

# Geophysical Abstracts 165 April-June 1956

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GEOLOGICAL SURVEY BULLETIN 1048-B





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By MARY C. RABBITT, DOROTHY B. VITALIANO, S. T. VESSELOWSKY, and others

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GEOLOGICAL SURVEY BULLETIN 1048-B

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



**UNITED STATES DEPARTMENT OF THE INTERIOR**

**Fred A. Seaton, *Secretary***

**GEOLOGICAL SURVEY**

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

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# CONTENTS

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	Page
Introduction.....	93
Extent of coverage.....	93
List of journals.....	93
Form of citation.....	94
Abstractors.....	94
Age determinations.....	95
Earthquakes and earthquake waves.....	99
Earth tides and related phenomena.....	110
Elasticity.....	112
Electrical exploration.....	119
Electrical logging.....	126
Electrical properties.....	128
Exploration summaries and statistics.....	129
General geophysics.....	131
Geodesy.....	131
Geotectonics.....	132
Glaciers.....	133
Gravity.....	134
Heat and heat flow.....	144
Internal constitution.....	146
Isostasy.....	149
Isotope geology.....	150
Magnetic field of the earth.....	153
Magnetic properties.....	156
Magnetic surveys.....	162
Microseisms.....	166
Radioactivity.....	166
Radioactivity logging and surveying.....	172
Seismic exploration.....	176
Strength and plasticity.....	185
Submarine geology.....	185
Volcanology.....	185
Index.....	189



## **GEOPHYSICAL ABSTRACTS 165, APRIL-JUNE 1956**

By MARY C. RABBITT, DOROTHY B. VITALIANO, S. T. VESSELOWSKY,  
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 circulation (such as dissertations, open-file reports, or memoranda) or of papers presented orally at meetings unless summaries of substantial length are published. Abstracts of papers in Japanese and Chinese are based on abstracts or summaries in a western language accompanying the paper.

#### **LIST OF JOURNALS**

The following list supplements the List of Journals published in Geophysical Abstracts 160 (January-March 1955, Bulletin 1033-A) and the supplements published in Geophysical Abstracts 161, 162, 163, and 164. Full titles and abbreviations of journals cited for the first time in this issue (with the sponsoring organization and its address where these do not form part of the title) are given.

Akad. Nauk SSSR Lab. vulkanol. Trudy—Trudy Laboratorii vulkanologii, Akademii Nauk SSSR, Moskva.

Arctic—Arctic Institute of North America, Montreal, Canada.

Československé Akad. Věd Geofys. Ústavu Práce, Geofys. Sborník—Práce Geofysikálního Ústavu Československé Akademie Věd Geofysikální Sborník. Praha.

Colliery Guardian—London.

Dansk Geol. Foren. Medd.—Meddelelser fra Dansk Geologisk Forening. København.

Jour. Nuclear Energy—Journal of Nuclear Energy. Pergamon Press, London.

Minería (Peru)—Instituto de Ingenieros de Minas del Peru. Lima.

Nagoya Univ. Jour. Earth Sci.—Journal of Earth Sciences Nagoya University. Japan.

North Dakota Geol. Survey Rept. Inv.—North Dakota Geological Survey, Report of Investigation. Grand Forks, N. Dak.

Philippine Geologist—Society of Philippine Geologists, Manila, P. I.  
Portugal Serviço de Fomento Mineiro Estudos, Notas e Trabalhos—Estudos,  
Notas e Trabalhos do Serviço de Fomento Mineiro. Oporto.  
Quart. Jour. Seismology—Quarterly Journal of Seismology. Central Meteorological Observatory, Tokyo.  
Tulsa Geol. Soc. Digest—Tulsa Geological Society Digest. Tulsa, Okla.  
Wyoming Geol. Assoc. Guidebook—Wyoming Geological Association, Laramie.  
Zeitschr. Gletscherkunde u. Glazialgeologie—Zeitschrift für Gletscherkunde und Glazialgeologie. Universitätsverlag Wagner, Innsbruck, Austria.

#### FORM OF CITATION

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

#### ABSTRACTORS

Abstracts have been prepared by J. R. Balsley, P. E. Byerly, W. J. Dempsey, W. H. Diment, R. G. Henderson, George V. Keller, D. R. Mabey, Virginia S. Neuschel, L. C. Pakiser, and Isidore Zietz as well as by the principal authors. The notation "Author's abstract" followed by the initials of an abstractor indicates a translation of the author's abstract.

## AGE DETERMINATIONS

- 165-1. Hahn, Otto. Radioactive methods for geological and biologic age determinations: *Sci. Monthly*, v. 82, no. 5, p. 258-265, 1956.

A review of methods of age determination, including the lead, helium, rubidium-strontium, potassium-calcium, potassium-argon, carbon-14, and tritium methods.—V. S. N.

- 165-2. Levi, Hilde. Bibliography of radiocarbon dating: *Quaternaria*, v. 2, p. 257-263, 1955.

This bibliography of papers on the principles, methods and results of radiocarbon dating, compiled by the København laboratory, covers the years 1946-54. Annual supplements are planned.—D. B. V.

- 165-3. McCallum, G. J. Evaluation of the accuracy of the New Zealand radiocarbon dating method: *New Zealand Jour. Sci. Technology*, sec. B, v. 37, no. 3, p. 370-381, 1955.

The radiocarbon dating apparatus using the CO<sub>2</sub>-filled counter has been in operation for more than a year and has proved stable for that period. Limits of error are  $\pm 1$  standard deviation. Sources of error include variation in the half-life of C<sup>14</sup>; chemical exchange of C<sup>14</sup> or physical intrusion of other carbon; isotopic fractionation; and the effect of industrial CO<sub>2</sub> in the atmosphere. It is felt that consistency of results now justifies the use of two standard deviations (2 $\sigma$ ), rather than four, as defining the maximum measureable age. Improvements now being planned include increase in sensitive volume, automatic correction voltage, and a multichannel printometer. An appendix shows variations in the ratio of beta rays to alpha rays in the radon decay series.—D. B. V.

- 165-4. Gill, Edmund D. Radiocarbon dates for Australian archaeological and geological samples: *Australian Jour. Sci.*, v. 18, no. 2, p. 49-52, 1955.

The results of radiocarbon dating of 13 late Quaternary samples from Australia, made at four different laboratories, are compiled chronologically in a table which includes description of each sample and its geologic, climatic, and biological history. After stressing the need for extreme care in collecting samples for dating, Gill in conclusion "regards this as the fundamental point in using C<sup>14</sup> dates—to determine precisely what has been dated."—D. B. V.

- 165-5. Schwarzbach, M., and Münnich, K. O. Zur Bestimmung des absoluten Alters der Grábók-Vulkane (West-Island) [On the determination of the absolute age of Grábók volcano (western Iceland)]: *Naturw.*, Jahrg. 43, Heft 8, p. 177, 1956.

Radiocarbon dating of a thin peat layer in fresh-water sediments, definitely older than the lava from Grábók, in western Iceland, sets an upper limit of 3,700  $\pm 120$  years for the age of the volcano. The lower limit is A. D. 870, the date of settlement of Iceland. The age is probably between 1,100 and 3,700 years. A weathered tuff directly overlying the sediments probably corresponds to Hekla Ash H<sub>4</sub>, which has been dated as 3,830  $\pm 120$  years old.—D. B. V.

- 165-6. Bradley, William C. Carbon-14 date for a marine terrace at Santa Cruz, California: *Geol. Soc. America Bull.*, v. 67, no. 5, p. 675-677, 1956.

Mollusk shells pitting the 100-foot wave-cut terrace on the California coast in the vicinity of Santa Cruz have been determined by radiocarbon analysis to be more than 39,000 years old. It is concluded that the emergence which led to the formation of this terrace began at some time prior to that time, which is in agreement with other recent work in southern California and Australia.—*D. B. V.*

- 165-7. Ruhe, Robert V. Radiocarbon dates and Pleistocene chronological problems in the Mississippi Valley region: A discussion: *and* Leighton, Morris M. A reply: *Jour. Geology*, v. 64, no. 2, p. 191-194, 1956.

A discussion of Horberg's paper "Radiocarbon dates and Pleistocene chronological problems in the Mississippi Valley region" [see *Geophys. Abs.* 162-179] which proposes a revision of the radiocarbon chronology in Iowa developed by Ruhe and Scholtes [see *Geophys. Abs.* 162-180]. Leighton replies to Ruhe's discussion and suggests further field study in central Iowa and additional radiocarbon dating.—*V. S. N.*

- 165-8. Suess, Hans E. Absolute chronology of the last glaciation: *Science*, v. 123, no. 3192, p. 355-357, 1956.

Radiocarbon measurements have established that the Tazewell substage of the Wisconsin glaciation in North America represents the time of the maximum southward extent of the ice front between 17,000 and 18,000 years ago after a more or less continuous advance of more than 10,000 years. At least four episodes of colder climate at intervals of about 3,500 years followed the Tazewell maximum. From apparent radiocarbon ages of carbonate from three deep-sea cores that Emiliani had used for  $O^{18}$  determinations of paleotemperatures, a rate of deposition, and temperature, could be determined as a function of time. These data indicate that a period of decreasing temperatures began about 80,000 years ago, and that the temperature reached a minimum about 15,000 years ago. This latter time coincides within the accuracy of the method with the time of the maximum extent of the North American ice sheet. Thereafter a relatively rapid temperature increase took place, leading to conditions resembling those of the present. A less pronounced temperature minimum about 55,000 years ago preceded a relatively moderate period of about 45,000 years before the present. Two main types of climatic fluctuations are indicated: one of the order of 40,000 years, the other of the order of 3,500 years. The last glaciation embraces at least two of the long periods. The minimums in the obliquity of the earth's axis seems to be reflected in these records, though the minimums in the obliquity precede the temperature minimums by nearly 10,000 years.—*M. C. R.*

- 165-9. Tilton, George R. The interpretation of lead-age discrepancies by acid-washing experiments: *Am. Geophys. Union Trans.*, v. 37, no. 2, p. 224-230, 1956.

Powdered samples of minerals used for age determination were washed in cold 6M hydrochloric acid and the isotopic composition of the lead so removed compared with that from the original sample. In two minerals with low thorium-lead ages, the acid-soluble lead contained more radiogenic  $Pb^{208}$  in proportion to radiogenic  $Pb^{206}$  than the lead of the original sample. In several minerals with high uranium-lead ages, the acid-soluble lead contained more radiogenic  $Pb^{206}$

than radiogenic  $\text{Pb}^{208}$ . Analysis of acid washes indicated excess radiogenic  $\text{Pb}^{208}$  was accompanied by excess of soluble thorium relative to uranium, but excess radiogenic  $\text{Pb}^{208}$  was accompanied by an excess of soluble uranium relative to thorium. Transfers of material, which are the cause of lead-age discrepancies, involve both parent and daughter elements; ages will be too low or too high depending on whether loss of parent or daughter has predominated. Some loss of lead may be due to loss of intermediate daughters in the decay chains.—*M. C. R.*

- 165-10. Jaffe, Howard W., Evans, Howard T., Jr., and Chapman, Randolph W. Occurrence and age of chevkinite from the Devil's Slide fayalite-quartz syenite near Stark, New Hampshire: *Am. Mineralogist*, v. 41, no. 5-6, p. 474-487, 1956.

The age of chevkinite, an accessory mineral from the fayalite-quartz syenite of the Devil's Slide ring dike near Stark, N. H., is calculated by the Larsen method [see *Geophys. Abs.* 154-14732] to be 207 million years; the maximum uncorrected age from the total lead, uranium, and thorium analyses is 208 million years. Zircon from the same rock gives an age of 227 million years by the Larsen method. These determinations confirm Chapman's dating of the syenite as Mississippian.—*D. B. V.*

- 165-11. Hurley, Patrick M., Larsen, Esper S., Jr., and Gottfried, David. Comparison of radiogenic helium and lead in zircon: *Geochim. et Cosmochim. Acta*, v. 9, no. 1/2, p. 98. 102, 1956.

Direct comparison of helium and radiogenic lead in nonmetamict zircon crystals shows a 25 percent discrepancy between these radiogenic constituents. Only three-fourths of the helium expected is actually present, in crystals of a wide range in age, activity, total  $\alpha$ -radiation, and size. The absolute accuracy of the helium analysis is believed to be within 5 percent, therefore it does not seem likely that the discrepancy is due to incomplete recovery of helium. A process of helium loss which would leave the same proportion remaining in the crystalline material despite differences in helium content and age is not yet visualized; the question will have to remain open until other evidence can be brought to bear on it.—*D. B. V.*

- 165-12. Kuroda, P [aul] K. On the isotopic constitution of radium ( $\text{Ra}$ -223/ $\text{Ra}$ -226) in uranium minerals and recent problems in geochronology: *New York Acad. Sci. Annals*, v. 62, art. 8, p. 177-208, 1955.

The  $\text{Ra}^{223}/\text{Ra}^{226}$  ratio was determined in 32 mineral samples by a new method, the  $\text{Ra}^{224}$ -addition method. Results show the ratio is not constant in minerals from different sources. The variation is not always attributable to nonequilibrium between radium and uranium. Better agreement may be obtained among  $\text{Pb}^{206}/\text{U}^{238}$ ,  $\text{Pb}^{206}/\text{U}^{235}$ , and  $\text{Pb}^{207}/\text{Pb}^{206}$  ages if calculations are made with lead isotope ratios and experimentally obtained values of the  $\text{Ra}^{223}/\text{Ra}^{226}$  ratio.—*M. C. R.*

- 165-13. Shillibeer, H. A., and Burwash, R. A. Some potassium-argon ages for western Canada: *Science*, v. 123, no. 3204, p. 938-939, 1956.

Ages of 15 core samples from Alberta and Saskatchewan and 2 outcrop samples from the Marian River area of the Northwest Territories were obtained from potassium-argon determinations on feldspar. Core samples with one exception came from depths of more than 2,300 feet and the deepest from 11,700 feet. Ages ranged from 1,180 to 1,770 million years, with one anomalously low result.—*M. C. R.*

- 165-14. Holmes, Arthur, and Besairie, Henri. Premières mesures de géochronologie à Madagascar [First measurements of geochronology in Madagascar]: *Inst. Sci. Madagascar Mem.*, sér. D, tome 6, p. 191-199, 1954.

Age determinations on seven radioactive minerals (two monazite, two thorianite, two samarskite, and one uraninite), from six places in Madagascar are tabulated. One, an alluvial monazite from southeast of Antsirabe, gave an uncorrected age of 700 million years. The ages of the others, all from pegmatites, range from 250 to 495 million years. Four principal pre-Karoo geologic cycles are now established. The earliest, represented by the ancient Androyen system and ending with an as-yet-undated series of granite and pegmatite intrusions, is overlain unconformably by the Graphite system whose cycle closed with intrusions 700(?) million years ago; the third, post-lower Cambrian, ended with granite intrusions 485 million years ago; and the fourth, post-Devonian, ended with the Andringitréan intrusions, 255 million years old.

In a note added after the paper had gone to press, the isotopic analysis of the lead from the alluvial monazite is quoted as yielding an age of 2,420 million years rather than 700, but this does not alter the stratigraphic conclusions.—*D. B. V.*

- 165-15. Schumacher, E. Alterbestimmung von Steinmeteoriten mit der Rubidium-Strontium-Methode [Age determinations of stone meteorites with the rubidium-strontium method]: *Zeitschr. Naturforschung*, Band 11a, Heft 3, p. 206-212, 1956.

The rubidium and strontium content of three stone meteorites (Forest City, Pasamonte, and Bustee) were determined, by mass spectrometric isotope dilution analysis, with an accuracy of  $\pm 2$  percent. From the  $\text{Sr}^{87}$  abundance, an age of  $(4.7 \pm 0.4) \times 10^9$  years is calculated, based on a half-life of  $4.9 \times 10^{10}$  years for  $\text{Rb}^{87}$ . These results are compared with earlier determinations [see *Geophys. Abs.* 160-151; 162-171]. A new upper limit of  $6.75 \pm 0.3$  percent is obtained for the primordial abundance of  $\text{Sr}^{87}$ .—*D. B. V.*

- 165-16. Gerling, E. K. Nakhozhdeniye v meteoritakh inertnykh gazov i ikh isotopnyy sostav [The presence of inert gases in meteorites and their isotopic composition]: *Akad. Nauk SSSR Doklady*, tom 107, no. 4, p. 559-561, 1956.

Precise analyses of the chemical composition of six meteorites found in different parts of the U. S. S. R. established the presence of neon and argon, in addition to helium already found by other scientists. Three isotopes of neon and two of argon were found in quantities that make it probable they were formed by irradiation with high-energy cosmic particles. This fact must be taken into account in the determination of the age of meteorites by the isotope method.—*S. T. V.*

- 165-17. Aldrich, L. T. Measurement of radioactive ages of rocks: *Science*, v. 123, no. 3203, p. 871-875, 1956.

Review of current methods of age determination indicates rubidium-strontium methods and potassium-argon measurements are consistent with each other and more satisfactory for dating large igneous intrusions than any other method. Comparative data are given for determinations by several methods on minerals from the Brown Derby pegmatite and the Quartz Creek granite, Garrison County, Colo.—*M. C. R.*

- 165-18. Horne, J. E. T., and Davidson, C. F. The age of the mineralization of the Witwatersrand: Great Britain Geol. Survey Bull., no. 10, p. 58-73, 1955.

The galena associated with the uraninite from the banket reefs of the Witwatersrand is of two types: minute blebs disseminated throughout the uraninite and composed mainly or wholly of radiogenic lead, and free galena mechanically separated from the uraninite and composed of lead of which 42 percent is radiogenic. The  $Pb^{207}/Pb^{206}$  ratio in this radiogenic component corresponds to a mean age of generation of 1,820-1,845 million years, with the over-all period extending indefinitely before and after this date.

The apparent ages of the uraninite derived from the ratios  $Pb^{206}/U$ ,  $Pb^{207}/U$ , and  $Pb^{207}/Pb^{206}$  are respectively 1,328-1,352, 1,593-1,652, and 1,965-2,070 million years. The most probable reason for the poor agreement in ages is reworking of the reefs to give more than one generation of uraninite. This is shown by a chemical study of a "young" uraninite from West Rand Consolidated Mines, selected with careful mineragraphic control; the uncorrected age of this mineral is only 159 million years. The hypothesis of reworking accounts satisfactorily for the abnormal isotopic composition of the free galena.

The results of the investigations fail to show conclusively whether the initial mineralization was of a syngenetic or epigenetic character. The minimum age of the initial mineralization is approximately 2,000 million years.—V. S. N.

- 165-19. Eckermann, H. von, and Wickman, F[ranz] E. A preliminary determination of the maximum age of the Alnö rocks: Geol. Fören. Stockholm Förh., band 78, häfte 1, p. 122-124, 1956.

The apparent age of the rocks of Alnö, determined on three niobium-containing minerals of the perovskite-pyroxene series, is calculated as 562 million years. As the amount of original lead has not yet been determined, this value indicates only the maximum age; if it should be correct, the Alnö complex should be regarded as Eocambrian, which is doubtful in the light of the field evidence.—D. B. V.

- 165-20. Stieff, Lorin R., and Stern, Thomas W. The interpretation of the  $Pb^{206}/U^{238} < Pb^{207}/U^{235} < Pb^{207}/Pb^{206}$  age sequence of uranium ores: Proceedings of the International Conference on Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 540-546, 1956; Interpretation of the discordant age sequence of uranium ores: U. S. Geol. Survey Prof. Paper 300, p. 549-555, 1956.

Discordant age sequences have been explained by loss of radon, loss of lead or uranium, present of original radiogenic lead, and reworking of uranium deposits or multiple periods of deposition or both. The choice of explanation determines which of the three ages ( $Pb^{206}/U^{238}$ ,  $Pb^{207}/U^{235}$ , or  $Pb^{207}/Pb^{206}$ ) is believed to be most nearly the "true" age. None of these explanations has been satisfactorily established by detailed mineralogic or isotopic studies. Available data indicate that the natural variation in the  $U^{238}/U^{235}$  ratio is less than 1 percent; that selective loss of large amounts of radon does not occur in massive unaltered uranium ores; that recent alteration of pyritic uranium ores results in loss of uranium rather than loss of lead; that the  $Pb^{207}/Pb^{206}$  age is least affected by loss of lead or uranium; and that lead minerals associated with many uranium ores contain large amounts of radiogenic lead appreciably older than the surrounding uranium ores. One of the most important problems in determining the age of uranium ores is to recognize the geologic process or processes that result in the discordant age sequence.—M. C. R.

## EARTHQUAKES AND EARTHQUAKE WAVES

- 165-21. Due Rojo, Antonio. Notas sísmicas de 1954 [Seismological notes for 1954]: Rev. Geofísica, año 14, no. 55, p. 243-245, 1955.

The most destructive earthquakes of the year were those of February 5 in Chiapas, Mexico, April 25 in Watsonville, Calif., April 20 in central Greece, July 2, in Sorsogón, Philippine Islands, July 6 in Fallon, Nev., and September 14, in Orléansville, Algeria. The difference between magnitude and intensity of earthquakes was strikingly shown by the deep earthquake of March 29 in Spain, which was of magnitude 7.5 but of intensity 3 near the epicenter. A map shows the epicenters of the 410 most important shocks.—*M. C. R.*

- 165-22. Lotze, Franz. Aktuo-geologische Charakteristik des Jahres 1954 [Current geological characteristics of the year 1954]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1955, Heft 12, p. 513-520.

This is a summary of disasters due to exogene and endogene geologic forces throughout the world in 1954. Earthquake activity was particularly catastrophic in the Mediterranean area (Greece and Algeria), Mexico, Chile, and the Philippines. Altogether, earthquakes killed about 2,000 and caused 800 million DM worth of damage; the earthquake at Orléansville accounted for the greatest part of these. Volcanic activity was not particularly violent; the only fatalities occurred in Java, where 56 were killed by an eruption of Merapi.—*D. B. V.*

- 165-23. Milne, W. G. Canadian west coast earthquakes, 1952: Dominion Observatory Ottawa Pubs., v. 16, no. 9, p. 313-325, 1953.

Data are given on 218 local earthquakes recorded at Victoria, Alberni, and Horseshoe Bay, British Columbia, during 1952. Epicenters have been determined for 56 and are plotted on a map of the area. Some correlation between epicenters and known faults is noted.—*M. C. R.*

- 165-24. Sauer, Walther. Los terremotos de la provincia de Imbabura [The earthquakes of the province of Imbabura]: Bol. informaciones cient. nac. (Ecuador), v. 8, no. 71, p. 159-169, 1955.

This is a description of the geologic background and macroseismic effects of two earthquakes that shook the province of Imbabura in Ecuador in 1955. The chief damage of the stronger shock, on July 20, was in the villages of Cotacachi and Quiroga, where the intensity of the shock was between 5 and 6. Minor damage was caused at Atuntaqui and Ibarra, where the intensity was between 4 and 5. The epicentral zone is believed to be the north-south structural line along which the volcanic centers of Yanaurcu, Cotacachi, and Cuicocha lie. The epicenter of the other shock, on May 11, was in the Cayambe region where two sets of faults intersect. This shock was felt in Ibarra more strongly than in Cotacachi, and destroyed houses in Tabacundo.—*D. B. V.*

- 165-25. Gwinner, Manfred P. Erdbebenherde und Tektonik in Oberschwaben [Earthquake foci and structure in Upper Swabia]: Neues Jahrb. Geologie u. Paläontologie Monatsh., Jahrg. 1955, Heft 11, p. 475-478.

Plotting of all available structural and earthquake data on a map of the Molasse trough of Upper Swabia in southwestern Germany shows that tectonic activity is currently taking place along structural lines discovered by seismic reflection surveys.—*D. B. V.*

- 165-26. Tandon, A. N. Zones of India liable to earthquake damage: Indian Jour. Meteorology and Geophysics, v. 7, no. 1, p. 93-94, 1956.

A map of India and vicinity showing zones "liable to severe damage," "liable to moderate damage," and "liable to damage minor or nil" from earthquakes. The map also shows the epicentral zones of major earthquakes where there has been severe damage to structures. A list of 78 important earthquakes is included.—*M. C. R.*

- 165-27. Tandon, A. N., and Mukherjee, S. M. The Manipur-Burma border earthquake of 22 March 1954: Indian Jour. Meteorology and Geophysics, v. 7, no. 1, p. 27-36, 1956.

The epicenter of the earthquake, which was felt over a large part of India was located from worldwide observations at  $24.38^{\circ}$  N. lat,  $95.15^{\circ}$  E. long; the origin time was  $23^{\text{h}}42^{\text{m}}12.5^{\text{s}}$  G. M. T., and the depth of focus  $180 \pm 10$  km. The distribution of first motion indicated the displacement at the focus was most probably along a reverse fault striking N.  $50^{\circ}$  E. and dipping northwest at an angle of  $60^{\circ}$ . The motion was along a line striking N.  $78^{\circ}$  E. such that the hanging wall moved northeast and up. Accelerograph records at Shillong and Chatra (modified Mercalli intensities 6 and 4) show maximum horizontal accelerations of 5 cm per sec<sup>2</sup> and 2 cm per sec<sup>2</sup> respectively, which are the minimum accelerations for these intensities as determined by the U. S. Coast and Geodetic Survey.—*M. C. R.*

- 165-28. Alcaraz, A[turo]. The Lanao earthquake, Philippines: Philippine Geologist, v. 9, no. 2, p. 48-49, 1955; and Kintanar, R. L., Quema, J[ose] C., and Alcaraz, A[urturo]. The Lanao earthquake, Philippines, 1 April 1955: no. 3, p. 51-78, 1955.

A very strong earthquake occurred on April 1, 1955, in central western Mindanao with the epicenter between Lake Lanao and Panguil Bay,  $7^{\circ} 55'$  N. lat and  $124^{\circ} 05'$  E. long, and at a depth of 40 to 60 km. The tremor was of normal focus, had a maximum intensity of 8 (using a Philippine adaptation of the Rossi-Forel scale reduced to only 9 intensities), and may have reached a maximum acceleration of 0.5 *g*. The earthquake was of tectonic origin although no true surface expression of the movement was observed. Evidence from the apparent change of levels of the lake water and from the distribution of slides, boils, and observed fissures suggest a major fracture oriented approximately N.  $75^{\circ}$  W. starting a little east of Masui on the eastern side of Lake Lanao and extending toward and beyond Molave in Misamis Occidental.—*V. S. N.*

- 165-29. Byus, Ye I. O seysmichnosti Zakavdaz'ya [On the seismicity of Transcaucasia]: Akad. Nauk SSSR Izv. Ser. geofiz., no 1, p. 95-99, 1956.

The Caucasus region, especially Transcaucasia, is seismically very active. Historical data are available for about 2,600 earthquakes during the 18 centuries since the first-mentioned earthquake in A. D. 139. Several earthquakes during the last 50 years have been of intensity 7 and 8. The depth of the foci ranged from few kilometers to about 150 km. Most epicenters have been located on the Akhalkalaki plateau. The epicenters of the more violent earthquakes (more than intensity 6) have alternated between the western and the eastern parts of the area.—*S. T. V.*

- 165-30. Kirillova, I. V. K voprosu ob osrednenii karty epitsentrov [On an average epicenter map]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 123-126, 1955.

In establishing correlations between the tectonic characteristics of a region and its seismicity, a reliable map of epicenters is necessary. Using the Caucasus region as an example, a new type of map is suggested. The map of the Caucasus is covered with a grid of vertical and horizontal lines, 15 km apart. The epicenters determined within each 30×30 km rectangle are related to the center of the rectangle and indicated by a circle of diameter depending on the number of earthquakes. This transfer of the epicenter is permissible because errors in the determination of the epicenters are greater than this displacement. Such a map is believed to give a better idea of the seismicity of the region.—S. T. V.

- 165-31. Karapetyan, N. K. Godograf seysmicheskikh voln Malogo Kavkaza [The traveltime curve of seismic waves in the Little Caucasus]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 100-104, 1956.

The epicenter, depth of focus, intensity, and traveltime curves of 26 earthquakes which occurred from 1933 to 1952 in Little Caucasus were determined from the records of six local stations. The focal depths ranged from 25 to 37 km. Velocities of longitudinal waves in granite, basalt, and ultrabasalt layers were found to be 5.54, 6.41, and 7.94 km/s; the corresponding *S*-wave velocities are 3.28, 3.61, and 4.46 km/s. Traveltime curves for depths of 0, 15, and 30 km are given for *P*, *P*\*,  $\bar{P}$ , *S*, *S*\*,  $\bar{S}$ .—S. T. V.

- 165-32. Yurkevich, O. I. K voprosu o seysmichnosti Zakarpat'ya [On the seismicity of Zakarpatskaya,]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 154-156, 1955.

This is a brief review of seismic phenomena from 1790 to the present in Zakarpatskaya in the Ukrainian S. S. R. Most of these earthquakes were weak, but the intensity of the earthquake of November 10, 1940 was 9. Nine earthquakes were recorded during 1952-53 after the installation of three seismic stations in this area. Most of the earthquakes occur at relatively shallow depths, and thus are often recorded at just one station.—S. T. V.

- 165-33. Vvedenskaya, N. A. Po povodu obobshcheniya nablyudeniy statsionarnykh seysmicheskikh stantsiy Sredney Azii [Generalizations on observations from the permanent seismic stations of Central Asia]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 137-141, 1955.

Greater precision of data in the seismological bulletins published by the Central Seismological Service of the U. S. S. R. is important. Methods of determining the focus of an earthquake are discussed and the possibility of using the first arrivals of *pP*, *sP*, and *sS*, which are usually clearly recorded at epicentral distances greater than 2,000 km is suggested. Epicenters are classified in two groups in seismological bulletins of the U. S. S. R., those located within 20-25 km, and those with errors of 50-60 km.—S. T. V.

- 165-34. Tskhakaya, A. D. K voprosu seysmichnosti Akhalkalakskego nagor'ya [On the seismicity of Akhalkalaki highland]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 105-108, 1956.

