1261G, Warren Lake; and 1262G, Patterson Lake.—W.L.G.

- 191-548. Canada Geological Survey. Aeromagnetic maps of Northwest Territories: Canada Geol. Survey, Dept. of Mines and Tech. Surveys, Geophys. Papers 1263G-1266G, 1275G-1278G, and 1287G-1290G, 1962.

Aeromagnetic maps that show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following: 1263G, Brazen Lake; 1264G, Rockpoint Lake; 1265G, Delight Lake; 1266G, Alcantara Lake; 1275G, Whirlwind Lake; 1276G, Escort Lake; 1277G, Majeau Lake; 1278G, Anderson Lake; 1287G, Portman Lake; 1288G, Imogen Lake; 1289G, Grampus Lake; and 1290G, Kidder Lake.—W.L.G.

- 191-549. Gianfrani, A. Rilevamento geomagnetico del Monte Nuovo [Geomagnetic survey of Monte Nuovo (with English abstract)]: Associazione Geofisica Italiana Atti del X Convegno Annuale, Roma, 1960, p. 215-221, 1960.

An analysis of the results of a geomagnetic survey of Monte Nuovo from the standpoint of volcanology shows that the distribution of the isoanomalies of the Z and H components is similar to that due to a subterranean dipole with its center at a depth of about 185 m. Isoanomaly maps are included.—V.S.N.

- 191-550. Särchinger, Hellmuth, and Peschel, Gerald. Nachweis eines bisher unbekanntes Teiles des Roteisenerzlagers am Südrand des Büchenbergsattels durch erdmagnetische Messungen [Detection of a hitherto unknown part of the Red Iron Ore layer at the south edge of the Büchenberg anticline by geomagnetic measurements (with English and Russian summaries)]: Zeitschr. Angew. Geologie, v. 7, no. 6, p. 292-295, 1961.

A magnetic survey revealed an anomaly on the south edge of the Buchenberg anticline near Elbingerode, in the central Harz mountains of Germany, that proved to be due to a part of the Red Iron Ore formation. Results of susceptibility measurements on drill core specimens are given. Micromagnetic surveys on 2m×5m grid in the vicinity of one of the boreholes served to distinguish the two different kinds of ore (in schalstein and in Stringocephalus beds) and bring out structural details.— D.B.V.

- 191-551. Khomenko, V. I. Typy magnitnykh anomalii Zakarpattya [Types of magnetic anomalies of the Transcarpathians]: Akad. Nauk Ukrayin. RSR Dopovid, no. 2, p. 176-180, 1961.

Six types of aeromagnetic anomalies are recognized in the Transcarpathian region. The characteristics of each are described and the distribution of magnetic bodies and their physical and geometrical parameters are given.— A.J.S.

- 191-552. Stupak, N.K. Ispoil'zovaniye geofizicheskikh metodov razvedki pri poiskakh mestorozhdeniy silikatnogo nikelya v Srednem Pridneprov'ye [Application of geophysical methods in prospecting for nickel silicate deposits in the middle Dnieper region]: Geofiz. Razvedka, no. 3, p. 86-92, 1961.

The application of the magnetic and gravimetric methods to exploration for ultrabasic massifs, with which the nickel silicate deposits of the middle Dnieper region of the Ukrainian crystalline shield are associated, is discussed. A systematic magnetic and gravimetric survey carried out in this region in 1955-58 has resulted in prognostic maps of the distribution of areas of ultrabasic rocks. These maps were confirmed by drilling of boreholes.— A.J.S.

- 191-553. Stroiteleva, A. V., and Kulikova, M. V. Kratkiy obzor geofizicheskoy izuchennosti nalichiya zhelezo-rudnykh mestorozhdeniy v Tsentral'nom Kazakhstane [Short review of geophysical study of the presence of iron deposits in central Kazakhstan], in Zhelezorudnyye Mestorozhdeniya Tsentral'nogo Kazakhstana i Puti ikh Ispol'zovaniya: Moscow, Akad. Nauk SSSR, p. 9-12, 1960.

Geophysical operations in the Kazakh S.S.R. up until 1949 consisted mainly of large-scale (1:5,000-1:25,000) ground magnetic surveys in the vicinity of iron deposits. Subsequently, aeromagnetic surveys on a smaller scale (1:100,000) have been employed in wider exploration efforts. This work has not resulted in locating any large iron deposits, but anomalies in previously known fields have been confirmed and several small skarn-type iron deposits have been found. Much aeromagnetic data on central Kazakh S.S.R. has now been collected for analysis. The flight lines were at an altitude of 50-100 m, and the maps are on a scale of 1:25,000, 1:100,000, and 1:200,000. A total area of 1,205,000 sq km had been covered at the beginning of 1957.— J.W.C.

- 191-554. Ivankin, P. F., and Malygin, A. A. K metodike interpretatsii i sistematiки magnitnykh anomalii na primere Leninogorskogo rudnogo rayona [Method of interpreting and systemizing magnetic anomalies in the example of the Leninogorsk mining region]: Akad. Nauk Kazakh. SSR., Trudy Altay. Gornometallurg. Nauchno-Issled. Inst., v. 12, p. 49-55, 1962.

The magnetic field in the Leninogorsk mining district is characterized by contrasts and complexities. Four types of anomalies are distinguished: (1) Normal field corresponding to those broad areas in which the field is simple in make-up and variations in intensity are small; (2) superposed local anomalies of the first order which generally are caused by a single intrusion; (3) superposed anomalies of the second order related to the contacts of intrusions; and (4) narrow local superposed anomalies of the third order related to faults and contact deposits. The magnetic field of the area is determined by the synthesis of these four types.—J.W.C.

Tal'-Virskiy, B. B., and Fomin, V. M. Nature of the magnetic and gravity anomalies of the Bukharo-Khivin oil-gas area and of Kyzyl-Kum. See *Geophys. Abs.* 191-377.

191-555. Andreyev, V. I., and Kuprin, V. I. Geologo-geofizicheskaya otsenka perspektiv zhelezorudnogo polya na glubokikh gorizontakh na primere tashtagol'skogo mestorozhdeniya [Geologic-geophysical evaluation of the prospects of an iron ore field in deep horizons as exemplified by the Tashtagol deposits]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 8, p. 82-94, 1961.

The method of evaluation of the deep-level magnetite deposits (over 1,000 m) in the Tashtagol area of the Sayan-Altay region is discussed. A comparison is made between magnetic prospecting in the area during 1931-36, structural geological prospecting in 1947-49, and land and airborne magnetic surveys in 1955-58 and 1959. General agreement was found between the results of the structural-geological prospecting and the later geophysical prospecting.—A.J.S.

191-556. Provodnikov, L. Ya. Rel'yef skladchatogo fundamenta Zapadno-Sibirskoy nizmennosti [The relief of the folded basement of the West Siberian Lowland]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 11, p. 57-64, 1960.

The character of the folded pre-Jurassic basement of the West Siberian Lowland is described on a basis of airborne magnetic surveys, seismic probing, and deep boreholes.—A.J.S.

191-557. Karatayev, G. I. Stroyeniye zemnoy kory v Zapadnoy Sibiri po geofizicheskim dannym [Structure of the earth's crust in western Siberia according to geophysical data]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 11, p. 65-82, 1960.

A new method of qualitative and quantitative interpretation of combined magnetic and gravity anomalies in the territory of west Siberia is presented. The structures of the relief of the pre-Jurassic folded basement and the crust thickness to the Conrad and Mohorovičić discontinuities, determined by a statistical investigation of the distribution of magnetic and gravitational masses in the profiles studied, are discussed.—A.J.S.

191-558. Loshchakov, A. I. K voprosy ob interpretatsii aeromagnitnykh nablyudeny, provedennykh v almazonosnykh rayonakh zapadnoy Yakutii [Concerning the question of interpretation of aeromagnetic observations made in the diamond regions of western Yakutia, in Primeniye aerometodov pri poiskakh korennykh mestorozhdeniy, almazov]: Moscow, *Akad. Nauk SSSR*, p. 85-100, 1960.

Calculations of depths of burial and susceptibilities of basic rocks were made from aeromagnetic anomalies and compared with actual values. The best results were obtained from anomalies associated with linear bodies striking nearly perpendicular to the direction of the flight lines, provided the anomalies

were of sufficient size for accurate measurement of gradients. Calculated depths of burial of all relatively large bodies were judged sufficiently accurate, as were also most calculated susceptibilities. Calculations from anomalies associated with round bodies of limited vertical extent were the most inaccurate; errors in depths of burial of 40 percent and more were found, and the variation of observed susceptibilities was so large that the lithologies could not be determined.— J.S.W.

- 191-559. Loshchakov, A. I. Opyt interpretatsii regional'nogo magnitnogo polya i svyaz' namagnichennykh tel s tektonikoy v almazonosnykh rayonakh zapadnoy Yakutii [Experiment in interpretation of the regional magnetic field and the relation of magnetized bodies to tectonics in the diamond-bearing regions of western Yakutia in *Primeneniye aerometodov pri poiskakh korennykh mestorozhdeniy almazov*: Moscow, Akad. Nauk SSSR, p. 101-114, 1960.

Kimberlite intrusions occur as both dikes and pipes in the Yakutia region. The pipes are always found at intersections of basement fracture zones inferred from aeromagnetic data. The deviation of calculated boundaries from the actual fault outcrops is within the limits of error expected due to dip of surface faults and from inexact location of the flight lines.— J.S.W.

- 191-560. Barygin, V. M. Poiski kimberlitovykh trubok aerometodami [Prospecting for kimberlite pipes from the air]: Akad. Nauk SSSR, Yakuts. Fil. Sibirskoye Otdeleniya Trudy, Sbornik 6, p. 172-179, 1961., translation by N. W. Wilson in *Mining Mag.*, v. 107, no. 2, p. 73-78, 1962.

The most effective methods of airborne exploration for kimberlite-type ultrabasic rocks on the Siberian platform are discussed, and the following combination of methods is recommended for exploration for these diamond-bearing rocks: (1) visual observations from the air; (2) aeromagnetic survey; (3) air-photographic survey; (4) coordination of the data from the aeromagnetic survey with those from the air-photographic survey; (5) aeromagnetic selective re-survey; (6) coordination of new data with earlier data as final basis for a ground survey; (7) field geological interpretation of air photographs and testing of magnetic anomalies; and (8) geophysical surveys on the ground.— V.S.N.

- 191-561. Overseas Geological Surveys. Geophysical field surveys - British Borneo 1961: Overseas Geol. Surveys Rept. for 1960-61, p. 12, 1962.

Ground magnetic surveys were carried out in the area of bauxite source-rocks of Sarawak to determine the desirability of an aeromagnetic survey. The results show that most of the bauxite source-rocks in West Sarawak produce magnetic anomalies and that an aerial survey might locate undiscovered rocks that may weather to bauxite. The magnetic background, however, is generally flat and the density of the anomalies is low. Thus, an aeromagnetic survey would be unjustifiable unless a large proportion of the anomalies were associated with deposits of economic importance.

Resistivity and gravity surveys to determine the depth and form of various known ore bodies are discussed briefly.— V.S.N.

#### MICROSEISMS

- 191-562. Leet, L[ewis] Don, and Leet, Florence J. Cause of microseisms—a theory: *Geol. Soc. America Bull.*, v. 73, no. 8, p. 1021-1022, 1962.

Worldwide compression of the earth's crust, evidenced from the reduction of surface areas in mountain-making, faulting, and creep and revealed by pre-

cise surveys, is proposed as the ultimate cause of microseisms. The strained crust, broken into blocks of many sizes, is "singing." When extensive storm areas move over strained blocks, the regional changes in atmospheric loads cause temporary increases in microseismic activity.— Authors' abstract

- 191-563. Oliver, Jack [E.]. A worldwide storm of microseisms with periods of about 27 seconds: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 507-517, 1962.

On June 6, 1961, a storm of microseisms with periods of about 27 sec and a duration of about 8 hr was detected by long period seismographs throughout the world. At Palisades, ultra-sensitive seismographs detected the storm for an interval of about 2 days during which the periods of the waves decreased from about 28 to about 20 sec. The seismic waves appear to be largely of the Rayleigh type and seem to originate in the southern or equatorial Atlantic Ocean. The favored hypothesis on the nature of the source mechanism suggests that the seismic waves were generated by dispersed ocean waves striking the coast of the Gulf of Guinea. A second hypothesis suggests that the microseisms are a form of harmonic tremor associated with magmatic activity beneath the South Atlantic Ocean.— Author's abstract

- 191-564. Iyer, H. M. World-wide microseismic study: *Nature*, v. 194, no. 4833, p. 1031-1033, 1962.

Some interesting problems concerning microseisms, including that of their origin, are discussed. It is proposed that all modern seismograph stations should take an active interest in microseisms. A coordinated program, along lines that are suggested or better, carried out by at least a selected number of stations for an experimental period of time should provide solutions to many unsolved problems in microseismic science and prove a valuable tool in geophysics and in the meteorology of remote island stations.— D.B.V.

- 191-565. Bath, Markus. Direction of approach of microseisms: *Royal Astron. Soc. Geophys. Jour.*, v. 6, no. 4, p. 450-461, 1962.

Three methods for determination of the direction of approach of microseisms (Jensen's, Teissyre-Seimek's, and the amplitude method) that can conveniently be applied to standard seismograph records in three matched components are investigated. Theories are given for all three with special emphasis on the limitations in their use and influence of different wave types. The methods are applied to the Uppsala long-period records for two single-source cases typical of Scandinavian microseisms; the results agree well with each other and the errors are of comparable magnitude. Jensen's method and the amplitude method are preferred because they involve less evaluation work and fewer theoretical restrictions. These methods are as reliable as any others including the tripartite, and can also be used in cases with two or more sources if the angular separation between sources is sufficiently large and if the sources are of comparable strength.— D.B.V.

- 191-566. Decae, A. On some movements of the ground in Geneva: *Royal Astron. Soc. Geophys. Jour.*, v. 3, no. 1, p. 112-120, 1960.

The methods adopted (mainly geodetic) for measuring ground motions in connection with the construction and alinement of the 25 GeV proton synchrotron in Geneva, Switzerland are reviewed. Among the different movements recorded were small shocks and microseisms. About 100 small shocks per year with amplitude of 0.01 mm are felt at Geneva, half of them from the nearby Valais. Microseisms with 10- $\mu$ m amplitude and 4-sec period sometimes last for days or even a week, and are more of a nuisance. They are due to surf pounding the Atlantic coast under gales from the west.— D.B.V.

- 191-567. Zátopek, Alois. Sur la nature et l'origine des microséismes européens [On the nature and origin of European microseisms (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 5, no. 1, p. 51-63, 1961.

Results of analysis of microseism records obtained at Prague, Czechoslovakia, are summarized. It is concluded that microseisms in Europe are controlled mainly by circulation (particularly cyclonic) in the area east of the frontal zone between North America and the west coast of Europe. Their periods are 3-9 sec, and the amplitudes generally decrease toward the south and east; no formula fitting the decrease of amplitude with distance has been found. Microseisms produced in connection with cyclonic activity in first order source areas in this active zone are developed simultaneously throughout the European continent. Local differences are due to second order sources of smaller size, usually appearing near the coast. The Longuet-Higgins theory seems best to explain the production of microseisms in Europe.—D.B.V.

- 191-568. Moskvina, A. G., and Shebalin, N. V. A study of seismic noise and calculation of the optimum seismograph constants [with Russian summary]: Československá Akad. Věd Studia Geophys. et Geod., v. 5, no. 3, p. 227-230, 1961.

The spectrum of seismic noise (microseisms) was studied at more than 30 stations in the U.S.S.R. The periods of the noise are found to range from 0.1 to 5-7 sec. The spectrum varies from station to station, but the general shape of the spectral curves is similar: There are one or two maximums in the period range 0.1-0.6 sec with maximum amplitudes ranging from 0.01 to 1.0  $\mu$ , a deep minimum in the period range 0.6-2.0 sec with maximum amplitudes ranging from 0.001 to 0.1  $\mu$ , and a large maximum (or two maximums) in the range of storm microseisms, 2-8 sec, with maximum amplitudes ranging up to 1.0  $\mu$  or more. It is concluded that the sites of new seismic stations should not be chosen on the basis of geologic studies of the ground alone, but that trial seismic registration is absolutely indispensable.—D.B.V.

- 191-569. Kárník, Vít, and Tobyáš, Vladimír. Underground measurements of the seismic noise level (with Russian summary): Československá Akad. Věd Studia Geophys. et Geod., v. 5, no. 3, p. 231-236, 1961.

In order to find the seismic noise level at different places in Bohemia, several trial measurements were made in 1959-60 in six abandoned mine galleries: Nový Krún, Jáchymov, Mořina, Újezdec, Náchod, and Kasperské Hory. Short-period vertical electrodynamic seismographs were used with five different combinations of constants. The results are tabulated and compared with those found in a mine at Příbram and at the Průhonice seismic station.

Noise with periods of 0.1-0.2 sec has an amplitude less than 1-2  $\mu$ ; noise with periods of about 0.5 sec prevails in the short-period range and its intensity depends primarily on distance from towns; and noise with a period of 1 sec was rarely found with the magnifications used, but microseisms with periods beginning with 2 sec were regularly observed. These results permit the choice of a suitable station for experiments with sensitive seismographs and the selection of their response characteristics.—D.B.V.

- 191-570. Zátopek, Alois. Les microséismes de Praha au cours de l'Année Géophysique Internationale [Microseisms at Prague in the course of the International Geophysical Year (with Russian summary)]: Československá Akad. Věd Studia Geophys. et Geod., v. 4, no. 3, p. 233-249, 1960.

The periods and amplitudes of microseisms recorded at Prague during the International Geophysical Year and first half of 1959 are plotted as a function of time. The largest periods were 8 sec, and the maximum amplitudes were

2.8 $\mu$ . Comparison with meteorologic data confirms previous conclusions (see Geophys. Abs. 183-502); microseisms at Prague are a complex phenomenon closely related to circulation in the eastern part of the Atlantic frontal zone. Under complicated meteorologic conditions they may be generated simultaneously at several sources, the resulting records representing a superposition of waves. (See also Geophys. Abs. 190-487.)—D.B.V.

191-571. Korchagina, O. A., Meshkov, M. M., and Monakhov, F. I. K voprosu o chastotnoi selektsii okeanicheskikh shtormovykh mikroseyzm [On the problem of frequency selection of oceanic storm microseisms]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 771-775, 1962.