The Akhalkalaki highland (Georgian S. S. R.-Armenian S. S. R. border region) is an area of considerable seismic activity; during the last 50 years there have been three earthquakes of intensity 8, and from 1932 to 1952 more than 500 rather

violent earthquakes. Their epicenters, determined from the records of eight local seismic stations, cluster into two groups separated by a narrow aseismic strip.—*S. T. V.*

- 165-35. Chernyavkina, M. K. Ob otsenke pogreshnostey opredeleniya epitsentrov posleduyushchikh tolekhov Chatkal'skogo zemletryaseniya [Evaluation of the errors in the determination of the epicenters of the aftershocks of the Chatkal' earthquake]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 104-122, 1955.

A study of 195 aftershocks of the Chatkal' earthquake of November 2, 1946 has been made on the records of nine seismic stations in central Asia. Errors in the determination of the epicenters are affected by the errors in the measurement of the epicentral distances of the individual stations but even more by the position of the selected stations. From the theory of observations, it is concluded that for any combination of selected stations, there is an ellipse of errors elongated in the direction of Ferghana fault. This suggests movements are taking place in this area.—*S. T. V.*

- 165-36. Ichikawa, M. On the distribution of compressions and dilations of the *P*-wave: [in Japanese with French abstract]: Quart. Jour. Seismology, v. 20, no. 4, p. 17-27, 1956.

The records of the earthquakes of February 28, 1950, March 4, 1952, and July 18, 1952 were studied by Hodgson's method and by an extension of Hodgson's method, and it is concluded that the quadrant hypothesis of motion at the focus is preferable to the hypothesis of a cone.—*M. C. R.*

- 165-37. Nikitin, P. N., and Kutasheva, E. V. Katalog mestnykh zemletryaseniya v rayone Kavkazshikh Mineral'nykh Vod [Catalog of local earthquakes in the region of the mineral waters (Mineral'nyye Vody) of the Caucasus]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30 (157), p. 157-175, 1955.

Since 1771, 174 earthquakes have occurred in an area about 30 miles long, characterized by the presence of several springs. Most were of feeble intensity, but the strongest were of intensity 7. The correlation noticed between the occurrence of the earthquakes and the behavior of mineral springs (decrease in supply, or change in place) suggested that by detailed observations, the regime of the springs may be used in the prediction of earthquakes.—*S. T. V.*

- 165-38. Gurevich, G. I. K voprosu o prirode medlennykh dvizheniy, svyazannykh s zemletryaseniya:ni [On the nature of slow movements, related to earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 31 (158), p. 135-154, 1955.

By microscopic observation of destructive tests of metallic specimens and making this process as slow as possible, it can be seen that the breaking of a specimen is not an abrupt process, but is preceded by small discontinuous deformations, explained as the slipping of the molecules along one another. Similar phenomena must be associated with tectonic ruptures, causing earthquakes. Installation in existing seismic stations of special oscillographs adjusted to very low frequencies, or of instruments indicating slow displacements of the ground is suggested. These instruments would serve as the forecasters of approaching seismic shocks.—*S. T. V.*

- 165-39. Matuzawa, Takeo. Feldtheorie der Erdbeben: Näheres über das Quellengebiet [Field theory of earthquakes: Details of the source region]: Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 4, p. 341-347, 1954.

Further discussion of Matuzawa's "steam engine" theory of earthquake origin with relation to two-phase convection, deep foci, and energy. In circular source areas, a temperature rise of  $5^{\circ}\text{C}$  is needed to produce the required stress but only about  $1.7^{\circ}\text{C}$  in elliptical regions.—*M. C. R.*

- 165-40. Satō, Yasuo. Relation between seismic intensity and epicentral distance (2): Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 2, p. 211-220, 1955.

An empirical formula relating seismic intensity  $I$  and epicentral distance  $\Delta$  (in units of 100 km) is  $I = a + b\Delta$ . Seismic intensities as determined by postcard questionnaires are plotted against distance for 12 earthquakes. Values of the coefficients  $a$  and  $b$  for these shocks range from 3.5 to 8.6 ( $a$ ) and  $-0.71$  to  $-1.78$  ( $b$ ).—*M. C. R.*

- 165-41. Solov'yev, S. L. O svyazi energii i intensivnosti zemletryaseniya [The relation between energy and intensity of an earthquake]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 357-359, 1956.

Gutenberg and Richter have proposed an equation relating the energy  $E$  of an earthquake with its magnitude  $M$  in the form  $\log E = -1 + 1.6M$  where  $E$  is expressed in megajoules. To give agreement with seismological observations, Gutenberg changed this to the quadratic form  $\log E = 3.6 + 2.14M - 0.054M^2$ . According to Solov'yev it is impossible to characterize an earthquake by just one parameter; at least three must be used, one each for longitudinal, transverse, and surface waves. For surface waves,  $M = \log \frac{A}{T} - \log \left( \frac{A}{T} \right)^*$ , where  $A$  and  $T$  are the greatest displacement and the period of the wave; and  $\left( \frac{A}{T} \right)^*$  denotes the same quantities in the earthquake chosen as the unit of comparison. This definition of  $M$  is applicable to epicentral distances greater than  $8^{\circ}$ . For distances less than  $8^{\circ}$ ,  $M$  is determined from the transverse waves and therefore cannot be represented by a straight line.—*S. T. V.*

- 165-42. Matuzawa, Takeo, and Hasegawa, Hiroshi. Feldtheorie der Erdbeben: Elliptisches Quellengebiet [Field theory of earthquakes: Elliptical source regions]: Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 3, p. 231-246, 1954.

This is a mathematical analysis of strain in an elliptical plate fastened at the edge and subject to constant pressure on one side. The special case is worked out of  $b=2h$ ,  $a=4h$ ,  $\sigma=\frac{1}{4}$ , and  $z=-h$  (where  $2h$  is the thickness of the plate). The maximum horizontal shearing stress is found to be greater, though not much, than the compressive stress. Applied to earthquakes, this means that the slip can be horizontal.—*M. C. R.*

- 165-43. Takagi, S. On the origin of earthquake on the asymmetric push conical type of the distribution of initial motion of seismic wave (the 14th paper). [in Japanese with English summary]: Quart. Jour. Seismology, v. 19, no. 3-4, p. 71-76, 1955.

The "asymmetrical conical push type" of initial motion of seismic waves indicates that the momentum of earthquakes is not conserved at any initial time

and suggests explosion of magma in a magma chamber as the earthquake origin.—*D. B. V.*

- 165-44. Yamaguti, Seiti. On the changes in the heights of mean sea levels, before and after the great earthquakes: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 1, p. 27-31, 1955.

Monthly mean sea levels at Aburatabo from January 1900 to October 1954 show a rather conspicuous minimum in the month immediately preceding a strong earthquake in Japan. The changes seem more closely associated with earthquakes in southwestern Japan rather than those in the northeastern part.—*M. C. R.*

- 165-45. Kishinouye, Fuyuhiko. Human susceptibility to shock vibrations of the ground: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 2, p. 207-210, 1955.

Susceptibility of human being to shocks is lower than to harmonic vibrations. Variations in susceptibility should be considered in determining earthquake intensity distributions and intensity scales.—*M. C. R.*

- 165-46. Kanai, Kiyoshi, and Suzuki, Tomisaburo. Relation between the property of building vibration and the nature of ground. (Observation of earthquake motion at actual building) II: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 1, p. 109-120, 1955.

Observations of earthquake-induced vibrations in eight buildings of the same construction on different foundations show that the smaller the rigidity of the ground, the greater the damping of the building. According to an empirical formula,  $M \propto T_0^{-8}$  where  $M$  is the maximum ratio of the amplitude of the motion of the roof-floor to that of the basement, and  $T_0$  is the natural period of the ground.—*M. C. R.*

- 165-47. Puchkov, S. V., and Kats, A. Z. Opyt instrumental'nogo seysmicheskogo microrayonirovaniya gruntov [Experiences of seismic micro-zoning of ground on the basis of instrumental data]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30 (157), p. 208-216, 1955.

To test the effect of the upper layer of the ground on incoming earthquake waves, three complete seismic stations with similar equipment were installed in central Asia, one on sand, one on clay, and one on well-cemented sandstone. Accelerations were computed from the records of 29 local earthquakes at epicentral distances of 10 to 100 km recorded in a 6-week period. The ratio of accelerations in  $P$  in sand, clay, and well-cemented sandstone was 1:0.5:0.3. These data justify a detailed subdivision of area on the basis of seismic danger.—*S. T. V.*

- 165-48. Ogawara, M. Probability of the coming felt earthquake to Tokyo [in Japanese with English summary]: Quart. Jour. Seismology, v. 20, no. 3, p. 1-12, 1955.

A prediction by stochastic methods of the probability of the occurrence of earthquakes of intensity 3, 4, 5, greater than 5, and greater than 6 in different intervals of time after September 1, 1955.—*M. C. R.*

- 165-49. Petrushevskiy, B. A. Znachenie geologicheskikh yavleniy pri seysmicheskoy rayonirovani [Importance of geologic phenomena in seismic zoning]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 28(155), p. 1-59, 1955.

This is a discussion of the possibility of predicting earthquakes and of ways to approach the solution of this problem. Petrushevskiy finds the method suggested by G. P. Gorshkov is incomplete, but capable of being developed. I. Ye. Gubin's "seismotectonic" method of seismic zoning is considered unscientific, and applicable to only a very few regions with clear evidence of faulting. Several errors in the predictions and in maps of seismic zoning of different parts of the U. S. S. R. are cited. All earthquakes cannot be related to faults visible on the surface of the earth. In many places, as, for example, in the seismically very active region of the Hindu Kush, observed earthquakes cannot be related to the faults visible on the surface, but are related to deep fractures, not reaching the surface. The geology of depth in such regions must be studied, using all known methods of geophysics.—*S. T. V.*

- 165-50. Gerasimov, I. P. *Primeneniye geomorfologicheskikh metodov pri seysmotektonicheskikh issledovaniyakh* [The application of geomorphologic methods in seismotectonic studies]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25(152), p. 87-96, 1954.

In a theoretical study Gerasimov develops ideas about the correlation between the geomorphologic features of an area and its seismicity, similar to those found by Dumitrashko and Lilienberg [see Geophys. Abs. 160-119]. Features of the valleys produced by erosion, and hence influenced by the time interval since their formation, are analyzed in more detail, and the results applied to the geomorphologic and seismologic data obtained in exploration of the seismically active region around the lake Issyk Kul in Central Asia.—*S. T. V.*

- 165-51. Asano, Shūzō. On the accuracy of hypocenter determination: Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 4, p. 371-380, 1954; v. 33, pt. 2, p. 199-206, 1955.

Methods of determining the focus of an earthquake were evaluated by applying them to the data from three explosions, including the 2d and 3d Isibuti explosions [see Geophys. Abs. 161-118, 119]. From an assumed approximate epicenter and traveltime curve, a least-squares adjustment was made to determine the epicenter, velocity, origin time, and depth. The first two were relatively well determined in all cases, but the origin time and depth seem to be sensitive to the nature of the superficial layer (uniform structure was assumed).—*M. C. R.*

- 165-52. Vvedenskaya, N. A. *O tochnosti opredeleniya polozheniya ochaga zemletryaseniya metodom zasechek* [The accuracy of determinations of the focus of an earthquake by the method of intersections]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 127-136, 1955.

The accuracy of the location of the focus of an earthquake by determining the intersection of three or more spherical surfaces around a corresponding number of stations with radii equal to the *S-P* difference times velocity is affected by errors in identification of the waves, by the precision of the determinations of the time of arrival, by the position of the focus with reference to the stations, and by the reliability of the determination of seismic velocities. The relative importance of these different errors is evaluated using as an example central Asia, where records of eight stations are now available, and Vvedenskaya concludes that, if the epicentral distance is between 100 and 1,000 km and if the difference in the times of arrival of seismic waves can be measured within  $\pm 1$  sec, the position of the epicenter can be found within  $\pm 10$  km.—*S. T. V.*

- 165-53. Kolosenko, M. N. Opredeleniye azimuta na epitsentr dalekogo zemletryaseniya po momentam vstupleniya seysmicheskoy volny na dvykh stantsiyakh [Determination of the azimuth of the epicenter of a distant earthquake from the first arrivals of a seismic wave at two stations]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 89-103, 1955.

A new method is described for the precise determination of the epicenter of an earthquake from the measured difference in the time of arrival of a definite wave at two seismic stations. The geographic position of these stations and their distance apart must be accurately known as well as the approximate position of the epicenter. The method involves the geometric relations between the position of the epicenter and the midpoint of the line connecting the stations. The distance between the stations must not be too short; in examples cited this distance ranges from about 300 to 1,800 km. The times of arrival of the selected wave must be measured within 0.2-0.5 sec. Tables and a nomogram chart for use of the method are given.—*S. T. V.*

- 165-54. Adlung, Alfred. Ermittlung von Emergenzwinkeln mit Hilfe des Wellenfrontverfahrens [Determination of the angles of emergence with the aid of the wave front method]: Gerlands Beitr. Geophysik, Band 64, Heft 4, p. 262-277, 1955.

Curves of the angles of emergence of *P*, *PKP*, *S*, and *SKS* have been drawn using data from 41 earthquakes, and the velocity of propagation in the upper layers determined from experiments with blasts.—*M. C. R.*

- 165-55. Golenetskiy, S. I., and Gayskiy, V. N. Dva mekhanizma dlya graficheskoy obrabotki nablyudeniy nad blizkimi zemletryasenyami [Two devices for the graphical processing of the observational data of near earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30 (157), p. 195-197, 1955.

This is a description of two drawing instruments: a "hyperbolograph," used when the epicenter of an earthquake is to be determined from the records of three stations and a known velocity, and a combination of two hyperbolographs linked by a bar to trace a locus of intersection of two hyperbolas, used when the velocity of seismic waves is not known.—*S. T. V.*

- 165-56. Ichikawa, M. Sur premier impétus et réseau d'observatoires séismologiques [On the first impulse and the network of seismologic observatories (in Japanese with abstract in French)]: Quart. Jour. Seismology, v. 20, no. 3, p. 21-28, 1955.

Studies of the amplitudes of the first impulse from shallow shocks as a function of epicentral distance indicate the Milne-Shaw seismograph is 3 to 5 times as sensitive as the Mainka, Galitzin, Wood-Anderson or Sprengnether instruments 10 to 20 times as sensitive, and Benioff or Grenet instruments about 150 times. To determine epicenters, increase in magnification is more useful than increasing the number of observatories. One hundred seismographs as sensitive as the Galitzin distributed over the world would permit determining nearly precisely the epicenters of all shocks of magnitude greater than 6.—*M. C. R.*

- 165-57. De Breaecker, J. Cl. Use of amplitudes: Part II, Focal depths: Seismol. Soc. America Bull., v. 45, no. 4, p. 279-284, 1955.

By using the curve of the variation of amplitude of  $P_n$  with epicentral distance [see Geophys. Abs. 163-97], the focal depth may be determined. Given the depth of one shock, the depths of others may be determined by comparison of the maximum amplitude of  $P_n$  with the maximum amplitude of surface waves at a group of stations—*M. C. R.*

- 165-58. Kárník, Vít, and Vaněk, Jiří. Traveltimes of  $P$  and  $S$  waves for Praha: Československé Akad. Věd Geofys. Ústavu Práce, Geofys. Sborník, no. 16, p. 107-157, 1954.

Traveltime curves for  $P$  and  $S$  determined from observations at Praha are similar in the interval from  $20^\circ$  to  $105^\circ$  to the Jeffreys-Bullen curve and between those for surface focus and  $0.00R$ . Between  $10^\circ$  and  $20^\circ$  the Praha traveltime curves are different from other curves, probably a regional effect as most of the observations in this interval were from earthquakes in the eastern Mediterranean and Asia Minor.—*M. C. R.*

- 165-59. Haseba, T. On anomalies of the appearance time of the seismic initial motion in Japan [in Japanese with English summary]: Quart. Jour. Seismology, v. 20, no. 3, p. 13-20, 1955.

Some anomalies are related to crustal structure, but others are apparently due to errors in time or in recognizing the first motion.—*M. C. R.*

- 165-60. Hodgson, J. H., and Allen, J. F. J. Tables of extended distances for  $PKP$  and  $PcP$ : Dominion Observatory Ottawa Pubs., v. 16, no. 10, p. 329-348, 1954.

Tables of extended distances for  $PKP_1$ ,  $PKP_2$  and  $PcP$  are presented, for surface focus and for focal depths ranging from  $0.00R$  to  $0.12R$  by steps of  $0.01R$ . The tables are based on the Jeffreys-Bullen traveltime curves for the equivalent phases. They are consistent with earlier tables giving extended distances for  $P$ , so that the several phases can be used in a single solution.—*Authors' abstract*

- 165-61. Santo Akima, Tetsuo. Comparative studies of surface waves travelling across Tibet Plateau and Sea of Japan, with some notes on the method of finding the velocities of surface waves for a limited position of their path: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 1, p. 49-64, 1955.

The crust in the region from Assam to southwestern Japan determined from dispersion curves of Rayleigh and Love waves consists of two layers, 15 and 19 km thick, of densities 2.6 and 3.0, and with shear wave velocities of 3.27 and 3.80 kmps respectively. Nagamune's data on dispersion curves of seven shocks may be classified in two groups, the difference being attributed to the characteristic crustal structure beneath Tibet, Tsinghai, and Sikang plateaus. Both Love wave and Rayleigh wave dispersion data fit a double-layer crust 16 and 15 km thick of density 2.7 and 3.0 and with shear wave velocities of 3.3 and 3.8 kmps in this area. A dispersion curve for part of a mixed path may be computed from the observed dispersion curve, but to use it for determination of crustal structure requires such accuracy in the original data that it probably should not be attempted unless the part of the path under consideration is two-thirds the entire path.—*M. C. R.*

- 165-62. Ewing, Maurice, and Press, Frank. Rayleigh wave dispersion in the period range 10 to 500 seconds: *Am. Geophys. Union Trans.*, v. 37, no. 2, p. 213-215, 1956.

For periods greater than 75 sec, Rayleigh wave dispersion is primarily influenced by the variation of shear velocity with depth in the mantle; for periods less than 75 sec, the dispersion is primarily influenced by velocity variations within the crust and the velocity contrast at the Mohorovičić discontinuity. At a period of about 75 sec, the group velocity is 3.9 km/s. For periods between 75 and 225 sec, the group velocity decreases with increasing period to a minimum of about 3.5 km/s. Beyond this, the group velocity increases more rapidly, to a maximum of about 4.1 km/s at about 400 sec. The dispersion curve is in two parts for periods less than 75 sec because of the difference between continental and oceanic paths. The maximum group velocity for oceanic Rayleigh waves is about 4 km/s for a period between 30 and 40 sec. A minimum group velocity of slightly less than 3 km/s for periods of 16-18 sec and a maximum of 3.9 km/s at about 75 sec is observed for continental Rayleigh waves.—*M. C. R.*

- 165-63. Kanai, Kiyoshi; Osada, Kaio; and Yoshizawa, Shizuyo. Observational study of earthquake motion in the depth of the ground. V. (The problem of the ripple of earthquake motion): *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 32, pt. 4, p. 361-369, 1954.

Ripples (low-amplitude short-period waves superimposed on large-amplitude long-period waves) were studied on seismograms obtained at the surface and 300 m underground at the Hitachi mine in Ibaraki. The predominant period of the ripple corresponds to the natural period of the surface layer.—*M. C. R.*

- 165-64. Kats, A. Z. K voprosu ob uchete gruntovykh usloviy pri seysmicheskoy microrayonirovani [On the estimation of the soil conditions in seismic microzonning]: *Akad. Nauk SSSR Geofiz. Inst. Trudy*, no. 30 (157), p. 217-225, 1955.

The mechanical properties of the upper layer of the ground have considerable influence on the vibrations of structures during an earthquake. These vibrations are much greater on loose ground than on hard rock; resonance may be established by steady impulses. Formulas are derived for the distribution of energy in a seismic wave coming from the granite basement to sedimentary formations, and divided into reflected and refracted longitudinal and transverse waves. At some angles of incidence it is possible for the refracted longitudinal wave to contain a smaller amount of energy but much greater amplitude of vibrations. This increase of amplitude is determined by the ratio of the densities of the media and their seismic velocities. When the course of the vibrations is on the free surface of the sedimentary layer, the amount of the energy reflected from the granite is affected by the length of the generated wave and the thickness of the upper layer.—*S. T. V.*

- 165-65. Matorina, T. V., Oborina, S. F., and Savarenskiy, Ye. F. Opredeleniye skorosti rasprostraneniya prodol'nykh voln v obolochke zemli na osnove nablyudeniya nad glubokim zemletryaseniym [Determination of the velocity of propagation of longitudinal waves through the mantle on the basis of observational data of a deep earthquake]: *Akad. Nauk SSSR Geofiz. Inst. Trudy*, no. 30 (157), p. 22-29, 1955.

Wiechert's formula for the variation of velocity with the depth has been extended graphically to deep-focus earthquakes and applied to the records of the

Afghanistan earthquake of January 6, 1951 with the focal depth of 220 km. The times of arrival of *P* and *S* waves were determined from the seismograms of 42 stations in the U. S. S. R.; the combined traveltime curve was constructed and then approximated by a parabola of the third degree, thus making the determination of the derivative with respect to epicentral distance very simple and accurate. As compared with the Jeffreys-Bullen traveltime curve this curve has the advantage of being constructed from local data reflecting the structural details of the region. Tables are given for the seismic velocity at different depths.—*S. T. V.*

- 165-66. Pasechnik, I. P. Azimutal'naya chetyrekhkomponentnaya ustanovka s naklonnymi seysmografami [Four-component installation with inclined seismographs for azimuthal determination]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3 p. 285-289, 1956.

Local feeble earthquakes are often recorded at only one station. It is difficult to determine the azimuth with one vertical and two horizontal seismographs. An arrangement of four seismographs, set on a common base plate at an angle of 45° to the horizon, has great advantages, giving more accurate records which can be readily interpreted and making possible the determination of the azimuth of the earthquake. A description of such an installation is given, with the sample seismograms.—*S. T. V.*

- 165-67. Shebalin, N. V. Opyt instrumental'nykh nablyudeniy na Tsentral'noy Seysmicheskoy Stantsii Moskva [Experiences with the instrumental observations at the central seismic station at Moscow]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30 (157), p. 176-192, 1955.

This is a discussion of methods of improving the precision of instruments of the Moscow station. If the highest possible precision of seismographs is to be attained, the effect of the dynamic coupling of the seismometer-galvanometer system must be considered. As the result of changes in the construction of the instruments, chiefly the modification of the galvanometer damping the vertical seismograph now reproduces the frequencies of the vibrations of the ground in the range of the natural periods from 0.3 to 10 sec within 5 percent, and the horizontal seismograph reproduces the frequency of the waves within 1 percent in the range from 0 to 30 sec. Other improvements include better recording of the time to 0.1 sec.—*S. T. V.*

- 165-68. Higuti, T., and Onozaki, S. On the abnormal free vibration of Wiechert's 200 kg horizontal seismograph [in Japanese with English summary]: Quart. Jour. Seismology, v. 20, no. 3, p. 29-36, 1955.

Unexpectedly large residual damping of free vibration was traced to faults in the form of the springs supporting the pendulum and the construction of the fastening devices.—*M. C. R.*

- 165-69. Dowling, J. J. Adjustable magnetic control for seismographs: Jour. Sci. Instruments, v. 31, no. 6, p. 222, 1954.

A brief note on a device, described as a magnetic spring control, by means of which the period of seismograph pendulums can be adjusted without disturbing the pendulum by touching it.—*M. C. R.*

- 165-70. Solov'yev, V. N. Fotoelektricheskiy signalizator sil'nykh zemletryaseniy [The photoelectric signal device for violent earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30 (157), p. 193-194, 1955.

The main element of an improved instrument for signaling violent earthquakes consists of a photoelectric cell which remains inactive until the deflections of the galvanometer exceed a certain limit after which it performs such operations as decreasing the amplitudes of the galvanometer deflections, increasing the voltage on the lamps of the recording apparatus, thus making the seismograms clearer, starting an alarm for the station staff, and changing the speed of the recording tape. The great advantage of the new design is its very low consumption of electric energy.—S. T. V.

## EARTH TIDES AND RELATED PHENOMENA

- 165-71. Melchior, Paul J. Sur l'amortissement du mouvement libre du pôle instantané de rotation à la surface de la Terre [On the damping of the free movement of the instantaneous pole of rotation at the surface of the earth]: Accad. Naz. Lincei Atti, Cl. sci. fis., mat. et nat. Rend., v. 19, fasc. 3-4, p. 137-142, 1955.

Mathematical calculations of relaxation time from observations of polar movement range between 20 years and infinity. Polar movement is of too short period and its characteristics too little known to determine this factor within reasonable limits.—D. B. V.

- 165-72. Gutenberg, B[eno]. Damping of the earth's free nutation: Nature, v. 177, no. 4515, p. 887-888, 1956.

Bondi and Gold have considered that the free nutation of the earth has a characteristic damping time of the order of 10 periods and conclude that the damping results from nonelastic behavior of the mantle. Schweydar has shown that the motion of the poles can be explained with good approximation as a beat phenomenon between the free Chandler period of 14 months and a periodic annual displacement of the axis of inertia. Deep-focus earthquakes and postglacial uplift of glacial areas indicate the mean time of viscous relaxation in the upper 700 km of the mantle is of the order of several hundred years. It does not seem possible to interpret the decay curve of the nutation and to discriminate the effect of damping from the beat phenomenon.—M. C. R.

- 165-73. Munk, W[alter] H. Polar wandering: a marathon of errors: Nature, v. 177, no. 4508, p. 551-554, 1956.

Darwin's original paper on polar wandering indicated that if the earth is rigid, there would be no polar movement, and if the earth is plastic, there could be such movement. Kelvin's arguments for a rigid earth denied the possibility of polar wandering within the framework of Darwin's analysis. If, however, an error in Darwin's equation is corrected, the solution indicates there can be no polar wandering no matter how fluid the earth is. Darwin's equations are based on movement of the geoidal pole at a rate proportional to the separation of the rotation pole from the pole of figure. From dynamic considerations the velocity of the rotation pole is proportional to its separation from the pole of figure, and from elastic considerations the velocity of the geoidal pole is proportional to its separation from the pole of rotation. When Darwin's equations are modified to account for this difference, polar wandering is simple. Darwin had hoped that his paper would put certain restraints on contemporary arguments for polar

wandering, but in fact it was followed by a renewed wave of enthusiasm for large polar displacements. "In this controversy between physicists and geologists, the physicists, it would seem, have come out second best. They gave decisive reasons why polar wandering could not be true when it was weakly supported by palaeoclimatic evidence; and now that rather convincing palaeomagnetic evidence has been discovered, they find equally decisive reasons why it could not be otherwise."—*M. C. R.*

- 165-74. Rudnick, Philip. The spectrum of the variation in latitude: *Am. Geophys. Union Trans.*, v. 37, no. 2, p. 137-142, 1956.

A Fourier series analysis of the motion of the Earth's rotation axis in the frequency range 0.74 to 1.14 cycles per year, containing 93 percent of the total power in the motion, shows: an annual line without recognizable structure comprising about 22 percent of the power in the region examined; the Chandler component comprising about 78 percent of the power, with band structure somewhat broader than heretofore recognized, leading to a value 9.5 year for the amplitude decay time; an annual component of excitation in agreement with previous determinations, equivalent to a root-mean-square displacement of the axis of inertial symmetry of  $0.023''$  of arc; a continuous spectrum of excitation which is well determined in the Chandler region, at least roughly determined at other frequencies below annual, but not determined above the annual frequency. The magnitude of the continuous spectrum below annual frequency is consistent with the hypothesis that it, in association with the annual line, arises in the atmosphere, but lack of a determined spectrum at higher frequencies prevents examination of side-band symmetry.—*Author's abstract*

### ELASTICITY

- 165-75. Zvolinsky, N. V., and Skuridin, G. A. Ob asimptoticheskom metode resheniya dinamicheskikh zadach teorii uprugosti [On the asymptotic method of solving dynamic problems of the theory of elasticity]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 2, p. 134-143, 1956.

The usual procedure in solving dynamic problems in the theory of elasticity is to establish the differential equation in a general form and after solving it to substitute values of the different parameters in accordance with the conditions of the problem. To avoid the mathematical difficulties of this procedure and to obtain approximate solutions, which are satisfactory in many practical problems of exploration geophysics, it is suggested that the procedure adopted in the treatment of electromagnetic waves be followed, and that the problem be simplified from the outset by omitting certain parameters completely or assuming for them their asymptotic values. Following this procedure, the problem of the reflection of an elastic cylindrical wave from the plane boundary of semispace is treated. The solution can be reduced to the problem of Cauchy, valid both for the longitudinal and transverse waves.—*S. T. V.*

- 165-76. Gurevich, G. I. K voprosu o fizicheskikh osnovakh teorii rasprostraneniya uprugikh voln [On the physical foundations of the theory of the propagation of elastic waves]: *Akad. Nauk SSSR Geofiz. Inst. Trudy*, no. 30 (157), p. 314-348, 1955.

The physical assumptions underlying the fundamental mathematical relations of the theory of elasticity are critically analyzed and tested for the limits of their applicability. Gurevich is trying to establish formulas usable both for solid and liquid bodies, and for very slow deformations, as well as for rapid vibrations.

These conditions are found in geology and seismology, where we have to deal both with very slow movements connected with plastic flow of rocks and with rapid oscillations in earthquakes. The propagation of deep seismic waves near the core of the earth is also under conditions bordering the solid and the liquid state of the medium.—*S. T. V.*

- 165-77. Bycroft, G. N. Forced vibrations of a rigid circular plate on a semi-infinite elastic space and on an elastic stratum: Royal Soc. London Philos. Trans., ser. A, v. 248, no. 948, p. 327-368, 1956.

The impedance of a rigid circular plate attached to the free surface of a semi-infinite elastic space or an elastic stratum is determined for its four degrees of freedom. The solution of the dual integral equations arising from this mixed boundary-value problem is avoided by reference to Rayleigh's reciprocal theorem. This enables the functions of frequency, which determine the in-phase and out-of-phase components of displacement of the plate, to be located between two close bounds and lying much closer to one than to the other. These bounds appear as infinite integrals involving branch functions and are reduced to tractable finite integrals by integration in the complex plane. Dissipation of waves to infinity produces an effective damping, and the added effect of the inclusion of true damping in the medium is discussed.

It is to be expected, of course, that the unloaded rigid plate attached to the free surface of a semi-infinite elastic space does not resonate. The change of impedance of the plate with frequency is found to be similar for the two translations and also similar for the two rotations. Resonance occurs in the case of vertical and horizontal translation of the plate attached to the surface of an elastic stratum. However, it does not exist for rotations of the plate on the stratum. Instead, a maximum in the response appears, this maximum being more defined the greater the ratio of plate diameter to stratum depth. The addition of small true damping in the medium changes the characteristics very little.

Experimental work substantiating these theoretical results, together with a general discussion of the results and their applications in geophysics and engineering, is being published shortly.—*Author's abstract*

- 165-78. Eason, G., Fulton, J., and Sneddon, I. N. The generation of waves in an infinite elastic solid by variable body forces: Royal Soc. London Philos. Trans., ser. A, v. 248, no. 955, p. 575-607, 1956.

This paper is concerned with the determination of the distribution of stress in an infinite elastic solid when time-dependent body forces act upon certain regions of the solid. It is assumed that the strains are infinitesimal so the equations of classical theory apply. A general solution of the equations of motion for any distribution of body forces is derived by use of four-dimensional Fourier transforms, and from that the general solution for an isotropic solid. General solutions are also obtained for the statical problem, the two-dimensional problem, and the equations of motion in the case of axial symmetry. Several special two-dimensional and three-dimensional problems are considered on the basis of the general solutions, including among others the distribution of stress produced by periodic and impulsive point forces, a point force moving with uniform velocity along the line in which it acts, or perpendicular to the direction of force, and the effect of a circular disk of pressure.—*M. C. R.*

- 165-79. Kosminskaya, I. P. Amplitudnyye krivyye i godografy faz voln, vyzvannykh harmonicheskoy sosredotochennoy siloy v odnorodnom ideal'no uprugom prostranstve [Amplitudes and traveltime curves

of waves produced in homogeneous perfectly elastic medium by a harmonic concentrated force]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 286-301, 1955.

The amplitude and traveltime curves of waves produced in an ideally elastic homogeneous medium by a concentrated harmonically varying force, applied at a point of the medium, have been studied by adapting formulas to the specific conditions of the problem as suggested by Gamburtsev. Results indicate: that near the source of the disturbance the motion is complicated (the composite wave propagates here with the velocity of transverse waves) and at distances greater than twice the wavelength of the transverse wave, in the direction of the force, longitudinal waves predominate, their amplitude being five or more times greater than the amplitude of transverse waves. In the direction perpendicular to the acting force the predominant vibration is the transverse wave.—*S. T. V.*

- 165-80. Iida, Kumizi, and Aoki, Harumi. On the visco-elastic waves radiated from a spherical cavity in elastico-viscous medium: Nagoya Univ. Jour. Earth Sci., v. 3, no. 2, p. 105-126, 1955.

The displacement in the wave that results from application of a pressure pulse to the interior of a spherical cavity in an elastico-viscous medium is a damped sinusoidal displacement with amplitude proportional to pressure, area of the cavity, and dimensionless relaxation, and inversely proportional to the rigidity. The velocity of the wave front is in close agreement with that in a perfectly elastic medium. Attenuation of the wave increases with distance from the source. Nonoscillatory deformation is produced in the vicinity of the spherical cavity. The wave motion is more closely related to that in a perfectly elastic medium than in a firmo-viscous medium.—*M. C. R.*

- 165-81. Ishkov, P. K. O rasprostraneniі uprugikh voln v sloye, lezhashehem na uprugom osnovanii [The propagation of elastic waves in a layer lying on an elastic base]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 124-133, 1956.

This is an analysis, following the method of Lamb, of the conditions under which the propagation of waves along the boundary of an elastic layer overlying an elastic base is possible. The material of the layer, as well as that of the base, is assumed to be volumetrically incompressible. The problem is reduced to the solution of the equations of the theory of elasticity with the boundary conditions expressing the continuity of the strains and stresses on the plane separating the layer from the foundation. Two surface waves are possible; the velocity of propagation can be determined from the given conditions. Tables and graphs facilitate the solution of the problem for different elastic properties of the media considered.—*S. T. V.*

- 165-82. Helbig, K. Die Ausbreitung elastischer Wellen in anisotropen Medien [The propagation of elastic waves in anisotropic media]: Geophys. Prosp., v. 4, no. 1, p. 70-81, 1956.

Anomalies in velocities have been found in underground seismic surveys in siderite mines of Siegerland (Germany). These anomalies can be explained by assuming that the slates are aeolotropic. Peculiarities connected with propagation of elastic waves in aeolotropic media are discussed with particular reference to media consisting of thin beds of isotropic materials. Schlieren pictures of wave fronts are shown which indicate the validity of the theory.—*W. H. D.*

- 165-83. Matschinski, Matthias. Zur Theorie der sogenannten Kopfwellen mit unendlich kleinen Amplituden [On the theory of so-called head waves with infinitely small amplitudes]: *Geofisica Pura e Appl.*, v. 32, p. 19-30, 1955.

This is a consideration of the case of two reflected waves in seismology and general mechanics. For every incident (primary) wave there are three secondary waves—reflected, refracted, and boundary. The general properties of the concept of "wave" are reviewed, including thermal and geometric damping, and the conditions under which a group of waves form or do not form a single wave. A new solution of the wave equation resembling that of D'Alembert is developed. Finally, the possibilities of interference of two waves and the impossibility of interference in the general case of two groups of waves are treated.—*D. B. V.*

- 165-84. Keylis-Borok, V. I. Asimmetrichnyye interferentsionnyye volny v sloistoy srede [Asymmetric interference waves in a multilayer medium]: *Akad. Nauk SSSR Doklady*, tom 107, no. 4, p. 533-536, 1956.

The propagation of elastic waves through an axially symmetric multilayer medium [see *Geophys. Abs.* 141-14032] is generalized so the only limitation imposed is that the semispace is formed of plane parallel elastic layers, and the problem solved in a general form. It is shown that waves of two kinds are produced: those with displacements in the vertical radial plane, and those with horizontal tangential displacements. Both kinds of waves can be used in investigations of the damping of surface waves in the crust of the earth.—*S. T. V.*

- 165-85. Kosminskaya, I. P. Sposoby analiza amplitudnykh krivyykh i godografov faz slozhnykh garmonicheskikh voln [Methods of analyzing the curves of the amplitudes and the traveltime curves of the phases forming composite harmonic waves]: *Akad. Nauk SSSR Geofiz. Inst. Trudy*, no. 30(157), p. 302-313, 1955.

Graphical methods are described which make possible the determination of the component waves, if the composite wave is known. This problem in general has an infinite number of solutions, but can be solved with good approximation when the component amplitudes as well as the phases are very different. If the component amplitudes and phases are found, the traveltime curves of individual waves can be also determined.—*S. T. V.*

- 165-86. Suzuki, Ziro, and Sima, Hiromu. On forms of seismic waves generated by explosion. II: *Tōhoku Univ. Sci. Repts.*, 5th ser., v. 6, no. 3, p. 162-170, 1955.

Wave motion from the detonation of a cap consists of several regular wave groups, which are governed by a simple law of propagation, and an irregular part that is apparently the result of the superposition of regular waves. Waveform varies widely even within the distance range of one or two wavelengths, which is not in agreement with mathematical studies on elastic or visco-elastic waves unless an unreasonably large viscosity is assumed.—*M. C. R.*

- 165-87. Stoneley, R[obert S]. The propagation of surface elastic waves in a cubic crystal: *Royal Soc. London Proc., Ser. A*, v. 232, no 1191, p. 447-458, 1955.

The paper discusses the possibility of the propagation of elastic waves, analogous to Rayleigh waves or Love waves, over a (001) surface of a cubic crystal. An

examination of symmetrical cases in which the direction of propagation is parallel to the x-axis or makes an angle of  $45^\circ$  with it shows that waves with amplitude falling off exponentially with distance from the free face do not exist for every set of values of the three elastic constants chosen at random. For crystals of aluminum and copper these Rayleigh-type waves do not exist, but for rock salt their existence is demonstrated both for the symmetrical cases and for an asymmetrical case. In the latter the particles describe ellipses in a plane inclined to the direction of propagation.

Waves of Love type can exist only in the two symmetrical cases cited; it is shown that then the general Rayleigh-type motion degenerates into a superposition of Rayleigh waves and Love waves.

It is easily seen that for all types of crystals the general result will be the same, but that the algebraical and arithmetical work involved will be extremely heavy.—*Author's abstract*

- 165-88. Pekeris, C. L. The seismic surface pulse: *Natl. Acad. Sci. Proc.*, v. 41, no. 7, p. 469-480, 1955.

Exact and closed expressions are derived for both the horizontal displacement  $q(t)$  and the vertical displacement  $w(t)$  of the surface of an uniform elastic half-space due to the application at the surface of a point pressure pulse varying with time like the Heaviside unit function  $H(t)$ . Both are of the form  $(1/r)f(T)$  where  $T=(ct/r)$  and  $c$  is the shear velocity. Both horizontal and vertical displacements become infinite at the time of arrival of the Rayleigh wave, but the arrival of the shear wave is marked only by a change in the slope of the displacements.—*M. C. R.*

- Satō, Yasuo. Study on surface waves II. Velocity of surface waves propagated upon elastic plates: *Geophys. Abs.* 149-13588.

Errata and appendix appear in *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 33, pt. 1, p. 49-50, 1955.—*M. C. R.*

- 165-89. Satō, Yasuo. Study on surface waves XII. Non-dispersive surface waves: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 32, pt. 4, p. 349-360, 1954.

There are only three possible nondispersive surface waves: Rayleigh waves, Stoneley waves, and a type symbolized as  $\left[ \frac{EE}{E} \right]$ . The velocity of this wave is obtained as function of  $\Gamma(\equiv \rho^*/\rho)$  and  $\gamma^*(\equiv V^*/V_s)$ .—*M. C. R.*

- 165-90. Satō, Yasuo. Analysis of dispersed surface waves by means of Fourier transform I: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 33, pt. 1, p. 33-47, 1955.

The amplitude and the phase angle of the Fourier transform of the curve observed at any station express the spectrum near the origin and the phase shift caused by the propagation. Dispersion curves so obtained are in good agreement with those determined by the conventional method of measuring intervals between crests. As an example a dispersion curve is computed for the record of an explosion at Lake Haruna and thickness of the ice estimated as 31.5 cm, in good agreement with the observed thickness of 34 cm.—*M. C. R.*

- 165-91. Takahashi, Takehito. Analysis of the dispersion curves of Love waves: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 33, pt. 3, p. 287-296, 1955.

The dispersion of Love waves in a heterogeneous medium is developed; the problem is taken as two dimensional, with  $Z$ -axis vertically downward and density and rigidity as functions of  $Z$ . The result is applied to one of the dispersion curves of Love waves from the Assam earthquake.—*M. C. R.*

- 165-92. Yamaguchi, Rinzo, and Satō, Yasuo. Range of possible existence of Rayleigh- and Sezawa-waves in a stratified medium: Tokyo Univ. Earthquake Research Inst. Bull., v, 33, pt. 3, p. 265-273, 1955.

Kanai has shown that there is a critical boundary between existence and non-existence of surface waves under given relations of wavelength to thickness of layer ( $L/H$ ), rigidity in the layer to that in the substratum ( $\mu'/\mu$ ) and velocity of  $S$  wave in the substratum and layer  $(v/v')^2$ . This boundary is calculated more precisely and shown graphically in a table.—*M. C. R.*

- 165-93. Raman, C. V. The elasticity of crystals: Current Sci. (India), v. 24, no. 10, p. 325-328, 1955.

In any given direction within a crystal, three types of waves can be propagated, each with different velocities and each also varying with direction. The wave velocity for each of the three types and for any particular direction is expressible as a function of direction and certain linear combinations of the elastic constants. The simplest possible cases are cubic crystals of the  $T_d$  and  $O_h$  class; the most complex, the triclinic. A table gives values of the elastic constants  $d_{11}$ ,  $d_{12}$ ,  $d_{44}$ , and  $d_{45}$  (according to the general theory of stress and strain components) and  $C_{14}$ ,  $C_{15}$ , and  $C_{44}$  (according to the classic theory) for 16 cubic synthetic crystals, in terms of  $10^{11}$  dynes per  $\text{cm}^2$ . Many of the crystals—such as NaCl, KCl, diamond, ZnS,  $\text{CaF}_2$ , Cu—can occur naturally. These data are of practical interest mainly in engineering construction, where polycrystalline solids are in common use.—*D. B. V.*

- 165-94. Shimozuru, Daisuke, and Murai, Isamu. Elasticity of marble with special reference to its elastic aeolotropy: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 1, p. 65-72, 1955.

Velocities of elastic waves were measured, using ultrasonic pulse apparatus, along three rectangular edges of each cubic specimen of marble. The elasticity of marble is calculated on the assumptions that marble is a polycrystalline aggregate of calcite and that the elasticity is not affected by grain boundaries. The velocities of dilatational and rotational waves calculated from the elasticity equations are 6,609 m per sec and 3,904 m per sec respectively. Four of the six specimens showed some aeolotropy, velocities in the other two were almost equal in three directions but less than the calculated velocities, presumably as a consequence of the space between crystals.—*M. C. R.*

- 165-95. Shimozuru, Daisuke. A note on the elasticity of marble: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 1, p. 73-77, 1955.

Velocities of dilatational and rotational waves as a function of hydrostatic pressure were computed from Birch's equations based on Murnaghan's theory of finite strain. The calculated velocities of dilatational waves are in good agreement with experimental velocities given by Hughes when the pressure is more than 2,000 bars; the wide discrepancy below that pressure may be attributed to the existence of pore space in the specimen. Laboratory measurements of rotational wave velocity are much lower than the calculated velocities, but the theoretical velocity does not take into account the effect of grain boundaries, which must have some importance especially in shear.—*M. C. R.*

- 165-96. Hughes, D. S., and Kennel, J. M. Variation of elastic wave velocity with frequency in fused quartz and Armco iron: Jour. Applied Physics, v. 26, no. 11, p. 1307-1309, 1955.

The velocity dispersion in fused quartz and in Armco iron was investigated by measuring the resonant frequency of small cylinders using quartz crystals on the ends as drivers and detectors. With x-cut crystals and y-cut crystals the computed velocities of the dilatational waves in the range 2.0-5.0 Mc and shear waves in the range 1.5-3.0 Mc decrease with frequency. This decrease in both cases is regarded as unreasonably large and is ascribed primarily to sample geometry. Simple standing plane waves, either dilatational or shear, cannot satisfy the boundary conditions in a free cylinder. A mosaic crystal was then constructed of sectors of y-cut crystals such that the driver generated and the detector transmitted only torsional waves. With these crystals and viscous coupling between the crystals and sample, the velocity in fused quartz was constant within  $\pm 1$  m per sec for the frequency range 0.6-3.0 Mc. The velocity in Armco iron was constant within  $\pm 2$  m per sec in the range 0.5-1.5 Mc and decreased about 10 m per sec in the range 1.5-3.0 Mc.—*Author's abstract*

- 165-97. Hughes, D. S., and Maurette, Christian. Variation of elastic wave velocities in granites with pressure and temperature: Geophysics, v. 21, no. 2, p. 277-284, 1956.

The dilatational and rotational wave velocities have been measured as functions of pressure and temperature for five granites. The pressure range was 200-5,000 bars or higher. Dilatational velocities were measured over the temperature range 20-300°C; rotational wave velocities over the range 20-200°C. These data indicate that below fairly shallow depths in the granitic layer the velocity is constant or even slightly decreasing.—*Authors' abstract*

- 165-98. Toulis, W. J. Theory of a resonance method to measure the acoustic properties of sediments: Geophysics, v. 21, no. 2, p. 299-304, 1956.

The theory of resonance for a pressure release cylindrical chamber is explored and equations are derived for determining absolute values of the velocity of sound and the attenuation constant in sediment samples. The essential measurements that need to be made are the determination of the frequencies of the lower modes of resonance and the associated sharpness of resonance. Corrections are derived also for the finite thickness and the acoustic losses in the chamber walls.—*Author's abstract*

- 165-99. Shumway, George. A resonant chamber method for sound velocity and attenuation measurements in sediments: Geophysics, v. 21; no. 2, p. 305-319, 1956.

Sound velocity and attenuation measurements in unconsolidated marine sediments have been made by a resonance method which utilizes a thin-walled plastic cylinder as a pressure-release container to hold samples. Velocities were determined from resonant frequencies which lay between 23 and 36 kc per sec for the 2 inch diameter by 4 inch long cylindrical container used. Attenuation was determined from the sharpness of the resonant modes. Relatively undisturbed sediment samples were obtained by diver, in shallow water, using the same plastic containers in which the acoustic measurements are made. Deep sea samples were obtained by cutting sections from cores which were taken in plastic tubes.

Velocities for shallow water sediments in the San Diego area ranged from 4,840 fps (0.978 times sea water velocity) for fine silt to 5,680 fps (1.147 times sea water velocity) for medium sand, measured at 60°F and atmospheric pressure. Velocities in deep-sea red clay samples ranged between 0.980 and 1,040 times the sea water velocity, at 60°F and atmospheric pressure. Attenuation coefficients for shallow-water San Diego sediments varied from about 1 to 4 db per ft for silts, to about 3 to 8 db per ft for sand.—*Author's abstract*

165-100. Press, Frank, and Dobrin, Milton B. Seismic wave studies over a high-speed surface layer: *Geophysics*, v. 21, no. 2, p. 285-298, 1956.

The propagation of compressional, shear, and surface waves was studied along a 3,200-ft profile at a location where a 95-ft thick surface layer of Austin chalk, with a compressional velocity of about 9,900 fps, overlies a 400-ft section of Eagle Ford shale with a speed of about 6,500 fps. Woodbine sand, with a velocity of about 9,900 fps, underlies the shale.

Refracted first arrivals transmitted through the high-speed surface layer show an increase of frequency with distance from the shot. A refracted second arrival from the Woodbine decreases in frequency and, after correction for spreading, increases in relative amplitude with distance. This would indicate that the high-speed surface layer acts as a high-pass filter for energy transmitted horizontally and as a low-pass filter for energy transmitted vertically through the layer. Shear waves transmitted through the Austin chalk are also observed.

Surface waves consist of two groups of arrivals; a brief train of high-frequency waves (greater than 20 cps) propagated almost entirely in the surface layer is followed by a short train of low-frequency waves. Unlike surface waves in most other localities, the two groups show almost no dispersion. The characteristics of both kinds of waves are interpreted qualitatively in terms of the layering.—*Authors' abstract*

## ELECTRICAL EXPLORATION

165-101. Khovanova, P. I. Opyt ispol'zovaniya zemnykh tokov niskoy chastoty s razvedochnymi tselyami [Experiences in the use of low-frequency earth currents in prospecting]: *Akad. Nauk SSSR Geofiz. Inst. Trudy*, no. 30 (157), p. 272-277, 1955.

In experiments with stray currents during the summer of 1952 in a region where these currents were rather intense owing to the proximity of electric railroads and other electric installations, Khovanova observed that the earth currents varied with time so slowly that it was possible to measure the potential drop in steps of 10 millivolts over distances of several hundred meters. From a graph of the observed values along a selected profile, it is possible to distinguish sections of decreased or increased potential drop. Those showing the minimums indicate presence of ore bodies with high electric conductivity. The drawback to the procedure is the impossibility of controlling the direction of the currents.—*S. T. V.*

165-102. Sebestyén, Károly. Tellurikus áram regisztráló berendezés [Telluric current recording apparatus]: *Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények*, kötet 5, szám 1, p. 53-63, 1956.

Describes a field apparatus which combines into one compact unit all the instruments necessary to record telluric currents. Details of construction and circuits are shown diagrammatically, along with a typical example of the field record obtained.—*D. B. V.*

- 165-103. Groshevoy, G. V. Vysokochuvstvitel'nyy dvukhramochnyy zerkal'nyy gal'vanometr bez induktivnoy svyazi [Two-coil reflex galvanometer free of inductive coupling]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 29 (156), p. 78-79, 1955.

The use of two-coil galvanometers in measurements of telluric currents by the differential method can result in errors because of inductive coupling between the coils. This is a description of such an instrument that is not affected by inductive coupling and yet is highly sensitive.—S. T. V.

- 165-104. Tikhonov, A. N., and Shakhshvarov, D. N. Metod rascheta elektromagnitnykh poley, vzbuzhdayemkh peremennym tokom v sloistyykh sredakh [The method of evaluating electromagnetic fields excited in stratified media by alternating current]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 245-251, 1956.

The solution for an alternating electrical field generated by a dipole in a semi-space composed of plane-parallel layers, obtained in a general form by Tikhonov and Mukhina [see Geophys. Abs. 141-12047], has now been obtained in a form adapted for use with modern computing machines.—S. T. V.

- 165-105. Wait, James R. Radiation resistance of dipoles in an interface between two dielectrics: Canadian Jour. Physics, v. 34, no. 1, p. 24-26, 1956.

Exact expressions are derived for the radiation resistance of electric and magnetic dipoles located in the plane interface between two semi-infinite lossless dielectrics. For the electric dipole the ratio of the radiation resistance in an interface to the corresponding value in free space is approximately equal to  $N$ , the relative refractive index, for  $N$  greater than 5. For a vertically oriented magnetic dipole or small loop situated in the interface, the ratio is approximately  $2/5 N^3$  for values of  $N$  greater than 5.—M. C. R.

- 165-106. Wait, James R. Transient fields of a vertical dipole over a homogeneous curved ground: Canadian Jour. Physics, v. 34, no. 1, p. 27-35, 1956.

Expressions are derived for the transient fields of a dipole or short vertical antenna on a smooth spherical conducting earth, and energized by a current which is discontinuous in time. When the antenna current is a linear function of time, the radiation field on a flat perfectly conducting earth is of step-function form. The departure from the step shape of the field is due to the finite conductivity and the dielectric constant of the ground, the induction and static fields of the antenna, and the curvature of the earth. For distances greater than 50 km and times less than 0.1 microsecond following the first arrival of the signal, the curvature of the earth begins to have a marked effect. At distances between 20 and 100 km the induction field of the source dipole becomes appreciable for times greater than 10 microseconds.—M. C. R.

- 165-107. Tikhonov, A. N., and Chetayev, D. N. O vozmozhnosti ispol'zovaniya soprotivleniya izlucheniya anteny dlya elektrokartirovaniya [On the possibility of using the resistance of an antenna for electrical sounding]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 346-348, 1956.

Theoretical investigations and available experimental data on the emission of electromagnetic waves from an antenna erected at a certain height above the

ground make it possible to determine the electrical resistivity of the ground from the measured total resistance of the antenna. This value serves as an indicator of the possible presence of buried ore bodies. Several charts are given to be used for the interpretation of the data.—*S. T. V.*

- 165-108. Belluigi, Arnaldo. Sul metodo geoelettrico "Elflex" per la ricerca diretta del petrolio [On the Elflex electrical method for direct exploration for petroleum]: Servizio geol. Italia Boll., v. 77, fasc. 1, p. 131-166, 1955.

The direct (normal) electromagnetic effect of a quasi-stationary single electrode, placed on the horizontal surface of a uniform ground, is calculated. Then the radial component of the electric field is analyzed, taking, or not, into account the dielectric constant  $\epsilon$  of the medium. A result, which is of fundamental importance for the Elflex, is that in a same dissipating medium ( $\sigma \neq 0$ ), the weight of this parameter:  $\epsilon \neq 0$  (dispersive for the low frequencies) on the electric field, renders this field predominant, with a maximum (in certain range of values ( $\omega\epsilon/\sigma$ )) with regard to the isofrequent electric field, with  $\epsilon=0$ . Some simple ways of transition from the single pole to the alternating dipole are indicated. The evaluation of the "applied voltages" is exposed; these voltages are dependent upon the proprieties of the electric field and other specific proprieties, here extensively discussed, and finally the "reflection of the e. m. waves with very low frequency" is briefly treated.—*Author's abstract*

- 165-109. Chetayev, D. N. O vozvratnom metode elektrorazvedki [The reflex method of electrical exploration]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 210-213, 1956.

Two possibilities of using radio waves in geophysical exploration are pointed out: either by measuring the energy emitted by an antenna and that consumed by the ground in different amounts, which depends on the height of the antenna and the presence underground of electrically conductive bodies; or by varying the frequency of the radio emission and finding the frequency corresponding to the changes in the resistivity of the emission, which determines the depth of the buried conductors.—*S. T. V.*

- 165-110. Wait, James R., and Howe, H. Herbert. Amplitude and phase curves for ground-wave propagation in the band 200 cycles per second to 500 kilocycles: U. S. Natl. Bur. Standards Circ. 574, 17 p., 1956.

Field strength and phase of very-low-frequency ground waves from a short vertical antenna have been computed and are shown graphically. The conductivity between the source and observer is considered to be essentially homogeneous, and 4,  $10^{-2}$ , and  $10^{-3}$  mhos per meter, corresponding to sea water, well-conducting land, and poorly conducting land. The distances from source to receiver are taken as 1 to 1,500 miles.—*M. C. R.*

- 165-111. Poritsky, H. Propagation of transient fields from dipoles near the ground: British Jour. Applied Physics, v. 6, no. 12, p. 421-426, 1955.

The propagation in air and underground of an electromagnetic wave originated by a current pulse in a small antenna located at or near the surface of the ground is studied. The treatment is based upon the resolution of a spherical wave into proper plane waves, this resolution being analogous to one used by Weyl for the steady-state case.

A double-integral representation is obtained for (the Hertz potential of) the field. For a vertical dipole on the ground, one of the integrations is carried out above ground and in a certain conical range underground, while the second integration is carried out for special directions and locations.—*Author's abstract*

- 165-112. Wait, James R. Mutual electromagnetic coupling of loops over a homogeneous ground—an additional note: *Geophysics*, v. 21, no. 2, p. 479-484, 1956.

Wait has previously given several formulas for electromagnetic coupling between small wire loops over homogeneous conductive flat ground [see *Geophys. Abs.* 162-67]. These results are now extended to include the case when the case when the axes of both loops are parallel to, and above the ground. The mutual impedance ratio for coaxial and coplanar loops with axes parallel to ground in relation to conductivity, frequency separation, and height are shown graphically. These show that from the standpoint of minimizing the response of the overburden in an airborne electromagnetic prospecting scheme, the coaxial loop arrangement is to be preferred.—*M. C. R.*

- 165-113. Makino, Naofumi. Electromagnetic methods [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 249-254, 1953.

This is a report on recent studies of field procedures for the electromagnetic galvanic method, giving examples of the calculations of the field produced by direct current in conductors or in the earth, and of experimental results of exploration for conducting veins, buried mine drifts, or wires.—*D. B. V.*

- 165-114. Kiyono, Takeshi; Kimura, Koichi; and Kobayashi, Keiichi. Theoretical study on the electromagnetic induction method (II): *Butsuri-Tankō*, v. 7, no. 4, p. 195-201, 1954.

In this report, the secondary magnetic field produced by a spherical body in the uniform field is obtained from the electromagnetic equations. and the expression for amplitude and phase angle of the secondary field deduced by L. B. Slichter is generalized to the case of a magnetic sphere. The effects of the permeability on the secondary field are discussed, and the existence of the frequency for which the amplitude of the magnetic field takes a minimum value.—*Author's abstract*

- 165-115. Belluigi, Arnaldo. La funzione dello strato elettricamente conduttivo sottile [The function of a thin electrically conducting layer]: *Geofisica Pura e Appl.*, v. 32, p. 71-84, 1955.

The electromagnetic effect of change of thickness in a conducting interlayer in ground of high resistivity when the ground is excited by low-frequency a-c (horizontal dipole) current is of practical importance in estimating tonnages of conducting minerals discovered electrically. Laborious calculations lead to analytic estimates of the electrical field which may be expressed in tables or diagrams (six tables are appended). Belluigi derives the concept of the electrical horizon as an extensive thin conducting layer of critical thickness, a concept already implicitly obtained in another way by Evans [see *Geophys. Abs.* 26-225].

It is first demonstrated that the effect of the interlayer (obviously decreasing with depth) characteristically depends, according to depth, on variations of its thickness, decreasing substantially with increase of thickness. Whereas for shallow ore bodies tonnage estimates can generally be made approximately, for deeper bodies they are usually more exact, using both components of conductivity

(horizontal) in phase and in quadrature. Given, therefore, that such electromagnetic effect is properly a function of the induction factor, this property is used to introduce a new practice (frequency variation) of survey by so-called "pseudoresonance" for maximum geoelectromagnetic effect.—*D. B. V.*

- 165-116. Belluigi, Arnaldo. Campo generato da un cavo percorso da corrente alternata disteso su un terreno con interstrato [Field generated by a cable carrying alternating current lying on a terrain with interlayer]: *Geofisica Pura e Appl.*, v. 32, p. 85-101, 1955.