With a new setup for the multicascade frequency selecting apparatus the amplification of microseisms with a period of 7.5 sec is approximately fifty times that of the microseisms with the period of 5.5 sec (see Geophys. Abs. 186-531). The new setup located in Crimea produced no intensification of microseisms for cyclones in the North Atlantic at a considerable distance from the coast. However, one or two days after the cyclone reached its maximum intensity one can find the storm microseisms (probably due to surge at the coast) on the traces. Thus, the new setup is more sensitive than the ordinary seismic apparatus.—W.S.J.

191-572. Monakhov, F. I., and Dolbikina, N. A. Struktura mikroseyzm i metody opredeleniya napravleniy na istochniki ikh obrazovaniyu [Structure of microseisms and methods for determining the directions of the sources of their formation]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 10, p. 1463-1465, 1960.

Studies of the true distribution of directions of propagation of microseisms (see Geophys. Abs. 176-291) are extended for determining origin and also the degree to which interference is effective. This was accomplished by synchronous azimuthal and profile observations, the latter allowing the interference waves to be eliminated from the recorded data.—A.J.S.

## RADIOACTIVITY

191-573. Fleyshman, D. G., and Glazunov, V. V. Opredeleyeniye konstanty  $\beta$ -raspada K<sup>40</sup> [Determination of the beta-decay constant of K-40]: Atomnaya Energiya, v. 12, no. 4, p. 320-322, 1962.

The specific beta-activity of K-40, measured on one gram of natural potassium, is found to be 1,630 $\pm$ 5 beta-particles per min. If the K-40 concentration in natural mixtures of isotopes is 0.0119 $\pm$ 0.0001 percent or 0.0122 $\pm$ 0.0001 weight percent, the beta-decay constant of K-40 is  $\beta=4.67\pm 0.05\times 10^{-10}\text{yr}^{-1}$ .—D.B.V.

191-574. Mezhiborskaya, Kh. B. Fotoneutronnyy metod opredeleniya berilya [Photoneutron method of determining beryllium]: Moscow, Gosatomizdat, 52 p., 1961.

The photoneutron method of detecting beryllium, based on the nuclear reaction  $\text{Be}^9 + \gamma \rightarrow \text{Be}^8 + n$ , is described. The ways of detecting and recording the neutrons, the gamma sources that can be used, and the devices used in the determination and prospecting of beryllium are discussed in the first section. The second section describes in detail the laboratory variant of the method, including methods of analyzing the results. The third section concerns technical safeguards in the handling of the apparatus.—D.B.V.

191-575. Bloxam, T. W. Quantitative determination of uranium and thorium in rocks: Jour. Sci. Instruments, v. 39, no. 7, p. 387-389, 1962.

Uranium and thorium in silicate rocks and other geologic materials may be determined quantitatively by counting their natural gamma emission at 1.76 and 2.62 Mev, respectively. Improved sample holders have increased the sensitivity and precision to the extent that both uranium and thorium may be determined in the parts per million range. Samples of 200 grams or less are required, and counting times of 1 hour per channel are generally sufficient.—H.H.T.

- 191-576. Torio, Francisco. La energia de los núcleos atómicos [The energy of atomic nuclei (with English summary)]: *Rev. Geofísica*, v. 20, no. 78, p. 111-123, 1961.

The behavior of an atomic nucleus, either stable or radioactive, is explained. Gain and loss of energy are shown in a graph. A simplified demonstration is given of the Weizsäcker formula for nuclear energy.—D.B.V.

- 191-577. Shneiderov, A[natol] J. Radioactively induced stratification and discontinuity zones of the earth: *Boll. Geofisica Teor. ed Appl.*, v. 4, no. 13, p. 94-96, 1962.

An hypothesis is presented to explain the nature and origin of the seismically determined discontinuities in the earth's mantle. The simultaneous process of radioactive and gravitational differentiation of dust and gas particles that occurred during the stage of the proto-earth and continued through the following stages resulted in a radial migration of spherical zones of radioactive concentrates. The speed of migration and the temperatures of the zones are considered to be functions mainly of the energy content of the radioactivity. The temperature difference between the radioactive and inert zones of the mantle, and the subsequent possible differences in the physical-chemical state of the zones, are considered to be the cause of the seismic discontinuities observed. The possibility that the Mohorovičić discontinuity is the uppermost zone of radioactive concentration in the mantle is suggested.—Author's abstract

- 191-578. Ushakova, A. M. K radioaktivnosti porod Perzhanskogo intruzivnogo kompleksa [On the radioactivity of the rocks of the Perzhan intrusive complex (with English summary)]: *Geokhimiya*, no. 4, p. 354-357, 1961.

The radioactivity of the Perzhan intrusive complex, which occurs in the Sushchano-Perzhan fracture zone in the northwest part of the Ukrainian crystalline massif, has been studied. An increase in radioactivity is linked with the occurrence of filmy to ochreous coatings in fissures that have an uranium content of  $37-72 \times 10^{-4}$  percent, compared to an average of  $25 \times 10^{-4}$  percent in the granite. Radioactivity is high in the Perga-Rudnya Perzhan area, where hydrothermal quartitization has occurred; this suggests that hydrothermal processes have been largely responsible for the introduction of radioactive elements into the Perzhan complex.—D.B.V.

- 191-579. Mattana, N., Sanna, S., and Serra, A. La radioattività naturale a Cagliari e sue correlazioni con alcuni elementi meteorologici [The natural radioactivity at Cagliari and its correlation with some meteorological elements (with English abstract)]: *Associazione Geofisica Italiana Atti del X Convegno Annuale*, Roma, 1960, p. 95-122, 1960.

The measurement and behavior of the radon and thoron contents of the atmosphere at Cagliari during 1959 are discussed. It is found that a reliable correlation exists between natural radioactivity and wind and rainfall. Results are given in tables and graphs. A method is given also for the approximate computation of artificial radioactive contamination of the atmosphere after a few minutes of air sampling.—V.S.N.

- 191-580. Mazor, E. Radon and radium content of some Israeli water sources and a hypothesis on underground reservoirs of brines, oils and gases in the Rift Valley: *Geochim. et Cosmochim. Acta*, v. 26, p. 765-786, 1962.

Radon and radium concentrations in waters from 117 Israeli water sources were measured by radon extraction and Geiger counting. Radium concentrations varied from less than 2 to  $1,000 \times 10^{-12}$  curie per liter, all but two being less than  $180 \times 10^{-12}$  curie per liter. Radon concentrations exceeded the radium concentrations by from 0 to  $21,300 \times 10^{-12}$  curie per liter. The radioactivity and characteristics of the waters from the Dead Sea and Lake Kinneret areas of the Jordan Rift Valley are consistent with a model of underground reservoirs containing brine, oil, and gaseous phases. In this model, uranium is extracted from rock by the oil, radium is extracted from rock and from oil by brine, and radon produced by radium decay migrates into or escapes with the gas to appear as surface emanations or in meteoric waters. Conditions for accumulation of salts and organic material and for trap formation in the Rift Valley are considered to have been optimal. — A.B.T.

- 191-581. Shvedov, V. P., Gritchenko, Z. G., and Gedonov, L. I. Kонтсentratsiya Be<sup>7</sup> v prizemnom sloye vozdukha i atmosferynykh osadkakh [Concentration of Be-7 in ground-level air and atmospheric precipitations]: *Atomnaya Energiya*, v. 12, no. 1, p. 64-66, 1962.

Results of measurements of the Be-7 concentration in ground-level air and in atmospheric precipitations in the vicinity of Leningrad during a 15-month period in 1960-61 are tabulated. A seasonal variation with a maximum in summer and minimum in winter is clear. There is a constant transition factor from the specific activity of the atmospheric precipitations to the specific activity of the ground-level air; this factor, called the concentration coefficient, is about  $4.5 \times 10^5$ . — D.B.V.

## RADIOACTIVITY SURVEYING AND LOGGING

- 191-582. Matveyev, A. V. K voprosu ob aeropoiskakh v lesnykh rayonakh [On the problem of aerial prospecting in wooded areas]: *Atomnaya Energiya*, v. 11, no. 6, p. 550-552, 1961.

The screening effect of forest cover in airborne gamma-surveying is found to be small, and to be governed not so much by absorption of gamma radiation by the forest vegetation as by the difficulty of accurate alinement of flight lines and possibly by certain geochemical processes in forest soils. — D.B.V.

- 191-583. Troitskiy, S. G., Shashkin, V. L., and Bykova, K. I. Apparaturnyye spektry  $\gamma$ -izlucheniya beskonechnykh plastov uranovykh rud [Apparatus spectra of gamma-rays from infinite layers of uranium ores]: *Atomnaya Energiya*, v. 12, no. 1, p. 67-70, 1962.

The spectrum of gamma rays from infinite and semi-infinite layers of uranium ores having effective atomic numbers from 9 to 23 (calculated on the basis of chemical analyses) is investigated. Results are tabulated. It is apparent that in the case of infinite layers, impulses of an amplitude corresponding to energies less than 400 Kev predominate. — D.B.V.

- 191-584. Troitskiy, S. G., Shashkin, V. L., and Bykova, K. I. O vozmozhnosti razdel'nogo opredeleniya urana i toriya po dannym izmereniy spektrrov  $\gamma$ -izlucheniya rud v yestestvennom zaleganii [On the possibility of separate determination of uranium and thorium according to the data of measurements of gamma-ray spectra of ores in their natural occurrence]: *Atomnaya Energiya*, v. 12, no. 1, p. 70-72, 1962.

The "apparatus spectrum" of gamma rays from infinite and semi-infinite layers of uranium and thorium ores with uniform effective atomic numbers has been determined experimentally. Results, which are tabulated, suggest that the determination of uranium and thorium separately in such measurements, stabilized by means of an alpha-ray datum, can best be carried out in the energy intervals 400-600 and 1,100-1,300 Kev. The uranium equivalent of thorium, calculated for a narrow energy interval (about 25 Kev), in practice is not affected by the diameter of the crystals of NaI (Tl), effective atomic number of the medium, or thickness of the filters usually used in quantitative gamma-ray measurements.— D.B.V.

- 191-585. Peacock, J. D., and Williamson, R. Radon determination as a prospecting technique: *Inst. Mining and Metallurgy [London] Trans.*, v. 71, pt. 2, p. 75-85, 1960-61.

Of three techniques tried for measuring the radon from soil the most successful was the alpha-chamber technique of sucking the soil air into a 2×8.6×8.6 cm chamber between a pair of opposed alpha scintillation probes. Field measurements were made over known uranium-bearing veins in southern Scotland, where counting rates range from 2 to 9,000 counts per minute in contrast to instrumental background rates usually not exceeding 20 counts per minute; counting rates above background of less than 100 counts per minute are not significant. Two anomalies, one of 248 and the other of 660 counts per minute maximum activity, were checked by trenching. The first did not reveal uranium-bearing material, but was probably due to radioactivity washed down from known uraniferous ground 500 feet away. The second trench exposed a small uraniferous fracture-filling in hornfels at 6 1/2 foot depth. The method is recommended for delineating favorable zones in known uranium-bearing areas masked by soil.— A.B.T.

- 191-586. Seya, Kiyoshi. A theoretical consideration of radioactive intensity in the air [in Japanese with English abstract]: *Japan Geol. Survey Bull.*, v. 13, no. 1, p. 1-16, 1962.

Methods of evaluating the radioactivity effect of topography and geology for interpretation of airborne radioactivity surveys are discussed. The cause of abnormal relations between intensity of radioactivity and altitude above the terrain as found, for example, in an airborne survey in 1957 over Yamaguchi Prefecture is examined in detail, and, as a result, an improved method of making altitude corrections is presented. The paper is well illustrated with graphs carrying English subtitles.— V.S.N.

- 191-587. Davis, F. J., and Reinhardt, P. W. Radiation measurements over simulated plane sources: *Health Physics*, v. 8, p. 233-243, 1962.

An extended-source calibration area was set up in the Nevada Test Site area to standardize instrumentation and improve interpretation of aircraft measurements of fallout. A simulated plane source array was laid out with positions at 100-ft intervals in the form of a 2,000-ft square. For ground measurements a smaller square array of 100 positions at 10-ft intervals was placed in the center of the large array. Two sets of sources were used: Co-60 and Cs-137 of 4.5 and 15 mc, respectively, in the large array and sources 1/100 of these values in the smaller array. Measurements 3 ft above ground indicate 200  $\mu$ r per hr for Co-60 and 225  $\mu$ r per hr for Cs-137. Measurements were made in aircraft at 100-ft intervals above the array using scintillation counters and a 256-channel scintillation spectrometer. Flights for comparison of point sources were made over Co-60, Cs-137, and I-131. Data on the relations between radiation intensity above point and plane sources as well as spectral data are given. For these sources the tests demonstrate that above certain heights the effect of build-up cannot be neglected but is adequately represented by a linear formula.— V.S.N.

- 191-588. Davis, F. J., and Reinhardt, P. W., eds. Extended- and point-source radiometric program: U.S. Atomic Energy Comm. Civil Effects Exercise CEX-60.3, 64 p., 1962.

Four government agencies and one private company participated in an aircraft instrument intercalibration exercise in November 1960 over an extended-source calibration area in the Nevada Test Site area. Various types of aircraft and instrumentation devices - mostly scintillation detectors - were used. Flights ranging in altitude from 100 to 1,000 ft included background measurements, instrument calibration, intercalibration, proof-testing equipment, comparison of point- and area-source measurements, measurements of air attenuation and buildup of gamma radiation, and gamma-ray spectral measurements (see also Geophys. Abs. 191-587).— V.S.N.

- 191-589. Rothe, Klaus. Radiometrische Bestimmungen an Mineralien und Gesteinen (Grundlagen, Messverfahren mit Zählrohr, Eichung und Anwendung) [Radiometric determinations on minerals and rocks (Principles, methods of measurement with counting tube, calibration, and application)]: Freiburger Forschungshefte, C 68, 159 p., 1959.

The principles, methods of measurement and evaluation, and possibilities of application of radiometric determinations made with the tube counter in the laboratory, in the field, and in boreholes are treated in detail. Particular attention is given to problems of the calibration of tube counters. The comparative advantages and disadvantages of scintillometers and tube counters are appraised. Ionization methods, such as emanometry, are not considered.— D.B.V.

- 191-590. Yakubovich, A. L. Stsintillyatsionnaya radiometricheskaya apparatura i vozmozhnosti yeye primeneniya dlya geologicheskikh poiskov i razvedki [Scintillation radiometric apparatus and potentialities of its application to geological prospecting and exploration]: Moscow, Ugletekhizdat, 56 p., 1958.

Several types of scintillators are described and illustrated by circuit diagrams.— J.W.C.

- 191-591. Bates, Robert G. Natural gamma aeroradioactivity of the Oak Ridge National Laboratory area, Tennessee and Kentucky: U.S. Geol. Survey Geophys. Inv. Map GP-308, 1962.

The natural gamma aeroradioactivity is shown for an area of 9,000 sq mi, and its intensity is found to be related to the type of soil or rock at the surface. Well-defined linear radioactivity units in the Valley and Ridge province are closely related to the areal geology. The traces of most of the major thrust faults in the province are accurately outlined. Radioactivity levels are highest in the Great Smoky Mountains and lowest over the Cumberland Plateau and Highland Rim.— W.L.G.

- 191-592. Books, Kenneth G. Natural gamma aeroradioactivity of parts of the Los Angeles region, California: U.S. Geol. Survey Geophys. Inv. Map GP-309, 1962.

An aeroradioactivity map of parts of the Los Angeles region, California, has been published at a scale of 1:250,000 (1 inch=about 4 miles). Radioactivity levels are shown for approximately 2,800 sq mi. In the coastal plain areas and in the San Fernando Valley, the radioactivity ranges from 200-300 to 600-900 counts per second. In the Mojave Desert area, radioactivity ranges from 400-500 to 900-1,200 counts per second. In general, radioactivity associated with lowland alluvium is lower than that associated with consolidated rocks at higher elevations.— W.L.G.

- 191-593. Schmidt, Robert G. Aeroradioactivity survey and areal geology of the Hanford Plant area, Washington and Oregon (ARMS-1): U.S. Atomic Energy Comm., Civil Effects Study CEX-59.4.11, 25 p., 1962.

An airborne gamma radioactivity survey of 9,000 sq mi in south-central Washington and north-central Oregon indicates a moderate range in the level of radioactivity and a general relationship between the various levels and the geology of the region. The radioactivity reasonably attributable to natural sources in the Hanford Plant area ranges from 160 to 900 counts per second. Radioactivity ranges generally associated with the commonest geologic units are: Yakima basalt, 350-600 counts per second; Ellensburg formation, 300-400 counts per second; stratified lake and stream deposits, 400-600 counts per second; glacial outwash, 300-700 counts per second; wind-deposited silt, 350-750 counts per second; and Recent alluvium, 160-500 counts per second. A geologic map and an aeroradioactivity map are included with the report. (See also Geophys. Abs. 187-543.)—V.S.N.

- 191-594. Haruki, Kiyonosuke, and Nakazawa, Jiro. On the radioactivity of the Miocene sedimentary rocks in the Chugoku Mountainland [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 13, no. 1, p. 59-66, 1962.

Geiger and scintillation surveys were made over the Miocene sedimentary rocks of the Bihoku group in the Chugoku Mountains of Shimane and Tottori Prefectures, Japan. Maximum radioactivities of 0.051-0.079 and 0.046-0.050 mr per hr were found in the Takahara area and in the Miinohara and Tari areas, respectively. A  $U_2O_8$  content of 0.001-0.002 percent was found in samples from some areas, but the localities are discontinuous and limited in size.—V.S.N.

- 191-595. Kawachi, Yosuke; Obi, Itsuaki; Saito, Tsuguo; and Uno, Kaichi. Reconnaissance radiometric survey on Nan-etsu Mine, Niigata Prefecture [in Japanese with English abstract]: Japan Geol. Survey Bull., v. 13, no. 1, p. 67-72, 1962.

A radioactivity survey over the Cu-Pb-Zn veins of the Nan-etsu mine, Niigata Prefecture, Japan, showed no evidence of a radioactivity anomaly.—V.S.N.

- 191-596. Filippov, Ye. M. K voprosu o glubinnosti issledovaniya gornyykh porod i rud metodom rasseyannogo gamma-izlucheniya [On the problem of the depth of investigation of rocks and ores by the method of diffused gamma radiation]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 3, p. 103-108, 1960.

An equation is presented for the distribution of diffused gamma radiation when the source and detector are both at the surface of the medium (the wall of a borehole), and graphs illustrate the depth of penetration of the method (radial distance from the wall of the borehole).—A.J.S.