This is a mathematical consideration of the electromagnetic field generated by a rectilinear infinitely long cable carrying a-c current, lying on the surface of a terrain including a horizontal infinitely long interlayer for the case with the interlayer outcropping at the surface, and for the interlayer lying at a fixed depth. In the first section, Belluigi discusses the electromagnetic field as a function of the thickness of the superficial conducting layer, reaching the same conclusions as in the preceding paper (see above abstract); in the second, in which the field is considered as a function of the thickness of the layer and of its substratum, the same law of variation with thickness of the superficial layer is obtained, and extended to the case of the upper layer having greater resistivity than the lower. The problem of an interlayer at a fixed depth in an infinite homogeneous ground is considered in the third section; and in the fourth the asymptotic electromagnetic effect (that at great distance from the cable) is examined. The paper concludes with establishment of methods for determining depth and electrical characteristics of the interlayer with respect to those of the enclosing medium, giving the complete solution.—*D. B. V.*

- 165-117. Engineering and Mining Journal. New airborne geophysical method speeds prospecting: *Eng. Min. Jour.*, v. 157, no. 3, p. 84-91, 1956.

A Canso aircraft equipped with airborne magnetometer, dual frequency electromagnetic system, scintillation counter, strip camera, and radio altimeter is being used by Aeromagnetic Surveys, Ltd. The electromagnetic system measures the phase shift of a 400-c signal and a 2300-c signal. The ratio of the phase shift of the two frequencies provides significant information on the conductivity of the conductor producing the electromagnetic anomaly.—*D. R. M.*

- 165-118. Bacon, Lloyal O. The circular line electrode in equipotential prospecting: *Mining Engineering*, v. 8, no. 2, p. 213-216, 1956.

In the circular-line electrode method of equipotential prospecting, one of the energizing electrodes is placed in an ore body by lowering the electrode into a drill hole; the other is a circular-line electrode with a radius of about 700 feet placed on the surface of the ground. Equipotential points are then determined at 25- to 100-foot intervals on the ground surface. The results are interpreted qualitatively.—*L. C. P.*

- 165-119. Kunetz, G [ésa]. Einfluss vertikaler Schichten auf elektrische Sondierungen [Effect of vertical layers on electrical surveys]: *Zeitschr. Geophysik*, Jahrg. 21, Heft 1, p. 10-24, 1955.

This work is concerned mainly with the effect of plane, thin layers with very high, or conversely, very low, electrical resistivity on the distribution of potentials created by introduction of direct current by point electrodes.

First it is assumed that the layer in question is enclosed in an infinite homogeneous medium, then that the medium is limited above by the horizontal earth's

surface and below by the equally horizontal surface of a nonconducting substratum, and that the thin layer is vertical.

From this potential distribution can be determined the electrical field at the surface at the midpoint between two current electrodes, with the electrodes either parallel or at right angles to the layer. By multiplying by a factor proportional to the square of the distance between the electrodes, the so-called "apparent specific resistivity" is obtained, a well-known parameter which in a homogeneous medium is equal to the true specific resistivity.

The numerical results for different combinations of layers and their resistivities are plotted in several groups of curves as a function of length of spread. Finally the results are given for a vertical contact between two broad horizontal layers of unequal conductivity resting on a nonconducting substratum.—*Author's summary, D. B. V.*

- 165-120. Carpenter, E. W., and Habberjam, G. M. A tri-potential method of resistivity prospecting: *Geophysics*, v. 21, no. 2, p. 455-469, 1956.

A method is described whereby three resistances are measured for a four-electrode configuration and relations among these three resistances and their corresponding apparent resistivities are derived. The electrode configuration used is one in which the electrodes are colinear with  $X_{11}=X_{22}=r$  and  $X_{12}=X_{21}=r+s$  where  $r$ =the distance between  $C_1$  and  $P_1$  or between  $C_2$  and  $P_2$ , and  $s$  is the distance between  $P_1$  and  $P_2$ . The ratio  $r/s$  is held constant as the scale of the configuration is increased and the results are presented as graphs of the apparent resistivity plotted against  $s$  or  $r$ . The Wenner electrode configuration is the particular case for which  $r/s=1$ . The method may be used as a means of distinguishing between the effects of lateral and vertical resistivity changes on depth probes.—*M. C. R.*

- 165-121. Clark, A. R. The determination of the long dimension of conducting ore bodies: *Geophysics*, v. 21, no. 2, p. 470-478, 1956.

The solution of Laplace's equation in prolate spheroidal coordinates has been used to show that the resistivity profile obtained when one current electrode is in the conducting body can be used to estimate the extent of the body along the long axis. Theoretical and experimental curves over a dipping conductor are similar. There is apparently a relation between the length of spindlelike ore bodies, one dimension of which is much greater than the other two, and the distance from the current electrode at which the calculated resistivity profile abruptly changes slope. For nearly vertical bodies this point marks the length. As the dip of the body decreases the change in slope occurs at a distance which is a smaller fraction of the body length. The method provides a rapid means of determining whether the longer axis of the conductor is such that further investigation, or drilling, is warranted.—*M. C. R.*

- 165-122. Kiyono, Takeshi. Ground resistivity methods [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 237-243, 1953.

This is a review of the theoretical developments in electrical prospecting in the last 10 years, including methods of interpretation of resistivity data.—*D. B. V.*

- 165-123. Noguchi, Takashi. Spontaneous polarization method [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 223-226, 1953.

A review of progress in the spontaneous polarization method, including theoretical analysis of the potential curves due to ore deposits, three-dimensional

distribution of the natural potential, anomalies caused by special surface layers, and attainable depth.—*D. B. V.*

- 165-124. Kunori, Shoichi; Nakabayashi, Kazutaka; and Shibatō, Kihei. A review of the origin of the generation of S. P. current [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 227-236, 1953.

This is a review and bibliography of the self-potential method.—*D. B. V.*

- 165-125. Wilckens, Friedrich]. Die Grundlagen der Eigenpotential-methode [The basic principles of the self-potential method]: *Zeitschr. Geophysik*, Jahrg. 21, Heft 1, p. 25-40, 1955.

After a discussion of the contradictions in the literature concerning the self-potential method, it is shown that the SP curve measured near ore bodies is due mainly to the potential drop at the ore and electrolyte boundary, an explanation well in accordance with the oxidation-reduction theory. To illustrate, electrochemical processes in the vicinity of graphite deposits are examined in particular. The various methods of measuring the potential drop are reviewed briefly.—*D. B. V.*

- 165-126. Suyama, Junji. Equipment and field techniques of electrical prospecting [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 244-248, 1953.

A general description of electrical prospecting apparatus with a discussion of sources of error.—*D. B. V.*

- 165-127. Barsukov, O. M. Spособ graduirovki izmeritel'nykh elektrorazvedochnykh priborov [A method of calibrating the measuring instruments for electric prospecting]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 1, p. 109-111, 1956.

Voltmeters, ammeters, and similar instruments can be calibrated in the field by determining the indications of the instrument with several known resistances inserted in the circuit and treating the obtained data by the method of least squares. An example illustrates the procedure.—*S. T. V.*

- 165-128. Fritsch, Volker. Geoelektrische Baugrunduntersuchungen in Jugoslawien und Oesterreich [Geoelectrical foundation investigations in Yugoslavia and Austria]: *Geophys. Prosp.*, v. 4, no. 1, p. 24-36, 1956.

Examples are given illustrating the application of geoelectrical methods to engineering problems in Austria and Yugoslavia. Numerous examples deal with dam-site problems. Resistivity methods were used for bedrock investigations, to check the efficiency of cement injections into rock, and to investigate the seepage of water underneath dams. Resistivity methods were also used for the detection of cavities underneath roads. On the Vienna airport, a radio method was used to detect cavities.—*W. H. D.*

- 165-129. Manfredini, Antonio. Su alcuni risultati ottenuti nel campo dei metodi elettrici a corrente continua [On some results obtained in the field by the direct current electrical method]: *Servizio geol. Italia Boll.*, v. 76, fasc. 2, p. 613-614, 1955.

In the Marsiliana plain (Comune di Orbetello, Grosseto), electrical resistivity profiling indicated the presence of three water-bearing gravels at different depths,

but in the Capalbio region (Comune di Capalbio, Grosseto), surveys showed no ground water to a depth of 400 m.—*D. B. V.*

- 165-130. Kurata, Nubuo. On searching for ground water [in Japanese with English summary]: Butsuri-Tankō, v. 6, no. 3-4, p. 179-185, 1953.

Electrical surveys, including apparent resistivity, self-potential, and electrical logging have been used in Japan in the search for ground water.—*D. B. V.*

- 165-131. Tsukada, Tadashi; Ochiai, Toshiro; Hasegawa, Kazuo; and Ozawa, Takeo. Electrical exploration on Isahaya Bay: Butsuri-Tankō, v. 7, no. 4, p. 202-207, 1954.

An electrical resistivity survey was made to determine the structure beneath Isahaya bay, Nagasaki-ken, which is to be reclaimed as arable land. Electrodes were set at or under the surface of the water with buoys. Two layers were distinguished.—*M. C. R.*

- 165-132. Rocha Gomes, Albertino Adélio, and Silva, Fernando José da. Prospeção de pirites no Baixo Alentejo [Prospecting for pyrite in Baixo Alentejo (with English summary)]: Portugal Serviço Fomento Mineiro Estudos, Notas e Trabalhos, v. 10, fasc. 1-2, p. 37-77, no date.

The pyrite-bearing belt in the province of Baixo Alentejo, Portugal has been explored since 1944 for new ore bodies. By the end of 1949, a Swedish company using the Turam electromagnetic method had covered an area of 577 km<sup>2</sup> with 528,504 observations, and recommended drilling of the most promising anomalies. As a result of this drilling, a deposit was found at Aljustrel with 1,400,000 tons of assured ore. Although this discovery alone justifies the whole campaign, it is recommended that the Turam method be supplemented by other geophysical methods. Some strong anomalies occurred over barren areas, and exploitable ore bodies have been known to escape detection. Exploration for pyrite will be continued to include the Tertiary basin of the Sado river, the Almodôvar, Albernoa and Odemira Cercal areas, and the great Montemor-Serpa porphyry belt.—*D. B. V.*

- 165-133. Terrones L., Alberto J. La aplicación de metodos modernos de exploración minera en el Peru [The application of modern mining exploration methods in Peru]: Minería (Peru), año 4, no. 11, p. 10-16, 1955.

By special arrangement with the Cerro de Pasco Corp., a geophysical crew of the Newmont Mining Corp. has been carrying on systematic exploration in Peru. So far, their work has consisted of regional surveys of the porphyry copper area in the south, using Brant's method of determining percentage of sulfides per volume at depth. This method is particularly useful where disseminated deposits are overlain by barren rock. The cost of such surveys runs between \$700 and \$1,500 per km<sup>2</sup> depending on degree of detail and accessibility and character of the terrain.

All geophysical methods could profitably be employed in Peru, particularly with helicopter transportation.—*D. B. V.*

### ELECTRICAL LOGGING

- 165-134. Nechay, A. M. Opredeleniye litologicheskikh svoystv gornykh porod po rezul'tatam geofizicheskikh issledovaniy v skvazhinakh [The identification of lithologic properties of rocks from the results of geophysical investigations in drill holes]: Prikladnaya geofiz., vypusk 11, p. 3-49, 1954.

If two solutions of any salt of different concentrations are separated by a semi-permeable membrane, a difference of electromotive force, called the potential of diffusion, appears on the membrane separating the two solutions. The weaker solution receives a charge of the same sign as the ion having greater mobility. A similar situation is found in oil wells, where the concentration of the salt in the mud is different from that in the liquid filling the pores of the surrounding formations, and the walls of the drill holes, slightly permeated with the mud, in which there is some intermediate concentration. The intensity of the electromotive forces is also determined by the petrographic properties of the formations, their porosity, and permeability.

More than 700 combinations of different rocks were investigated as possible membranes and the electromotive forces measured as functions of the "lithologic coefficient" of the rocks forming the electrolytic cell. Then, in reverse, from the measured voltages and other data, it is possible to determine the nature of rocks at a given depth in the drill hole. For this purpose it is necessary to make measurements with the mud as found and again after adding sufficient amount of sodium chloride to the mud.—*S. T. V.*

- 165-135. Karplus, Walter J., and Smith, Otto J. M. The application of electrical transients to well logging: *Jour. Petroleum Technology*, v. 8, no 3, p. 53-55, 1956.

If a current pulse which varies exponentially with time is transmitted through one pair of in-hole electrodes and the resulting voltage transient is measured with a second pair of electrodes, then the integral of this voltage transient with respect to time should be directly proportional to the electrical resistivity of the medium. This was verified by a laboratory model of a transient logging system.—*G. V. K.*

- 165-136. Komarov, S. G., Sokhranov, N. N., and Chukin, V. T. Provedeniye elektricheskogo karottazha pri sil'nykh blushdayushchikh tokakh [Electrical well logging in the presence of strong stray currents]: *Prikladnaya geofiz.*, vypusk 10, p. 36-47, 1953.

Stray currents interfering with electrical measurements in drill holes can be either of telluric origin or, more often, caused by industrial installations. The stray currents are not distributed uniformly throughout the depth of the drill hole, but attain a maximum at the depth of some 600-700 m. Spontaneous potential can be measured in the presence of stray currents by using the so-called "stabilized electrode," that is an electrode of great length (in the measurements described, 80 m long). It is necessary to repeat the measurements to ascertain that they are not affected too much by the stray current. In measurements of apparent resistivity a single-pole arrangement is recommended. In temperature measurements it is necessary to use the feeding source of higher voltage.—*S. T. V.*

- 165-137. Broding, R. A., and Rumrnerfeld, Ben F. Simultaneous gamma ray—resistance logging as applied to uranium exploration: *Tulsa Geol. Soc. Digest*, v. 23, p. 173-181, 1955.

A condensed version of the paper in *Geophysics* [see *Geophys. Abs.* 163-156].—*M. C. R.*

- 165-138. Fuchida, Takato. Recent progress in well logging [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 272-277, 1953.

Review of recent progress and developments in electrical and radioactivity logging.—*M. C. R.*

- 165-139. Chuman, R. W. Electric log correlation of the Mesaverde Group in southwestern Wyoming: Wyoming Geol. Assoc. Guidebook, 10th Ann. Field Conf., p. 95, 1955.

Correlation of the Mesaverde Group by electric logs was attempted in an effort to point out major stratigraphic traps. A cross section shows the correlation across the southern part of the Green River-Washakie Basins for a distance of approximately 144 miles.—*V. S. N.*

### ELECTRICAL PROPERTIES

- 165-140. Stuart, Malcolm R. Dielectric constant of quartz as a function of frequency and temperature: Jour. Applied Physics, v. 26, no. 12, p. 1399-1404, 1955.

Measurements of dielectric constant and power loss were made from 1 to 90 kc per sec and from 20°C to 400°C. The dielectric constant parallel to the optic axis for all frequencies show a sharp rise, which occurs as successively higher temperatures for higher frequencies. The loss at a given frequency has a temperature maximum which is higher, the higher the frequency. The results are partially explained by assuming that ions are present in "tunnels" parallel to the optic axis. The density and mobility of these ions are obtained. The density is temperature dependent in such a way as to lead to an activation energy of 17.7 kcal per mole. Lithium ions were introduced into the crystals, and effects caused by these ions were at least compatible with the assumption that lithium ions were originally present. Perpendicular to the optic axis none of the above effects exist.—*Author's abstract*

- 165-141. Erkel, András, and Bod, Magdolna. A gerjesztett potenciálmérések eredményeinek kiértékelése, tekintettel a laboratóriumi közetvizsgálatokra [Interpretation of the results of induced potential measurements with respect to laboratory experiments]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 5, szám 1, p. 3-17, 1956.

Discusses the theory of induced potentials in rock samples (filtration potential, polarization potential, oxidation-reduction potential, ion transfer, and hysteresis characteristics), and presents by means of graphs the results of laboratory measurements on samples of clay, trachydolerite, coal, and galena. In coal, the induction is directly related to rank and strongly influenced by the percentage and electrical properties of accessory minerals. The laboratory observations are compared graphically with electric logs from the Hungarian coal measures.—*D. B. V.*

- 165-142. Hill, H. J., and Milburn, J. D. Effect of clay and water salinity on electrochemical behavior of reservoir rocks: Am. Inst. Min. Metall. Petroleum Engineers Trans., v. 207, Jour. Petroleum Technology, v. 8, no. 3, p. 65-72, 1956.

Electrical resistivity and diffusion potentials were measured for cores from a wide variety of petroleum reservoir rocks, including clean sandstones, shaley sandstones, and limestones. Empirical equations which differ in detail from those of other investigators were set up for the relationships between resistivity, electrochemical potential, porosity, cation-exchange capacity, and connate-water salinity. The application of these equations to electric log analysis is limited by the fact that all measurements were performed on fully water-saturated rocks.—*G. V. K.*

- 165-143. Shibatō, Kihei; Kishi, Haruo; and Takagi, Shinichiro. Study on spontaneous polarization of powdered pyrite: *Butsuri-Tankō*, v. 7, no. 4, p. 186-194, 1954.

A description of experimental determinations of the time variations of the spontaneous polarization that occurs between pyrite and solution when distilled water is passed through powdered pyrite in a cylindrical tube.—*M. C. R.*

## EXPLORATION SUMMARIES AND STATISTICS

- 165-144. Dobrin, Milton B., and Van Nostrand, Robert G. Exploration geophysics makes rapid strides: *World Oil*, v. 142, no. 5, p. 129-141, 1956.

This is a condensed version of "Review of current developments in exploration geophysics" by the same authors in *Geophysics* [see *Geophys. Abs.* 164-132].—*L. C. P.*

- 165-145. Donohoo, H. V. W. Annual review, geophysics and geochemistry: *Mining Engineering*, v. 8, no. 2, p. 174-183, 1956.

Airborne magnetic, electromagnetic, and radiation surveys were extensively used during 1955 in geophysical exploration for economic mineral deposits; most airborne geophysics was done by contractors. Ground geophysical work, on the other hand, was done largely by mining company personnel. Airborne electromagnetic, magnetic, and radioactivity surveys are considered by mining companies to pay for themselves. There are differences of opinion, however, as to whether the results of other geophysical work justify the cost; many believe that the "pay-off" will come over a long period. To date, 85 percent of airborne electromagnetic anomalies have been confirmed by ground electromagnetic checks.

The nuclear magnetometer has been adapted for portable use on the ground and is also being used in fixed-wing aircraft. A magnetic susceptibility bridge is now on the market. High-frequency seismic reflection techniques are being tested in mining exploration problems.—*L. C. P.*

- 165-146. Hammer, Sigmund. Geophysical activity increases five percent: *Oil and Gas Jour.*, v. 54, no. 24, p. 190-194, 1955.

During the first 6 months of 1955 geophysical activity in exploration for petroleum increased 5 percent in rate over the total for 1954. Graphs and tables show geophysical activity by method and region.—*D. R. M.*

- 165-147. Fedynskiy, V. V. Desyat' let raboty nauchno-issledovatel' skogo instituta geofizicheskikh metodov razvedki (NIIGR) 1944-1954 [Ten years of investigations at the NIIGR (Scientific research institute of geophysical methods of exploration) 1944-54]: *Prikladnaya geofiz.*, vypusk 12, p. 3-30, 1955.

This is a brief history of the institute since its founding in 1944. A bibliography of papers published by members of the staff of the institute is appended.—*S. T. V.*

- 165-148. Lerici, C. M. Prospezioni archeologiche [Archeological exploration]: *Riv. Geofisica Appl.*, anno 16, no. 1-2, p. 7-32, 1955.

An illustrated review of the use of geophysical methods, geochemical methods, aerial photography, and submarine surveys in archeological research in England, Mexico, Egypt, Sweden, and Italy.—*M. C. R.*

- 165-149. Carabelli, E. Ricerche geofisiche sperimentali su antiche necropoli. [Experimental geophysical surveys in ancient burial places]: Riv. Geofisica Appl., anno 16, no. 1-2, p. 33-49, 1955.

Experimental measurements of the amplitude of vibrations set up in the ground by a generator, seismic reflection, and electrical resistivity at the Cerveteri necropolis in Rome indicated characteristic changes could be associated with the tombs. Electrical resistivity horizontal profiling near Fabriano, where aerial photographs had indicated promising areas for archeological research, led to discovery of some Picene tombs.—*M. C. R.*

- 165-150. Joesting, H. R. Geophysical exploration in Alaska: Arctic, v. 7, nos. 3 and 4, p. 165-175, 1954 [1955].

A review of geophysical investigations of geologic and related problems and of problems worthy of future investigation. Permafrost, geothermal studies, sedimentary geology and oil exploration, prospecting for metalliferous lode deposits and radioactive minerals, and volcanology are included.—*M. C. R.*

- 165-151. Cortes, H[enry] C., and Gsell, R. N. There is oil under those shelves: Oil and Gas Jour., v. 54, no. 22, p. 103-107, 1955.

Gravity, aeromagnetic, seismic refraction, and seismic reflection methods of exploration are being used in the search for oil in continental shelf areas. Geophysical operations in shelf areas involve problems not found in land operations, and costs are somewhat higher.—*D. R. M.*

- 165-152. Black, Rudolph A. Geophysical exploration for uranium on the Colorado Plateau: Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 766-770, 1956; and U. S. Geol. Survey Prof. Paper 300, p. 721-726, 1956.

The applicability of standard geophysical methods in exploration for uranium have been tested on the Colorado Plateau by both Federal agencies and private contractors. Most of the work has been in areas where the uranium is concentrated in the Morrison formation or in the Shinarump conglomerate. Geophysical methods have not been capable of detecting the uranium minerals directly because of the small proportion of uranium ore in relation to the amount of host rock, but electrical resistivity and seismic refraction methods have proved to be of some value in the detection and delineation of such geologic guides to ore as thickening of the ore-bearing member of the Morrison and the channels filled with the Shinarump.—*M. C. R.*

- 165-153. Denson, M. Elner. Geophysical-geochemical prospecting for uranium: Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 772-781, 1956; and U. S. Geol. Survey Prof. Paper 300, p. 687-703, 1956.

Preliminary results from field reconnaissance projects of the U. S. Atomic Energy Commission indicate that the combination of geophysical and geochemical exploration can be a useful and an economic exploration procedure.—*M. C. R.*

- 165-154. Hayashi, Hajime. Recent development of geophysical exploration for oil [in Japanese with English summary]: Butsuri-Tankō, v. 6, no. 3-4, p. 137-140, 1953.

In the past 5 years nearly 30,000 gravity stations were occupied in oil regions of Japan; anomalies are distinct in mountain regions, indistinct in plains. Seismic reflections are generally poor in quality because of thick near-surface unconsolidated formations; the efficiency of seismic surveys is also low because of difficulties of shothole drilling and transportation in water-covered paddies.—*D. B. V.*

- 165-155. Iida, Kumizi. On the geophysical exploration for coal [in Japanese with English summary]: Butsuri-Tankō, v. 6, no. 3-4, p. 141-157, 1953.

This compiles data on geophysical exploration for coal in Japan and analyses the results. Most of the surveys were by seismic refraction, with electrical methods used in the lignite and anthracite fields; more recently, reflection and gravity methods were employed.—*D. B. V.*

- 165-156. Satō, Kōnosuke. Geophysical explorations in mining of Japan [in Japanese with English summary]: Butsuri-Tankō, v. 6, no. 3-4, p. 158-166, 1953.

This discusses the application of the various geophysical methods to mineral exploration in Japan and correlations between geophysical and geological data.—*D. B. V.*

### GENERAL GEOPHYSICS

- 165-157. Colbert, L. O. Geophysical research in Alaska: Arctic, v. 7, nos. 3 and 4, p. 159-164, 1954 [1955].

An outline of the status of the geodetic network, of observations of gravity, geomagnetism, radio propagation, and seismology, and suggested problems for future research in Alaska.—*M. C. R.*

- 165-158. Beals, C. S., Hodgson, J. H., Innes, M. J. S., and Madill, R. G. Problems of geophysics in the Canadian Arctic: Arctic, v. 7, nos. 3 and 4, p. 176-187, 1954 [1955].

A review of studies of geomagnetism (by Madill), gravity (by Innes), seismology (by Hodgson), and Arctic problems of the future (by Beals).—*M. C. R.*

- 165-159. Matschinski, Matthias. I fenomeni di fluttuazione in geofisica.—Loro descrizione matematica e loro applicazione dal punto di vista pratico [Fluctuation phenomena in geophysics.—Their mathematical description and practical application]: Accad. Naz. Lincei Atti Cl. sci. fis. mat. et nat. Rend., v. 18, fasc. 4, p. 378-385, 1955.

Mathematical analysis of the variations to which all observed and measured geophysical quantities are subject leads to the conclusion that the fluctuations of the potential field and fluctuations of vector gradient, expressed by mean tensors, are a double gradient of a scalar superpotential  $\Phi$  which can be resolved by the usual equation  $\Delta\Phi=0$ . This superpotential, evidently not equal to the field potential, is a "fluctuation potential." Any kind of fluctuations of field can be inserted in the calculation of a single scalar function, with a reduced number of measurements and observations.—*D. B. V.*

### GEODESY

- 165-160. Ross, J. E. R. Geodetic investigations in the Canadian Arctic: Arctic, v. 7, nos. 3 and 4, p. 191-194, 1954 [1955].

A review of past work and proposed future investigations.—*M. C. R.*

- 165-161. Subbotin, M. I., and Nersesov, I. L. Flyuksmetricheskiy naklonomer [A fluxmeter inclinometer]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30 (157), p. 198-207, 1955.

An inclinometer, designed to measure inclinations of the ground of short duration, from several minutes to 1 or 2 hr, is based on the changing magnetic flux through the frame of the instrument. The instrument installed in a seismically very active region at Garm, in central Asia, was found to be very sensitive. In a special excavation, the instrument recorded inclinations of very short duration and of an amplitude of  $0.03''$ , produced probably by near earthquakes. A detailed theoretical discussion of the operation of the instrument and the description of different elements of the inclinometer are presented.—S. T. V.

### GEOTECTONICS

- 165-162. Gurevich, G. I. O "mekhanicheskom analize voprosov tektoniki" v ego tragitsionnom izlozhenii [Mechanical analysis of the problems of tectonics as usually set forth]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 31 (158), p. 3-106, 1955.

The practice in modern textbooks on structural geology and tectonics of giving explanations of geologic processes in terms of the laws of mechanics and the theory of elasticity is commendable, but quotations are given from books of well-known geologists, both Russian and foreign, of numerous illiterate formulations, scientific absurdities, and so on. Geologists apparently do not know mechanics, and mathematicians are not interested in geology.—S. T. V.

- 165-163. Carey, S. Warren. Wegener's South American-African assembly, fit or misfit?: Geol. Mag., v. 92, no. 3, p. 196-200, 1955.

A statement by Jeffreys that the Wegener fit of South America and Africa is a misfit of  $15^\circ$  has been widely quoted and accepted. However, careful check by any rigorous method will show that these continents do in fact fit together as precisely as their forms can be defined. Whether continental drift be true or false, this argument against it must be abandoned.—*Author's abstract*

- 165-164. Scheidegger, A[drian] E. The physics of orogenesis in the light of new seismological evidence: Royal Soc. Canada Trans., v. 49, sec. 4, p. 65-93, 1955.

Compilation and analysis of fault-plane studies show the main features of displacements in the crust and mantle are: localization in almost planar zones dipping at an intermediate angle beneath recent mountain and island belts; an elastic aftereffect in the material of the mantle; and a predominance of horizontal (transcurrent) motion. None of the present theories of orogenesis is compatible with the new seismological data. The mechanical behavior of the mantle corresponds to a material of which there has been no example observed in the laboratory. What is required is a mechanical material in which, during failure, the direction of the differential displacements does not coincide with the surface of rupture.—M. C. R.

- 165-165. Carey, S. Warren. Correlation of the post-Triassic history of Tasmania with secular variation in temperature and viscosity of the sub-crust: Royal Soc. Tasmania Papers and Proc., v. 88, p. 189-191, 1954.

The post-Triassic igneous activity, sedimentation, epeirogeny, peneplanation, and faulting of Tasmania may be correlated genetically with secular variation in the temperature of the sub-crust.—*Author's abstract*

### GLACIERS

- 165-166. Baird, P. D., and Sharp, R. P. *Glaciology: Arctic*, v. 7, nos. 3 and 4, p. 141-152, 1954 [1955].

A two-part paper, consisting of a brief review of the recent history of the science by Baird, and a survey of some desirable research by Sharp. Problems related to velocity relations in glaciers, structure, phase relations, oxygen-isotope studies, and micrometeorology and the regime of glaciers are outlined.—*M. C. R.*

- 165-167. Loewe, Fritz. Die Erforschung der "Inlandeise"—Grönland, Antarktis [The investigation of "inland ice"—Greenland, Antarctica]: *Umschau*, Jahrg. 56, Heft 4, p. 110-113, 1956.

This is a semipopular review of investigations of the Greenland and Antarctica ice sheets, which includes reference to seismic determinations of ice thickness, and the depression of the crust beneath the ice load.—*D. B. V.*

- 165-168. Wegener, Kurt. Die Temperatur in grönländischen Inlandeis [The temperature in the Greenland icecap]: *Geofisica Pura e Appl.*, v. 32, p. 102-106, 1955.

This presents the results of temperature measurements in the Greenland icecap by the Wegener expedition in 1930-31 and 1948-51. The measurements were made in boreholes drilled to 125 m at camp VI, 80 km from the edge of the ice sheet at 1,600 m elevation, where the ice is 1,600 m thick; and to 150 m at a station ("Eismitte") in the center of the ice, 400 m from the edge at 3,000 m elevation, with ice thickness of 3,000 m. The mean surface temperature, measured in holes 5 m deep, amounted to  $-28^{\circ}\text{C}$  at Eismitte, corresponding to a linear temperature gradient of  $2.8^{\circ}$  per 300 m of thickness, or  $0.9^{\circ}$  per 100 m; and to  $-13^{\circ}\text{C}$  at camp VI, indicating a linear gradient of about  $0.8^{\circ}$  per 100 m thickness.