- 191-597. Polak, L. S., Filippov, Ye. M., Kuznetsov, G. A., and Zhavoronkov, V. Ya. Issledovaniye spektra rasseyannogo gamma-izlucheniya primenitel'no k resheniyu nekotorykh zadach geofiziki [Investigation of the spectrum of diffuse gamma radiation as applied to the solution of certain problems of geophysics]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 3, p. 111-116, 1961.

The effects of rock density and composition on the spectrum and intensity of gamma radiation are investigated by the diffuse gamma-radiation method.

It was found that in density determination of rocks and ores by this method, identical results obtained by the differential and integral rates of counting indicate the absence of heavy components in the medium studied.—A.J.S.

- 191-598. Aksel'rod, S. M., and Putkaradze, L. A. K voprosu ob etalonirovaniy apparatury radioaktivnogo karotazha (RK) [Concerning the question of calibration of radioactivity logging apparatus (RK)]: *Razvedochnaya i Promyslovaya Geofizika*, v. 38, p. 112-114, 1960.

Normal calibration procedures for the gamma-ray logging apparatus, RK, consist of determining the increase in the number of counts per second recorded when the gamma-ray intensity is increased by a fixed amount above background. It is assumed that the ratio of recorded counts per second to gamma-ray emissions is constant over the working range of the instrument. Tests of two instruments indicate, however, that the response is not linear, a factor which causes errors of 8 to 12 percent at a true gamma-ray intensity of 5,000 counts per second. Future calibrations should, therefore, include comparisons of instrument response at several different intensities of gamma radiation.—J.S.W.

## SEISMIC EXPLORATION

- 191-599. Rice, R. B. Inverse convolution filters: *Geophysics*, v. 27, no. 1, p. 4-18, 1962.

This paper discusses a digital computer approach to the problem of performing the inverse of the reflection process, that is, to "divide out" the reflection wavelet of which the record is composed to leave only the impulses representing the reflection coefficients. Finite, bounded inverse filter functions are obtained which will reduce seismic wave forms to best approximations to the unit impulse in the least squares sense. The degree of approximation obtained depends on the time length of the inverse filter. Inverse filter functions of moderate length produce approximate unit impulses whose breadths are 50 percent or less than those of the original wavelets. Hence, these filters will increase resolution well beyond the practical limits of instrumental filters. Their effectiveness is more or less sensitive to variations in the peak frequency and shape of the composition wavelet, and to interference, depending on individual conditions. Although this sensitivity problem can be solved to some extent through the proper design of the inverse filter, it is aggravated by the usual lack of knowledge about the form of the composition wavelet.—D.B.V.

- 191-600. Sherwood, J. W. C. The Seismoline, an analog computer of theoretical seismograms: *Geophysics*, v. 27, no. 1, p. 19-34, 1962.

A description is given of the Seismoline, an electrical analog computer of theoretical reflection seismograms involving all primary and multiple reflections. The computer utilizes an analogy between seismic wave propagation through a stratified earth and electrical wave propagation along a lumped-parameter transmission line. A description is given of the prototype Seismoline and the experimental tests performed on it. It is concluded that it provides a convenient, speedy, and sufficiently accurate computer for the quantity production of theoretical seismograms, except possibly in cases where the acoustic impedance contrasts of the geologic section are extremely low. Changes in the velocity and thickness of the various geologic layers may be made with ease, and the resulting changes on the seismogram can be viewed almost simultaneously. This inherent flexibility introduces the possibility of a feedback process whereby an operator might modify his filter settings or the geologic model in order to effect a better match between corresponding theoretical and field seismograms.— Author's abstract

- 191-601. Molotova, L. V., and Vasil'yev, Yu. I. O velichine otnosheniya skorostey prodol'nykh i poperechnykh voln v gornykh porodakh. II [On the magnitude of the ratio of the velocities of longitudinal and transverse waves in rocks. Pt. 2]: Akad. Nauk SSSR Izv. Ser. Geophys., no. 8, p. 1097-1116, 1960.

This is a continuation of an earlier paper on methods of determining  $v_p/v_s$  in rocks (see Geophys. Abs. 184-540). The functional relationship between the  $v_p/v_s$  ratio and the frequency of elastic waves from several cycles per second to tens of megacycles per second propagating through a heterogeneous medium is discussed. Tables of  $v_p$  at depth  $H$ , the ratio  $v_p/v_s$ , and the Poisson coefficient  $\sigma$  are given for various crystalline and sedimentary rocks, determined in the field and laboratory. The  $v_p/v_s$  ratio ranges from 1.7 to 1.9 in crystalline and metamorphic rocks and from 1.5 to 14.0 in sedimentary rocks.—A.J.S.

- 191-602. Bulin, N. K. Velichina otnosheniya srednikh skorostei prodol'nykh i poperechnykh voln v osadochnykh otlozheniyakh Turkmenii [Magnitude of the mean velocity ratio for longitudinal and transverse waves in the sedimentary deposits of Turkmenia]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 6, p. 713-718, 1962.

The mean velocity ratio  $K=v_p/v_s$  is examined on the basis of the material collected by the 1956-60 expeditions in the Turkmen S.S.R. In order to find the dependence of  $K$  on depth, the arrival times of  $PS_n$  phases generated at various interfaces were determined. A graph shows that  $K$  decreases with increasing depth. A second graph shows that  $K$  is a function of the mean velocity of the longitudinal waves. It is hoped that the results of this investigation can be useful in seismic prospecting.—W.S.J.

- 191-603. Cagniard, L[ouis]. Reflection and refraction of progressive seismic waves: New York, McGraw-Hill Book Company, Inc., 282 p., 1962.

This book is a translation and revision of Cagniard's original book (1939) by Edward A. Flinn and C. Hewitt Dix. It discusses the exact solution of the fundamental problem of transient elastic wave propagation by means of the Laplace transform and demonstrates that in order to get back to the time domain the solution can be put in form of a direct Laplace transform through a sequence of mathematical transformations that allows inversion by inspection. The unfamiliar notation of the original edition has been extensively revised, and the concept of wave slowness (reciprocal velocity) has been introduced throughout. In the introductory section, the fourteen chapters and the accompanying appendixes are outlined briefly.—V.S.N.

- 191-604. Oblogina, T. I. O novom sposobe opredeleniya koefitsiyenta pogloshcheniya seysmicheskikh voln [A new method for determination of the absorption coefficient of seismic waves]: Prikladnaya Geofizika, no. 27, p. 3-11, 1960.

A new method is proposed for determining the seismic wave absorption coefficient independently of the divergence coefficient. It is based on the specific concept of the characteristic number of a function introduced by Lyapunov. The characteristic number of the amplitude curve coincides with the inverse value of the absorption coefficient, and the problem is reduced to determining the characteristic number of the curve. The method proposed permits determination of the absorption coefficient from experimental data, independently of the divergence coefficient.—A.J.S.

- 191-605. Bennett, A[rthur] D. Study of multiple reflections using a one-dimensional seismic model: Geophysics, v. 27, no. 1, p. 61-72, 1962.

A one-dimensional seismic model consisting of a multisection metal rod was used in a study of multiple reflections. The model was designed from velocity data provided by an acoustic velocity log. Reflecting interfaces were introduced into the model by changing the rod diameter. An acoustic pulse simulating a shot was applied near the top of the model by a magnetostrictive transducer. Reflections were detected by a crystal receiver placed at the top of the model. Means were devised to achieve an acceptable correspondence in character between a field seismic record obtained at a well site and a synthetic record produced by the model based on acoustic velocities in the well. Model techniques were worked out to separate and identify primary and multiple reflections as an aid in the interpretation of field seismic records.— Author's abstract

191-606. Hammond, J[oseph] W. Ghost elimination from reflection records: *Geophysics*, v. 27, no. 1, p. 48-60, 1962.

A method is described for the elimination of ghost energy from reflection records. Two or more shots at different depths are recorded on magnetic tapes. The magnetic tapes are then composited in groups of two or more. The formula is derived for the calculations of shot depth separation and the relative displacements of the magnetic tapes on replay. The application of the method to an everyday field technique is illustrated with examples.— Author's abstract

191-607. Marek, František. Deutungsverfahren der logarithmischen Laufzeitkurven [Methods of interpretation of logarithmic traveltime curves (with Russian summary)]: *Československá Akad. Věd Studia Geophys. et Geod.*, v. 4, no. 3, p. 292-294, 1960.

A method is proposed that is useful for analysis of seismic data obtained by the reflection method in regions where seismic logging has not been carried out, so that interpretation must be based on effective velocities. The traveltime curves are merely constructed on semilogarithmic paper. Plotted on transparent paper, these curves constitute a very helpful template. An example of its use is discussed.— D.B.V.

191-608. Pierau, H. Die Entstehung multipler Impulse durch pulsierende Gasbläschen ("Bubbler") bei Reflexionsseismischen Messungen auf dem Festland [The origin of multiple impulses due to pulsating gas bubbles ("Bubbler") in seismic reflection measurements on land]: *Boll. Geofisica Teor. ed Appl.*, v. 3, no. 12, p. 325-330, 1961.

With the aid of seismograms recorded during seismic reflection work in the Bavarian molasse, it is shown that multiple pulses generated by pulsating gas bubbles occur not only in offshore operations but also under certain geologic conditions in shallow hole shooting on land.— Author's abstract, A.J.S.

191-609. Timoshin, Yu. V. O gruppirovanii seysmopriyemnikov na bol'shikh bazakh [On the grouping of seismometers on large bases]: *Vyssh. Ucheb. Zavedeniye Izv., Neft' i Gaz*, no. 12, p. 9-14, 1961.

The widespread use of the method of grouping geophones on large bases has necessitated the development of methods of quantitative calculation of the effect of the curvature of the wave front on the directionality characteristics of different interference systems. This problem is treated in the present paper. A linear approximation of the wave front, consisting of two lines meeting at an angle in the center of the group, is worked out. The accuracy of this approximation is discussed, and formulas are derived for calculating the directionality characteristics of such linear groups in the case of curved wave fronts.— D.B.V.

- 191-610. Rosemann, Heinz. Der Einfluss der Ankopplung des Seismometers an den Untergrund auf die Energieübertragung [The effect of coupling of the seismometer to the ground on the transfer of energy]: Freiberger Forschungshefte, C 64, 63 p., 1959.

It is shown theoretically and experimentally that a geophone on the earth's surface forms a vibrating system as a result of the elastic contact with the substratum. The dependence of the resonance properties on the constants of the geophone and ground and on the type of geophone arrangement is mentioned. As a result of resonance the vibrating system geophone-ground can be a source of persistent natural vibrations that arise in the system under the action of the waves reaching the geophone. As in practice the constants of the ground vary along a profile, various distortions of amplitude and phase are introduced into the seismic records of different receiving channels that interfere with wave correlation and interpretation of data. Therefore, the resonance phenomenon must be eliminated or significantly reduced. For this the band width of the system is shifted to a higher frequency range than the vibrations to be recorded and the logarithmic damping decrement is increased. The natural vibrations can then be filtered out with the measuring apparatus. The shift of the transmitting range of the vibrating system is attained in practice if the geophones are set in shallow holes about 20-30 cm deep, covered with earth, and the earth tamped down. If the measurements are being made on crystalline, metamorphic, or sedimentary rocks, it is recommended that the geophone be set on a layer of sand a few centimeters thick. This makes the measuring places fairly identical. The geophone should also be covered to protect it from wind. Good results can be attained in places where creep has taken place. In swampy areas it is well to set up in pipes driven into the ground. In winter it is best to set the geophone on a layer of snow.— Author's summary, D.B.V.

- 191-611. Hagedoorn, J. G. On Hawkin's paper "The reciprocal method of routine shallow seismic refraction investigations" (Geophysics, December, 1961, p. 816-819): Geophysics, v. 27, no. 4, p. 534-535, 1962.  
Hawkins, L. V. Reply by author to preceding discussion: *ibid*, p. 535, 1962.

Hagedoorn believes Hawkins' review article (see Geophys. Abs. 188-533) describes a method that is unnecessarily complicated; the "plus-minus" method (see Geophys. Abs. 178-358) is much simpler. Hawkins replies that the complications are apparent rather than real. Only a single subtraction is involved for each recording station for each corrected traveltime curve (the recorded traveltime minus the time-depth), and this is similar to the single subtraction used in the "plus-minus" method.— D.B.V.

- 191-612. Puzyrev, N. N. K voprosu o primeneniі uproschennykh skhem nablyudeniya pri izuchenii skladchatogo fundamenta Zapadno-Sibirskoy nizmenosti metodom prelomlennykh voln [Regarding application of simplified procedures of observation in the study of the folded basement of the West Siberian Lowland by the method of refracted waves]: Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika, no. 11, p. 102-105, 1960.

Assuming a discrete correlation of seismic waves according to their dynamic and kinematic characteristics, a simplified method is proposed for identification of head waves from the folded basement of the West Siberian Lowland. A system of two traveltime curves from two symmetrically arranged shots and seismographs is solved with respect to the depth.— A.J.S.

- 191-613. Melle, F. A. Van. Current research to improve the effectiveness of standard geophysical methods, in Exploration geophysics -- today and tomorrow: Geophysics, v. 27, no. 1, p. 137-140, 1962.

Specific developments and the general trend in seismic research of the last few years are discussed. The trend is basically one toward sophistication or refinement of instruments and techniques. The increasing complexity of seismic analysis seemingly puts a premium on big companies but in actuality the premium is on intelligence; there is still room for the small independent with an original approach and the ability to deliver quality work.—V.S.N.

- 191-614. Faust, Lawrence Y. Case history of geological-geophysical cooperation: *Am. Assoc. Petroleum Geologists Bull.*, v. 46, no. 7, p. 1058-1062, 1962.

The case history of the Cement oil field in Oklahoma is cited as an example of effective cooperation between geologists and geophysicists. A seismic survey was initiated in 1941 in the hope of developing features of interest outside the producing area, and correlation of well information gave a wealth of geologic information. Thus as seismic work progressed there developed a joint effort of major proportions among the geologists and geophysicists working on the project. Each member of the team, in an atmosphere of mutual respect, confined his attention to his own specialty, revising and reevaluating his own work until accord was achieved. Care was exercised to separate the factual from the conjectural until full agreement was reached on the acceptance of data.

Modern methods have become so sophisticated that the team may now require augmentation by a physicist and a mathematician, and on occasion perhaps a petroleum engineer.—D.B.V.

- 191-615. Zhadin, V. V. Ob issledovanii pogloshcheniya prodol'nykh i poperechnykh voln sposobom seismicheskogo karotazha [On investigation of longitudinal and transverse wave absorption by the seismic logging method]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 3, p. 80-93, 1960.

The apparatus and methods for measuring the absorption of longitudinal and transverse elastic waves by seismic logging in horizontally layered sedimentary strata are discussed. The processing of the observational data and the method of recognition of the waves are explained. The relative error in determination of absorption coefficients is considered, and traveltime and amplitude curves are illustrated. It was found that absorption of elastic waves in a friable water-saturated medium is close to that in solids, varying greatly with the content of gas in the pores.—A.J.S.

- 191-616. Kage, Erhardt. Die Magnetbandtechnik in der Reflexionsseismik für die elektronische Auswertung [Magnetic tape recording technique in seismic reflection surveying for electronic interpretation (with English and Russian summaries)]: *Zeitschr. Angew. Geologie*, v. 7, no. 9, p. 462-465, 1961.

The use of magnetic tape recording and playback systems to obtain the most details possible from a seismogram and the possible ways of presenting the results are reviewed. Non-German equipment typical of the present state of development of the technique is described.—D.B.V.

- 191-617. Holz, Peter. Operating ideas from South Africa—Seismic prospecting: *Canadian Mining Jour.*, v. 83, no. 7, p. 58, 1962.

A hydraulic vibrator developed for use as a source of energy in seismic prospecting is described. The frequency of the vibrator varies from 50 to 150 cycles per second for investigating depths to 2,000 feet and from 30 to 100 cycles per second for depths to 20,000 feet. The force output is three-fourths ton for shallow depths and 10 tons for depths to 20,000 feet.—V.S.N.

- 191-618. Sengbush, R. L. Stratigraphic trap study in Cottonwood Creek field, Big Horn Basin, Wyoming: *Geophysics*, v. 27, no. 4, p. 427-444, 1962.

Stratigraphic trap production in the Cottonwood Creek field is controlled by loss in porosity and facies change in the "E" zone of the Phosphoria dolomite. The edge of the field was delineated on the seismic records through loss in amplitude of the high-frequency "E" zone reflection due to thinning and decrease in velocity contrast of the "E" zone. Variable-area cross sections show vividly this stratigraphic change. This study indicates that present techniques of magnetic tape recording and processing coupled with synthetic seismograms and the attendant filter theory approach to the seismic method have increased the capability of the seismic method to find stratigraphic traps.— Author's abstract

- 191-619. Bunce, Elizabeth T., and Fahlquist, Davis A. Geophysical investigations of the Puerto Rico trench and outer ridge: *Jour. Geophys. Research*, v. 67, no. 10, p. 3955-3972, 1962.

Results of seismic investigation of the Puerto Rico Trench and its outer ridge are presented as a crustal section. Three layers above the mantle, having compressional velocities of 2.2, 5.3, and 6.6 kmps, are defined continuously from the Nares Basin to within 20 km of the north wall of the trench. Extension of the seismic section to the north wall indicates that these three layers may crop out. A 4.2-kmps layer is clearly defined in the Nares Basin but pinches out to the south. The M-discontinuity ( $v=7.7-8.3$  kmps) varies in depth from 12.2 km to a minimum of 9.8 km. South of the trench a 4.6-kmps layer overlies one of 6.6 kmps. Velocities under the trench are not concordant with those under the outer ridge; a 5.7-kmps layer at a depth of 10 km overlies 7.4-kmps material at 14 km. It is suggested that the trench section is displaced downward at least 2 km relative to the outer ridge and that the materials have subsequently been altered. A gravity profile computed from the seismically-determined layer densities and thicknesses agrees well with the measured free-air anomaly except at the axis of the trench, where the computed values are 50-70 mgal too high.— D.B.V.

- 191-620. Macpherson, J. D. A new interpretation of seismic refraction profiles obtained in the Hartlen Point region of the Scotian Shelf: *Seismol. Soc. America Bull.*, v. 52, no. 3, p. 693, 1962.

Refraction results obtained in the Hartlen Point region of the Scotian Shelf off Nova Scotia are revised in the light of subsequent reflection surveys and echo-sounding. The earlier concept of a thin sedimentary layer above hard rock bottom has been reinterpreted as a continuously variable profile caused by weathering of the basement rock.— D.B.V.

- 191-621. Weber, J. R., Sandstrom, N., and Arnold, K. C. Geophysical surveys on Gilman Glacier, northern Ellesmere Island [with French abstract], in *General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub.*, no. 54, p. 500-511, 1961.

Geophysical surveys were carried out on Gilman Glacier and the adjoining icecap of northern Ellesmere Island during the summers of 1957 and 1958. Seismic refraction and reflection measurements show that a maximum compressional wave velocity of 3,795 m per sec was reached at a depth of 50 m on Gilman Glacier and of 3,810 m per sec at a depth of 100 m on the icecap. Reflection profiles show that the ice thickness varies from 380 to 760 m on the glacier, and from 400 to 800 m on the icecap. The mean shear stress at the bed of the glacier is calculated to be 0.85 bars. Ice thickness calculated from gravity measurements made at 200 stations during 1958 shows close correla-

tion with the seismic results. Measurements of surface movement of Gilman Glacier give a maximum velocity of 25 m per yr. (See also Geophys. Abs. 187-323.)—V.S.N.

- 191-622. Levin, Franklyn K. The seismic properties of Lake Maracaibo: Geophysics, v. 27, no. 1, p. 35-47, 1962.

The seismic properties of Lake Maracaibo were investigated in an extensive experimental program. The controlling factor was found to be extremely low mud velocities produced by free gas in the bottom mud. The most important seismic phenomenon was singing, and its characteristics were investigated in detail. Deviations from the behavior expected from a simple theory were found. A strong, low-frequency mud wave was present. Where the mud was not too thick, normal dispersion occurred.— Author's abstract

- 191-623. Overseas Geological Surveys. Geophysical field surveys - Bechuanaland 1961: Overseas Geol. Surveys Rept. for 1960-61, p. 12-14, 1962.

An experimental seismic survey was carried out in the Masama-Lephepe area in June 1961 to test the effectiveness of the method in determining the thickness of the Stormberg basalts which overlie the Cave sandstone, an important aquifer in the region. The high velocity of the Cave sandstone (17,400 ft per sec) makes it practicable to use the refraction technique to estimate its depth under the basalt cover. This high velocity is presumably due to the compaction of the sandstone under the weight of the basalt. Where the basalt overburden is thin, velocities in the Cave sandstone are much lower - 10,500 to 13,000 feet per sec - and in these areas interpretation of refraction data may be difficult. Ambiguity may be avoided by running a continuous refraction profile extended to an area where conditions are known from drilling or can be reliably deduced from seismic records.

The refraction method was used also to find the amount of throw on the Zofontein fault in the Mamabule area and thus to determine whether the Middle Ecca coal beds on its down-thrown side are at an economically acceptable depth. The vertical displacement was found to be not less than 650 to 700 feet.

Geophysical surveys across the postulated boundary of the Karroo basin are mentioned briefly.—V.S.N.

- 191-624. Rische, Hans. Zur Erfassung und Deutung tiefer Reflexionen im Thüringer Becken [On the detection and interpretation of deep reflections in the Thuringian Basin (with English and Russian summaries)]: Zeitschr. Angew. Geologie, v. 7, no. 3, p. 105-108, 1961.

A reflection profile in the center of the Thuringian Basin of Germany is presented, in which reflections with traveltimes up to 8 sec could be detected. Four deep horizons are indicated; horizon K, nearly 3 km deep; I, more than 4 km deep; II, dipping from about 6 km to 9 km in a southeasterly direction; and III, nearly 14 km deep. Possible interpretations of these boundaries in the light of gravity and magnetic data are discussed.—D.B.V.

- 191-625. Thomas, Erich. Strukturelemente im Raume Ostmecklenburg und Nortostbrandenburg auf Grund von Ergebnisse seismischer Refraktionsmessung [Structural elements in the east Mecklenburg and northeast Brandenburg area on the basis of seismic refraction survey data (with English and Russian summaries)]: Zeitschr. Angew. Geologie, v. 7, no. 6, p. 274-281, 1961.

Refraction measurements made in the eastern part of East Germany in 1958 and 1959 reveal many anomalies that are interpreted as anticlines and synclines. This interpretation is confirmed by boreholes that have since been drilled at Lychen and Kremmen. In the western part of the surveyed area the

undoubted seismic anomalies are not reflected in the gravimetric record, whereas in the eastern part the gravity minimums clearly correspond to seismic anticlines and gravity maximums to seismic synclines. Further investigations are recommended.— D.B.V.

- 191-626. Herrmann, Horst. Ergebnisse einer reflexionsseismischen Regionalprofil im Vorland des Mitteldeutschen Hauptabbruches [Results of a regional seismic reflection profile in the foreland of the Central German Main fracture (with English and Russian summaries)]: Zeitschr. Angew. Geologie, v. 7, no. 6, p. 281-285, 1961.

A reflection profile in the Altmark axial depression east of the Elbe in Germany clears up some problems of interpretation of earlier surveys made in the area. The north flank of the Calvörde block is a flexure accompanied by minor deformations, not a fault (with "Gardelegen break") as inferred from gravimetric data, and was uplifted in post-Cretaceous time. The formation of the Brehm and Grieben salt domes is probably related to tectonic events in the Central German Main fracture. The Triassic anticlines of Zerben and Kabelitz with their associated salt masses are older; they possibly began to form in Jurassic time.— D.B.V.

- 191-627. Reinhardt, Hans-Günter. Ergebnisse reflexionsseismischer Übersichtsmessungen in der nordöstlichen Altmark [Results of seismic reflection reconnaissance measurements in the northeastern Altmark (with English and Russian summaries)]: Zeitschr. Angew. Geologie, v. 7, no. 6, p. 286-291, 1961.

Structure contour maps of the approximate base of the Tertiary, the base of the Cretaceous, a coral oolite in the Oxfordian, and horizons in the upper Buntsandstein and pre-saline Zechstein are presented, based on seismic reflection reconnaissance work in the northeastern Altmark and adjacent areas in East Germany. A reflection profile across the Auslosen, Wittenberge, Meeseberg, and Gross Schwechten salt domes shows the various types and genetic histories of the salt structures.— D.B.V.

- 191-628. Grosse, Siegfried. Die Abbildung des Reliefs der Oberkreide bei geringmächtiger Bedeckung in refraktionsseismischen Messergebnissen [The representation of the relief of the Upper Cretaceous with thin cover in seismic refraction data (with English and Russian summaries)]: Zeitschr. Angew. Geologie, v. 7, no. 11, p. 592-595, 1961.

In the northeastern part of the German Democratic Republic the 4-km isochrone map does not satisfactorily reveal changes in depth to the Upper Cretaceous below the Tertiary and Pliocene cover; this is due to the dependence of the velocity on depth in the marly Upper Cretaceous beds. Cases in which the 2-km isochrone map indicates geologic conditions more reliably are discussed. When the Upper Cretaceous is less than 200 m deep, the 2-km travel-time curve cannot be used; some other type of representation is needed. The intercept time fulfills the requirements; with this, the amplitude of time variation is proportional to the pre-Tertiary relief.— D.B.V.

- 191-629. Tuparev, P., Doykov, Zh., and Avramchev, L. Predvaritelni rezultati ot kompleksnoto geologo-geofizichno t"rsene i prouchvane na slepi rudni tela v nakhodishte "Gramatikovo", uchast"ik "Keremidoto" [Preliminary results of the complex geological and geophysical survey and exploration of blind ore bodies in the "Gramatikovo" deposit, "Keremidoto" sector]: Minno Delo i Metalurgija, v. 16, no. 3, p. 34-38, 1961.

The combination of seismic surveys and geophysical logging is found to be the most satisfactory means for exploration of the hydrothermal ore bodies in

the Keremidoto region of the Strandza metallogenetic province. The ore-bearing formations occur on the Grammatikovo anticline, a second-order structure on the north limb of the Stoilovo syncline.— V.S.N.

- 191-630. Akrabova, A. Prilagane metoda na otrazhenite v<sup>1</sup>lni v usloviyata na razsedna tektonika v Kamchiyskoto predplaninsko ponizhenie [Applying the method of refracted waves to the areas of fault tectonics in the Kamchia foredeep]: *Minno Delo i Metalurgija*, v. 16, no. 12, p. 25-30, 1961.

The results of a seismic refraction survey to determine the structure of the Kamchia depression in Bulgaria are discussed. The structure is highly complex; however, interpretation of the seismic data produced satisfactory results. Particular attention is given to identifying and tracing major faults.— V.S.N.

- 191-631. Petkevich, G. I. Schema tipiv shvydkisnykh rozriziv v Predkarpats'komu progyni [A scheme of the types of velocity profiles in the cis-Carpathian downwarp]: *Akad. Nauk Ukrain. RSR Dopovidi*, no. 5, p. 627-630, 1961.

Four types of relationship between seismic wave velocities and depth of geologic formations are distinguished on the basis of data on the elastic properties of the rocks in the cis-Carpathian downwarp. The velocity zones have a Carpathian strike and are related to definite tectonic elements.— A.J.S.

- 191-632. Telyakova, Z. Kh. Rezul'taty issledovaniy zemnoy kory yuzhnoy chasti Zapadno-Sibirskoy nizmennosti metodom glubinnykh seismicheskikh zondirovaniy [Results of investigations of the crust in the south part of West Siberian Lowland by the method of deep seismic sounding]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 7, p. 3-15, 1961.

Deep seismic soundings by the method of correlated refracted waves along a 52.9-km and a 11.2 km profile from Verkhniy Karagat to Mamontovo in the Kulunda Steppe of the south part of the West Siberian Lowland are reported. The seismogeological characteristics of the area along the profile were found to be represented by the six main seismic wave groups: I, II, III, IV, V, and M. The first five were from interfaces in the crust, and the M-group was from the M-discontinuity. The approximate zones where these wave groups could be traced were established, and the elastic properties of the subsurface strata were determined. The thickness of the crust in this region was found to be 43 km.— A.J.S.

- 191-633. Tal'virskiy, D. B., and Khakhlev, Ye. M. Stroyeniye poverkhnosti doyruskogo fundamenta v nizhnem techenii r. Yenisey po dannym seymorazvedki [Surface structure of the pre-Jurassic basement in the lower reaches of the Yenisey River according to seismic prospecting data]: *Akad. Nauk SSSR, Sibirskoye Otdeleniye, Geologiya i Geofizika*, no. 6, p. 96-98, 1961.

Seismic investigations in the region adjoining the Yenisey River in Siberia along a profile from Yakuty to Ust' at the estuary of the river carried out in 1958-59 are reported. Three groups of refracted seismic waves were identified: (1) those from the Mesozoic horizons with velocities of 1,900-3,500 m per sec; (2) those probably related to the eroded overburden of the pre-Jurassic basement with velocities of 4,300-4,700 m per sec; and (3) the waves refracted from the pre-Jurassic basement. The third group of waves is used for oil and gas exploration.— A.J.S.

- 191-634. Bokanenko, L. I., and Isayev, V. S. Predvaritel'nyye rezul'taty o-predeleniya moshchnosti l'dov El'brusa seymicheskim metodom

[Preliminary results of determination of the thickness of the ice on Mount Elbrus by the seismic method], in *El'brus. Eksped. Moskov. Gos. Univ. Inst. Priklad. Geofiziki: Akad. Nauk SSSR Inf. Sbornik o Rabotakh po Mezhdunarod. Geofiz. Godu*, no. 5, p. 10-58, 1960.

Seismic measurements were carried out on the Terskol Glacier on Mount El'brus during the summer of 1958 as a part of the International Geophysical Year program. The seismic equipment and the method of investigation are described, and the difficulties which seriously hampered the investigation are mentioned. The limited seismic data are analyzed in detail and found to be in fair agreement with data from glaciological investigations.— V.S.N.

191-635. Berzon, I. S., Pak, V. A., Yakovlev, V. N., and Leontiyev, I. Y. *Sondage seismique du glacier Fedtchenko. Observations gravimetriques sur le glacier Fedtchenko* [Seismic sounding of the Fedchenko Glacier. Gravimetric observations on the Fedchenko Glacier (in English with French abstract)], in *General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub.*, no. 54, p. 520-529, 1961.

The results of seismic sounding of Fedchenko Glacier in 1958 were reported earlier in *Glyatsiologicheskaya ekspeditsiya na lednik Fedchenko: Tashkent, Akad. Nauk Uzbek. SSR*, p. 84-109, 1960 (see *Geophys. Abs.* 189-582). Gravimetric measurements were also carried out as a supplement to the seismic survey. Results indicate that the seismic method supplemented by gravity surveying is a particularly effective means of determining the thickness and form of valley-type glaciers.— V.S.N.

191-636. Palgov [Pal'gov], N. N. Thickness of the glaciers of Kazakh S.S.R. in accordance with the calculation methods and seismic measurements [with French abstract], in *General Assembly of Helsinki, 1960, Snow and Ice Commission: Internat. Assoc. Sci. Hydrology Pub.*, no. 54, p. 512-519, 1961.

This is an English version of the paper published in *Glyatsiologicheskoye Issledovaniya v Period MGG*, no. 1: Alma-Ata, Akad. Nauk Kazakh SSR, p. 136-149, 1961 (see *Geophys. Abs.* 189-284).— V.S.N.

191-637. Central Water and Power Research Station Poona. Seismic refraction survey - Proposed Ukai dam site; India Ministry of Irrigation and Power Central Water and Power Research Sta. Poona Annual Research Mem., 1961, p. 310-312, 1962.

The results are discussed of a seismic refraction survey to locate a suitable dam site on the Ukai River above the originally selected site where a shear zone interferes with construction.— V.S.N.

191-638. Behrendt, John C., and Parks, Perry E., Jr. Antarctic peninsula traverse: *Science*, v. 137, no. 3530, p. 601-603, 1962.

A 1,700-km geological and geophysical traverse was made in the area south of the Bellinghousen Sea and George VI Sound from November 30, 1961 through February 5, 1962. Reflections from bedrock obtained at 26 locations suggest that the Antarctic Peninsula and its southern extension form an island separated from the Sentinel Mountains to the south. The depression constitutes a continuation of Byrd Basin (subglacial). If the ice were removed, the Ross Sea and the Weddell Sea would be connected, and the base of the Antarctic Peninsula may be only about 200 km across instead of 400 km.— D.B.V.

- 191-639. Murrell, S. A. F., and Misra, A. K. Time-dependent strain or "creep" in rocks and similar non-metallic materials: *Inst. Mining and Metallurgy [London] Trans.*, v. 71, 1961-62, pt. 7, p. 353-378, 1962.

A survey is presented of the literature on experimental observations of time-dependent strain in rocks, and a comparison is made with the published results of experimental work with other non-metallic materials. The theories currently held concerning creep are outlined.

Recent research has shown that brittle ionic and covalent crystals can be plastic under the right conditions and that both the brittle and plastic behavior can be explained in terms of the same defects of the crystal lattice as in the case of metals. The experimental results reviewed show that time laws of creep of crystalline rocks and single mineral crystals are very similar to those of metals. Ice also shows a power law dependence of the steady-state creep rate on stress and follows an Andrade transient creep law.— V.S.N.

- 191-640. Obert, Leonard. Effects of stress relief and other changes in stress on the physical properties of rock: *U.S. Bur. Mines Rept. Inv.* 6053, 8 p., 1962.

Evidence is presented to show that when rock is stress-relieved during the course of mining or in drilling a core it may be altered or damaged so that the physical properties of the relieved specimen are not the same as those of the rock in place. This type of change may also result from stress change other than that accompanying stress relief, such as is produced by application of relatively large compressive stress. Virtually all rock types, when subjected to moderate to high stress or change of stress, produce seismic disturbances that are attributed to microfracturing, and salt specimens under compression show visible evidence of internal fracture. Solid cores, stress-relief cores, and cutter-relief blocks of rock from widely different rock types fracture visibly and sometimes break during the stress-relief process. Therefore, if the physical properties of rock are determined from laboratory tests, the stress history and the possibility of damage should be considered.— V.S.N.

- 191-641. Judd, W. R., and Huber, Carolyn. Correlation of rock properties by statistical methods, in *International Symposium on Mining Research*: New York, Pergamon Press, v. 2, p. 621-648, 1962.

A statistical approach is described for correlating physical properties of rocks based on a comparison of apparent specific gravity, percent porosity, scleroscope hardness, abrasive hardness, specific damping capacity, moduli of rigidity and rupture, static and dynamic moduli of elasticity, compressive strength, impact toughness, longitudinal velocity of sonic wave propagation, tensile strength, and Poisson's ratio. The following general conclusions are drawn: (1) A direct linear relationship exists between modulus of rigidity and Young's modulus, between compressive strength and Young's modulus, modulus of rigidity and modulus of rupture, and between the laboratory values of the static and dynamic moduli of elasticity. (2) A direct curvilinear relationship exists between modulus of rupture and impact toughness with shore hardness and longitudinal velocity. (3) Specific damping capacity has an inverse curvilinear relationship with impact toughness, compressive strength, modulus of rigidity and Young's modulus. (4) A direct, slightly curvilinear relationship exists between specific gravity and modulus of rigidity and Young's modulus, and between modulus of rigidity and longitudinal velocity. There is overwhelming statistical evidence that prediction of rock properties cannot be based entirely on existing and conventional theories of elasticity. Results to date indicate that computer analysis can be made of available data from a multitude of rock tests by various government bureaus, and the method shows promise of providing equations to predict rock properties within a relatively narrow and useful range.— V.S.N.

- 191-642. Paterson, M. S., and Weiss, L. E. Experimental folding in rocks: *Nature*, v. 195, no. 4846, p. 1046-1048, 1962.

This is a preliminary account of experiments on a fine-grained phyllite and a micaschist in which prominent kinking and folding by flexural slip have been achieved, leading to microstructures that are strikingly similar geometrically to many structures observed in the field. The experiments were carried out at room temperature and at a confining pressure of 5,000 kg per cm<sup>2</sup>. The specimens were compressed between parallel platens, without a spherical seat, at a rate of shortening of 1 mm per min. The total strains corresponded to relative changes in length ranging from 5 to 80 percent. The main observations are summarized, and 7 photographs are given. A fuller description and more detailed analysis will be published elsewhere.—D.B.V.

- 191-643. Link, Harald. Über die Unterschiede statisch, dynamisch und seismisch ermittelter Elastizitätsmoduln von Gestein und Gebirge [On the differences between statically, dynamically, and seismically determined moduli of elasticity of rock and bedrock (with English summary)]: *Geologie u. Bauwesen*, v. 27, no. 3/4, p. 131-145, 1962.