Corrected temperature-depth curves show a gradient of  $0.9^{\circ}$  per 100 m at Eismitte, corresponding to the linear gradient. Complete correlation cannot be expected as heat flow in névé is slower than in ice. At camp VI the gradient is  $3^{\circ}$  per 100 m, beginning from the higher surface temperature.—*D. B. V.*

- 165-169. Förtisch, O[tto], and Vidal, H. Glaziologische und glazialgeologische Ergebnisse seismischer Messungen auf Gletschern der "Ötztaler Alpen 1953/1954 [Glaciological and glacial-geological results of seismic measurements on glaciers of the Ötztaler Alps, 1953-54]: *Zeitschr. Gletscherkunde u. Glazialgeologie*, Band 3, Heft 2, p. 145-169, 1956 (English summary, p. 168-169).

Seismic measurements were made along transverse and longitudinal profiles of the Gepatschferner and Kesselwandferner and of the tongue of the Hintereisferner glaciers in the Ötztaler Alps (Austria) in 1953 and 1954, in order to determine the thickness of the ice and to study its elastic behavior. Longitudinal wave velocities ranged from 1,600 m per sec in névé to 3,000 m per sec in melting "dead ice" and 3,500-3,850 m per sec in fresh "dead ice" and normal glacier ice. Sporadic velocities as high as 4,000 m per sec were occasionally noted. Different velocities were found for shot and countershot. The average velocity for glacier ice is taken as 3,600 m per sec. Transverse wave velocities, measured only on the

Hintereisferner, varied between 1,600 and 1,925 m per sec, and the Poisson's ratio was 0.36. Velocities on bedrock ranged between 4,400 and 5,700 m per sec; those above 5,400 represent solid rock, below that, frozen ground moraine.

On the basis of the profiles established by these measurements, the volume of ice in the Kesselwandferner is calculated to be 0.3 km<sup>3</sup> (equal to an ice cube 670 m on edge); in the Hintereisferner tongue, 0.44 km<sup>3</sup>, and in its tributaries, 0.40 km<sup>3</sup>, totaling the equivalent of an ice cube 900 m on edge.—*D. B. V.*

### GRAVITY

- 165-170. Müller, Iván. A nehézségi erő eloszlása a Kraszovszkij-, Hayford- és a Bessel-ellipszoid felületén [The distribution of gravity on the surface of the Krasovskii, Hayford, and Bessel ellipsoids]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 4, szám 2, p. 71-81, 1955.

The constants for use in Clairaut's extended theorem for the distribution of gravity on the surface of a rotating ellipsoid may be determined either theoretically or empirically. The Krasovskii, Hayford, and Bessel ellipsoids are each calculated in three different ways: theoretically, by assuming a homogeneous internal mass distribution; theoretically, using Stokes' formula and neglecting internal mass distribution; and empirically, using Cassinis' normal formula (based on gravity observations, reduced to the geoid rather than to the ellipsoid). The results are compared numerically and graphically.—*D. B. V.*

- 165-171. Lyustikh, Ye. N. Tektonika glubokikh chastey zemnoy kory po gravimetricheskim dannym [The tectonics of the deep parts of the crust according to gravimetric data]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 26 (153), p. 152-159, 1955.

Isostasy can be the result of the displacements of underground masses, but cannot produce them. Isostasy is not the general condition of the earth's crust though found in many regions. Even where found, isostasy can be the result of many different distributions of underground masses of different densities. A better interpretation of the geologic conditions of a region is given by topographic anomalies. Distribution in many island arcs is of great interest, but the isostatic anomalies there do not help much in geologic interpretation of the anomalies.—*S. T. V.*

- 165-172. Egyed, László. Új módszer az átlagsűrűség meghatározására [On a new method of determination of mean density]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 4, szám 2, p. 31-36, 1955.

Describes an analytical and areal method of determining density for use in gravity measurements, which is essentially an extension of the Nettleton method.—*D. B. V.*

- 165-173. Goguel, Jean. Tidal gravity corrections for 1955: *Geophys. Prosp.*, v. 3, supp., p. 1-29, 1955.

Tables, with explanation of their use.—*M. C. R.*

- 165-174. Morelli, Carlo. Tidal gravity corrections for 1955: *Geophys. Prosp.*, v. 3, supp., p. 30 + 12 figs., 1955.

Graphs, calculated for  $\lambda_0 = 15^\circ$  E.—*M. C. R.*

- 165-175. Goguel, Jean. Utilization géologique des prospections gravimétriques [Geologic application of gravity surveys]: *Annales des Mines*, 144<sup>e</sup> année, no. 5, p. 26-37, 1955; reprinted as France Bur. Recherches géol., géophys., et minières Pub., no. 17, 1955.

This is a review of the theory of gravity measurements, including examples of interpretation of local anomalies, the various corrections to be applied (especially the isostatic), and methods of determining residual anomalies. Practical geologists are concerned primarily with superficial disturbances in the crust and therefore in local residual anomalies. In consideration of crustal movements on a large scale, the areas characterized by anomalies of great extent whose sign remains constant no matter what system of isostatic reduction is applied are of major importance. Isostatic corrections must also be considered by geodesists in their precise calculations of the figure of the earth as a whole.—*D. B. V.*

- 165-176. Oszlaczky, Szilárd. Gravimetrikus tömeghatási és térképhatási táblázatok [Tables for the gravimetric effects of cylindrical masses]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 5, szám 1, p. 27-45, 1956.

Table I, which serves for three-dimensional interpretation, gives the gravity effect of 22.5° sectors of vertical hollow cylinders at different heights above or below the level of the station, from an inner radius  $R$  to infinity, with  $\sigma$  (density) = 1. Table II, similar to Hammer's topographic tables, lists the effects of different sectors with radii ranging from 100 m to 22,000 m, with  $\sigma = 2$ .—*D. B. V.*

- 165-177. Haáz, István Béla. Gravitációs és mágneses hatású réteg dolésének és sűrűségének, illetve mágnesezhetőségének meghatározása [Determination of the dip, density, and magnetic susceptibility of a layer from its gravity and magnetic effect]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 4, szám 2, p. 45-46, 1955.

Calculations are presented which show how the dip of an infinite inclined dike may be determined without ambiguity, by taking into account the character, as well as the position, of the extreme gravity or magnetic effect. Furthermore, the sign of the anomalous density or susceptibility may be obtained. Their values are indicated by the amplitude of the effects.—*D. B. V.*

- 165-178. Matsuzawa, Akira. The method of analysis for gravitational prospecting [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 213-222, 1953.

Ambiguity in interpretation of gravity surveys is reduced by use of independent data such as drilling logs or seismic data, or by use of residual gravity and second derivative methods.—*D. B. V.*

- 165-179. Stackler, W. F. Can gravity surveys map subsurface structures?: *Oil and Gas Jour.*, v. 54, no. 28, p. 263-267, 1955.

Revised version of a paper that originally appeared in *Oil in Canada* under title "Structural prospecting with the gravity meter." [See *Geophys. Abs.* 163-11].—*D. R. M.*

- 165-180. Ball, George M. A note on gravitational interpretation: *Mines Mag.*, v. 46, no. 4, p. 42-43, 1956.

This is a brief discussion of the interpretation of isogal and second derivative maps.—*L. C. P.*

- 165-181. Satō, Yasuo. A note on Tsuboi-Nagata's method: Tokyo Univ. Earthquake Research Inst. Bull., v. 32, pt. 3, p. 259-269, 1954.

In the Tsuboi-Nagata method of analysis of gravity or magnetic anomalies, it is assumed that the observed distribution on some finite domain is repeated cyclically outside this domain. The method may be used with a isolated anomaly distribution by inserting a null region between the cyclical repetition of the anomaly. Results are in agreement with those obtained by Rikitake's method involving Hermite functions.—*M. C. R.*

- Mikov, D. S. The interpretation of magnetic and gravitational anomalies by the method of the exclusion of elementary fields. See Geophys. Abs. 165-278.

- 165-182. Bendefy, László. Szintezési alappontok időközi magasságváltozásának meghatározása [Determination of temporal changes of elevation of base levels]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 4, szám 2, p. 3-30, 1955.

This paper investigates the possibility of determining, after a given interval, the altitude of a base level without releveling, if precise levellings had previously been made at different times. In a purely geodetic method, the probable movement is extrapolated from graphs of previously recorded changes; the gravitational-geodetic method similarly utilizes data on changes in gravity anomaly at the station, where the relations between gravity fluctuations and changes of level have been established. It is immaterial whether the gravity variations are due to isostatic or tectonic processes, but the method can not be applied if the changes of level are due to compaction and thus unrelated to gravity anomalies. Levellings in Hungary in the previous century include errors of several decimeters, therefore conclusions based on the old surveys are invalid. The more reliable levellings of the present century indicate strong tectonic movements rather than epeirogenic uplift with tilt.—*D. B. V.*

- 165-183. Shokin, P. F. Nekotoryye zakonomernosti smeshcheniya nul'punkta u kvartsevykh gravimetrov [Certain regularities in the drift of zero of quartz gravimeters]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 256-271, 1955.

This is the continuation of the study of the drift of the zero point in quartz gravimeters [see Geophys. Abs. 164-159]. One conclusion is that this drift is different during transport than when the instrument remains at a station. Several empirical equations derived by statistical methods are given for the drift, but are valid only for the specific instruments.—*S. T. V.*

- 165-184. Bulanzhe, Yu. D., and Popov, E. I. Kvartsevykh gravimetr dlya opredeleniya opornykh gravimetricheskikh punktov [Quartz gravimeter for the determination of the gravimetric base stations]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30(157), p. 240-249, 1955.

The GAE-2 gravimeter recently designed and manufactured by the Geophysical Institute is based on the Nørgaard gravimeter. The quartz measuring system and many other elements of the construction are the same; the main differences are the new angle-measuring device with microscopic attachment making possible a reading with an error of only  $\pm 0.4-0.8\mu$ , and a double thermostat.

Laboratory and field experiments in a wide range of conditions of temperature and pressure have shown that gravity determinations can be made with errors of

a fraction of a milligal. The instrument weighs 50 kg, and its dimensions are 590×510×310 mm.—*S. T. V.*

- 165-185. Lozano Calvo, Luis. El calibrado de los gravímetros mediante el gradiente vertical [Calibration of gravimeters by the vertical gradient of gravity]: *Rev. Geofísica*, año 14, no. 55, p. 209-218, 1955.

A formula and practical method for the calculation of gravimeters by the vertical gradient of gravity, taking into account the effect of the mass of the building in which the calibration is made.—*M. C. R.*

- 165-186. Matsuda, Takeo. North American gravimeter [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 210-212, 1953.

A description of the North American gravimeter, which is being used in Japan in surveys of oil, gas, and coal fields.—*D. B. V.*

- 165-187. Tsuboi, Chuji. Gravity measurements by means of gravimeters [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 206-209, 1953.

A brief history of the development of gravimeters, detailed description of the Worden instrument, and an outline of surveys in progress with it in Japan. The Bouguer map of the Kanto district is included.—*D. B. V.*

- 165-188. Woollard, G. P., Rose, J. C., and Bonini, W. E. The establishment of an international gravity standard: *Am. Geophys. Union Trans.*, v. 37, no. 2, p. 143-155, 1956.

A program was begun in 1949 to establish a gravity reference standard based on precise pendulum measurements over a range (4,500 milligals) sufficient to check the over-all linearity of geodetic-type gravimeters and to furnish a calibration good to 1 part in 10,000. Both gravimeter and pendulum measurements have been made along a route from Fairbanks, Alaska to Mexico City. The accuracy of any set of pendulum values depends on controlling factors associated with the design of the equipment, external or special factors, including changes in the magnetic field, or ambient temperature, operational procedure, and the methods of reduction. Results are compared with those obtained by the U. S. Coast and Geodetic Survey using Brown pendulums, and the Dominion Observatory using Cambridge equipment.—*M. C. R.*

- 165-189. Worzel, J. Lamar, and Shurbet, G. Lynn. Gravity anomalies at continental margins: *Natl. Acad. Sci. Proc.*, v. 41, no. 7, p. 458-469, 1955.

Gravity observations at 104 stations on 7 profiles off the Atlantic coast from Maine to Cape Hatteras have been studied along with topographic and seismic data. These indicate the true edge of the continent is at about the 1,000-fathom curve. The maximum thickness of sediments is near the base of the continental slope. The present structure is the result of sedimentation; as the sedimentation continues, the oceanic crust is depressed closely in isostatic equilibrium until the surface of the sediment reaches sea level. The continental slope moves seaward over this thickened sedimentary section as the top of the sediment approaches sea level. All these sections represent intermediate stages in this process, the most advanced being the New York and Cape May sections. The steepness of the Mohorovičić discontinuity varies considerably and is not related to the near-

surface structure at the continental margin. The continental crust thins fairly abruptly in about 200 km to the oceanic crustal thickness.—*M. C. R.*

- 165-190. Marshall, C. E., and Narain, H. Regional gravity in the eastern and central Commonwealth [of Australia]: Sydney Univ., Dept. Geology and Geophysics Mem. 1954/2, 101 p., 1954.

A regional gravity map of eastern Australia based on 9 traverses totaling more than 10,000 miles and more than 900 observations, a 470-mile traverse between Melbourne and Adelaide, and 7 shorter traverses shows the following features: a positive anomaly belt all along the eastern coast; two negative anomaly regions of north-south trend; low-gravity basins around Roma and in South Australia; large negative anomaly regions over the New England batholith and the Bathurst granite; a region of very low gravity with a narrow, comparatively high gravity belt around Alice Springs; and a large negative anomaly basin near Lake Amadeus between Alice Springs and Ayers Rock. The north-south anomaly belts are explained as evidence of crustal warping. The Roma region is probably a deeper sedimentary basin within the Artesian Basin, but the South Australia low is the result of crustal warping. Negative anomalies over the New England and Bathurst batholiths are probably due to deep granite roots. Double fracturing and faulting of the crust have been postulated to explain the anomalies in the Alice Springs region, and crustal sagging to explain the anomalies in the Lake Amadeus region. Most traverses over batholiths have given large negative anomalies which are probably due to roots. No evidence of root formations was found in the traverse from Bega to Spencer's Creek, suggesting granitization in this region resulted from metasomatism of preexisting rocks.—*M. C. R.*

- 165-191. Garland, G. D. Interpretations of gravimetric and magnetic anomalies on traverses in the Canadian Shield in northern Ontario: Dominion Observatory Ottawa Pubs., v. 16, no. 1, p. 1-57, 1950.

Gravity measurements have been made in the area from Ottawa to the Manitoba boundary, and north to Moosonee, mostly at reconnaissance scale. Magnetic observations were also made at gravity stations along certain traverses. Regional gravity trends apparently result from conditions deep within the crust. An east-west trend is parallel to the folding and thrust faulting in the Timiskaming sediments; a northeast-southwest trend is believed to result from tectonic activity of Huronian age. Most of the regional anomalies can be explained as the result of irregularities in the thickness of the granitic layer. Gravity lows apparently represent remnants of the roots of early Precambrian mountains. Regions of relatively high anomaly are largely covered by Precambrian sedimentary rocks; the implication is that these regions were low basins so that the surface rocks were preserved from the great erosion that bared large granite masses elsewhere. A departure from isostatic equilibrium is indicated as the roots have long outlived the topographic features they once supported. Local gravity anomalies can be directly correlated with surface geology. There was no agreement between magnetic and major gravity anomalies.—*M. C. R.*

- 165-192. Garland, G. D. Gravity measurements in North America with the Cambridge pendulum apparatus. II: Royal Soc. London Proc., Ser. A, v. 233, no. 1193, p. 203-213, 1955.

The series of pendulum measurements from Mexico City to Edmonton [see Geophys. Abs. 155-14820] has been extended by 10 additional pendulum stations from Lethbridge, Alberta to Fairbanks, Alaska. The gravity values for all

stations were based on a value of 980.6220 cm per sec<sup>2</sup> at Ottawa. At the most northerly station, Fairbanks, the value of gravity is 982.2477 cm per sec<sup>2</sup>. Geographical coordinates, elevations, descriptions and sketches of the locations of stations, and gravity values are given.—*M. C. R.*

- 165-193. Dyer, W. B. Gravity prospecting in southwestern Ontario: Canadian Oil and Gas Industries, v. 9, no. 3, p. 37-43, 1956.

A gravity survey has been made of more than 1,000 square miles in the Salina Guelph area, southwestern Ontario to locate Silurian reef structures similar to those already yielding gas in the area. Reef anomalies range from 0.8 milligal to 0 or even below the regional gravity. The criteria in selecting anomalies must therefore be shape and areal extent. An additional guide is the fact that the majority of residual anomalies over reefs have been found to be gravity maximums surrounded by low-intensity negative values. Reefs were found in 26 percent of the completely tested anomalies; 55 percent of these were productive of gas.—*V. S. N.*

- 165-194. Chudoba, Vratislav. O Československých gravimetrických základech [Gravimetric nets in Czechoslovakia]: Československé Akad. Věd Geofys. Ústavu Práce, Geofys. Sborník, no. 13, p. 19-47, 1954 (English summary, p. 45-47).

Eighteen gravity stations in the Potsdam system have been determined in Czechoslovakia with pendulum equipment, and a network of 162 triangles with 108 first-order stations and 409 second-order stations was begun in 1948 and completed in 1954 with a Nørgaard gravimeter. Preliminary Faye and Bouguer anomaly maps of western Czechoslovakia are included.—*M. C. R.*

- 165-195. Válek, Rostislav. Gravimetrická měření ve střední části Slovenských Karpat a jejich interpretace [Gravimetric observations in the central part of the Slovak Carpathians and their interpretation]: Československé Adak. Věd Geofys. Ústav Práce, Geofys. Sborník, no. 14, p. 49-92, 1954 (English summary, p. 91-92).

The greatest anomalies (—60 milligals) are in the region of the crystalline cores of the Low and High Tatra, not only in the Flysch of the northern arc of the Carpathians where it might be expected from the surface geology. A possible explanation is a rise of 5 km in the granite-basalt boundary in an easterly direction and towards Poland from its greatest depth between the Low and High Tatra.—*M. C. R.*

- 165-196. Day, A. A. On the values of gravity at St Anne (Alderney), St Peter Port (Guernsey) and St. Helier (Jersey): Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 7, no. 2, p. 76-79, 1955.

Using the Worden gravimeter belonging to the Geological Survey, the differences of gravity have been determined between the Ordnance Survey Office, Southampton, and St. Anne, St. Peter Port, and St. Helier, in the Channel Islands. The values of gravity at the three new stations, referred to the Potsdam system, are found to be: St. Anne  $g=981,044.4 \pm 0.4$  mgal; St. Peter Port  $g=981,052.9 \pm 0.4$  mgal; St. Helier  $g=981,028.1 \pm 0.4$  mgal.—*Author's summary*

- 165-197. Lyustikh, Ye. N. Anomalii sily tyazhesti i glubinnaya tektonika Indonezii i drugikh ostrovnykh dug [Gravitational anomalies and

the deep tectonics of Indonesia and other island arcs]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 26(153), p. 160-197, 1955.

This is a long and very detailed criticism of the geologic interpretation by Vening Meinesz and others of the gravity anomalies in Indonesia. Lyustikh proposes instead an explanation based on horizontal displacements of deep masses combined with movements caused by physicochemical changes in the volume.—*S. T. V.*

- 165-198. Tribalto, Giuseppe. Indagini geofisiche svolte durante l'anno 1954 nel Lazio [Geophysical investigations during 1954 in Lazio]: Servizio geol. Italia Boll., v. 76, fasc. 2, p. 615-615, 1955.

More detailed measurements were made in the area between Ceccano and Frosinone upstream and Ferentino and Stazione Sgurgola downstream to supplement the gravimetric survey of the Valle Latina, Rome [see Geophys. Abs. 152-14207]; three seismic refraction profiles were made to clarify the results. The area in question forms a structural depression between the Lepini and Ernici mountains. The gravity results are presented on a Bouguer map. The seismic survey showed limestone with a velocity of about 4,100 m per sec at a depth of about 500 m; this is overlain by middle Miocene sediments in which the velocity is 3,200 m per sec; a layer, presumably lithoid tuffs, in which the velocity is 2,400 m per sec; and a cover of alluvial and fluvioacustrine deposits, tuffs, and travertines, in which the velocity is 1,800 m per sec.

Results of the gravity survey of the Pontine Plain near Rome [see also Geophys. Abs. 157-20] are presented in a Bouguer map which shows highs near Cisterna and Capanna Guardapasso, and a pronounced low between Cisterna and Aprilia.—*D. B. V.*

- 165-199. Zaccara, Gaetano. Su alcuni rilevamenti gravimetrici ed elettrici nell' Italia centro-meridionale [On some gravimetric and electrical surveys in south-central Italy]: Servizio geol. Italia Boll., v. 76, fasc. 2., p. 617-618, 1955.

The gravity survey of south-central Italy begun in 1952 and 1953 has been concluded, and Faye anomalies have been calculated for all 1,100 stations; the gravity map is scheduled for publication in 1955. Results of a detailed gravity survey of northwestern Lazio have already been published [see Geophys. Abs. 157-19].

Electrical resistivity measurements east of Lake Vico in Caprarola revealed a usable superficial aquifer and showed a contact between tuff and lava at 20 m; drilling based on these results found water in the lava at depths of 18 and 24 m. Resistivity profiles in similar terrain in Frascati showed a contact at about 40 m that is now being drilled.—*D. B. V.*

- 165-200. Falini, Filippo. Determinazione del gradiente regionale di gravità nell'area delle pianura del Garigliano e del basso Volturno (Campania) [Determination of the regional gravity gradient in the area of the plains of the Garigilano and the lower Volturno (Campania) (with French, English, and German summaries)]: La Ricerca Sci., anno 26, no. 4, p. 1134-1149, 1956.

A gravimetric survey was made in the coastal flats of the Volturno and Garigliano rivers near Naples, in conjunction with seismic, electric, and magnetic prospecting for oil. The shape of the conventional gravity profiles (with Bouguer,

latitude, and topographic corrections) showed so little agreement with the inferred shape of the main sedimentary basin that a strong regional gradient was evident. As the usual methods for regional corrections were difficult or impossible to apply, the gradient was calculated by interpolation (least-squares method) of a linear equation of the two geographical coordinates between the gravity values measured on 33 selected stations. A gradient of 1 milligal per km was found. In spite of an excellent correlation coefficient (0.96), the residuals between observed and interpolated values remained rather high. Two main causes of variation are concluded to exist: density variation at great depths, and density variations within the first 3,000 m due to lateral changes in thickness of the Tertiary and Quaternary cover. Density contrasts within the Mesozoic contribute little to the variation (3 to 4 milligals compared to 50 and 30 milligals, respectively, for the above causes).—*D. B. V.*

- 165-201. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity survey along the lines of precise levels throughout Japan by means of a Worden gravimeter. Part 6. Chubu district: Tokyo Univ. Earthquake Research Inst. Bull., supp. v. 4, pt. 5, p. 199-310, 1955.

This is the complete report, the preliminary version of which was published in the Proceedings of the Japan Academy [see Geophys. Abs. 158-30]. This report includes a map (scale 1:500,000) of Bouguer anomalies based on the International formula. Station data and observations are tabulated.—*M. C. R.*

- 165-202. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity survey along the lines of precise levels throughout Japan by means of a Worden gravimeter. Part 7. Tōkoku district: Tokyo Univ. Earthquake Research Inst. Bull., supp. v. 4, pt. 6, p. 311-406, 1956.

This is the complete report, the preliminary version of which was published in the Proceedings of the Japan Academy [see Geophys. Abs. 158-29]. This report includes a map of Bouguer anomalies based on the International formula and station data and observations.—*M. C. R.*

- 165-203. Gloden, Alb[ert], and Coron, Suzanne. Anomalies de la pesanteur au G.-D. de Luxembourg [Gravity anomalies in the Grand Duchy of Luxembourg]: Ciel et Terre, 72<sup>e</sup> année, no. 1-2, p. 73-79, 1956.

The topographic and isostatic (Pratt, Airy, and Vening Meinesz) anomalies are tabulated for the 1948 gravimetric survey of Luxembourg [see Geophys. Abs. 158-22]. The topographic corrections average 0.5 milligal, seldom exceed 1 milligal. The various isostatic corrections were calculated under the following assumptions: density of crust, 2.67; thickness of crust (Pratt), 113.7 km; depth of masses of compensation (Airy), 20, 30, 40, and 60 km; depth of compensation (Vening Meinesz), 80 km, with degree of regionality corresponding to radius of 116.2 km. All anomalies are positive, and the order of 30 milligals, on the average. Anomalies according to Airy,  $T=30$  km, are shown on a map.—*D. B. V.*

- 165-204. Cattala, Louis. Interprétation tectonique de la gravimétrie de Madagascar [Structural interpretation of the gravity survey of Madagascar]: Inst. Sci. Madagascar Mem., Sér. D, tome 6, p. 35-41, 1954.

Interpretation of the gravity survey of Madagascar [see Geophys. Abs. 164-177], based on measurements uncorrected for topographic effect, indicates there are two

principal structural directions, corresponding to those of Besairie's structural map; one is almost parallel to the east coast, the other is close to the line joining Maintirano and Fort Dauphin. When the Bouguer anomalies are plotted graphically against altitude, the slope of the lines for altitudes below 800 m is close to that of the theoretical slope for isostatically compensated areas (density assumed to be 2.67), whereas for higher elevations it is nearly horizontal. This suggests that the higher crystalline blocks are more rigid and thus compensated regionally on a large scale, but the others, less rigid, are compensated more locally. Three sections are traced, one through Tulear, Ihosy, and Sahasinaka, a second from Tsitondroina to Betafo, and the third near Sakoa. These show uplifted and depressed blocks, bounded by faults, that correspond to the major geologic units; some of the boundaries may actually be flexures rather than faults.—*D. B. V.*

- 165-205. Cizancourt, Henri de. Essai d'interprétation de certaines anomalies de la pesanteur en Méditerranée Occidentale et en Afrique du Nord [Trial interpretation of certain gravity anomalies in the western Mediterranean and northern Africa]: *Annales Géophysique*, tome 9, no. 2, p. 126-154, 1953

The first part of this note deals with the description of interpretation methods applied in this paper; an isostatic reduction based on the notion of equilibrium of stresses is introduced. In the second part the anomalies of the zone under examination are discussed. The average isostatic anomaly shows extensive zones, alternately positive and negative, the origin of which is interpreted as being closely related to orogenesis. Part of the Atlas Range represents "set" zones, which have completed their tectonic evolution, and another part, including the western Mediterranean, represents undations due to tectonic deformations. The isostatic equilibrium of these latter parts and the build-up of the coastal ranges is examined. Furthermore a zone of Miocene basins along an alinement oblique to the regional trend appears to represent recent tectonic movements. With the exception of this general outline, local anomalies are not discussed.—*Author's abstract*

- 165-206. Harrison, J. C. An interpretation of gravity anomalies in the eastern Mediterranean: *Royal Soc. London Philos. Trans., Ser. A*, v. 248, no. 947, p. 283-325, 1955

An interpretation of the gravity data obtained by H. M. Submarine Talent in the eastern Mediterranean in 1950. Seismic data were used with the gravity and geologic data near Malta. The northern part of the island is downfaulted by a series of faults, and the gravity anomalies reflect this faulting. Southwest of Malta the anomalies are much larger than can be explained by observed topographic differences, and a fault with considerably greater throw partially concealed by sediments is indicated. The islands of Kithera, Crete, Scarpanto, and Rhodes form an approximately semicircular arc that separates the predominantly shallow water of the Aegean Sea from the deeper water of the eastern Mediterranean. There are very large negative anomalies outside the arc; the Aegean Sea shows uniformly high positive isostatic anomalies. These are interpreted as indicating that in this area the crust has a uniform thickness and that the Mohorovičić discontinuity is parallel to the surface. The strong positive anomalies on Cyprus are associated with mafic or ultramafic rocks near the surface. The sediments underlying the Nile delta have been estimated from the gravity data to form a lens-shaped body perhaps 10,000 ft. thick at the center; a depression of the crust by weight of the sediments is included.—*M. C. R.*

- 165-207. Shurbert, G. Lynn, and Ewing, Maurice. Gravity reconnaissance survey of Puerto Rico: *Geol. Soc. America Bull.*, v. 67, no. 4, p. 511-534, 1956.

A gravity survey of Puerto Rico designed primarily to connect 2 profiles of gravity stations at sea consisted of 396 new stations at an average spacing of about 2 miles, that approximated 9 north-south and 4 east-west profiles. A map of modified Bouguer anomalies shows positive of about 90 milligals along the northern and southern coasts, increasing to 165 milligals in the central part of the island. This information with gravity and seismic information at sea in the area has been used to deduce a north-south structure section through San Juan. The mantle is calculated to lie about 29 km below sea level under Puerto Rico. The Tertiary sedimentary basins and outcrops of Antillean intrusives are characterized by gravity minimums; but the largest maximum cannot be correlated with surface geology.—*D. B. V.*

- 165-208. Yüngül, Sülhi. Prospecting for chromite with gravimeter and magnetometer over rugged topography in east Turkey: *Geophysics*, v. 21, no. 2, p. 433-454, 1956.

From 1952 to 1954 gravity and magnetic surveys were made in Turkey over the concessions of the Eastern Chromite Works to discover new chromite reserves in a region of rugged topography and complicated geology. As a result of these surveys a new chromite ore body of 250,000 tons was discovered at the bottom of an open cut beneath a thin horizontal sheet of chromite.

It is shown that gravity prospecting is a more promising technique for locating relatively large chromite masses, even over rugged topography, than might have been expected. The terrain corrections, which constitute the major part of the computations, must be simplified and it is important that the correct surface densities be employed. In addition, difficulties arising from the high and variable magnetic susceptibilities in serpentines must be surmounted. The mass of chromite estimated from the gravity results agrees well with the amount found by subsequent drilling.—*Author's abstract*

- 165-209. Frantti, Gordon E. Geophysical investigations in the central portion of Michigan's Upper Peninsula: *Mining Engineering*, v. 8, no. 1, p. 70-72, 1956.

Regional gravity and ground magnetic surveys have been made in the Upper Peninsula of Michigan under the auspices of the Geophysical Committee of Michigan College of Mining and Technology. The regional gravity anomalies indicate the dividing line between the Lake Superior and Lake Michigan basins. Local gravity anomalies indicate the possibility of iron formations beneath the Paleozoic sediments.—*L. C. P.*

- 165-210. Jarmell, Sol. Gravity investigation in the Renovo area of Central Pennsylvania: *Producers Monthly*, v. 20, no. 5, p. 36-40, 1956.

A gravity survey was made over an area of about 700 square miles in the northern part of Clinton County, Pennsylvania. The Bouguer contours followed the geographical trend of the geologic structures. The residual anomaly map obtained by removing the regional gradient can be correlated with the known local structural features. A gravity low occurring over the gas-producing Leidy dome was interpreted as a deficiency of mass produced by a horizontal cylindrical salt body at a depth of not greater than 13,086 feet.—*Author's abstract*

## HEAT AND HEAT FLOW

- 165-211. Jacobs, J. A., and Allan, D. W. The thermal history of the earth: *Nature*, v. 177, no. 4500, p. 155-157, 1956.

The equation of heat conduction for a radioactive earth has been solved with the aid of an electronic computer. The problem is broken into two parts: the cooling of the earth from its initial temperature, and the heating up of the earth due to radioactivity. The initial temperature depends on the origin of the earth; four curves have been considered: the melting-point curves due to Bullard, Uffen, and Jacobs, and a temperature distribution due to a cold origin. Four earth models have been considered in regard to distribution of radioactivity. There are thus 16 possible combinations. The investigation as carried out so far indicates in all models considered that the temperature at depth has continued to increase throughout geological time, and that the temperature at the core boundary has increased most probably by about 300°C. Also although radioactivity plays a major part in the thermal history of the earth, the initial distribution of temperature dominates thermal conditions at depth and near the surface for the first thousand million years or so.—*M. C. R.*

- 165-212. Lyubimova, Ye. A. O teplovom rezhime zemli [The thermal regime of the earth]: *Akad. Nauk SSSR Geofiz. Inst. Trudy*, no. 26 (153), p. 39-50, 1955.

The thermal history of the earth, since its origin in the hypothetical process by the condensation of the interstellar dust particles, is discussed. The assumption is made that the heat was produced by the radioactive disintegration of the elements. The first analysis was made with an assumed homogeneous distribution of radioactive sources and constant thermal conductivity throughout the earth, later the computations were repeated for a stratified earth model with different concentrations of radioactive substances in every layer. The most recently determined disintegration constants of U, AcU[U<sup>235</sup>], Th, K, and their content in meteorites and in different terrestrial formations were taken into account.—*Author's summary, S. T. V.*

- 165-213. Urey, Harold C. The cosmic abundances of potassium, uranium, and thorium and the heat balances of the earth, the moon, and Mars: *Natl. Acad. Sci. Proc.*, v. 41, no. 3, p. 127-144, 1955.

Reasons have been given for believing that the abundances of the elements K, U, and Th in the chondritic meteorites are higher than the mean abundances of these elements in planetary bodies by about a factor of 3.19. Using decreased abundances of these elements, it is shown that the thermal properties of the earth, the permanent nonequilibrium shape of the moon, and the absence of a core in the planet Mars can be understood. The lower abundance of potassium gives a more regular curve for the abundance of elements in this region of the periodic system, though it disagrees with the astronomical data in this respect. It is difficult to secure sufficient heat for this purpose on the basis of abundances of K, U, and Th as used in this paper. It is suggested that Al<sup>26</sup> may have supplied the radioactive heat for this purpose and that other heating processes previously suggested may have been important as well. As an alternative, it is also possible that depletion of these radioactive elements in the earth, the moon, and Mars during their formation may account for the lower abundances of these elements required to secure reasonable thermal histories for these planets.—*Author's conclusions*

- 165-214. Custodio de Moraes, J. Temperatura do terreno [Temperatures of the ground]: Coimbra Univ. Mus. Mineralog. Geol. Mem. e Noticias, no. 38, 8 p., 1955.

Temperatures have been measured once daily since 1927 at depths of 0.4, 0.7, 1.3, and 3 m and since 1943 at depths of 6 and 10 m also. The annual variation with depth is less than a degree at 10 m and would presumably be imperceptible at 15 m. There is a lag of several weeks between the minimum and maximum in air and those at 3 m; the lag at 10 m is 6 months.—*M. C. R.*

- 165-215. Webb, John. Thermal conductivity of soil: *Nature*, v. 177, no. 4517, p. 989, 1956.

The thermal resistivity of soil is calculated by assuming the soil consists of a two-phase system of uniformly packed spheres surrounded by air as 400 cm-degree C per calorie. The conductivity of dry soil on this basis is 0.0025 cal per cm per sec per degree C. The observed conductivity is only one-third this value; the discrepancy may be due to the assumption of ideal packing.—*M. C. R.*

- 165-216. Bondam, J., and Bøgvad, R. The geothermal gradient at Ivigtut, South Greenland: *Dansk Geol. Foren. Medd.*, Bind 13, Hefte 1, p. 42-45, 1955.

Temperatures were measured, usually at intervals of 50 m, in deep vertical diamond-drill holes near the cryolite deposits at Ivigtut. The thermocouples used were checked in melting ice and the accuracy kept within 0.2°C. The precision was determined from upward and downward measurements at the same depth as about 0.5°C. The temperature-decreasing effect of the Arsuk fiord is marked in the drill holes nearest the water. The geothermal gradient is of the order of 1°C. for 60 to 75 m.—*M. C. R.*

- 165-217. Kashpur, Ya. N. Izmereniye temperatury v samoy glubokoy skvazhine Donbasa [Temperature measurement in the deepest drill hole of the Donets basin]: *Prioroda*, no. 3, p. 88-89, 1955.

Temperature measurements were made in March 1952 in a drill hole, in the Stalino district of the Donets basin to a depth of 1,450 m. Readings were made by an electric thermometer every 20 m. The greatest temperature, measured at 1,450 m, was 54°. The temperature gradient varied slightly in different formations.—*S. T. V.*

- 165-218. Garvitch, Z. S. A field instrument for measuring temperatures of natural boiling pools: *Jour. Sci. Instruments*, v. 32, no. 7, p. 261-263, 1955.

For measuring the temperatures of natural boiling pools in the Taupo-Rotorua thermal area of New Zealand, an instrument capable of direct measurement of superheat is used. One sensitive element of a differential resistance thermometer bridge is immersed in the pool, and the other is permanently fixed in a miniature hypsometer built into the instrument. The indication on the instrument meter is therefore a measure of the difference between the temperature of the pool and the local boiling point. Differences of 0.02°C. are detectable. The power is furnished by a motorcycle battery, and the whole instrument is mounted on a pack frame.—*M. C. R.*

- 165-219. Blackwell, J. H. The axial-flow error in the thermal conductivity probe: *Canadian Jour. Physics*, v. 34, no. 4, p. 412-417, 1956.

Using Jaeger's radial boundary condition, Blackwell finds an upper limit to the axial-flow error in thermal conductivity probes. A numerical example is included.—*M. C. R.*

### INTERNAL CONSTITUTION

- 165-220. Gurevich, G. I. Ob osnovnykh osobennostyakh povedeniya anomal'nykh zhidkostey (K probleme tverdo-zidkogo sostoyaniya) [On the fundamental peculiarities in the behavior of anomalous liquids (On the solid-liquid state)]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 31 (158), p. 107-134, 1955.

The possibility of establishing one equation of state for all "condensed" bodies—that is, all nongaseous bodies—is discussed on the basis of numerous experiments, made primarily by M. P. Volarovich and his coworkers. Such an equation would have a certain number of parameters that are specific for any body and vary with the conditions of loading, with temperature, and with the time of the action of external forces. Great advantages are to be expected from such an equation, particularly in seismological studies. In the present paper the effect of different properties of the investigated bodies on the shape of the curve representing the variation of the deformation of the body with the intensity of the applied force are discussed graphically and analytically.

At the end of the article M. P. Volarovich, the editor of the journal, comments that he finds the article very informative, but does not expect much use of such a generalized equation of state and would prefer to deal with several equations, each one applicable to just a certain group of bodies.—*S. T. V.*

- 165-221. Davydov, B. I. O fazovykh perekhodakh pri vysokikh davleniyakh [Phase transitions under high pressures]: Akad. Nauk. SSSR Geofiz. Inst. Trudy, no 26 (153), p. 86-91, 1955.

On the basis of quantum theory, equations are derived for the total energy  $E$  of a body, assuming its temperature to be absolute zero. This is permissible because the effect of the pressure near and within the earth's core has a much greater effect than the temperature. A general equation for the total energy of the body is derived and then a family of curves is constructed representing the energy variation corresponding to different volumes. The stable physical condition of the body, corresponding to certain volume, is characterized by the lowest value of the energy. As the  $E$  curves cross one another, stable equilibrium will be characterized on the left and right side of any definite volume by sections of different  $E$  curves, corresponding to different pressures. Points of  $E$  curves with the same tangent determine the points of possible transition of the body from one state to another. An example is given for hydrogen, the only element for which the necessary data are available. This element, present in large planets of the solar system, must be transformed to the solid state under a pressure of  $1.85 \times 10^6$  atmosphere when its density will be changed from 0.7 to 0.96.—*S. T. V.*

- 165-222. Båth, Markus. Jordkärnan—ett aktuellt geofysiskt problem [The earth's core—a modern geophysical problem (with summary in English)]: Fören. filosofi och specialvetenskap Skrifter, p. 15-43, no date, (Meteorol. Inst. K. Univ. Uppsala Medd. 45).

A critical review of knowledge (as of May 1952) of the earth's core, especially the nature of the discontinuity at the core boundary.—*M. C. R.*

- 165-223. Magnitskiy, V. A. O fizicheskom sostoyanii veshchestva v glubokikh oblastyakh zemnogo shara [The physical state of matter in the deep parts of the earth]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 26 (153), p. 61-85, 1955.

Experimental evidence on the constitution of the interior of the earth and the physical state of the matter in the deep parts of the earth seems to be contradictory. For great regions, such as whole continents, the earth is in a state of static equilibrium, as if the earth were liquid. This idea is supported by the apparent horizontal flowing of subcrustal material. But numerous phenomena indicate the earth is an elastic body of varying elasticity, on the average about that of steel.

Assuming the earth to be an elastico-viscous substance (following Maxwell's theory), Magnitskiy derives an equation for its periodic deformations. This equation covers all possible deformations of the earth and with appropriate choice of physical constants represents elastic vibrations with the period of few seconds or geologic processes of millions of years duration. The probability of physicochemical transformations of the deep underground layers must not be overlooked. For example, two reactions involving the compounds most frequently found at depth,  $\text{Mg}_2\text{SiO}_2 = \text{MgSiO}_3 - 2.3$  calories, and  $\text{MgO} + \text{MgSiO}_3 = \text{Mg}_2\text{SiO}_4 - 6.4$  calories, may be connected with important thermal phenomena, and changes in the specific volumes must be considered as the most important factors in many geotectonic processes.—S. T. V.

- 165-224. Molodenskiy, M. S. Plotnost'i uprugost'vnytri zemli [Density and elasticity in the earth's interior]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 26 (153), p. 121-130, 1955.

The methods of celestial mechanics are used to evaluate possible variations of the density of the earth with depth within the limits determined by the known values of the mass, moment of inertia, and nutation of the earth's axis. The sudden increase in the density at the surface of the core cannot be greater than 4.6 g per  $\text{cm}^3$ . The variation of density is not much different from that determined by Bullen. If the density of the earth at any depth, and seismic velocities at this same depth are known, the bulk modulus and shear modulus can be computed. This method is more precise than that used in astronomical computations by Chandler.—S. T. V.

- 165-225. Shimazu, Yasuo. Chemical structure and physical property of the earth's mantle inferred from chemical equilibrium condition: Nagoya Univ. Jour. Earth Sci., v. 3, no. 2, p. 85-90, 1955.

If the mantle is isothermal and incompressible and if chemical and hydrostatic equilibria are attained, the distribution of chemical elements would be controlled by differences in their chemical affinities and by gravitational separation due to differences in density. Calculation of the equilibrium distribution of the  $\text{FeO-MgO-Fe-SiO}_2$  system indicates FeO would increase with depth to a maximum at a depth of several hundred kilometers and then decrease toward the center of the earth. MgO decreases with depth. As the silicate within the mantle is generally thought to be olivine,  $(\text{Fe, Mg})_2\text{SiO}_4$ , then the ratio of fayalite ( $\text{Fe}_2\text{SiO}_4$ ) to forsterite ( $\text{Mg}_2\text{SiO}_4$ ) will vary with depth and the fayalite concentration will be a maximum at a depth of several hundred kilometers. As increase of FeO in olivine causes a decrease in elastic wave velocity and increase in density, a possible origin of the 20° discontinuity is indicated.—M. C. R.

- 165-226. Savarenskiy, Ye. F. Stroyeniye obolochki zemli po seysmicheskim dannym [The structure of the mantle on the basis of seismic data]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 26 (153), p. 100-116, 1955.

This is a critical analysis of theories of the structure of the mantle, defined as the layer between depths of about 50 and 2,900 km.—S. T. V.

- 165-227. Hodgson, J. H. A seismic survey in the Canadian Shield, II: Refraction studies based on timed blasts: Dominion Observatory Ottawa Pubs., v. 16, no. 6, p. 169-181, 1953.

During the rockburst studies, described in Part I [see Geophys. Abs. 157-117]<sup>1</sup> of this series, blasts timed at their source were recorded at one or more of the stations of the profile.

One group of blasts, at La Cave and at Rolphton, were timed automatically by the stations maintained at those points. These blasts frequently recorded at the other station of the pair, and sometimes at Ottawa. Timing and location were not as precise as in other sections of this work, but it was possible to determine mean velocities for  $P_1$  and  $S_1$  of  $6.29 \pm 0.04$  km per sec and  $3.44 \pm 0.03$  km per sec respectively. The uncertainties listed are Probable Errors of the means.

A second group of blasts, occurring at La Cave and at Temiskaming, were precisely located and were timed with the greatest possible accuracy. They were recorded at stations lying northwestward toward Kirkland Lake, and the series thus provided a reverse profile.  $P_1$  and  $S_1$  velocities obtained, with probable errors, were  $6.19 \pm 0.07$  km per sec and  $3.54 \pm 0.07$  km per sec. A very strong phase, both in the  $P$  and  $S$  group, suggested the existence of a second layer, but this interpretation proved to be inconsistent with the evidence of other secondary arrivals.

The final group of blasts provided data on the variation of velocity with rock type. The source was near Sudbury and as the blasts were recorded at eight different stations of the rockburst profile a variation of  $47^\circ$  of azimuth was obtained. This provided many different sections across the Huronian basin. Mean velocities, and their Probable Errors, for  $P_1$  and  $S_1$  were  $6.189 \pm 0.023$  and  $3.551 \pm 0.007$  km per sec.

The mean for all determinations, including that made with the aid of rockbursts, together with the Probable Error of the mean, proved to be: for  $P_1$   $6.234 \pm 0.012$  km per sec, and for  $S_1$   $3.544 \pm 0.011$  km per sec. Secondary arrivals, in general, satisfied the single-layer travel time curves developed for the rockburst profile, although in this case also there were variations from the curves such as might have been due to variations in rock type and variations in crustal thickness.—*Author's abstract*

- 165-228. Katz, Samuel, and Ewing, Maurice. Seismic refraction measurements in the Atlantic Ocean. Part VII: Atlantic Ocean basin, west of Bermuda: Geol. Soc. America Bull., v. 67, no. 4, p. 475-509, 1956.

Four cross sections through the crust and continental margins from Bermuda to the continent prepared from results of 25 seismic refraction observations in the Atlantic Ocean west of Bermuda and other available data show the contrast between oceanic and continental crustal structure. Under the continent the velocity is close to 6.0 km/s near the surface, may increase with depth to nearly 7.0 km/s at about 35 km, and is more than 7.7 km/s in the mantle. The upper part of the continental crust (velocity 6.0-6.3 km/s) thins seaward and disappears near the foot of the continental slope. At the deep-sea stations (mean depth 4.9 km) the mean thicknesses of sediments and crustal rocks are 1.3 km and 5.1 km.

The velocities in the crustal rocks are as high as 7.1 km/s; toward Bermuda, the mean velocity decreases to 5.6 to 6.5 km/s, and in several areas velocities near 4.5 km/s (volcanic rocks and consolidated sediments) are observed. Velocities in the mantle at 9.4 to 13.4 km below sea level are 7.7 to 8.5 km/s.

A conspicuous constant-frequency arrival at the traveltimes of the first reflection is interpreted as a wave refracted along the ocean floor, possibly within a layer of low velocity sediment 0 to 150 ft thick. Sound velocity in sediments near the ocean floor is calculated on the basis of reflection at the critical angle as 1.78 to 2.21 km/s.—*D. B. V.*

- 165-229. Butterlin, Jacques. Nouvelles indications au sujet de la constitution géologique des fonds de la mer des Antilles [New information on the geologic constitution of the depths of the Caribbean Sea]: Soc. géol. France Comptes Rendus, no. 2, p. 13-14, 1956.

Eardley's estimate of 5-9 km of sial under a thin cover of sediment under the sea bottom about 320 km southeast of Puerto Rico (Geophys. Abs. 157-178) is cited as additional evidence that the Caribbean is not a permanent, simatic ocean basin [see Geophys. Abs. 164-202].—*D. B. V.*

- 165-230. Katz, Samuel. Seismic study of crustal structure in Pennsylvania and New York: Seismol. Soc. America Bull., v. 45, no. 4, p. 303-325, 1955.

Blasts at two quarries in northern New York and central Pennsylvania have been recorded to a distance of 309 km. The data indicate an essentially homogeneous, unlayered crust, with elastic wave velocities possibly increasing with depth. An average crustal thickness for the region is 34.4 km, with no indication of significant difference in thickness between the two areas. Observed compressional wave velocities for the crust are 6.39 and 6.31 km/s for New York, and 6.04 km/s for Pennsylvania. The corresponding shear wave velocities are 3.62 and 3.60 km/s, and 3.61 km/s. Average upper mantle velocities are 8.14 km/s for  $P_n$  and 4.69 km/s for  $S_n$ . The compressional wave velocity of anorthosite near Tahawas, N. Y. is 6.63 km/s. No near-vertical reflections from the Mohorovičić discontinuity were observed.—*Author's abstract*

- 165-231. Ozerskaya, M. L. Fizicheskiye svoystva porod kristallicheskogo fundamenta [Physical properties of the rocks forming the crystalline basement]: Priklandaya geofiz., vypusk 13, p. 23-40, 1955.

Lithologic studies of the upper sedimentary layer and the upper part of the crystalline Precambrian basement of the Russian Shield have been underway for several years. Numerous holes have been drilled 10-15 m into the basement for the total depth of as much as 2,600 m. Porosity, density, magnetic susceptibility, and seismic velocity, besides the mineralogical composition of specimens have been determined. No general conclusions can be made on the basis of this investigation, because of enormous extent of the area studied. The numerical data differ greatly from region to region and from hole to hole; they are represented in tables and graphs and in two maps.—*S. T. V.*

## ISOSTASY

- 165-232. Lyustikh, Ye. N. O raschete reologicheskikh svoystv astenosfery po "vsplyvaniyu" Fennoskandii [The evaluation of the rheological properties of asthenosphere from the "floating up" of Fennoscandia]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 360-364, 1956.

Determinations of the viscosity of the upper layer of the crust based on the measurements of the velocity of the isostatic uplift of the Baltic Shield are about  $10^{22}$ – $10^{23}$  poises. According to Lyustikh, this figure has no physical meaning, because the uplift of Fennoscandia, according to reliable geologic evidence, took place also before the last glaciation and therefore cannot be caused by isostatic forces.—*S. T. V.*

- 165–233. Bennema, J. Holocene movements of land and sea-level in the coastal area of the Netherlands: *Geologie en Mijnbouw*, jaarg. 16, no. 6, p. 254–264, 1954.

From critical study of all available data it is concluded that real subsidence of the southern coast of the Netherlands amounts to 2 or 3 cm per century. The glacioeustatic rise of sea level is a consistent, slowly dwindling transgression. At about 5500 B. C. the absolute rise of sea level was 75 cm per century; about 2000 B. C. the relevant rise was 13 cm per century; and since the Roman era the average has been about 4 cm per century. Transgressional and regressional phases show a periodicity of about 525 yrs, probably related to climatic conditions. Historical transgressions and regressions can be correlated with growth of glaciers and the polar ice sheet near Greenland.—*D. B. V.*

- 165–234. Iida, Kumizi, and Wada, Tatsuhiro. Vertical earth movement around the Bay of Ise as deduced from changes in heights of mean sea level: *Nagoya Univ. Jour. Earth Sci.*, v. 3, no. 2, p. 91–104, 1955.

Changes in the heights of yearly mean sea level at 15 mareograph stations on the coast of the Bay of Ise and near the mouths of five rivers flowing into the bay were studied to determine crustal deformation in the area. Changes since 1944 are marked and are believed to be related to the Tonankai earthquake of December 1944. The land seemed to be rising before the Tonankai earthquake, and to have risen after the earthquake recovering its former level. During the last few years there has been subsidence of 2 to 6 cm per year.—*M. C. R.*

## ISOTOPE GEOLOGY

- 165–235. White, F. A., Collins, T. L., [Jr.], and Rourke, F. M. Search for possible naturally occurring isotopes of low abundance: *Phys. Rev.*, v. 101, no. 6, p. 1786–1791, 1956.

A systematic search has been made for the existence of previously unobserved naturally occurring isotopes of low abundance. A two-stage mass analyzer was employed. With the exception of  $\text{Ta}^{180}$ , none were found. The improved abundance sensitivity of the two-stage spectrometer, however, allowed determinations of lower experimental "upper limits" to be placed on a large number of isotopes. The elements, sodium, aluminum, scandium, niobium, and cesium were confirmed to be monoisotopic. A comparison has also been made of abundance measurements obtained with this instrument to those obtained in previous investigations.—*Authors' abstract*

- 165–236. Cruikshank, A. J., Cowper, G., and Grummitt, W. E. Production of  $\text{Be}^7$  in the atmosphere: *Canadian Jour. Chemistry*, v. 34, no. 3, p. 214–219, 1956.

The concentration of  $\text{Be}^7$  in the atmosphere has been determined by measuring the activity associated with dust particles in air at ground level, collected at four widely spaced stations north of geomagnetic latitude  $55^\circ$ . It is calculated that

the observed concentration is maintained by a production rate of 2,300 atoms of  $\text{Be}^7$  per  $\text{cm}^2$  per day in northern latitudes, which is smaller but compatible with the value obtained from rain by Arnold and Al-Salih.—*D. B. V.*

- 165-237. Wickman, Frans E. The cycle of carbon and the stable carbon isotopes: *Geochim. et Cosmochim. Acta*, v. 9, no. 3, p. 136-153, 1956.

The total amount of sedimentary carbonate carbon (*A*) is estimated as  $2,450 \pm 560$  g per  $\text{cm}^2$  of earth's surface, with a  $\text{C}^{12}/\text{C}^{13}$  isotope ratio of  $88.55 \pm 0.05$ ; the total organic sedimentary carbon (*B*) is estimated to be between 0.1 and 0.5 percent in shales, with a  $\text{C}^{12}/\text{C}^{13}$  ratio of  $91.00 \pm 0.10$ . "Crustal carbon" is defined as the total amount of carbon atoms taking part in cyclic processes of the upper lithosphere, in which material is circulated between the earth's surface and the depths of the earth; the crustal isotope ratio (based on measurements on 37 diamonds, 19 carbonates from Ivigtut, 10 other carbonates from alkaline intrusions and sagvandite, and 6 graphites) is estimated as  $89.11 \pm 0.05$ . Using these ratios (referred to the Stockholm scale), the ratio *A/B* is found to be  $3.45 \pm 0.55$ , and *B* =  $700 \pm 200$  g per  $\text{cm}^2$  of earth's surface.

The remarkably close agreement between the crustal carbon ratio and that of air (89.2) lends support to the suggestion that the latter might represent, roughly, a mean sample of all volcanic gases emanating from the crust.—*D. B. V.*

- 165-238. Winsberg, Lester. The production of chlorine-39 in the lower atmosphere by cosmic radiation: *Geochim. et Cosmochim. Acta*, v. 9, no. 4, p. 183-189, 1956.

Examination of rain-water has revealed the presence of chlorine-39 formed by the interaction of cosmic radiation with argon in the lower atmosphere. The maximum amount of activity found agrees with what is expected from known reactions of cosmic radiation. Most of the production of chlorine-39 is due to the reaction  $\text{A}^{40} + \mu^- = \text{Cl}^{39} + n + \nu$ . In several cases little activity was found. This appears to result from meteorological phenomena. Chlorine-39 is potentially useful in meteorology with specific application to the study of rain.—*Author's abstract*

- 165-239. Mayne, K. I. Terrestrial helium: *Geochim. et Cosmochim. Acta*, v. 9, no. 4, p. 174-182, 1956.

The problem of terrestrial helium is considered in the light of the measured isotopic abundance ratio of helium in the atmosphere. New evidence shows that the rate of release of  $\text{He}^4$  from the earth's crust is about sixty times greater than previously estimated; thus, in order to maintain the atmospheric helium abundance ratio, the production of  $\text{He}^3$  in the atmosphere must be considerably greater than that calculated on the basis of cosmic-ray induced reactions on nitrogen (even in the limiting case of equal escape probabilities for the two helium isotopes). Extraterrestrial dust is considered as a source of  $\text{He}^3$ ; the amount required to be added per day is estimated to be 5,000 tons for the whole earth, depending on the history of the dust particles.

This dust is truly cosmic, not debris of the original collision which gave birth to the meteorites, nor of subsequent collisions between fragments of that catastrophe. Its origin is less certain; it may represent the primordial building material of the solar system, left over in the outer regions and now spiralling in toward the sun. Study of such dust would be interesting for geochemical and astrophysical reasons. The most suitable place to collect it is in the permanent

anticyclone region of Antarctica, where terrigenous contamination should be a minimum.—*D. B. V.*

- 165-240. Brown, R. M., and Grummitt, W. E. The determination of tritium in natural waters: *Canadian Jour. Chemistry*, v. 34, no. 3, p. 220-226, 1956.

The tritium content of rainwater and sea-water samples collected at Ottawa during 1951-53 ranges from 17.1 to 42.0 atoms of tritium per  $10^{18}$  atoms of hydrogen, with an average of 26.6. A marked effect of the thermonuclear tests in the Pacific was shown in Ottawa rainwater for 1954, the average T/H concentration is estimated to have  $260 \times 10^{-18}$ . In late 1954 and early 1955 surface sea water from widely separated sites showed T/H concentrations ranging from 3.0 to  $4.2 \times 10^{-18}$ , which corresponds to the amount of artificially produced tritium in Ottawa rain. Subsurface water samples collected off Nova Scotia in 1955 showed an unexpected level and pattern of concentration, T/H being  $32.4 \times 10^{-18}$  at the bottom (600 ft), and  $5.4 \times 10^{-18}$  at the surface. This is not thought to be a result of thermonuclear testing, and should be further investigated.—*D. B. V.*

- 165-241. Driver, G. E. Tritium survey instruments: *Rev. Sci. Instruments*, v. 27, no. 5, p. 300-303, 1956.

Two portable counters, one an instrument for semiquantitative measurement of tritium contamination on surfaces, and the other a sensitive detector of airborne tritium and tritium oxide vapor, are described. The surface monitor uses a sponge-rubber seal to the surface with an argon-methane counting mixture being admitted during measurements. The air monitor mixes methane with the air before counting and is capable of detecting a tritium concentration of  $10^{-5}$  millieuries per cc of air.—*M. C. R.*

- 165-242. Purkayastha, B. C., and Martin, G. R. The yields of  $^{129}\text{I}$  in natural and in neutron-induced fission of uranium: *Canadian Jour. Chemistry*, v. 34, no. 3, p. 293-300, 1956.

Measurements have been made, by a radioactivation technique, of the  $^{129}\text{I}$  formed in uranium by pile-neutron-induced fission, and in pitchblende by the natural fission of uranium. For the former, the amount corresponds to a fission yield of 0.90 percent at mass 129. An upper limit of 1 part in  $10^8$  can be set for the natural  $^{129}\text{I}/^{127}\text{I}$  abundance, which reduces by a factor of 30 the limit previously set by mass spectrometric investigations. Two samples of pitchblende containing 82 and 64 percent of  $\text{U}_3\text{O}_8$ , respectively, yielded values of 0.48 and 0.54 percent  $^{129}\text{I}$  in secular equilibrium with the uranium (relative to spontaneous fission rate). As not all fission in pitchblende is spontaneous, the neutron fission rate is calculated (from  $\text{Xe}^{129}$  yields of 0.222 and 0.301 percent, relative to total fission rate) as 0.32 and 0.49 percent of the spontaneous fission rate.—*D. B. V.*

- 165-243. Emiliani, Cesare. Pleistocene temperature variations in the Mediterranean: *Quaternaria*, v. 2, p. 87-98, 1955.

Oxygen isotopic analysis of four pelagic foraminifera from Mediterranean core 189 of the Swedish Deep-Sea Expedition of 1947-48 indicates 10 paleotemperature stages. The minimum temperature, at stage 2, corresponds to a radiocarbon age of 17,200 yrs. During most of the 200,000 years covered by the core, the Mediterranean was cooler than at present. The average rate of sedimentation was 4.3 cm per 1,000 yrs. Details of the isotopic analysis and correlations between core stages and continental stratigraphy are tabulated.—*D. B. V.*

- 165-244. Kulp, J. L., Ault, W. U., and Feely, H. W. Sulfur isotope abundances in sulfide minerals: *Econ. Geology*, v. 51, no. 2, p. 139-149, 1956.