The rapid, economical determination of elastic parameters of rock in place by seismic methods demands more accurate knowledge of their deviations from statically determined values. Static determinations of elastic parameters bring out the dependence on pressure and reflect the fact that the modulus of elasticity ( $E$ ) is sensitive to very fine differences in petrographic constitution, structure, moisture content, and preservation of rock. Poisson's ratio is especially strongly dependent on pressure. Dynamically determined  $E$  values ( $E_{dyn}$ ) lie about 10 to 100 percent higher than those determined statically ( $E_{stat}$ ); this is due to the time factor, for the dynamic stress acts momentarily.

$E$ -values determined on a number of Alpine dam foundations by seismic ( $E_{seism}$ ) and static ( $E_{stat}$ ) methods are compared; the seismic values are 3 to 12 times higher. It is also shown that under hydrostatic pressure, water-saturated samples give a higher  $E$  than dry; rock in place around test tunnels is thoroughly drained.  $E_{seism}$  reveals nothing about the modulus of deformation. Because of the extremely short-time action of the impulse,  $E_{seism}$  is considered to be the pure elasticity modulus. A particularly low  $E_{seism}$  is not a certain indication of a tendency toward plastic deformation.—D.B.V.

- 191-644. Kahler, F. Fels- und Geomechanik. Werden, Weg und Ziel einer neuer Wissenschaft [Rock mechanics and geomechanics. Formation, course, and goal of a new science]: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 89-94, 1960.

Rock mechanics is a part of the broader science of geomechanics. The latter seeks to explain mechanical processes in the solid earth's crust; its goal is difficult to attain and its applicability even more so. Rock mechanics is distinct from soil mechanics, whose methods are not applicable to solid rock. The purpose of rock mechanics is to study, with the help of all allied sciences, the phenomena in rock that give some idea of its past and present stress conditions, the operation of natural strain, and the effect of constructions such as mines, tunnels, and dams on those stress conditions.—D.B.V.

- 191-645. Clar, E. Gebirgsbau und Geomechanik [Rock structure and geomechanics]: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 186-190, 1960.

The field of geomechanics embraces everything that the word implies. It includes a branch of rock mechanics (Felsmechanik), and of bedrock mechanics (Gebirgsmechanik) analogous to soil mechanics. Geomechanics is one of the

major branches of geotectonics. The various types of structural evidence to be examined and interpreted to give a picture of the mechanical behavior of rocks are reviewed. In its deformation patterns, rock structure (Gebirgsbau) in itself contains an abundance of information on the mechanical behavior of natural rock bodies on a large scale, and technical practice should not overlook investigating these forms more thoroughly, geomechanically.— D.B.V.

- 191-646. Heitfeld, K. H. Die Bedeutung der historischen Denkweise in der Geologie für die Geomechanik [The significance of historical thought patterns in geology for geomechanics]: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 191-202, 1960.

The importance of geological ways of thinking in geomechanics is discussed. The fourth dimension, time, which plays such an important role in geology, is often not taken into account sufficiently in engineering geology. Examples are given to show the necessity of knowing the conditions of rock formation, the geologic development of sediments up to the present time, and probable further geologic events in a given area for purposes of foundation geology and geomechanics. The importance of the age relations of the different structural elements is also indicated.— D.B.V.

- 191-647. Müller, L. Die Geomechanik in der Praxis des Ingenieur- und Bergbaues [Geomechanics in engineering and mining practice]: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 203-214, 1960.

A number of examples from highway and dam construction, open pit mining, coal mining (models), and tunnel and underground power-house construction are cited to show how recent theoretical geomechanical information has already proved valuable in practice. However, the need for far more information, especially quantitative solutions, is evident. Basic research in geomechanics should not be just purely academic; eventually it should be unthinkable to undertake any steel or steel-and-concrete construction or earthworks without a geomechanical investigation specifically tailored to the project. Model studies can prepare the ground for and help interpret, but cannot replace, large scale investigations on actual cases; only from the latter will come the statistics which will form the basis for determining the effects of cutting into rock on its mechanical properties.— D.B.V.

- 191-648. Müller, Leopold. Über die Entstehung oberflächenparalleler Klüfte. Versuch einer geomechanischer Erklärung [On the origin of joints parallel to the surface. Attempt at a geomechanical explanation (with English summary)]: *Geologie u. Bauwesen*, v. 27, no. 3/4, p. 146-152, 1962.

Assuming that the distribution of stress behind steep rock walls is analogous to that behind the walls of underground excavations - an assumption that appears to be justified by many observations - it is possible to give a mechanical interpretation of the joints parallel to the surface of bedrock, which is subject to creep, flow, and rupture-flow. In such cases maximum stress is usually directed in a vertical-tangential direction at a small distance behind the rock face; as a result, tensile stresses arise across the face. Cracks parallel to the surface are formed when the tensile strength of the mass is exceeded; if it is not, there is merely an enhancement of potential spallation. Either case is of great importance in engineering geology, particularly for dam construction.— D.B.V.

- 191-649. Watznauer, A. Kritische Einschätzung gebirgsmechanischer Modellversuche und die Grenzen ihrer praktischen Anwendbarkeit [Critical evaluation of model studies of bedrock mechanics and the limits of their practical applicability]: *Geologie u. Bauwesen*, v. 27, no. 3/4, p. 199-200, 1962.

This is a discussion of the third meeting of the International Bureau of Rock Mechanics held in Leipzig, October 30-November 4, 1961, devoted largely to the question of model studies of rock mechanics. The strength values of a natural material are strongly scattered, but this scatter cannot be taken into account in a physical model; therefore, it is possible that the model may be based on improperly evaluated parameters and thus give false results. The chief danger lies in the well known fact that the strength of a rock sample is not necessarily the same as the strength of the rock in place. The second type of model, the stress equivalent model, is purely mathematical and has no similarity whatever to nature. The possibility of using stochastic methods, which provide a bridge to certain thermodynamic concepts, should be investigated further.—D.B.V.

- 191-650. Kvapil, Rudolf. Einfluss der Strahlungsenergie auf die Gesteinseigenschaften [Effect of radiation energy on rock properties]: Geologie u. Bauwesen, v. 25, no. 2/3, p. 142-147, 1960.

The effect of radiation on rock strength has so far received little attention, but it is important in geomechanical investigation of the deeper layers of the crust where the intensity of natural radiation is considerably greater than in the upper layers. At present the problem is being studied in several laboratories. It has been found that the irradiation of rock samples in a nuclear reactor causes changes in their strength, elasticity modulus, conductivity, and deformation. Deformation increases, a certain tendency to creep develops, and hardness is somewhat reduced. Many minerals change color. The sum total is a weakening of the rock. The carbonate minerals are particularly susceptible to radiation changes. Once altered by radiation, rock properties can be further altered by additional exposure to radiation, particularly at other energies.

Deformation resulting from stress brings about changes in density of rocks; there are concomitant changes in the effect of radiation, for the effect is inversely proportional to density. The use of radioactivity to produce measurable changes that can be interpreted in terms of stress conditions in the rock is discussed.—D.B.V.

- 191-651. Lozano Calvo, Luis. Sobre la interpretación mecánica de las deformaciones terrestres [On the mechanical interpretation of terrestrial deformations (with English summary)]: Rev. Geofísica, v. 20, no. 78, p. 97-109, 1961.

Current theories concerning the viscoelastic behavior of the earth's mantle and surface, and experiments on rock deformation at high temperatures and pressures are reviewed.—D.B.V.

- 191-652. Vinogradov, S. D. Eksperimental'noye izucheniye raspredeleniya chisla razryvov po energii pri razrushenii gornyykh porod [Experimental study of the distribution of the number of fractures according to energy during crushing of rocks]: Akad. Nauk SSSR Izv. Ser. Geofiz., no. 2, p. 171-180, 1962.

A study was made of the relationship of the number  $N$  of fractures to the seismic energy  $E$  that is liberated during crushing of rock samples and model materials. The slope  $\gamma$  of the graphs of distribution of  $N(E)$ ,  $\gamma = \Delta \log N / \Delta \log E$ , depends on the properties of the material being crushed as well as on the rate of deformation. The slope of  $\gamma$  also varies during the process of crushing.—J.W.C.

- 191-653. Khlobustov, A. A. O napravlenii eksperimental'nykh issledovaniy po deformatsii gornyykh porod [On the direction of experimental investigations on deformation of rocks]: Uzbek. Geol. Zhur., v. 6, no. 1, p. 5-15, 1962.

The history of experimental study of rock deformation is outlined briefly, and directions for future investigations are proposed.— A.J.S.

- 191-654. Bacon, L[loyd] O. A method of determining dynamic tensile strength of rock at minimum loading: U.S. Bureau Mines Rept. Inv. 6067, 22 p., 1962.

The results are summarized of laboratory work on the design of instrumentation for measurement of the dynamic tensile strength of a rock at the minimum loading that will cause fracture of rock in tension. Two methods were tested - a pendulum and a compressed-air pellet gun - for impacting one end of a rock core suspended by wires. The curves and results are presented of measurements on 6 basalt cores using a pendulum-impacting method and on 11 sandstone cores using the pellet-impacting method. Comparison with static tensile strengths of portions of the same cores shows that the dynamic tensile strength is one to four times the static tensile strength; however, this high ratio is open to question.— V.S.N.

- 191-655. Emery, C. L. The measurement of strains in mine rocks, *in* International Symposium on Mining Research: New York, Pergamon Press, v. 2, p. 541-553, 1962.

The technique of using photoelastic coatings for strain analysis of mine rock is discussed. The method operates on the principle that certain substances, including glass and some plastics, have the property of birefringence when strained and viewed under polarized light with an analyzer. The resulting color pattern can be interpreted quantitatively in terms of the strain in the birefringent material. If plastic patches are attached to the surfaces of rocks in working places in mines, they will record changes in magnitude and direction of the surface strains at the points of attachment. Some applications of the method are illustrated and discussed.— V.S.N.

- 191-656. Williams, E. T. Contribution to the discussion on paper entitled "Measurement of strains in mine rocks" (C.L.Emery), *in* International Symposium on Mining Research: New York, Pergamon Press, v. 2, p. 555-557, 1962.

A brief summary is given of the application of the photoelastic coating technique to measure rock strain in a coal mine in Great Britain.— V.S.N.

- 191-657. Emery, C. L. The photoelastic technique for studying rock strains: Canadian Mining Metall. Bull., v. 55, no. 604, p. 546-550, 1962.

The principles underlying the photoelastic technique for predicting strain patterns in mine rocks and their changes with changes in load are outlined briefly. The development of strain in rock, the theory of photoelasticity and how it is used to show directions and magnitudes of strains, the applications of the technique to mining, and examples of application are discussed (see also Geophys. Abs. 191-655).— V.S.N.

- 191-658. Utter, Stephen. Stress determinations around an underground mine opening, *in* International Symposium on Mining Research: New York, Pergamon Press, v. 2, p. 569-582, 1962.

The results are presented of strain relief measurements around a typical underground mine opening in the Climax Molybdenum Mine, Climax, Colo. Instrumentation used in the tests consisted of electric resistance strain gage rosettes and a portable static strain indicator. The installation of the instruments and methods of taking measurements are described, and the physical properties of the rock as determined in the laboratory are summarized in a table.— V.S.N.

- 191-659. Obert, Leonard. In situ determination of stress in rock: Mining Eng., v. 14, no. 8, p. 51-58, 1962.

The structural stability of any mine or underground opening in rock is dependent on the state of stress in the rock before mining, the stress distribution in the rock created by the opening, and the in place strength of the rock. A method is described for determining in place the absolute stress in rock by measurement of the deformation of a borehole before and after the rock is stress-relieved. The magnitude and direction of the applied stresses are calculated from the borehole deformation and modulus of elasticity of the rock. The results of absolute stress determinations made in the walls and pillars of underground openings in five rock types are presented. It is concluded that the borehole deformation method is satisfactory for use in rock that is relatively isotropic and for which stress-strain curves are linear and the hysteresis loop is closed.—V.S.N.

- 191-660. Kostelka, Ludwig. Bemerkenswerte Gebirgs-Spannungserscheinungen im Bergbau Bleiberg-Kreuth [Noteworthy rock stress phenomena in the Bleiberg-Kreuth mine workings]: Geologie u. Bauwesen, v. 27, no. 2, p. 82-88, 1962.

Two examples of unusual rock pressure phenomena are cited. One concerns the relaxation of a newly opened rock body as a result of penetration (by a mine shaft); the dependence of the relaxation phenomena on the progress of the shaft is indicated. The second example, in an area of old mine workings, concerns the changes in pressure relations in pillars upon the introduction of gobbing. The phenomena are taken to be indications of the collapse of a discrete rock body.—D.B.V.

- 191-661. Bollo, M. F. Application de la microsismique à la construction de galeries [Application of microseismic surveying to the construction of galleries (with English, German, and Italian summaries)]: Geologie u. Bauwesen, v. 26, no. 2, p. 79-86, 1961.

Microseismic investigations carried out with apparatus designed for underground use in mines give rapid and precise information about the nature of the rock traversed, such as definition of the "decompression zone." Analysis of the elastic waves and changes in the dynamic modulus show the "burned" or "fissured" zones. Continuous exact measurements of Young's modulus and Poisson's ratio reveal zones of weak or abnormal rock that require stronger timbering. The range of validity of mechanical or water-pressure experiments can also be determined, thus enhancing their value. Substantial savings have been effected in many cases by the resulting reduction of the "uncertainty coefficient" in driving mine tunnels. Since 1955, 187 underground workings have been investigated by this method.—D.B.V.

- 191-662. Lauffer, H. Ein Gerät zur Ermittlung der Felsnachgiebigkeit für die Bemessung von Druckstollen- und Druckschachtauskleidungen [A device for ascertaining rock flexibility for the adjustment of pressure-tunnel and pressure-shaft linings]: Geologie u. Bauwesen, v. 25, no. 2/3, p. 114-129, 1960.

A description is given of an improved version of the radial press, by means of which the deformation of pressure tunnels and shafts can be measured. The device is designed for use in connection with construction of aqueducts, but should also be applicable to damsites.—D.B.V.

- 191-663. Breth, H. Die Festigkeit vorbelasteter Böden [The strength of formerly loaded ground]: Geologie u. Bauwesen, v. 25, no. 2/3, p. 177-185, 1960.

The testing of the shearing strength of ground whose geologic load was once far greater than the weight of the present overlying material is discussed. An example of such over-compressed ground is the Tertiary molasse in southern Bavaria, once overlain by glaciers and now consolidated into the so-called "Flinz" and "Schlier" grounds. The apparatus used to test cylindrical samples is described fully, and some results obtained on "Schlier" are presented.—D.B.V.

- 191-664. Arnold, A. B. Case-hardening effect on unconfined compressive strength and elastic modulus of Iron Canyon agglomerate, California: *Geol. Soc. America Bull.*, v. 73, no. 8, p. 1023-1024, 1962.

During the investigation of the Iron Canyon Dam Site on the Sacramento River near Red Bluff, Calif., tests were made to determine strength properties of the foundation materials. Tests performed on the agglomerate show the effect of case hardening and a decrease in strength with depth.— Author's abstract

- 191-665. Hereth, A., and Schombierski, A. Ermittlung der Festigkeitsanisotropie eines Gesteinskörpers, der von mehreren Kluftscharen durchzogen wird, mit elektronischen Rechengertäten [Determination of the anisotropy of strength of a rock body that is traversed by several sets of joints, with electronic computers (with English summary)]: *Geologie u. Bauwesen*, v. 27, no. 3/4, p. 126-130, 1962.

In bedrock cut by several sets of joints, the directions of maximum and minimum strength must be determined. The investigation can be pursued for different kinds of stress simultaneously, and was developed from the method of coefficients of resistance. The coefficients  $\alpha$ ,  $\beta$ , and  $\gamma$ , corresponding to the resistance to different kinds of stress, can be estimated as safety factors either qualitatively or quantitatively by this method, depending on the quality and extent of the geologic surveys and the tests performed.—D.B.V.

- 191-666. Scheidegger, A[drian] E. Stresses in the earth's crust as determined from hydraulic fracturing data: *Geologie u. Bauwesen*, v. 27, no. 2, p. 45-53, 1962.

The stresses acting in the immediate vicinity of a well can be determined by analyzing data obtained during hydraulic fracturing operations. The theory underlying this method is based on the assumption that fracturing is induced in a well through failure of the material under tensile stress. Values of regional stresses are calculated for five wells for which bottom-hole pressure charts are available. Stress differences up to the order of 2,000 lb per sq in. are found. In all cases the stress state corresponds geologically to incipient transcurrent faulting. Although no undue conclusions should be drawn from such limited data, it is noteworthy that the stress state found is in agreement with the transcurrent faulting postulated by seismologists from earthquake fault plane studies.—D.B.V.

- 191-667. Talobre, Joseph. Dix ans de mesures de compression interne des roches; progres et résultats pratiques [Ten years of measurements of internal compression of rocks; progress and practical results (with English summary)]: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 148-165, 1960.

During the past decade, methods used by Electricité de France to measure rock compression in place have been considerably improved as to simplicity, speed, and economy. This paper describes the use of such measurements, the measuring procedures, details of one of the new methods, and some theoretical and practical results, with several examples.—D.B.V.

- 191-668. Protodyakonov, M. M. Methods of studying the strength of rocks used in the U.S.S.R., in *International Symposium on Mining Research*: New York, Pergamon Press, v. 2, p. 649-668, 1962.

Laboratory methods for determining the strength of rock samples of regular and irregular shape are described. Brief mention is made of methods of determining the strength of rocks in place. A reference list of 26 items is included.— V.S.N.

Uyeda, Seiya, and Yabu, Takeo. Some experiments on thermal shock fracture of rocks. See *Geophys. Abs.* 191-699.

- 191-669. Anzyferov [Antsyferov], M. S. Die seismoakustische Kontrolle beim Abbau von Kohlenflözen mit Neigung zu Gas- und Kohleausbrüchen [The seismoacoustic control in the mining of coal seams with a tendency toward gas and coal bursts]: *Freiberger Forschungshefte*, C 100, p. 21-40, 1961.

The seismoacoustic activity of coal beds that tend toward gas and coal bursts was observed systematically in mines in the Donets basin, and some individual measurements were made in the Yegarshinsk anthracite deposit. The results demonstrate convincingly that gas and coal bursts, bumps, and possibly other dynamic phenomena are accompanied as a rule by an intensification of seismoacoustic activity. The increase appears several hours, several shifts, or several days before the burst or bump, depending on the conditions of mining and rate of penetration. Immediately before a burst there is a depression in seismoacoustic activity. This does not guarantee a direct (10-20 minute) warning of a burst, but taken together with earlier observations these results suggest the possibility of direct prediction by means of analysis of the energetic and spectral features of the seismoacoustic impulses.— D.B.V.

- 191-670. Buben, Jiří. Seismische Untersuchung von Gebirgsschlägen bei Kladno im Jahre 1960 [Seismic investigations of mine bumps near Kladno in the year 1960]: *Freiberger Forschungshefte*, C 126, p. 21-32, 1962.

Records of some 540 mine bumps obtained by a seismograph in the Kladno coal mining district of Czechoslovakia during a three-month period late in 1960 are analyzed and compared with seismograms at the Průhonice earthquake station and with subjective observations underground. It was found that the form of the seismogram record depends on distance from the focus of the shock. The daily curve shows a maximum at the beginning of the early shift and a main minimum toward the end of the same shift. The weekly curve shows variations on idle days as well as on work days. The relationship between energy and frequency of occurrence was established. The temporal curve of energy shows that bumps tend to develop independently in individual fields, but at the same time indicates that some common factor is at work. The prediction of bumps remains a problem. A task for the immediate future is the localization of focuses of all bumps into clearly defined active regions, followed by detailed studies in each of these regions and correlation with local mining practice and nature of the country rock.— D.B.V.

- 191-671. Simáné, Jindřich. Die seismoakustische Station "Příbram A" [The "Příbram A" seismoacoustic station]: *Freiberger Forschungshefte*, C 126, p. 33-44, 1962.

In the application of seismoacoustic methods to investigation of overburden pressure and mine bumps, the chief problem is the automatization of the registration, especially in mines in very solid rock where deformation proceeds slowly and the time of measurement is therefore necessarily protracted. The station "Příbram A" on the 38th level of the Anna mine (depth 1,400 m in the

Pribram district of Czechoslovakia has been set up in such manner that the apparatus needs to be attended only once a week. The station has been operating for 6 months, and all apparatus has functioned completely efficiently. The results obtained testify to the applicability of this method to very solid rock; further, they indicate critical rise in the pressure in the interval of measurement, and thus suggest the possibility of predicting the occurrence of a bump.— D.B.V.

- 191-672. Höfer, Karl-Heinz. Gibt es eine Periodizität der Gebirgsschläge? [Is there a periodicity of mine bumps?]: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 166-176, 1960.

Recent investigations of the possible periodicity of mine bumps are reviewed, with many of the results presented in the form of graphs. No definite conclusions can be drawn from the individual investigations, but they strengthen existing presumptions. Earth tides apparently play a part in triggering mine bumps, but they are not the only factor. In most cases the cause should be sought in the mining activity itself, and measures must be taken to operate in such a way as to avoid unstable stress conditions.— D.B.V.

- 191-673. Huggenberger, Arnold U. Baukörper und Baugrund in ihrer Wechselwirkung [Body and foundation of a construction in their mutual action]: *Geologie u. Bauwesen*, v. 27, no. 3/4, p. 200-201, 1962.

A structure and its foundation constitute a construction unit, elastically coupled and permanently interacting. The foundation is a natural body whose properties must first be carefully studied and clarified; the form of the structure is controlled by the engineer's professional knowledge and ability. The investigation of the physical and technical properties of rock and rock assemblages as building materials is difficult, because an anisotropic jointed mass is involved. The deformation and stress conditions of an arch dam under variable water pressure can be analyzed thoroughly for concrete, which is essentially homogeneous in comparison. In particular, the shear and displacements along the edge to which the rock is subjected can be determined. Calculation procedures developed by the U.S. Bureau of Reclamation and the modified Hook law of elasticity permit such calculation, taking into account the creep of the concrete, the directions of main stress, the main stresses, and the normal and main strain and compressive strain inside the structure and at its edges. With the help of computers, the results can be available in a day or two.

The systematic development of rock technology and rock measuring techniques is absolutely necessary to comprehend all causes and effects to which the framework of the structure is subjected. The recent failure of two dams in Europe shows the disastrous consequences that can ensue when not enough attention is paid to the condition and behavior of both structure and foundation.— D.B.V.

- 191-674. Malina, J. Ein Grossscherversuch im Phyllitgestein bei ungestörter Lagerung der Probekörper [A super-shear test in phyllite rock with the tested bodies in undisturbed position (with English summary)]: *Geologie u. Bauwesen*, v. 27, no. 3/4, p. 120-125, 1962.

The Europa Bridge of the Brenner highway crosses the Sill Valley at a place where the deformed geological formations caused difficulties in designing the foundation of the five main piers. The first pier rests on strongly deformed quartz phyllite, which required unusually thorough geologic and mechanical observations that were accomplished by means of a system of observation tunnels. Three super-shear tests were also performed on undisturbed rock in addition to many bearing tests. The shear test was performed on blocks approximately  $1\text{m} \times \frac{1}{2}\text{m}$  left projecting above the bottom of one of the tunnels at locations predetermined by engineering and geologic studies. The

method of testing is described. Movements of the tested blocks were measured continuously by dial gauges. The exact amount of internal friction and coherence on the shear surface could be determined by plotting these movements. The results were of utmost importance with respect to securing the pier foundations against gliding.— D.B.V.

- 191-675. Oberti, Guido. Experimentelle Untersuchungen über die Charakteristike der Verformbarkeit der Felsen [Experimental investigations on the characteristics of the deformability of rocks (with English and French summaries)]: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 95-113, 1960.

The importance of testing rocks for their deformation characteristics, with special reference to problems connected with dam and tunnel sites, is stressed. The various types of fundamental research that can be carried out are examined, particularly in relation to investigations in test galleries aimed at determining the properties of the rock itself, efficiency of different kinds of tunnel linings, reinforcement, mutual action of rock and lining, and so forth. Some results obtained for different kinds of rock encountered are recorded. Finally, the possibilities afforded by the modeling of large structures such as dams for studying their behavior on their foundations, especially in conditions of heterogeneous anisotropic rock and in the presence of faults and fractures, are illustrated.— D.B.V.

- 191-676. Takano, Minoru. Brief considerations on rupture of arch dam abutment: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 130-141, 1960.

The results are reported of two-dimensional model studies, using four different models, of stress distribution in different kinds of foundations for arch dams.— D.B.V.

- 191-677. Reuter, F. Entspannungserscheinungen in der Baugrube der Rappsbodetalssperre/Harz [Relaxation phenomena in the Rappsbodetal dam excavation, Harz (with English summary)]: *Geologie u. Bauwesen*, v. 27, no. 2, p. 73-76, 1962.

Before excavating for the Rappsbodetal dam in the Harz, Germany, water permeability tests were made in boreholes perpendicular to the axis of the dam, and the base of the excavation was eventually set where denser rock was presumed to exist. Permeability tests made later showed the same permeability in boreholes in the bottom of and outside the excavation. It is concluded, therefore, that the ground in the excavation has arched and relaxed since removal of the weight of the rocks.— D.B.V.

- 191-678. Pancini, Mario. Results of the first series of tests performed on a model reproducing the actual structure of the abutment rock of the Vaiont dam: *Geologie u. Bauwesen*, v. 27, no. 3/4, p. 105-119, 1962.

A model that faithfully reproduced the internal structure of the abutment rock of the Vaiont dam, including bedding planes and real and incipient joints, was subjected to increasing hydrostatic loads. The dam abutment system withstood the tests. Displacements occurred in the abutment and cracks appeared in the upper part of the dam only under stresses far greater than those they had been designed to withstand. A new series of tests with heavy block abutments is now in progress.— D.B.V.

- 191-679. Rabcewicz, L. von. Aus der Praxis des Tunnelbaues. Einige Erfahrungen über echten Gebirgsdruck [From tunnel construction practice. Some experiences with true rock pressure (with English summary)]: *Geologie u. Bauwesen*, v. 27, no. 3/4, p. 153-167, 1962.

The processes that take place in a lined tunnel in weak rock under static loading (gravity, tectonic forces, or crushing) are described. Pressure exerts a shearing on the lining perpendicular to the main stress direction. The whole fracture zone moves toward the excavation, always perpendicular to the direction of main stress, as has also been shown by experimental results. The anisotropy of the rock, particularly bedding, weakens its stability. Deformation generally takes place in two stages: First the parts parallel to the main stress direction are squeezed out and closed together, and then the roof and floor move into the excavation. These same disturbances can also be observed in the case of bomb hits. Finally, recent facts about sprayed concrete lining and short-term or permanent concrete anchoring in weak rock are reported.—D.B.V.

- 191-680. Tremmel, E. Zur Abschätzung des Einflusses der unvollkommenen Zugspannungsübertragung im zerklüfteten Gebirge auf die Beanspruchung von Druckschachtpanzerungen [The estimation of the influence of incomplete propagation of tensile stress in jointed rock on the stress of pressure-shaft sheathing]: *Geologie u. Bauwesen*, v. 25, no. 2/3, p. 228-232, 1960.

In usual theoretical calculations of the interaction of the rock on pressure-shaft lining, it is assumed that the rock is a homogeneous isotropic elastic continuum; in nature, however, it is neither homogeneous nor isotropic and is crossed by joints that do not transmit tensile stresses. An attempt is made in this paper to calculate quantitatively the effect of the difference in behavior of rock toward pressure and tension. The method used is based essentially on the fact that the known direction of the largest principal stresses is associated with a reduced modulus of elasticity, and thus an elasticity-theory treatment of the problem is possible. The extension to three-dimensional cases is not difficult. Fairly general plane problems can be solved in this way.—D.B.V.

- 191-681. Abel, John F., Jr. Ice tunnel closure phenomena: U.S. Army Snow Ice and Permafrost Research Estab. Tech. Rept. 74, 37 p., 1961.

The mechanics of closure exhibited by ice tunnels are explained by treating the ice as a viscous solid that flows when subjected to a force at a rate dependent on the magnitude of the force, the area of relief open for flow, and the apparent viscosity of the solid. Closure data in under-ice tunnels and rooms in Greenland over the period 1955 through 1958 are presented and analyzed. It is shown that maximum closure rates can be predicted with reasonable accuracy with the empirical equations given for glacial ice in the temperature range 15-25°F, and with depths and spans of openings from 20-200 and 5-38 feet, respectively. Large openings in glacial ice at depths greater than 150 feet are not feasible because of the rapid closure rates at those depths.—V.S.N.

- 191-682. Sala, [Ilmari]. Experimental studies on the stress concentration index of sea-ice, in General Assembly of Helsinki, 1960, Snow and Ice Commission: *Internat. Assoc. Sci. Hydrology Pub.*, no. 54, p. 15-19, 1961.

The strength of sea ice is measured experimentally by two methods: (1) bending tests performed with an in-place cantilever beam, and (2) ring tensile tests performed so that a ring of sea ice is caused to fail by applying a compressive load normal to its axis. The theoretical stress concentration factor,  $\alpha$ , the reduced stress concentration factor,  $\beta$ , and the stress concentration index,  $\eta$ , satisfy the equation  $\eta = (\beta - 1) / (\alpha - 1)$ . The number value of  $\alpha$  for any hole or notch can be theoretically determined, the values of  $\beta$  can be experimentally determined, and  $\eta$ , which is an approximate constant for any material, can then be calculated from the above equation. The experiments give an approximate value of about 0 for the  $\eta$  of sea-ice in Finland.—V.S.N.

- 191-683. Serikov, M. I. Mekhanicheskiye svoystva morskogo antarkticheskogo l'da [Mechanical properties of Antarctic sea ice]: Sovetskaya Antarkt. Eksped. Inf. Byull., no. 25, p. 23-27, 1961.

Methods and results are described for tests conducted in 1959 at Mirnyy to determine the hardness and elasticity of local ice and its durability under bending, shearing, and compression. The lower layers of ice show greatest resistance to sharp impact, but elasticity is maximum in the upper layer. The central layers exhibited the greatest strength during the tests (see also Geophys. Abs. 189-608).— V.S.N.

#### SUBMARINE GEOLOGY

- 191-684. Cromie, William J. Preliminary results of investigations on Arctic Drifting Station Charlie, in *Geology of the Arctic*, v. 1: Internat. Symposium Arctic Geology 1st, Calgary, Alberta, 1960, Proc., p. 690-708, 1961.

Station Charlie, established on the pack ice of the Arctic Basin, drifted in an east-west line across a shallow peninsula of the Chukchi shelf during July and August 1959. Continuous soundings were taken with an accuracy of one meter across the feature and in adjacent deep water. A bathymetric profile has been constructed and the angles of slope computed from seismic reflections. Twenty-two piston cores were taken, and more than 100 bottom photographs were made. Dating by radiocarbon analysis of pelagic forams is in process. Reflection techniques were used for determining dip and strike of bottom sediments. Studies were made of long range sound transmission by seismic means. Both relative and continuous absolute values of the magnetic field were measured; records were taken during a magnetic storm and solar flare disturbance. A vertical seismometer, installed on the ice, recorded at least one earthquake. Small variations in atmospheric pressure were recorded continuously on a microvariobarograph.— V.S.N.

- 191-685. International Geophysical Year Bulletin No. 56. Preliminary results from Arctic Ocean Drifting Station Charlie: Am. Geophys. Union Trans., v. 43, no. 1, p. 110-116, 1962.

This report is based on a paper by W. J. Cromie, published under a similar title in *Geology of the Arctic*, v. 1, p. 690-708, 1961 (see Geophys. Abs. 191-684) and also as *Lamont Geol. Obs. Sci. Rept.* 3, 1960.— D.B.V.

- 191-686. Bezrukov, P. L., and Petelin, V. P. Rukovodstvo po shoru i pervichnoy obrabotke prob morskikh donnykh osadkov [A manual for collection and preliminary treatment of samples of sea floor deposits]: Akad. Nauk SSSR Inst. Okeanologii Trudy, v. 44, p. 81-111, 1960.

The apparatus and instruments used for collecting and preliminary treatment of sea floor deposits employed for several years by the expedition aboard the "Vityaz'" are described.— A.J.S.

- 191-687. Sasa, Yasuo, and Izaki, Akira. Submarine geology of the Tsugaru Straits: Japan Acad. Proc., v. 38, no. 3, p. 120-123, 1962.

The geology of the Tsugaru Straits between Hokkaido and Honshu, Japan, is summarized briefly from data of geologic mapping on both coasts, drilling, geophysical logging, seismic refraction and sonic surveys, submarine photography, and rock dredging.— V.S.N.

- 191-688. Bezrukov, P. L. Polozheniye morskoy geologii sredi smezhnykh nauk i eye osnovnyye zadachi [The place of marine geology among

related sciences and its basic problems]: Akad. Nauk SSSR, Okeanologiya, v. 1, no. 2, p. 257-264, 1961.

The status of marine geology with respect to the field of geology as a whole and also to oceanology is analyzed.—A.J.S.

- 191-689. Zhivago, A. V., Lisitsyn, A. P., and Udintsev, G. B. Voprosy morskoy geologii i geomorfologii [Problems of marine geology and geomorphology]: Akad. Nauk SSSR, Okeanologiya, v. 2, no. 3, p. 469-489, 1962.

This is a report on the 85 papers on marine geology and geomorphology, presented at the 10th Pacific Science Congress at Honolulu, in 1961.—A.J.S.

- Macpherson, J. D. A new interpretation of seismic refraction profiles obtained in the Hartlen Point region of the Scotain Shelf. See Geophys. Abs. 191-620.

## VOLCANOLOGY

- 191-690. Karapetyan, K. I. O novom, gegamskom tipe vulkanov [On the new Gegam type of volcano]: Akad. Nauk SSSR Izv. Ser. Geol., no. 5, p. 107-111, 1962.

Certain volcanoes in the Yeratumbersk (Uch-Tapalarsk) group in the north-east part of the Gegam (Agmagan) volcanic upland of Armenia do not fit into any present classification. These are small, monogenetic volcanoes built up by repeated interlayering of effusive lavas and unconsolidated material. The occurrence of this type of volcano is of definite interest not only from the point of view of classification, but also to the study of areal (multi-vent) eruptions. In this respect the rhythmic change in character of the eruption within the relatively brief time of the volcano's activity is noteworthy. In the active life of a volcano of the Gegam type, explosive phases alternate with periodic rises in the level of molten lava until it spills over the crater rim.—D.B.V.

- 191-691. Machado, Frederico, Parsons, Willard H., Richards, Adrian F., and Mulford, John W. Capelinhos eruption of Fayal Volcano, Azores, 1957-1958: Jour. Geophys. Research, v. 67, no. 9, p. 3519-3529, 1962.

This paper summarizes the great volume of material that has been published, mostly in Portuguese and French, on the 13-month flank eruption of Fayal Volcano in 1957-58 (see also Geophys. Abs. 186-613).—D.B.V.

- 191-692. Markhinin, Ye. K., Alypova, O. M., Nikitina, I. B., Pugach, V. B., and Tokarev, P. I. Izucheniye sostoyaniya vulkanov Klyuchevskoy gruppy i vulkana Sheveluch v 1960 g. [Studies of the condition of the volcanoes of the Klyuchevskoy group and Sheveluch Volcano in 1960]: Akad. Nauk SSSR Lab. Vulkanologii Byull. Vulkanol. Sta., no. 32, p. 3-13, 1962.

In 1960 the Klyuchevskoy group and Sheveluch were relatively quiet. Results of the usual systematic observations of the state of the volcanoes and of temperature and gas regime of the fumaroles are reported for Klyuchevskoy, Bezmyanniy, Ploskiy Tolbachik, and Sheveluch. Analysis of these observations leads to the conclusion that attention should be directed to the solution of three important problems: (1) improvement and broadening of seismic observations, which already permit the prediction of Bezmyanniy and promise to throw light on the internal structure of the Klyuchevskoy group. (2) Broadening and improvement of magnetic investigations in the vicinity of Bezmyanniy, particularly its crater, promising to provide data for interpretation of magnetic

anomalies that probably are related to the internal structure and possibly to its near-surface magma chamber; these investigations naturally would be made in conjunction with geologic and topographic work. (3) Detailed study of the output of microcomponents, such as Pb, Zn, and Ag, in solfataric vapors and gases. — D.B.V.

- 191-693. Borisova, V. N., and Borisov, O. G. Nablyudeniya v kratere vulkana Bezymyanniy letom 1960 g. [Observations in the crater of Bezymyanniy Volcano in the summer of 1960]: Akad. Nauk SSSR Lab. Vulkanologii Byull. Vulkanol. Sta., no. 32, p. 14-19, 1962.