The sulfur-32/sulfur-34 ratios in some 80 samples of hydrothermal, magmatic, and pegmatitic sulfides have been measured. The sulfur isotopic abundances within a deposit appear to be independent of the mineral species (pyrite, marcasite, chalcopyrite, sphalerite, galena, pyrrhotite, bornite, realgar, arsenopyrite, chalcocite), crystal habit, and, possibly, temperature and rate of deposition. The  $S^{32}/S^{34}$  ratio does appear related to the source of the sulfur. A high  $S^{32}/S^{34}$  ratio indicates a source initially rich in sedimentary sulfide; a low  $S^{32}/S^{34}$  ratio suggests a source initially high in sulfate. Most sulfides contain a  $S^{32}/S^{34}$  ratio near 22.2, that is, that of meteoritic sulfur.—*Author's abstract*

- 165-245. Hoekstra, Henry R., and Katz, Joseph J. Isotope geology of some uranium minerals: *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy*, Geneva, August 1955, v. 6, *Geology of uranium and thorium*, p. 547-550, 1956; and *U. S. Geol. Survey Prof. Paper* 300, p. 543-547, 1956.

This paper is concerned with variation of  $O^{18}/O^{16}$  in uraninite and pitchblende from which might be deduced the temperature of formation of these minerals. Efforts have been concentrated on determining isotope ratios in a number of ores and in correlating results with the nature of the ore. Decomposition of the samples is effected by bromide trifluoride. Oxygen is separated from the remaining products as pure molecular oxygen. Isotopic ratios are determined directly on this material.

Results show variation of isotope ratios amounting to 1.6 percent. Seemingly oxygen isotope ratios are not affected by treatment with water at or near room temperature. Experiments on synthetic uranium oxides indicate that temperatures approaching 300°C. are required to obtain a measurable rate of exchange of oxygen isotopes. Impurities in the samples often result in a measurable variation in isotope ratio. Weathered samples show higher  $O^{18}$  contents than unweathered samples from the same location.

Uranium oxides from pegmatites show a somewhat lower  $O^{18}$  content than those from hydrothermal or sedimentary deposits, but no reasonable estimates of temperature of formation of the ores is as yet possible. The only correlation obtainable with the samples is with the isotopic content of the ground waters associated with the ores. Impurities in the ores and weathering cause some variations from the  $O^{18}$  content of the ground water.

Exchange experiments with the same minerals and with synthetic oxides indicate that exchange rates are dependent upon temperature of formation of the mineral.—*Authors' abstract*

## MAGNETIC FIELD OF THE EARTH

- 165-246. Rikitake, Tsuneji. Magneto-hydrodynamic oscillations of a conducting fluid sphere in a uniform magnetic field: *Tokyo Univ. Earthquake Research Inst. Bull.*, v. 33, pt. 2, p. 175-198, 1955.

The general theory of magnetohydrodynamic oscillations of a liquid sphere, under the influence of a uniform magnetic field is developed. From the general differential equation it is clear that there are mutual couplings between the poloidal and toroidal magnetic fields except for the case of zonal oscillations. The coupling equation cannot be solved rigorously, but a normal mode of the oscillation

tion is obtained approximately by considering  $S_1^0$  and  $S_2^0$  type magnetic fields.—*M. C. R.*

- 165-247. Kato, Yoshio; Ossaka, Justo; and Okuda, Mitsunao. Investigation on magnetic disturbance by the induction magnetograph. Part IV: Tōhoku Univ. Sci. Repts., 5th ser., v. 6, no. 3, p. 137-149, 1955.

Bay disturbances recorded at Onagawa and Memambetsu magnetic observatories between September 18 and October 18, 1954, were accompanied by rapid pulsations at the beginning, and were recorded simultaneously and with the same periods and phase at both observatories. However, the amplitude of  $dZ/dt$  was much larger at Onagawa.—*M. C. R.*

- 165-248. Pudovkin, I. M. Nekotoryye voprosy teorii raschetov  $\Delta T$  [Some questions in the theory of the calculation of  $\Delta T$ ]: Prikladnaya geofiz., vypusk 13, p. 110-115, 1955.

The total variation  $\Delta T$  of the geomagnetic vector between two points near the earth's surface is expressed in terms of the partial increases of the components of the field and of the variations of the magnetic inclination and declination. Approximate expressions for  $\Delta T$  are given and the limits of their usability determined. The last expressions differ from place to place with the variation of their geographic coordinates. Several examples from different regions of the U. S. S. R. are given.—*S. T. V.*

- 165-249. Egedal, J., and Ambolt, N. [P]. The effect on geomagnetism of the solar eclipse of 30 June 1954 (supplementary communication): Jour. Atmos. Terrest. Physics, v. 8, no. 1-2, p. 105-107, 1956.

Magnetic observations from Niemegk, Leningrad, Moscow, Odessa, and Tiflis are in agreement with earlier observations [see Geophys. Abs. 163-28] that the effect is proportional to the departure of the daily variation, diminishes through the afternoon, and is of the order of magnitude predicted by Chapman.—*M. C. R.*

- 165-250. Yokoyama, Izumi. Geomagnetic studies of Volcano Mihara. The 6th Paper. (Continuous observation of changes in geomagnetic declination during the period from 1951 to 1954): Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 2, p. 251-257, 1955.

Continuous recording of magnetic declination at Nomashi village shows that declination tends toward the west whenever Mihara becomes active and returns eastward after the activity subsides. Declination at a station on Ooshima has been drifting in the opposite direction.—*M. C. R.*

- 165-251. Lisowski, Bolesław. O zmianach dziennych słonecznych deklinacji magnetycznej w Świdrze [Solar daily variations of magnetic declination at Świder (English summary)]: Acta Geophys. Polonica, v. 3, no. 1, p. 35-40, 1955.

Solar daily variations of declination for 1921 to 1936 at Świder are summarized in tables and figures showing the mean hourly variations for all months of the year, and for winter, equinox, summer, and the whole year.—*M. C. R.*

- 165-252. Munera Quiñonero, Jose. Noticia historica sobre cartografía geomagnetica española [Historical note on Spanish geomagnetic cartography]: Rev. Geofísica, año 14, no. 55, p. 248-255, 1955.

An historical description of magnetic maps of Spain and Spanish possessions from Lamont's map of epoch 1858.0, published in 1868, to the map of epoch 1953.2 published by the Instituto Geografico y Catastral.—*M. C. R.*

- 165-253. Kertz, Walter. Modelle für erdmagnetisch induzierte elektrische Ströme in Untergrund [Models for geomagnetically induced electric currents in the crust]: Akad. Wiss. Göttingen Math.-Phys. Kl. Nachr. Abt. IIa, no. 5, p. 101-110, 1954.

Kertz analyzes the magnetic field under the assumptions that the surface of the earth is a plane, and that the field is two dimensional (with a northward *X*-axis and downward *Z*-axis), introducing a linear "commutation operator" *K*. Distribution of linear currents in the ground can be determined from surface observations of the inner (downward) component; it is shown mathematically how, for shallow depths and constant current density, the linear current field in the ground approximates the magnetic field of a surface current.—*D. B. V.*

- 165-254. Meek, J. H., and Hector, F. S. A recording magnetic variometer: Canadian Jour. Physics, v. 33, no. 7, p. 364-368, 1955.

The recording magnetic variometer, designed to record day-by-day variations in the earth's magnetic field, consists of a detecting head, an amplifying circuit, and a recording meter. A 500-cycle oscillation is applied to two oppositely wound primary coils, each with a high permeability core. An external magnetic field is detected in a single secondary winding as a 1,000-cycle oscillation, rectified in a phase-sensitive detector and used to control the current in an additional winding that reduces the magnetic field on the cores to zero. The amount of this current is indicated on the recording meter.—*M. C. R.*

- 165-255. Gerard, V. B. A simple, sensitive, saturated-core recording magnetometer: Jour. Sci. Instruments, v. 32, no. 5, p. 164-166, 1954.

A recording magnetometer for use in studies of short-period geomagnetic fluctuations or in surveying when a continuous record of diurnal variation is needed has been designed on the principle of the saturated-core magnetometer. One version is portable and can be operated from dry batteries; it has a total power consumption of 4 watts. A second version operates from a-c lines and consumes about 50 watts. The two are almost identical electronically except for the valve types used. Comparison with records at the Amberley Observatory show the drift and temperature coefficient are negligible for most purposes. A circuit diagram is given.—*M. C. R.*

- 165-256. Waters, G. S., and Phillips, G. A. New method of measuring the earth's magnetic field: Geophys. Prosp., v. 4, no. 1, p. 1-9, 1956.

The earth's total magnetic field was determined by measuring the precession frequency of protons in a water sample. The technique, first reported by Packard and Varian in 1954, consists of impressing a large magnetic field (100 gauss or larger), approximately perpendicular to the earth's field, on a sample of water and suddenly (in 30 microseconds) removing this field. The protons, acting as gyroscopes, then precess at a frequency determined by the amplitude of the earth's magnetic field. A comparison of results with this technique and data from the Abinger observatory show the validity of the method.

Important practical considerations are the facts that an appreciable time is required to orient a sufficient number of protons (as much as 12 sec for distilled water using a 100 gauss field); and the inducing field must decay abruptly or

precession does not occur, thus imposing a low inductance and self-capacitance of the coil such that the current decay occurs in 30 microseconds or less. Addition of a paramagnetic solution (ferric nitrate) to the water sample will decrease the time required for orientation at the expense of signal strength.—*W. H. D.*

- 165-257. Özdoğan, İhsan. Variomètre électromagnétique pour la composante verticale [Electromagnetic variometer for the vertical component]: *Annales Géophysique*, tome 9, no. 2, p. 161-163, 1953.

A variometer for study of rapid variations of the vertical component of the geomagnetic field is based on the same principle as electromagnetic seismographs. The instrument has been in operation at the Chambon-la-Forêt observatory.—*M. C. R.*

### MAGNETIC PROPERTIES

- 165-258. Fanslau, Gerhard, and Frohlich, Friedrich. Über den Ferrimagnetismus des Erdkrustenfeldes [The ferrimagnetism of the field of the earth's crust]: *Forschungen u. Fortschr.*, Jahrg. 28, Heft 5, p. 134-138, 1954.

In earlier representations of rock magnetism a ferromagnetic model has been used to explain measurements on magnetite samples. The possibility is suggested that the ferrimagnetic oxide model be applied to rock magnetism, comparing the measurements to those on an ideal (artificial) magnetite. Accidental superpositions in the natural sample can more easily be localized and determined in this way. Even when ferromagnetic and ferrimagnetic phenomena resemble each other (as in the hysteresis loop and demagnetization factor), they are distinguished by differences in the order of magnitude. The spontaneous magnetization of magnetite-spinel is the difference between two antiparallel lattice-layer moments, but that in a ferromagnetic material is obtained from the sum. The whole lattice mechanism of iron oxide is different from that of pure iron, and as in rocks we are dealing with oxides, chiefly magnetite, the investigation of the geophysical conditions (pressure, temperature, and the like) should be based on the true relationships. That the magnetic properties of magnetite vary strongly with the relative percentages of both iron oxides but not, as generally supposed, directly with  $\text{Fe}_2\text{O}_3$  content, is a fact not to be neglected in investigation of rock magnetism.—*D. B. V.*

- 165-259. Li, Yin-Yuan. Domain walls in antiferromagnets and the weak ferromagnetism of  $\alpha\text{-Fe}_2\text{O}_3$ : *Phys. Rev.*, v. 101, no. 5, p. 1450-1454, 1956.

At the Néel temperature local nucleations of the antiferromagnetic order and their subsequent growth lead to the formation of domain walls. The domains in an antiferromagnet are thermodynamically stable only when the anisotropy force opposing the gradual switch of spins in the Bloch zone is small such that the wall energy is offset by the gain in entropy. However, in most cases the domain wall would owe its stability to the presence of lattice imperfections such as interstitial atoms or dislocations. A typical magnetization curve of an antiferromagnet with ferromagnetic domain walls is depicted.

The weak ferromagnetism observed in the (111) plane of  $\alpha\text{-Fe}_2\text{O}_3$  (hematite) is identified with the magnetization in domain walls pinned down by lattice imperfections. An assumption that the linear dimension of domains is, on the average,  $10^4$  atomic spaces gives the observed strength of the weak ferromagnetism. The disappearance of this ferromagnetism at ca  $-20^\circ\text{C}$  when the mag-

netic axis switches from a (112) direction to the (111) direction is due to the extreme difference in the anisotropy force in the (111) plane and that in a plane containing the (111) axis. The following experimental findings on  $\alpha$ - $\text{Fe}_2\text{O}_3$  are interpreted: the variation of the ferromagnetism as the temperature increases shows the general feature of the decrease of long-range order in cooperative phenomena, being very gradual at lower temperatures and growing sharper and sharper as the temperature approaches the Néel point; in the transition region of the two antiferromagnetic states of  $\alpha$ - $\text{Fe}_2\text{O}_3$  an applied field in the (111) plane causes a decrease of the temperature at which the ferromagnetic effect and the large magnetostriction effect disappear but produces no change in the neutron diffraction intensity of the (111) line.—*Author's abstract*

- 165-260. Urquhart, Helen M. A., and Goldman, J. E. Magnetostrictive effects in an antiferromagnetic hematite crystal: *Phys. Rev.*, v. 101, no. 5, p. 1443-1450, 1956.

Magnetostrictive distortions in an antiferromagnetic natural single crystal of hematite have been studied in the region of the transition near  $-25^\circ\text{C}$ , where the antiferromagnetic axis spontaneously shifts its crystallographic direction by  $90^\circ$ . The magnetostriction is shown to be closely related to the parasitic magnetization and is interpreted in terms of the existence of domain walls separating antiferromagnetic domains.—*Author's abstract*

- 165-261. Smith, D. O. Magnetization of a magnetite single crystal near the Curie point: *Phys. Rev.*, v. 102, no. 4, p. 959-963, 1956.

The isothermal M-H curves of magnetite in the principal crystallographic directions have been measured from room temperature to the Curie point. These curves give the anisotropy energy and spontaneous magnetization as a function of temperature. Near the Curie point the magnetizing field required to create a single domain is found to be  $<100$  amp per m, giving an unambiguous experimental determination of the spontaneous magnetization in this critical region. Temperature increments of  $0.1^\circ\text{C}$  define the Curie point with an uncertainty of  $<0.05^\circ\text{C}$ . In the neighborhood of the Curie point the M-H curves are very non-linear; replotting the data in the form of H-T curves at constant magnetization shows that in this region the magnetic energy can be expressed as  $U_m = -\mu_o WM^2/2$  where  $W$  is a constant.—*Author's abstract*

- 165-262. Kume, Shoichi. On some magnetic properties of ilmenite at low temperatures: *Acad. Japan Proc.*, v. 31, no. 10, p. 709-712, 1955.

The intensity of magnetization in 12 natural and synthesized ilmenite samples was measured at  $80^\circ\text{K}$  in a field of 14,000 oersteds. The measurements show that the intensity of magnetization increases as the Curie point and the ferric ion concentration in the mineral decrease. It has been inferred that pure ilmenite has a complete antiferromagnetic character. Akimoto has stated that the magnetization at room temperature is a maximum when the ferric ion concentration is near 12 atomic percent per molecule. Kume's results show the magnetization is still increasing when the ferric ion concentration is reduced to 2.6 atomic percent in solid solution. This may be explained by assuming that the crystal at low temperature behaves as a ferromagnetic substance.—*M. C. R.*

- 165-263. Grabovskiy, M. A., Petrova, G. N., and Isakova, L. I. O vozniknovenii termoostatochnogo namagnicheniya gornykh porod [The generation of thermoremanent magnetization of rocks]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 1, p. 56-66, 1956.

The thermal magnetization of magnetite, pyrrhotite, and nickel was studied by heating specimens to the Curie point and cooling them to room temperature in a constant magnetic intensity by a magnetizing coil. The results of the experiments show that if the specimens of ferrites or of ferromagnetic metals, such as nickel, have been heated to a temperature higher than their Curie point, they become magnetized as soon as the temperature is lowered. When the magnetic field is removed after cooling the specimens, important remanent magnetism is retained. The intensity of this thermoremanent magnetism is less, if the specimens are heated to a temperature much higher than the Curie point than if the heating does not go much above the Curie point.

The thermomagnetism is generated exclusively by the coercive force of the material; the process is irreversible, except above 500°. The ratio of the thermoremanent to induced magnetism is greater in materials having high coercive force, as rocks, where its intensity is greater than the terrestrial magnetic field. This stability of remanent magnetism explains why the magnetism of many rocks remains unchanged during different geologic processes.—S. T. V.

- 165-264. Grabovskiy, M. A., and Petrova, G. N. Ob ustoychivosti ostatochnogo namagnicheniya gornykh porod. [On the stability of the remanent magnetization of rocks]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 290-296, 1956.

Specimens of magnetite, pyrrhotite, and nickel were heated above the Curie point and cooled in a known magnetic field. At room temperature the magnetic field was removed, and the intensity of thermal magnetization and coercive force were determined. Comparison with the corresponding remanent magnetization and coercive force at a constant temperature, showed that up to a certain value of the magnetic field, the thermomagnetization and coercive force are greater than the remanent magnetization and the coercive force. Thus the thermal magnetization is more stable than the magnetization produced by other processes.

The thermal magnetization is the result of the following process. At the Curie temperature the initially magnetized and consequently magnetically anisotropic body can be considered completely isotropic and paramagnetic. Cooling immediately produces domains of spontaneous magnetization, which in turn produce new inner stresses, caused by magnetostriction, increasing in intensity with decreasing temperature and causing in turn a reappearance of magnetic anisotropy.—S. T. V.

- 165-265. Kruglyakova, G. I. O vliyani aktsessornykh mineralov na obrazovaniye obratnoy polyarnosti gornykh massivov [The effect of accessory minerals on the production of reverse polarity of rocks]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 214-217, 1956.

In studies of correlations between magnetic anomalies and the mineralogical composition of the ground in different parts of the Ukraine, negative magnetic anomalies as great as -100 and -200 gammas were related in several places to liparites. The remanent magnetization of liparites was found to be much more intense than the induced magnetization and of opposite polarity. In some places the ratio of remanent to induced magnetization  $J_r: J_i$  was as high as 40. A negative anomaly of more than -3,000 gammas in one place is attributed to the presence of a relatively small amount of hematite.—S. T. V.

- 165-266. Roquet, Juliette]. Étude des propriétés magnétiques de roches volcaniques à aimantation naturelle inversée [Study of the magnetic properties of volcanic rocks with natural inverse magnetization]: *Annales Géophysique*, tome 11, no. 4, p. 461-474, 1955.

Flow, sill, and dike rocks of Tertiary age from Auvergne and from Ahaggar, in southern Algeria, with natural reverse remanent magnetization have acquired thermoremanent (total or partial) magnetizations in the same direction as the magnetizing field, in the laboratory, after heatings and coolings in fields of the order of the earth's field. The heatings produced modifications of the capacities of magnetization of the rocks. The variation in time of remanent magnetizations acquired in weak fields is appreciable in many cases.—*P. E. B.*

- 165-267. Uyeda, Seiya. Magnetic interaction between ferromagnetic material contained in rocks: *Jour. Geomagnetism and Geoelectricity*, v. 7, no. 1-2, p. 9-36, 1955.

Magnetic, crystallographic, and electron-microscopic examinations have shown that the reverse remanent magnetism of various Japanese rocks is produced by magnetic interaction between two different ferromagnetic ilmenite-hematite solid solutions and not by magnetic interaction between titanomagnetite and ilmenohematite as was previously supposed [see *Geophys. Abs.* 158-60]. Expressions are developed for different geometric models of the two interacting ferromagnetic constituents and it is shown that a series of fine lamellae of the constituents is the most practical model. Electron-microscopic examination of various rocks exhibiting reverse remanent magnetization shows that they contain extremely fine exsolution lamellae similar to the Wickmannstätten structure. The various degrees of magnetic interaction of natural ferromagnetic minerals depend upon their state of coexistence.—*J. R. B.*

- 165-268. Doell, Richard R. Remanent magnetization of the upper-Miocene "blue" sandstones of California: *Am. Geophys. Union Trans.*, v. 37, no. 2, p. 156-167, 1956.

A study has been made of the magnetization of some upper Miocene sediments of California. Field evidence and laboratory experiments indicate that the main component of magnetization of these sediments was not acquired by alignment of detrital magnetic grains at the time of deposition, nor is it due to a later isothermal magnetization of these grains. A strong and stable magnetization appears to have developed through post-depositional and, in some cases, post-deformational growth of crystalline magnetic minerals *in situ*.—*Author's abstract*

- 165-269. Brynjólfsson, Ari. Ergebnisse bei partieller Entmagnetisierung des natürlichen Magnetismus isländischer Basalte [Results of partial demagnetization of the natural magnetism of Icelandic basalts]: *Naturw.*, Jahrg. 43, Heft 7, p. 154-155, 1956.

Partial demagnetization of some normally and inversely magnetized basalts from Iceland has a definite effect on direction and intensity of magnetization. In younger (postglacial) basalts, intensity was reduced about 43 percent, mean deviation accounting for about a fourth of this amount; change of direction was slight. In investigation of their viscous magnetization, specimens with weaker

intensity showed somewhat greater viscous magnetization and greater demagnetization than those with stronger intensity. Specimens from the surface of lava flows showed stronger and more stable magnetization than those from 30 cm or more below the surface.

In older (Miocene and Pliocene) basalts, the direction of magnetization changed much more appreciably and became more homogeneous than before demagnetization. The difference between "hard" and "soft" samples was conspicuous, the latter having lower intensity, greater decrease on demagnetization, and more change in direction. Demagnetization curves for normally magnetized older basalts correspond partly to those of the younger rocks but with strong differences at the beginning. The curves for inversely magnetized specimens show first (from 2 to 20 oersteds) an increase in intensity, then (from 25 to 50 oersteds) approximately constant intensity, and finally (60 to 140 oersteds) a decrease.

A very stable inversely magnetized specimen was heated to 720°C and cooled in the earth's field, becoming normally magnetized with a 33 percent increase in intensity; after demagnetization, the intensity of the heated specimen was only 4.5 percent greater than that of its natural state. The changes noted can be explained in part by decrease of viscous magnetization.—*D. B. V.*

165-270. Manley, Horace, and Burdon, David J. The thermo-magnetic properties and history of some plutonic rocks from the Leinster Granite, Ireland: *Jour. Geomagnetism and Geoelectricity*, v. 7, nos. 1-2, p. 37-50, 1955.

The susceptibility and remanent magnetization have been determined for seven representative samples of the granodiorite, granite, and basic enclaves that form the bulk of the Arrigle Complex, lying at the southwest termination of the Leinster Granite. The determinations were made on the rocks in their natural state and again after they had been heated to 600° and cooled in the earth's magnetic field and apparently in a normal atmosphere although the latter is not stated. From these have been calculated  $X$ , the ratio of the susceptibility after and before heating;  $S$ , the ratio of the thermoremanent magnetization to the remanent magnetization; and  $Z$ , the ratio of  $Q$  to  $T$ .

The authors assume that the magnetic mineral before and after heating is magnetite, and that it is responsible for both the induced and remanent magnetization. For the granodiorites,  $X$  averages about 30 and  $S$  about 50; this indicates to the authors that new magnetic minerals were developed by heating and suggests that the granodiorites, as now constituted, have not cooled through their Curie point. For the granites,  $X$  averages 1.3 and  $S$  about 32; this indicates that no new magnetic minerals have been developed by heating, but that the remanent magnetization of existing magnetic minerals has been greatly increased. This proves that the magnetic minerals of the granite have formed below their Curie point; the petrography indicates that magnetite has formed or reformed along with other deuteric changes, the most important of which is the change of hornblende to a biotite-quartz symplectite. Of the basic enclaves, the gabbros show  $X$  equal to 1.6 and  $S$  equal to 2.7; this proves that the gabbros have crystallized and cooled from above their Curie point in the normal manner of igneous rocks. Another enclave, supposedly a porphyritic dolerite, shows  $X$  equal to 3.9 and  $S$  equal to 21; either the dolerite has suffered much low-temperature metamorphism of its magnetic, or potentially magnetic, minerals, or it is a metamorphic rock closely resembling a dolerite.—*J. R. B.*

- 165-271. LeBorgne, E[ugène]. Susceptibilité magnétique anormale du sol superficiel [Abnormal magnetic susceptibility of the upper layers of the soil]: *Annales Géophysique*, tome 11, no. 4, p. 399-419, 1955.

Data are presented on the susceptibilities of soils from various localities and derived from a variety of rocks, including schists, granite, diabase, gabbro, basalt, and amphibolite. Mass susceptibilities were determined in a field of about 10 oersteds at room temperature. Sampling, both vertically and on the surface, indicates that high susceptibilities are restricted to the humus-bearing layer. The susceptibility in this layer hardly depends on the nature of the bedrock, provided that this is only slightly magnetic. For most of the samples studied the susceptibility of the humus-bearing layer is from several to a hundred times larger than that of the bedrock. The more humid soil samples had relatively lower susceptibilities. Fractioning of the soil by granulometric analysis indicates that the finest argillaceous fraction is the most magnetic. The behavior of the magnetic component of this fraction suggests that it is of the stabilized  $\gamma$ - $\text{Fe}_2\text{O}_3$  type and that it was formed in place. It is a material of high susceptibility, is appreciably "viscous" magnetically, as determined from drift of magnetometer deflections with samples, and undergoes an exothermic transformation to a less magnetic product at roughly  $700^\circ\text{C}$ .

The circulation of glucose solution through the soil to increase fermentation results, after a period of time, in a reduction in susceptibility, with concurrent reduction of iron and its inclusion in complex organic ions. The precipitation of iron from these complexes does not seem to yield a magnetic product. It seems likely that the magnetic constituent of the soil is formed by a reduction of  $\alpha$ - $\text{Fe}_2\text{O}_3$  followed by a reoxidation which yields a material of the stabilized  $\gamma$ - $\text{Fe}_2\text{O}_3$  type. This hypothesis is in agreement with observation. In a soil which remains moist, the iron tends to pass to the ferrous state and will be removed, if drainage is adequate, leaving a soil of low susceptibility.—*P. E. B.*

- 165-272. Opdyke, N. D., and Runcorn, S. K[ith]. New evidence for reversal of the geomagnetic field near the Pliocene-Pleistocene boundary: *Science*, v. 123, no. 3208, p. 1126-1127, 1956.

Polarity of the remanent magnetization of some of the lava flows of the San Francisco Mountain, Verde Valley, and Mormon Mountain volcanic fields of northern Arizona was determined by Brunton compass. Normal magnetization was found in lavas of Colton's stages III, IV, and V. One of six lavas in the Verde Valley field and 13 of 21 in the Mormon Lake field were reversely magnetized. These flows were of stage I or II (stage I rests on a late Pliocene surface and stage II flows occurred before the first glaciation in the San Francisco peaks). Baked clays underlying one normally magnetized and two reversely magnetized flows are magnetized concordantly with the lavas.—*M. C. R.*

- 165-273. Runcorn, S. Keith. Paleomagnetic survey in Arizona and Utah: Preliminary results: *Geol. Soc. America Bull.*, v. 67, no. 3, p. 301-316, 1956.

The position of the mean magnetic pole for five epochs (Precambrian, Pennsylvanian, Permian, Triassic, and Cretaceous) has been determined from measurements of remanent magnetization of sediments from the Colorado Plateau. Comparison with positions calculated from similar measurements in Great Britain [see *Geophys. Abs.* 157-39; 163-32] shows sufficiently close agreement to give strong support to the hypothesis of polar wandering.—*D. B. V.*

- 165-274. Ostrovskiy, M. I., and Martynova, T. A. Opyt izucheniya magnitnykh svoystv gornykh porod Kurskoy magnitnoy anomalii [Experimental studies of the magnetic properties of rocks from the Kursk magnetic anomaly]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 3, p. 349-356, 1956.

The magnetic susceptibility and mineralogical composition of more than 1,400 specimens, taken from ore deposits of Kursk magnetic anomaly were determined. The upper part of the ore bodies is formed of quartzite without magnetite; below this the quartzite contains hematite and some magnetite, and still deeper there is quartzite with a greater admixture of magnetite and some hematite. Small amounts of other minerals (biotite, aegirite, chlorite, and others) were found in the specimens. The magnetic susceptibility in the upper layers ranges from very low figures to  $7,000-8,000 \times 10^{-6}$ . In the lower layers it is as much as  $150,000 \times 10^{-6}$ . A correlation between susceptibility and the mineralogical composition of the specimen is evident.—*S. T. V.*

- 165-275. Grabovskiy, M. A. Opredeleniye vertikal'noy sostavlyayushchey magnitnogo polya nad dvukhfaznoy magnitnoy sistemoy posle eye termonamagnichivaniya [Determination of the vertical component of the magnetic field over a two-phase magnetic system after its thermomagnetization]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 157-164, 1956.

In laboratory experiments specimens of magnetite and pyrrhotite were combined into one mass and then thermomagnetized and cooled to room temperature; the magnetic field measured at a certain distance from the body was complicated with both maximums and minimums. The field pattern over the less magnetic pyrrhotite, inserted between two specimens of magnetite, indicates that pyrrhotite becomes magnetized in a direction opposite to the present earth's field. The negative magnetic field sometimes observed over certain parts of the profile may possibly be the result of thermal action combined with the erosion of some components of a combined system.—*S. T. V.*

- 165-276. Smith, D. O. Development of a vibrating-coil magnetometer: Rev. Sci. Instruments, v. 27, no. 5, p. 261-268, 1956.

The vibrating-coil magnetometer measures the magnetization of a small sample of magnetic material placed in an external magnetizing field by converting the dipole field of the sample into an electrical signal. To allow space for temperature- or pressure-generating apparatus around the sample, the measurement is made at distances up to 2 cm from the sample. The measurement is continuous and can be recorded on a chart as a function of time, temperature, crystallographic orientation, or magnetizing field. The present stable sensitivity is such as to provide one percent accuracy for a dipole moment of  $8.56 \times 10^{-4}$  amp-m<sup>2</sup> (the saturation moment at room temperature of a nickel sphere 1.5 mm in diameter).—*Author's abstract*

## MAGNETIC SURVEYS

- 165-277. Strakhov, V. N. Opredeleniye nekotorykh osnovnykh parametrov namagnichennykh tel po dannym magnitnykh nablyudeniy [The determination of certain basic parameters of magnetized bodies from magnetic observations]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 144-156, 1956.