The eruption of Bezymyanniy in April 1960 was of the Merapi type according to Gorshkov's classification. The eruption was two-phased - explosive and collapse - and related to the formation of the extrusive dome. Eruptions of Bezymyanniy occur periodically, in the fall and spring; the spring eruption is stronger and determines the height of the dome. The dome is asymmetrically onion-shaped and is cut by numerous radial cracks along which movement takes place. The asymmetry is related to the slope of the base of the volcano and crater floor. Until 1960 the dome was not only broadening but also increasing substantially in height. In 1960 there was no significant increase in height in spite of the increase of activity compared to previous years, but at the same time its width almost doubled due to slumping of blocks within the dome. The northwest crater appears to be the most active, suggesting that the present feeder conduit probably lies near the surface there. In the main cone the extrusion lies under a thick cover of pyroclastic material. — D.B.V.

- 191-694. Rudich, K. N., Sirin, A. N., and Timerbayeva, K. M. Sostoyaniya vulkana Ploskiy Tolbachik v avguste 1961 g. [State of Ploskiy Tolbachik Volcano in August 1961]: Akad. Nauk SSSR Lab. Vulkanologii Byull. Vulkanol. Sta., no. 32, p. 20-23, 1962.

Observations of Ploskiy Tolbachik in the Klyuchevskaya group have been made periodically in the last two decades. In August 1961 the emission of gas was weak enough to permit detailed examination of the depression in the western part of the crater floor. Few changes had taken place since it was last inspected 13 years before, and those were due to erosion and weak explosions. No strong eruptions appear to have occurred in the period 1941-61; activity has been mainly mild gas emission of varying intensity with occasional small eruptions consisting of weak ash explosions. The absence of fresh lava, bombs, or scoria in the depression in the crater floor suggests that reports of a "glow" and "flames" on Tolbachik should be regarded with skepticism. In 220 years Ploskiy Tolbachik has had 10 eruptions, only 4 of which were violent. — D.B.V.

- 191-695. Gorshkov, G. S. Zametki ob izverzhenii Karymskogo vulkana v 1960 g. [Notes on the eruption of Karymskiy volcano in 1960]: Akad. Nauk SSSR Lab. Vulkanologii Byull. Vulkanol. Sta., no. 32, p. 24-32, 1962.

The central cone of Karymskiy volcano, in the east central part of the Kamchatka Peninsula, lies in a caldera 5 km in diameter. In recent years it has been the most active volcano in the Kurile-Kamchatka Arc. Ash emissions of varying but usually insignificant intensity have been observed almost every year since 1952. Activity intensified at the end of the winter or beginning of spring in 1960; ash eruptions became increasingly frequent, sometimes raining fine ash as far as Zhupanovo 30 km away. Observations made from Zhupanovo and closer to the volcano in September and October are reported here. Previous eruptions are reviewed. A number of dates given in the literature for Karymskiy eruptions are shown to be either misprints or the result of errors or misunderstandings. The development of the caldera is outlined. — D.B.V.

- 191-696. Zelenov, K. K., and Kanakina, M. A. Biryuzovoye ozero (kal'dera Zavaritskogo) i izmeneniye khimizma ego vod v rezul'tate izverzheniya 1957 g. [Lake Biryuzovoye (Zavaritskiy caldera) and changes in the chemistry of its waters as a result of the 1957 eruption]: Akad. Nauk SSSR Lab. Vulkanologii Byull. Vulkanol. Sta., no. 32, p. 33-44, 1962.

Following the 1957 eruption of Zavaritskiy Volcano (on the island of Simushir in the Kuriles), observations were made in 1958 and 1959 of the chemical changes brought about in the water in Lake Biryuzovoye in the caldera by hydrothermal activity. NaCl and KCl decreased, and  $MgCl_2$ ,  $MgSiO_4$ , and  $CaSO_4$  increased somewhat, but the proportions still remained substantially close to those in sea water. It is concluded that the cations of the salts in ocean water - the alkalis and alkali metals, mainly Na - similarly can be accounted for by the process of submarine volcanism. — D.B.V.

- 191-697. Markhinin, Ye. K., Sirin, A. N., Timerbayeva, K. M., and Tokarev, P. I. Opyt vulkano-geograficheskogo rayonirovaniya Kamchatki i Kuril'skikh ostrovov [Attempt at volcano-geographic regionalization of Kamchatka and the Kurile Islands]: Akad. Nauk SSSR Lab. Vulkanologii Byull. Vulkanol. Sta., no. 32, p. 52-70, 1962.

Analysis of volcanic activity in Kamchatka and the Kurile Islands shows that the most active area of the whole arc is northern Kamchatka; four active volcanoes here (Klyuchevskoy, Sheveluch, Tolbachik, and Bezmyanniy) account for about 1/3 of all known eruptions and about 1/3 of those that occurred in the last 55 years. The variety of types of eruptions in this area is exceptionally wide, and it is natural that investigations leading to the working out of methods of predicting eruptions and studies of the internal structure of volcanoes have been carried on here.

The danger zone is 23,257 km<sup>2</sup> in extent, or about 6.36 percent of the total area of Kamchatka and the Kuriles, but it lies in uninhabited or sparsely settled regions. The probability of a catastrophic eruption at any particular volcano is extremely small, once in some thousands of years; the chance of a catastrophic eruption somewhere in the Kamchatka-Kurile region is once in 50-60 years. This paper is regarded only as an introduction to detailed volcanic regionalization of individual volcanoes. Those that merit first attention are Klyuchevskoy and Avachevskiy in Kamchatka and Ebeko, Goryashchaya, and Fussa in the Kuriles. — D.B.V.

- 191-698. Nakamura, Hisayoshi. Report on the geological studies of hot springs in Japan [in Japanese with English abstract]: Japan Geol. Survey Rept., no. 192, 126 p., 1962.

The more than 10,000 hot springs in Japan may be classified into two major groups: (1) Quaternary volcanic hot springs and (2) hot springs of pre-Quaternary igneous origin (see Geophys. Abs. 180-413). The major hot spring localities of each type are described. Hot springs of pre-Quaternary igneous origin usually issue from silicic igneous rocks and are characterized by high contents of  $HCO_3^-$  and  $Cl^-$ . They represent condensations from original magmatic emanations and thus are called residual hydrothermal hot springs. The special cases of the hot springs in the Tertiary oil fields and the Joban coalfield are discussed also. The relationship of the hot springs to the geologic structures of their respective areas is analyzed. The report is well illustrated with geologic maps and tables of chemical data. — V.S.N.

- 191-699. Uyeda, Seiya, and Yabu, Takeo. Some experiments on thermal shock fracture of rocks [with Japanese abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 39, pt. 4, p. 593-601, 1961.

Laboratory experiments to determine thermal shock resistance and thermal strain in basalt are described. Thermal strain is produced in a cylindrical sample of basalt by pouring hot molten metal into a coaxially drilled inner hole. The strain measured on the outer surface is found to increase with increase in temperature of the metal. Fracturing occurs when the critical strain is reached. These results are applied to Mihara Volcano where movement of the hot lava to the surface by means of cracks formed by thermal shock is suggested. Such a process would proceed almost instantaneously as compared with any process of heat transfer.— V.S.N.

- 191-700. Link, František. L'activité volcanique et les éclipses de Lune [Volcanic activity and eclipses of the moon (with Russian summary)]: Ceskoslovenská Akad. Věd Studia Geophys. et Geod., v. 5, no. 1, p. 64-75, 1961.

A study based in part on astronomical and volcanological observations and in part on the theory of eclipses and diffusion of light leads to the conclusion that great volcanic eruptions can pollute the atmosphere with volcanic ash to such an extent as to explain the complete or near invisibility of the moon during certain total eclipses.— D.B.V.

INDEX

	Abstract		Abstract
Abel, J. F. Jr -----	681	Bates, R. C -----	591
Abubaker, Iya -----	154	Báth, Markus -----	565
Adams, E. W -----	67	Battelli, O -----	438
Afanas'yev, G. D -----	1	Beard, D. B -----	421, 428
Afanas'yev, N. L -----	337	Beck, A. E -----	389
Agamaliyev, G. M -----	250	Bednářová-Nováková,	
Ahrens, T, J -----	205	Bohumila -----	458, 461
Akasofu, Syun-Ichi -----	429, 452	Behrendt, J. C -----	265, 369, 638
Aki, Keiiti -----	84, 105	Belash, V. A -----	224
Akrabova, A -----	630	Belevtsev, Y. N -----	531
Aksel'rod, S. M -----	598	Bennett, A. D -----	605
Aldrich, L. T -----	88	Bentley, C. B -----	405
Aleksandrov, K. S -----	201, 202, 358	Berezin, E. M -----	365
Alekseyev, A. S -----	174, 178	Berezkin, V. M -----	340, 341
Alekseyeva, K. N -----	47	Berishvili, G. P -----	453
Alferov, B. A -----	257	Berzon, I. S -----	635
Aliyev, V. I -----	43	Bezrukov, P. L -----	686, 688
Allen, J. R. L -----	312	Bhavsar, P. D -----	455
Alterman, Z -----	412	Bichevina, V. N -----	402
Alypova, O. M -----	692	Black, R. F -----	483
Anderson, D. L -----	153, 410	Blanchett, Jean -----	542
Anderson, K. A -----	455	Bloxam, T. W -----	575
Ando, Kiyomi -----	228	Bokanenko, L. I -----	634
Ando, Seiichi -----	84	Bollo, M. F -----	661
Andreyev, V. I -----	471, 555	Bol'shakov, A. S -----	470
Annell, Charles -----	16	Bol'shakova, O. V -----	446
Anpilogov, A. P -----	253	Bolt, B. A -----	116
Antsyferov, M. S -----	669	Bondarenko, V. M -----	241
Arkhangel'skiy, V. T -----	145	Bonnet, G -----	431
Arnold, A. B -----	664	Books, K. G -----	592
Arnold, K. C -----	621	Borisevich, I. V -----	1
Arnold, R. G -----	395	Borisevich, Ye. S -----	129, 130, 134
Aronov, L. Ye -----	132, 134		136, 138, 139, 141
Aronovich, Z. I -----	146	Borisov, O. G -----	693
Arshvila, S. V -----	134	Borisova, V. N -----	693
Artem'yev, M. E -----	375	Born, W. T -----	282
Asada, Toshi -----	88	Borovinsky, B. A -----	245, 268
Avramchev, L -----	629	Bouška, Jan -----	459, 462
Axford, W. I -----	422	Boyarov, A. T -----	252
Ayzenshtadt, G. Ye. -A -----	260	Bradley, R. S -----	413
		Bradner, Hugh -----	212
Babich, V. M -----	174, 175	Brant, A. A -----	288
	176, 181,	Breth, H -----	663
Bacon, L. O -----	654	Briggs, B. R -----	430
Balsley, J. R -----	533, 542	Briggs, M. H -----	34
Baranov, V. I -----	30	Brodskaya, S. Yu -----	468
Barnett, C. H -----	300	Bromery, R. W -----	532, 535
Barvenko, H. Ya -----	321		537, 539, 544
Barygin, V. M -----	560	Bronshten, V. A -----	59

	Abstract		Abstract
Brune, J. N	104	Decae, A	566
Buben, Jíří	670	Dempsey, W. J	536
Bucha, Václav	487	Deresiewicz, H	148, 149, 152
Buchheim, Wolfgang	247	Desio, Ardito	271
Bugaylo, V. A	510	de Visintini, G	352
Bulakh, Ye. G	335, 347	Dicke, R. H	324
Bulanzhe, Yu. D	362	Dmitriyev, V. I	234
Buldyrev, V. S	183, 186	Dobrin, M. B	276
Bulin, N. K	602	Dodd, R. T., Jr	9
Bull, C	492	Doe, B. R	415
Bullen, K. E	399	Doell, R. R	472
Bunce, E. T	619	Dobrikina, N. A	572
Burlatskaya, S. P	485	Donaldson, I. G*	384
Burša, Milan	294, 295, 297	Donoho, Paul	123
Bykova, K. I	583, 584	Doykov, Zh	629
		Doyle, H. A	122
Cagniard, Louis	603	Dudarev, A. N	477
Cain, J. C	429	Duestehoeft, W. C	248
Cambron, E	435	Dunayev, V. A	15
Campbell, Colin	284	Dunning, K. L	68
Canada Geological Survey	545, 546, 547, 548	D'yakonova, M. I	61
Caputo, Michele	271, 327	Emery, C. L	655, 657
Carpenter, E. W	124, 208	Emiliani, Cesare	20
Carozzo, M. T	342, 525	Everitt, C. W. F	474
Central Water and Power		Evernden, J. F	22
Research Station Poona	95, 194, 272, 637	Evison, F. F	483
Ceplecha, Zd	50, 162	Fahlquist, D. A	619
Červený, Vlastislav	162	Fairbairn, H. W	19, 21
Chang, C. C	423	Faust, L. Y	614
Chapman, Sydney	429, 460	Fedorova, N. A	521
Cherdyntsev, V. V	10	Fermandzhiev, I. I	527
Cherkasov, P. A	322	Ferraes, S. G	103
Chernyshev, I. V	4, 5	Fesenkov, V. G	53
Chetty, T. N	240	Filatov, V. A	518
Clar, E	645	Filin, T. D	304
Cleary, J	122	Filipov, Ye. M	596, 597
Clegg, J. A	474	Firsoff, V. A	69
Clough, R. W	109	Fleyshman, D. G	573
Compston, W	29	Florensov, N. A	94
Cook, G. E	329	Fomin, V. M	377
Cooter, I. L	464	Foose, R. M	289
Coppolino, S	239	Fremd, V. M	125
Cox, Allan	472	Fukutomi, Takaharu	392
Creer, K. M	484	Fuller, M. D	480
Cromie, W. J	684	Furumoto, A. S	102
Curedale, R. G	437		
Curtis, G. H	22	Gadzhiyeva, T. A	390
		Galanopoulos, A. G	98
Danilevich, S. I	25	Galperin, Ye. I	166
Davis, F. J	587, 588	Gamow, George	325
Davydova, N. I	191	Gantar, C	366, 367, 373
De Bremaecker, J. Cl	123	Garland, G. D	442

	Abstract		Abstract
Gayanov, A. J	382	Hereth, A	665
Gayskiy, V. N	99	Hermann, Horst	626
Gazaryan, Yu. L	179, 180	Hervás Burgos, Pablo	528
Gedonov, L. I	581	Hill, M. N	441
Geiss, Johannes	20	Hill, P. A	263
Gel'chinskiy, B. Ya	174, 177, 178	Hiltens, D. van	486
Gel'fand, N. I	500, 501	Hintenberger, H	40
Gerling, E. K	7, 12	Hodgson, J. H	406
Gianfrani, A	549	Höfer, Karl-Heinz	672
Giesecke, Alberto	290	Hoffman, A. A. J	75
Gilbert, F. P	537, 538, 539	Hofmann, Walther	313
Gilliland, W. N	309	Hollister, J. C	286
Girdler, R. W	305	Holmes, G. W	370
Glazunov, V. V	573	Holz, Peter	617
Glen, J. W	317	Hori, Minoru	84
Glicken, Milton	353	Horton, C. W	75
Glyuzman, A. M	222	Howell, L. G	465
Goldberg, R. A	420	Hower, J	19
Gol'denfel'd, I. V	26	Hoy, R. B	289
Gol'dfarb, M. L	136, 139, 140	Hron, František	162
		Huber, Carolyn	641
Golenetskiy, S. I	119	Hudson, J. A	156
Gorai, Masao	416	Huffaker, R. M	67
Gorelov, L. A	76	Huggenberger, A. U	673
Gorokhov, I. M	8	Hurley, P. M	19, 21
Gorshkov, E. S	469	Hutton, V. R. S	444
Gorshkov, G. S	695		
Goryunov, I. I	254	Idlis, G. M	54
Gouin, Pierre	435	Inghilleri, Giuseppe	366
Grabovskiy, M. A	468	International Geophysical Year	
Green, Ronald	263	Bulletin No. 56	685
Gregory, P. H	36	Irving, E	492
Grigorova, E. I	90	Isacks, Bryan	211
Gritchenko, Z. G	581	Isayev, V. S	634
Gross, W. H	475	Ivakin, B. N	193
Grosse, Siegfried	628	Ivankin, P. F	554
Grushinskiy, N. P	357, 381	Ivanov, I. B	3
Gurevich, G. I	106	Ivanov, K. G	55, 56
Gusev, Yu. M	514	Ivanova, K. S	25
Gutenberg, Beno	409	Iyer, H. M	564
Gzovskiy, M. V	107	Izaki, Akira	687
		Izmaylov, Y. P	358
Haefeli, Robert	316		
Hagedoorn, J. G	611	Jacobs, J. A	443, 447
Hagiwara, Takahiro	82	Jacobshagen, V	418
Halenka, Jaroslav	463	Jaeschke, Rudolf	432
Hammond, J. W	606	Jarosch, H	412
Harrison, E. R	424, 425	Jeffreys, Harold	113, 114, 300
Hart, S. R	9	Jenkins, E. B	421
Haruki, Kiyonosuke	594	Johnson, H. M	249
Hatuda, Zin'itiro	6	Jolley, E. F	443
Hawkins, L. V	611	Jones, D. C	285
Heitfeld, K. H	646	Jones, G. H. S	206
Henderson, J. R	534	Judd, W. R	641

	Abstract		Abstract
Kage, Erhardt -----	616	Konstantinova, A. G -----	200
Kahler, F -----	644	Konstantinova, L. S -----	518
Kakioka Magnetic Observatory --	436	Korchagina, O. A -----	571
Kalliokoski, Jorma -----	396	Kostelka, Ludwig -----	660
Kanai, Kiyoshi -----	87	Kotyuk, A. F -----	242
Kanakina, M. A -----	696	Kovalenko, N. D -----	241
Kane, M. F -----	339	Kovalenko, V. F -----	237
Kang, Yong-ho -----	479	Kovalevskiy, G. F -----	58
Kamenetskiy, F. M -----	237	Kozlov, I. G -----	256
Karakama, Ikuo -----	83	Kozulin, Yu. N -----	235
Karapetyan, K. I -----	690	Krasnov, B. A -----	356
Karatayev, G. I -----	557	Kravets', V. V -----	198
Kárník, Vít ----- 77, 97,	569	Kravtsov, G. S -----	115
Karyagina, Z. V -----	54	Křivský, Ladislav -----	450
Kashkay, M. A -----	43	Krutikhovskaya, Z. A -----	467, 482
Kastorskiy, S. A ----- 130,	139	Kuchina, G. N -----	25
Katyushkin, V. F -----	138	Kulikova, M. V -----	553
Katz, Samuel -----	205	Kun, V. V -----	168
Kaufman, A. A ----- 223,	251	Kuprin, V. I -----	555
Kawachi, Yosuke -----	595	Kurbatov, V. V -----	12
Kayano, Ichiro ----- 82,	83	Kuzhelov, G. K -----	482
Kazinskiy, V. A -----	328	Kuzivanov, V. A ----- 364,	365
Kebuladze, V. V -----	71	Kuz'min, A. M -----	13
Kelarev, V. V -----	15	Kuznetsov, G. A -----	597
Kellogg, P. J -----	426	Kuznetsov, G. F -----	511
Kelly, S. F -----	238	Kuznetsov, K. K -----	106
Kern, J. W -----	456	Kuznetsov, V. P -----	127
Khakhlev, Ye. M -----	633	Kvapil, Rudolf -----	650
Kharonova, V. Ya -----	61	Kvasha, L. G -----	56
Khlobustov, A. A -----	653		
Khokhlov, P. V -----	173	Ladynin, A. B -----	351
Khomenko, V. I ----- 493,	551	Lamar, D. L -----	326
Khomenyuk, Yu. V -----	233	Langbein, W. B -----	273
Kirnos, D. P ----- 128, 131,	143	Larionov, V. A ----- 481, 505,	512
Kirov, K. T -----	90	Laudon, T. S ----- 265,	369
Kishinouye, Fuyuhiko -----	80	Lauffer, H -----	662
Kivioja, L. A -----	338	Lawrence, L. J -----	417
Kizawa, Takashi -----	158	Lazarev, G. Ye -----	383
Kiziriya, L. V -----	71	Lebedev, T. S -----	376
Klíma, Karel -----	197	Lebedeva, F. V -----	167
Klimentov, P. P -----	391	Leet, F. J -----	562
Klushin, I. G ----- 292,	349	Leet, L. D ----- 207,	562
Knoppe, K. G -----	49	Lehmann, Inge -----	408
Knorre, K. G -----	30	LeMarne, A. E -----	393
Koczy, F. F -----	20	Leontiyev, I. Y -----	635
Kogan, S. Ya -----	112	Levadnyy, V. T ----- 225,	246
Kolbenheyer, Tibor ---- 227, 333,	334	Levin, F. K -----	622
Kolesnikov, Yu. A -----	137	Levskiy, L. K -----	44
Komlev, L. V -----	25	Link, František -----	700
Komovskiy, G. F -----	48	Link, Harald -----	643
Kondorskaya, N. V -----	97	Link, T. A -----	281
Konečný, Mojmír -----	449	Lisitsyn, A. P -----	689
König, H -----	40	Logachev, A. A -----	530
Konstantinov, G. N -----	518	Logovskaya, G. K -----	250

	Abstract		Abstract
Lombard, D. B	-----	209	Mikov, D. S ----- 520
Lomnitz, Cinna	-----	397	Millecamps, R ----- 318
Loshchakov, A. I	----- 558,	559	Miller, J. A ----- 23, 24
Lossovskiy, Ye. K	-----	170	Misra, A. K ----- 639
Lotgering, F. K	-----	466	Miyamura, Setumi ----- 84
Lovtshyus, A. V	-----	46	Mizyuk, L. Ya ----- 242
Lovtshyus, G. P	-----	46	Mohr, P. A ----- 306
Lowman, P. D	-----	68	Molina, F ----- 438, 451
Lozano, L	-----	368	Möller, Dietrich ----- 314
Lozano Calvo, Luis	-----	651	Molotkov, I. A ----- 185, 187
Lyons, P. L	-----	279	Molotkov, L. A ----- 188, 189, 190
Lyubimova, Ye. A	-----	387	Molotova, L. V ----- 601
Lyustikh, Ye. N	----- 302,	400	Momose, Kanichi ----- 490
			Monakhov, F. I ----- 571, 572
McCaslin, William	-----	540	Mongelli, F ----- 386
MacDonald, G. J. F	-----	31	Moore, C. M., Jr ----- 280
Machado, Frederico	-----	691	Morelli, Carlo ----- 366, 368, 373
McLarty, D. M. E	-----	277	
			386, 525
McLean, A. C	----- 371,	372	Morimoto, Ryohei ----- 86
Macpherson, J. D	-----	620	Morozova, I. M ----- 12
Maisuradze, O. M	-----	118	Mosetti, F ----- 342
Makarevich, K. G	-----	320	Moskvina, A. G ---- 143, 144, 568
Makarova, S. D	-----	93	Mosyagina, M. S --- 129, 130, 136
Maksimov, L. S	-----	142	Mulford, J. W ----- 691
Malina, J	-----	674	Müller, L ----- 647
Malygin, A. A	-----	554	Muller, Leopold ----- 648
Mälzer, Hermann	-----	314	Mumme, I. A ----- 380
Marek, František	-----	607	Mumme, W. G ----- 491
Mariani, F	-----	451	Munro, Mary ----- 24
Markhinin, Ye. K	----- 692,	697	Murai, Isamu ----- 85
Marussi, Antonio	----- 116,	271	Murina, G. A ----- 14
Mason, C. S	-----	441	Murrell, S. A. F ----- 639
Matalas, N. C	-----	273	
Matsuda, Tokihiko	-----	86	Nag, K. R ----- 155
Matsushita, S	-----	457	Nagai, Jiro ----- 6, 28
Mattana, N	-----	579	Nakamura, Hisayoshi ----- 698
Matumoto, Hideteru	-----	84	Nakamura, Kohei ----- 111
Matveyev, A. V	-----	582	Nakazawa, Jiro ----- 594
Matveyev, B. K	-----	213	Namnandorz, O ----- 62
Matveyeva, I. I	-----	7	Nassonov, V. A ----- 522
Mayaud, Pierre-Noel	-----	434	Nazarov, A. G ----- 110
Mazor, E	-----	580	Negi, J. G ----- 230
Mel'kanovitskiy, I. M	-----	269	Nepomnyashchikh, A. A ----- 523
Melle, F. A. Van	-----	613	Nersesov, I. L ----- 106
Menard, H. W	-----	307	Newfarmer, L. R ----- 278
Mencher, E	-----	21	Newton, R ----- 293
Meshkov, M. M	-----	571	Nicholls, H. R ----- 195
Meuschke, J. L	----- 538, 540,	542	Nikitina, I. B ----- 692
Mezhiborskaya, Kh. B	-----	574	Nikolov, N. S ----- 63
Michel, J. G	-----	123	Norris, D. K ----- 483
Mikhalevskaya, A. D	-----	25	Northrop, John ----- 121
Mikhaylova, N. P	-----	476	
Mikov, B. D	----- 503,	504	Obashev, S. O ----- 57

	Abstract		Abstract
Obert, Leonard -----	640, 659	Popov, V. I -----	303, 304, 311
Oberti, Guido -----	675	Popov, Ye. I -----	354, 360
Obi, Itsuaki -----	595	Potapov, I. I -----	32
Oblogina, T. I -----	604	Pounder, E. R -----	204
O'Keefe, J. A -----	68	Power, D. V -----	209
Oliver, J. E -----	211, 563	Poyarkova, Z. N -----	259
Omote, Syun'itiro -----	83	Praus, Oldřich -----	232
Onda, Isao -----	80	Preobrazhenskiy, V. B ---	135, 139
Orellana Silva, Ernesto -----	226		140, 141
Orlov, V. P -----	526	Pris, G. V -----	216, 219, 220
Osada, Kaio -----	87	Pros, Zdeněk -----	197
Osadchaya, R. I -----	15	Protodyakonov, M. M -----	668
Osawa, Yutaka -----	81	Provodnikov, L. Ya -----	506, 507
Osipov, I. O -----	163, 165, 169		508, 556
Ostenso, N. A -----	370, 405	Pugach, V. B -----	692
Ovchinnikov, L. N -----	15	Purtova, S. I -----	256, 257
Overseas Geological Surveys -	561, 623	Putkaradze, L. A -----	598
Overstreet, W. C -----	16	Puzyrev, N. N -----	612
		Pyatnitskiy, V. K -----	499
Pak, V. A -----	635		
Pal'gov, N. N -----	636	Rabcewicz, L. von -----	679
Palik, P -----	37	Rafter, T. A -----	417
Pancini, Mario -----	678	Ragimov, Sh. S -----	120
Panova, M. V -----	15	Ramaswamy, G -----	529
Parkhomenko, E. I -----	203	Rao, H. N. R -----	240
Parkinson, W. D -----	437, 440	Rao, V. B -----	261
Parks, P. E., Jr -----	638	Reinhardt, Hans-Günter -----	627
Parsons, W. H -----	691	Reinhardt, P. W -----	587, 588
Paterson, M. S -----	642	Renner, J -----	374
Paterson, N. R -----	236, 283	Reuter, F -----	677
Peacock, J. D -----	585	Rice, J. T -----	148
Pearson, R. C -----	18	Rice, R. B -----	599
Pearson, Ronald -----	35	Richards, A. F -----	691
Pěč, Karel -----	117	Ringwood, A. E -----	411
Pěčová, Jana -----	448	Rische, Hans -----	624
Pegum, D. M -----	379	Riznichenko, Yu. V -----	97
Pekeris, C. L -----	412	Robin, G. de Q -----	267
Peschel, Gerald -----	550	Rodrigues, B -----	88
Petelin, V. P -----	686	Rokityanskiy, I. I -----	74
Petkevich, G. I -----	631	Romanyuk, V. A -----	363
Petrova, G. N -----	485	Rosemann, Heinz -----	610
Petrucci, Giuseppe -----	239	Rosholt, J. N -----	20
Petrushevskiy, B. A -----	108	Rothe, Klaus -----	589
Petty, A. J -----	538, 540	Round, G. F -----	293
Pick, Miloš -----	296, 298	Roy, Amalendu -----	274
Pidgeon, R. T -----	29	Rudich, K. N -----	694
Pierau, H -----	608	Rush, Stanley -----	262
Pinchuk, I. A -----	260	Ryaboy, V. Z -----	378
Pinson, W. H., Jr -----	19, 21	Rýsavý, Josef -----	299
Plekhanov, G. F -----	58	Ryzhova, T. V -----	201, 202
Plokhikh, N. A -----	221		
Polak, L. S -----	597		
Polonskiy, A. M -----	218	Safronov, V. S -----	65

	Abstract		Abstract
Saito, Sadao -----	83	Simáné, Jindřích -----	671
Saito, Tsuguo -----	595	Simeon, G -----	439
Saito, Yutaka -----	490	Simonenko, T. N -----	502, 513
Sala, Ilmari -----	682	Sirin, A. N -----	694, 697
Saltykovskiy, A. Ya -----	400	Skur'yat, A. N -----	126
Sandstrom, N -----	621	Slepnev, Yu. S -----	27
Sanford, R. L -----	464	Smith, D. E -----	330, 331
Sanna, S -----	579	Smith, H. W -----	248
Santo, T. A -----	403, 404	Sobakar, G. T -----	376
Särchingcr, Hellmuth -----		550 Sobolev, G. A -----	203
Sardarov, S. S -----		11 Sobotovitch, E. V -----	46
Sarma, V. V -----	261	Solaini, Luigi -----	366
Sasa, Yasuo -----	687	Solonenko, V. P -----	78, 100
Sass, J. H -----	393	Solov'yev, O. A --497, 498, 516,	519
Sato, Yasuo -----	150	Solov'yev, S. L -----	97
Savarenskiy, Ye. F -----	97	Solov'yev, V. N -----	128, 131, 133
Savill, R. A -----	124, 208	Soluyan, S. I -----	173
Savonenkov, V. G -----	25	Spencer, T. W -----	151
Schcidegger, A. E -----	666	Sposito, A -----	439
Schmerling, E. R -----	420	Spreiter, J. R -----	430
Schmidt, R. A -----	394	Sprintsson, V. D -----	14
Schmidt, R. G -----	593	Stalinsky, P -----	204
Schombierski, A -----	665	Stankevich, L. I -----	258
Schulze, Reinhard -----	355	Starik, I. Ye -----	46
Segre, A. G -----	373	Stauder, William -----	132
Sehnal, L -----	332	Steenland, N. C -----	543
Sengbush, R. L -----	618	Steinhart, J. S -----	88
Serabryakova, Z. D -----	256, 257	Stern, T. W -----	16, 18
Serbulenko, M. G -----	515, 517	Strakhov, V. N -----	494, 495
Serikov, M. I -----	683	Strangway, D. W -----	475
Serra, A -----	579	Stroiteleva, A. V -----	553
Seya, Kiyoshi -----	586	Stupak, N. K -----	552
Shabanov, B. A -----	76	Sukhodol'skiy, V. V -----	358, 361
Shalayev, S. V -----	496	Svatkov, N. M -----	323
Shamina, O. G -----	167, 172	Svetov, B. S -----	215
Shangareyev, F. L -----	15	Swift, L. M -----	210
Shanin, L. L -----	1, 27	Swithinbank, Charles -----	319
Shashkin, V. L -----	583, 584		
Shats, M. M -----	46	Takahashi, Takehito -----	159, 160
Shaub, Yu. B -----	217	Takano, Minoru -----	676
Shebalin, N. V -----	97, 143, 147, 568	Takeshita, Hisashi -----	490
Sherwood, J. W. C -----	151, 600	Talobre, Joseph -----	667
Shestakov, G. I -----	3	Tal'-Virskiy, B. B -----	377
Shibata, Ken -----	24	Tal'virskiy, D. B -----	633
Shimazu, Yasuo -----	301	Tamrazyan, G. P -----	91
Shneiderov, A. J -----	577	Tarakanov, Yu. A -----	375
Sholpo, L. E -----	469	Tarkhov, A. G -----	241
Shraybman, V. I -----	378	Taylor, S. R -----	66
Shreve, R. L -----	315	Tazime, Kyozi -----	161
Shukolyukov, Yu. A -----	7	Telyakova, Z. Kh -----	632
Shul'ts, S. S -----	310	Thomas, Erich -----	625
Shumskiy, P. A -----	383	Thomas, H. H -----	18
Shurbet, D. H -----	89	Timerbayeva, K. M -----	694, 697
Shvank, O. A -----	343	Timofeyev, A. N -----	509
Shvedov, V. P -----	581		

	Abstract		Abstract
Timoshin, Yu. V -----	609	Vol'vovskiy, I. S -----	378
Tobyáš, Vladimír -----	569	Vorob'yev, G. G -----	62
Tokarev, P. I -----	692, 697	Voskresenskiy, Yu. N -----	192
Tokmagambetov, G. A -----	244	Vozoff, Keeva -----	442
Tokmakov, V. A -----	142	Vronskiy, B. I -----	52
Tolstikhin, I. N -----	292		
Torio, Francisco -----	576	Wait, J. R -----	427
Tovarenko, K. A -----	47	Wangersky, P. J -----	20
Tremmel, E -----	680	Wänke, H -----	40, 45
Treskov, A. A -----	96	Watkins, J. S -----	541
Troitskiy, S. G -----	583, 584	Watznauer, A -----	649
Trubitsyn, V. P -----	414	Weber, J. R -----	621
Tryggvason, Eysteinn -----	401	Weihsaupt, J. G -----	266
Tsaturyants, A. B -----	390	Weinreb, Sander -----	218
Tsepelev, N. V -----	184	Weiss, L. E -----	642
Tsikulin, M. A -----	60	Wells, J. W -----	312
Tskhakaya, A. D -----	92	Westley, Harold -----	16
Tsuya, Hiromichi -----	85	Westphal, K. O -----	447
Tugarinov, A. I -----	2	Wieduwilt, W. G -----	231
Tulin, V. A -----	359	Williams, E. T -----	656
Tuparev, P -----	629	Williamson, R -----	585
Turcan, A. N., Jr -----	255	Willis, I -----	492
Tuve, B -----	88	Wilson, J. T -----	308
Tweto, Ogden -----	18	Wilson, R. L -----	473
Tyapkin, K. F --- 346, 348, 350,	524	Winkler, J. R -----	455
		Winkler, E. M -----	17
Udintsev, G. B -----	689	Wold, R. J -----	265, 369
Uffen, R. J -----	407	Woods, J. P -----	275, 287
Uklonskiy, A. S -----	419	Woollard, G. P -----	264
Umezu, Naganori -----	228	Wright, J. K -----	124, 208
Uno, Kaichi -----	595	Wright, R. W -----	445
Unz, M -----	229		
Usami, Tatsuo -----	150	Yabu, Takeo -----	699
Ushakova, A. M -----	578	Yakovlev, V. N -----	635
Utter, Stephen -----	658	Yakubovich, A. L -----	590
Uyeda, Seiya -----	454, 699	Yamaguchi, Rinzo -----	157, 158
		Yanovskiy, B. M -----	469, 488
Valiyev, A. A -----	489	Yanvel', A. A -----	41
Valle, P. E -----	385	Yashchenko, M. L -----	8
Vanek, I -----	97, 197	Yaskawa, Katsumi -----	478
Varshavskiy, E. S -----	8	Yastrebova, T. A -----	256, 257
Vasil'yev, N. V -----	58	Ye, Shi-Yan' -----	128
Vasil'yev, Yu. I -----	196, 601	Yegorov, Yu. M -----	433
Vaysman, G. I -----	127	Yevsikova, L. G -----	335
Vdovyykin, G. P -----	38	Yokoyama, Izumi -----	70
Verbts'kyy, T. Z -----	243	Yoshiyama, Ryoichi -----	79
Vetchinkin, A. N -----	135	Yudin, I. A -----	64
Vinogradov, A. P -----	39, 49, 398	Yun'kov, A. A -----	336
Vinogradov, P. A -----	72, 73	Yun'kov, Ya. A -----	344, 345
Vinogradov, S. D -----	652		
Volarovich, M. P -----	199, 203	Zabelin, M. V -----	129, 134
Volodarskiy, R. F -----	270	Zadorozhnyy, I. K -----	49

	Abstract		Abstract
Zakharov, V. Kh -----	214	Zhavoronkov, V. Ya -----	597
Zampieri, L -----	367, 373	Zhilevich, I. I -----	134
Zans, V. A -----	388	Zhirov, K. K -----	3
Zátopek, Alois ----	97, 291, 567, 570	Zhivago, A. V -----	689
Zaytsev, L. P -----	171	Zhuravlev, V. K -----	58
Zelenov, K. K -----	696	Zommer, I. E -----	382
Zhadin, V. V -----	615	Zvoys'kiy, V. M -----	467
Zharkov, V. N -----	164		