Formulas are derived which give the total magnetic moment and the coordinates of the center of gravity of an infinite horizontal body, from the observed values of the  $Z$  vertical component, measured along a chosen profile. Errors are also evaluated which are due to the finite horizontal dimensions of the disturbing body.—*S. T. V.*

- 165-278. Mikov, D. S. Interpretatsiya magnitnykh i gravitatsionnykh anomalii metodom isklyucheniya elementarnykh poley [The interpretation of magnetic and gravitational anomalies by the method of the exclusion of elementary fields]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 2, p. 218-225, 1956.

For the interpretation of gravitational or magnetic anomalies of two-dimensional bodies, it is suggested that it be assumed that the disturbing body is composed of a number of prisms of the same density or magnetic properties and filling completely the volume occupied by the body. For every elementary prism it is possible under certain assumptions to evaluate its part in the anomaly; by consecutively subtracting these contributions of individual prisms or combinations of prisms until the total anomaly is exhausted, the shape the disturbing body is found. Four alignment charts and two tables of numerical values facilitate the procedure.—*S. T. V.*

- Satō, Yasuo. A note on Tsuboi-Nagata's method. See Geophys. Abs. 165-181.

- 165-279. Zmuda, A. J. Note on the adjustment of isomagnetic charts to mutual consistency: Jour. Geophys. Research, v. 61, no. 1, p. 57-58, 1956.

Precise aeromagnetic measurements of total magnetic intensity permit the construction of isomagnetic charts which are mutually consistent in the horizontal and vertical components of the geomagnetic fields. Equations incorporating this new result are provided.—*Author's abstract*

- 165-280. Katō, Yoshio. Recent development in magnetic prospecting [in Japanese with English summary]: Butsuri-Tankō, v. 6, no. 3-4, p. 255-264, 1953.

A review of the construction and use of the airborne magnetometer.—*D. B. V.*

- 165-281. Brundage, Harrison T. Australian aerial survey reports near completion: World Oil, v. 142, no. 7, p. 268-269, 1956.

This is a description of an aeromagnetic survey in northwestern Australia in which a plywood DeHavilland Mosquito was used as the aircraft.—*L. C. P.*

- 165-282. Agocs, W. B., and Isaacs K. Tunis to Lisbon airborne magnetometer profile: Geophys. Prosp., v. 4, no. 1, p. 10-23, 1956.

Results of an aeromagnetic survey flight from Tunis to Lisbon are presented together with geologic cross sections of the land areas traversed. Depth determinations were made using the horizontal distance ( $\times 0.625$ ) between tangent points for half-maximum slope. Depths of 16,900, 39,600, and 3,200 ft were computed for points in the Tunisian Basin. Depths ranging from 6,350 to 25,400 ft were computed from anomalies observed over the Chélif Basin and a depth of 10,560 ft was computed for the southern coastal basin of Portugal. As the aeromagnetic traverse was not perpendicular to the axes of the basins these

depths may be 3 to 5 times too large. It is pointed out that depths from a single profile are subject to large errors.—*W. H. D.*

- 165-283. Petrova, G. N. Opyt trassirovaniya magnitometricheskim metodom pogrebennogo razloma [Experiences in tracing a buried fault by the magnetometric method]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 30 (157), p. 278-285, 1955.

A fault buried under some 300-800 m of sedimentary deposits, along the northern slopes of Transilian Ala Tau ridge in central Asia has been traced magnetically. Ten magnetic profiles were made perpendicular to the direction of the ridge at distances about 10 km apart. The curves of the vertical component vector show clearly discontinuities over the fault.—*S. T. V.*

- 165-284. Meisser, O[tto]. Geophysikalische Anomalien in der Umgebung der Bleizinkerzlagertstätten der Trepča [Geophysical anomalies in the vicinity of the lead-zinc ore deposits of the Trepča]: Geologie, Jahrg. 3, Heft 6/7, p. 867-875, 1954.

Large-scale magnetic and self-potential surveys of the Trepča lead-zinc district in southern Croatia have provided data on structure beneath a thick overlying tuff.—*D. B. V.*

- 165-285. Cipa, W. Kurzbericht über einige erdmagnetische Untersuchungen an Lavaströmen und Tuffschloten in der Vordereifel [Short note on some geomagnetic investigations on lava flows and tuff vents in the fore-Eifel]: Zeitschr. Geophysik, Jahrg. 21, Heft 1, p. 48-52, 1955.

By means of vertical magnetic measurements in the Eifel volcanic area in Germany, the Dockweiler, Alftal, Mühlenberg, and Gerolstein lava flows have been traced under a cover of tuff and alluvium. Because of the high magnetization of the basaltic ash, several volcanoes and vents which had produced only tuff could be located and delineated, including the structure of the Dreis, Trautzberg, and Strohn crater lakes, and the vent of the Wöllersberg.—*D. B. V.*

- 165-286. Lauterbach, Robert. Beiträge zur tektonischen Deutung der geomagnetischen Übersichtskarte der Deutschen Demokratischen Republik [Contributions to the structural interpretation of the geomagnetic survey map of the German Democratic Republic]: Gerlands Beitr. Geophysik, Band 64, Heft 2, p. 156-172, 1955.

An interpretation of the vertical-component magnetic survey map of East Germany. Earlier publication in Zeitschrift der Karl Marx Universität [see Geophys. Abs. 160-48].—*M. C. R.*

- 165-287. Miller, Edward Titus, and Ewing, Maurice. Geomagnetic measurements in the Gulf of Mexico and in the vicinity of Caryn Peak: Geophysics, v. 21, no. 2, p. 406-432, 1956.

Maps of the earth's total magnetic intensity at a 100-gamma contour interval are presented for most of the Gulf of Mexico and about 12,600 square miles surrounding Caryn Peak in the northwestern Atlantic. These were prepared mainly from data obtained during *Vema* cruise no. 3 early in 1954. The field is remarkably uniform over an area including the deep basin of the Gulf of Mexico and extending northward almost to Texas and Louisiana. Numerous essentially circular anomalies of several hundred gammas amplitude exist near the edges of the calcareous West Florida and Campeche Banks. Caryn Peak exhibits a similar

anomaly which is attributed to remanent magnetization of basic igneous rock. It is concluded that at Caryn Peak during the volcanic activity, probably in late Cretaceous time the earth's magnetic field had approximately the same direction as now.

It is concluded that the scarps bounding the calcareous banks are not tectonic. It is suggested that they roughly coincide with lines of now buried basic volcanoes around which the limestone banks developed. In the area of the Gulf of Mexico which has been surveyed there is no anomaly like the several hundred gamma linear positive found off the eastern coast of North America, near the transition from a thick continental to a thin oceanic crust. If present, it must lie near the shoreline in the vicinity of Texas and Louisiana. This supports other evidence that the crust beneath the outer shelf and continental rise off Texas and Louisiana is of a thin oceanic type similar to that under the main basin. In this interpretation a thick column of sediments has spread out over part of the deep basin.—*Authors' abstract*

- 165-288. Yokoyama, Izumi. Magnetic survey in Temmabayshi district, Aomori prefecture [in Japanese with English summary]: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 1, p. 163-173, 1955.

Magnetic surveys in exploration of an iron-sand body consisted of about 40 east-west profiles, along which dip was measured, of 3 components at Sakata, and measurement of vertical gradient along 2 profiles. Depth to and extent of the magnetic body were estimated from the observations.—*M. C. R.*

- Frantti, Gordon. Geophysical investigations in the central portion of Michigan's Upper Peninsula. See *Geophys. Abs.* 165-209.

- 165-289. Opp, Albert G. A magnetometer survey of the Keene Dome, McKenzie County, North Dakota: North Dakota Geol. Survey Rept. Inv. 19, map and text, 1956.

This map shows results of a vertical intensity magnetometer survey to determine the cause of deformation of the sediments of the Keene dome, a part of the Nesson anticline in northeastern McKenzie County. Producing oil wells, dry holes, and holes being drilled were plotted on the map to show the relationship between magnetic anomalies and oilfields. The magnetometer data indicate that the Keene dome was probably formed by a vertically faulted basement and that the Keene dome and the Beaver Lodge structure are separate anomalies on the Nesson anticline.—*V. S. N.*

- 165-290. Hansen, Miller. Geomagnetic survey of the Tioga area, North Dakota: North Dakota Geol. Survey Rept. Inv. 21, map and text, 1956.

Results of a vertical intensity magnetic survey of an area of about 560 square miles are presented as a map on a scale of an inch to the mile and contour interval of 10 gammas. Superimposed on the magnetic contours are structure contours on the top of the Mission Canyon. Observations were made at nearly all accessible mile corners, in an area which includes several producing oilfields.—*M. C. R.*

- 165-291. Melchiori, Jorge. Exploración geológica y geofísica en las minas de Cercapuquio [Geological and geophysical exploration in the mines of Cercapuquio]: *Minería (Peru)*, año 4, no. 10, p. 25-29, 1955; no. 11, p. 17-21, 1955; año 5, no. 12, p. 12-16, 1956.

The first installment of this paper on mineral exploration in the Cercapuquio lead-zinc district, Peru, outlines the stratigraphy, igneous geology, structure, and mineralization; the second and third discuss the magnetic and electromagnetic surveys. Four parallel magnetic profiles, two more than 3,000 m long and two about 500 m, were made across the Cercapuquio syncline with a total of 620 measurements; most of these were of the horizontal component, as the area is near the equator. As no immediately practical results were obtained, the magnetic method was abandoned. Electromagnetic measurements were made along the north and south limbs of the syncline, using vertical loops as the veins dip steeply, with stations about 100 m apart. The results were not definitive, but the veins that could be traced, seem to be more or less mineralized for almost all their length in the north limb and probably also in the south.—*D. B. V.*

### MICROSEISMS

- 165-292. Schuyler, Garret L. Computation of the directions of microseisms at tripartite stations: *Seismol. Soc. America Bull.*, v. 45, no. 4, p. 285-288, 1955.

The potentialities of tripartite stations are unlikely to be fully realized until more modern techniques of computation are used. For practical routine work in tracking storms, a set of 18 nomograms will permit determination of bearings without computations. A sample is shown for the station at Naha, Okinawa.—*M. C. R.*

- 165-293. Arakawa, Y. On the microseisms caused by a typhoon [in Japanese with English summary]: *Quart. Jour. Seismology*, v. 20, no. 3, p. 43-47, 1955.

While typhoon no. 14, September 1954, was over the ocean south or southwest of Honshu, the periods of the microseisms were 7-8 sec at Matsushiro and 3-5 sec at Nagano and Matsumoto, but as the typhoon advanced toward the northeast, the periods were 4-5 sec at all three stations.—*M. C. R.*

### RADIOACTIVITY

- 165-294. Fritze, K., and Strassmann, F. Indirekte Bestimmung der Halbwertszeit des Rubidiums [Indirect determination of the half-life of rubidium]: *Zeitschr. Naturforschung*, Band 11a, Heft 4, p. 277-280, 1956.

The half life of  $\text{Rb}^{87}$  is calculated on the basis of analyses of two different lepidolites (from South Africa and Varuträsk, Sweden). The ages are determined from the  $\text{K}^{40}/\text{A}^{40}$  ratio as 2.64 and  $2.06 \times 10^9$  yrs, respectively; the half life is then calculated, from this value and the  $\text{Rb}^{87}/\text{Sr}^{87}$  ratio, as  $4.6 \times 10^{10}$  yrs  $\pm 10$  percent. The proportion of nonradiogenic  $\text{A}^{40}$  and  $\text{Sr}^{87}$  is assumed to be negligible.—*D. B. V.*

- 165-295. Hée, A[rlette], and Jarovoy, M[ichel]. Autoradiographie des rayons  $\beta$  du potassium [Autoradiography of beta rays of potassium]: *Annales Géophysique*, tome 9, no. 2, p. 153-157, 1953.

The sensitivity of the emulsions in use do not permit obtaining the whole of the long trajectories of radiation from potassium.—*M. C. R.*

- 165-296. Sakakura, Arthur Y. Air scattering of gamma rays from thick uranium sources: Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 748-751, 1956; and U. S. Geol. Survey Prof. Paper 300, p. 715-719, 1956.

To develop a means of interpreting gamma-ray intensities measured at considerable air distance between natural sources and a detector, a knowledge of the radiation-intensity distribution from sources of various strengths and configurations is necessary. The intensity from an infinitely thick elementary source was measured as a function of the air distance above and to the side of the source, and a semiempirical expression of the following three factors fitted to the experimental data: the inverse-square exponential law corresponding to the hardest gamma ray; a buildup factor, a polynomial in air distance to account for scattering and the complexity of the spectra; and an obliquity factor, a function of the angle of view from source to detector. This expression was integrated over different surface areas; from the integrations the area under the curve recorded on a counting ratemeter was calculated. Quantitative relationships between the peak intensity and the area under the curve and the source strength and size are established as function of the velocity and distance of a detector from the source. The method has been applied to the airborne radioactivity surveys made by the U. S. Geological Survey but is broadly applicable to measurements made with comparable detectors at considerable air distances from natural sources.—*M. C. R.*

- 165-297. Hurley, Patrick M. Direct radiometric measurement by gamma-ray scintillation spectrometer. Part I: Uranium and thorium series in equilibrium: Geol. Soc. America Bull., v. 67, no. 4, p. 395-404, 1956.

Where uranium and thorium are in secular equilibrium with their decay products, these elements may be determined by this direct radiometric method if the materials show more than 0.01 percent equivalent uranium. This method is based on the measurement in a scintillation spectrometer of the relative amplitude of the response from the 238 kev gamma ray from Pb<sup>212</sup>. Tests on known samples containing different relative proportions of uranium and thorium have verified the predicted precision of better than 4 percent standard deviation per single comparison with a standard when the element measured is a major contributor to the activity.—*Author's abstract*

- 165-298. Hurley, Patrick M. Direct radiometric measurement by gamma-ray scintillation spectrometer. Part II: Uranium, thorium, and potassium in common rocks: Geol. Soc. America Bull., v. 67, no. 4, p. 405-411, 1956.

The method described in Part I of this report [see preceding abstract] has been extended to the measurement of the uranium and thorium series and potassium in common rocks, or materials of comparable activity, in which the series are in secular equilibrium. The counting rate in an additional band centered on the photopeak from the 1.46 Mev gamma ray of K<sup>40</sup> permits the measurement of potassium and the removal of the counts due to the potassium in other channels.—*Author's abstract*

- 165-299. Wilkening, Marvin H. Variation of natural radioactivity in the atmosphere with altitude: Am. Geophys. Union Trans., v. 37, no. 2, p. 177-180, 1956.

The vertical distribution of radon decay products in the lower atmosphere has been measured during airplane flights, using both negative-wire and precipitator methods of sample collection. Data taken by the wire method show a very gradual decrease in activity with height, with considerable activity found to exist at 16,000 ft (msl). The precipitator results indicate an approximately linear decrease with altitude, with no appreciable activity found in samples collected by this method above about 11,000 ft. Measurements made at four ground stations in the altitude interval 4,620 to 10,297 ft gave similar results. The mean value for the coefficient of eddy diffusion in the atmosphere calculated from the precipitator data was  $7 \pm 4 \text{ m}^2$  per sec for the plane flights and  $11 \pm \text{m}^2$  per sec for the ground stations.—*Author's abstract*

- 165-300. Crosthwait, L. B. A measurement of atmospheric radioactivity at Wellington: New Zealand Jour. Sci. Technology, sec. B, v. 37, no. 3, p. 382-384, 1955.

A filter-paper method of collecting atmospheric radioactivity is described. Sixteen readings taken at Wellington, New Zealand in February 1955 show a mean radon concentration of  $34 \times 10^{-18}$  curies per cc. The method is considered reasonably good, particularly if only relative values are required, as for meteorological research.—*D. B. V.*

- 165-301. Chapman, N. G., and Humphrey, R. W. An investigation of the variation of the atmospheric radioactivity at Wellington from 5 May to 18 July 1955: New Zealand Jour. Sci. Technology, sec. B, v. 37, no. 3, p. 396-406, 1955.

Variations in the radon content of the atmosphere were measured at Wellington during the period May 5-July 18, 1955, using the filter-paper method. A lower limit for the average value of the radon content of  $37 \times 10^{-18}$  curies per cc is obtained. A diurnal variation showed principal and secondary minimums at about 12-14 hr and 20-21 hr, respectively. Northwest winds were accompanied by higher radioactivity than those from the southeast. As expected, the level of radioactivity decreased as wind velocity increased. The level of fission-product radioactivity in the atmosphere at the time of collection was calculated to be less than 1/1000 of the natural atmospheric radioactivity (for July 8).—*D. B. V.*

- 165-302. Tajima, Eizo, and Doke, Tadayoshi. Airborne radioactivity: Science, v. 123, no. 3189, p. 211-214, 1956.

Measurements of airborne radioactivity in Japan from March 16 to May 4, 1955 showed the presence of radon daughter products of the order of  $10^{-13}$  curies per liter, assuming they were in equilibrium, and activity with a half-life of 10 to 12 hrs which is compatible with activity due to thoron daughter products. The concentration of radon daughter products was larger at night than in the daytime because of temperature inversion. Artificial radioactivity, including alpha emitters, was also detected and apparently consists of two or more components of different origins.—*M. C. R.*

- 165-303. Reiter, Reinhold. Schwankungen der natuerlichen Radioaktivitaet der Luft, Messungen in 2600 m Seehoehe in den Nordalpen [Variations of the natural radioactivity of the air, measurements at an elevation of 2,600 m above sea level in the northern Alps]: Zeitschr. Naturforschung, Band 11a, Heft 5, p. 411-418, 1956.

This is a more complete report of investigations of atmospheric radioactivity carried out on the Zugspitzplatt in the northern Alps [see *Geophys. Abs.* 164–267]. Besides emphasizing the dependence of radon content of the air on geology and wind direction, it includes consideration of the effect of humidity (radioactivity is often extremely high with humidity more than 80 percent), relation to electrical conductivity and number of condensation nuclei per volume (conductivity increases with radioactivity), and the possible effect of the radioactivity on rainfall and organisms.—*D. B. V.*

- 165–304. Schumann, G. Untersuchung der Radioaktivität der Atmosphäre mit der Filtermethode [Investigation of the radioactivity of the atmosphere by the filter method]: *Archiv Meteorologie, Geophysik u. Bioklimatologie*, Band 9, Heft 2, p. 204–223, 1956.

Nongaseous radioactive substances in the air are trapped by aerosols and can be collected with them in filters. By placing the filter inside a counter, absolute activities may be measured. The radioactivity of the atmosphere at Heidelberg has been studied by the filter method at two stations 565 and 130 m above sea level. The decay curves give beyond the radon daughter products, the contributions of the thorium series, fission products from atomic bomb tests, and of RaD ( $\text{Pb}^{210}$ ). A consistent interpretation is obtained only when all weather factors are considered at the same time. The filter method was also used to study air from the ground in tunnels and boreholes, and a fault was located.—*M. C. R.*

- 165–305. Tanaevsky, Olga, and Vassy, Étienne. Radioactivité naturelle et artificielle de l'atmosphère [Natural and artificial radioactivity of the atmosphere]: *Annales Géophysiques*, tome 11, no. 4, p. 486–490, 1955.

Measurements of the radioactivity of air samples taken at a height of 4 m above the ground have been made since December 1953 at Val-Joyeux. The activity recorded, except for one case, has been due to the daughter products of radon and thoron. No annual periodicity is observable in the activity. An accumulation of atmospheric radon generally is observed when the atmosphere is calm, but it disappears with the slightest wind. The correlation or lack thereof of the observed activity due to radon and barometric pressure, wind, temperature, precipitation, and industrial contamination are discussed.

Measurements of radioactivity of precipitation were begun in January of 1955. The precipitation of April 6–7, 1955 was particularly radioactive, but was less than half of the "tolerance dosage" of  $2 \times 10^{-9}$  curies per liter of water. The radioactivity was evidently due to the nuclear explosions of March 1955.—*P. E. B.*

- 165–306. Deutsch, Sarah], Picciotto, E. [E.], and Houtermans, F. G. Radioactivity of iron meteorites by the photographic method: *Nature*, v. 177, no. 4515, p. 885–886, 1956.

Preliminary results of a study of the  $\alpha$ -radioactivity of two iron meteorites by the nuclear-emulsion method indicate the uranium contents  $< 0.6 \times 10^{-8}$  grains per g, and the thorium  $< 2 \times 10^{-8}$  grains per g.—*M. C. R.*

- 165–307. Armbrust, Bernard F., Jr., and Kuroda, Paul K. On the isotopic constitution of radium (Ra-224/Ra-226 and Ra-228/Ra-226) in petroleum brines: *Am. Geophys. Union Trans.*, v. 37, no. 2, p. 216–220, 1956.

The relative amounts of Ra-224, Ra-226, and Ra-228 in a number of petroleum brine samples from Oklahoma and northwestern Arkansas have been determined.

The highest concentration found was more than one millimicrocurie per liter of brine. Some brines contained radium isotopes characteristic of the thorium series, others contained Ra-226 which is characteristic of the uranium series, while others contained radium from both the thorium and uranium series. The radium isotopes in the brines are not in radioactive equilibrium with their uranium and thorium parents.—*Authors' abstract*

- 165-308. Pierce, Arthur P., Mytton, J. W., and Gott, Garland B. Radioactive elements and their daughter products in the Texas Panhandle and other oil and gas fields in the United States: Proceedings of the International Conference on Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 494-498, 1956; and U. S. Geol. Survey Prof. Paper 300, p. 527-532, 1956.

Abnormal concentrations of radioelements and their daughter products, including radon, helium, argon, radium, uranium, and thorium, are present in some oil and gas fields of the United States. Natural hydrocarbon gases contain as much as  $10^4$  micromicrocuries of radon per liter (at reservoir pressure), several percent of helium, and several tenths of 1 percent of argon. Oilfield brines may contain as much as  $10^{-8}$  g of radium per liter. Precipitates from these waters on pipes in oil wells contain as much as  $10^{-8}$  g of radium per gram. The uranium content of oilfield brines that have been analyzed is as much as 0.2 parts per million uranium.

Analyses of crude oils, oil seeps, and petroliferous rocks indicate that uranium is generally enriched in oil-seep soil and in heavy surface-active fractions of petroleum which adhere to the rocks, as compared with the crude-oil fraction of petroleum that is produced at the wellhead. Epigenetic concentrations of uranium in the form of metalliferous asphaltite, a carbonaceous mineraloid similar to thucholite, carburan, and huminite, have been found in oil and gas reservoirs and associated rocks in the Wichita-Amarillo uplift of Oklahoma and Texas and in other areas. Abnormal concentrations of radon and helium in the natural gases of the Panhandle oilfield of Texas are associated with uraniferous asphaltite nodules and impregnations in and adjacent to the reservoir rocks.—*M. C. R.*

- 165-309. Argentiêre, Rômulo. A radioatividade do solo de rochas não-uraníferas e toríferas [The radioactivity of nonuranium- and thorium-bearing rocks]: Brasil Univ., Escola de minas Rev., ano 19, no. 2-6, p. 11-16, 1954.

This is a rather comprehensive review of determinations of the radioactivity of rocks of the earth's crust, designed to aid prospectors for uranium and thorium deposits in correcting for the effect of such residual radioactivity along with cosmic-ray background count. An extensive bibliography is appended.—*D. B. V.*

- 165-310. Fair, D. R. R., and Howells, H. A survey of the natural gamma radioactivity in the West Cumberland area: Jour. Nuclear Energy, v. 1, no. 4, p. 274-279, 1955.

To obtain a reference datum for the natural radioactive background in the area, a survey was made within a 20-mile radius of Sellafield on the Cumberland coast, where the first British production piles were planned. Measurements were made at 238 selected points in three vans fitted out as mobile radiation laboratories and equipped for detection and measurement of gamma radiation and for the collection and counting of radioactive dusts in the atmosphere. The gamma-radiation level, measured by a  $4\frac{1}{2}$ -liter ionization chamber containing

argon at 20 atmospheres pressure, varied between 4 and 10 microroentgens per hour. Cosmic radiation contributed about half the measured value. The contribution from airborne radioactive dusts was negligible. No correlation was found with other factors such as position with respect to the coastline.—*M. C. R.*

- 165-311. Ponsford, D. R. A. Radioactivity studies of some British sedimentary rocks: Great Britain Geol. Survey Bull., no. 10, p. 24-44, 1955.

Field and laboratory studies have failed to reveal any economic deposits of uranium ore within the British sedimentary sequence, although in most cases radioactivity is due to the content of uranium. The studies are of scientific interest in demonstrating the existence, in the British sequence, of representatives of practically all the known radioactive sediments. The highest uranium contents are found in black shales in the Upper Cambrian, Upper Ordovician, and Upper Carboniferous rocks; in black nodules in New Red Sandstone strata; and in phosphatic beds of various ages. Except for some phosphorites of Lower Cretaceous and Tertiary age, no post-Triassic rocks have been found to possess a noteworthy radioactivity.—*V. S. N.*

- 165-312. Gibbs, H. S., and McCallum, G. J. Natural radioactivity of soils: New Zealand Jour. Sci. Technology, sec. B, v. 37, no. 3, p. 354-368, 1955.

The radioactivity of several soil types was examined for relationships to properties used in the identification and classification of soil profiles. Gamma radiations were measured in the field and laboratory, beta radiations in the laboratory. After correction for cosmic-ray background, gamma counts ranged from 410 to 2,420 counts per minute, beta counts from 21 to 154 counts per minute. Correlation with soil profiles shows that the initial level of radioactivity depends on the rock materials from which the soil is derived (high to moderate for graywacke, sandstone, siltstone, or rhyolitic ash, low for dolerite or andesitic ash); this level decreases with weathering and leaching. The upward-decreasing count rate in the profiles indicates there is no significant accumulation of radioactive substances and there is no significant circulation of radioactive substances by plant and animal life. As differences in count rate lessen with weathering and leaching, weakly or moderately weathered and leached soils are recommended for purposes of comparison.—*D. B. V.*

- 165-313. Russell, R. D. Lead isotopes as a key to the radioactivity of the earth's mantle: New York Acad. Sci. Annals, v. 62, art. 19, p. 435-448, 1956.

Values for the present ratio  $U^{235}/Pb^{204}$  for dated common minerals calculated from the  $Pb^{208}/Pb^{204}$  and  $Pb^{207}/Pb^{204}$  ratios differ by far more than can be attributed to experimental error. Of four possible explanations, the simplest and most probable is that which assumes a derivation of the younger and the older leads from different parts of the mantle. It is suggested that these parts have maintained, since an early time in the earth's history, permanent differences in their uranium to lead ratios. If this is so, the lead to uranium ratio of the mantle is approximately 8.3, which is significantly higher than most previous estimates; because the part of the mantle that gives rise to lead ores has been able to preserve small heterogeneities in its lead and uranium concentrations that would have been destroyed by convection currents, the lead isotope evidence is against the existence of convection currents.—*M. C. R.*

- 165-314. Kohman, Truman P. Extinct natural radioactivity: possibilities and potentialities: New York Acad. Sci. Annals, v. 62, art. 21, p. 503-542, 1956.

An extinct natural radionuclide is a nuclide whose lifetime is too short for detectable amounts to have persisted from the time of nucleogenesis to the present, yet long enough for its decay to have produced effects in nature that can be identified. The half life would probably have to be between  $\approx 3 \times 10^7$  and  $\approx 3 \times 10^8$  years. A survey of all known long-lived nuclides suggests there may be a small number with suitable half lives. Extinct radionuclides of moderate primordial abundance and specific energy release could have important geothermal significance if its half life were of the right order of magnitude, but the probability of such a nuclide is small. The relation between the age of a mineral that once contained an extinct radionuclide product suggests a possible method for determining with relatively high precision the ages of extremely old minerals.—*M. C. R.*

### RADIOACTIVITY LOGGING AND SURVEYING

- 165-315. Latta, Thomas E. Gamma-ray logging of drill holes: Mines Mag., v. 46, no. 4, p. 24-28, 1956.

Gamma-ray logging units range from elaborate, truck-mounted instruments to small, portable, hand-cranked models. Both scintillation and Geiger loggers are available; scintillation loggers are more versatile and sensitive than Geiger loggers, but they require more power, more stable circuits, and more technical "know-how" to operate and maintain. Uranium ore grade and thickness can be determined empirically as functions of the maximum deflection and width of a gamma-ray log anomaly. The problem of recognizing radioactive equilibrium and other problems of instrumentation and contamination are often ignored and may lead to misinterpretation.—*L. C. P.*

- 165-316. Brannon, H. R., Jr., and Osoba, J. S. Spectral gamma-ray logging: Am. Inst. Min. Metall. Petroleum Engineers Trans., v. 207, Jour. Petroleum Technology, v. 8, no. 2, p. 30-35, 1956.

Borehole measurements of gamma-ray spectra were made using a scintillation counter and a photographic technique of pulse-height analysis. Four energy peaks above 1 mev were noted, corresponding to the radiation from potassium, two daughter products of uranium, and a daughter product of thorium. The relative amplitudes of the four energy peaks varied considerably in the five holes tested and there was some indication that formations could be distinguished by their characteristic distribution of radiation energy.—*G. V. K.*

- 165-317. Comstock, Sherman S. Scintillation drill-hole logging: Proceedings of the International Conference for the Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 722-725, 1956.

The TU-5-A scintillation drill-hole logging unit used by the U. S. Atomic Energy Commission on the Colorado Plateau includes a probe, a ratemeter, an audio power supply, and a strip chart recorder. The probe housing is a stainless-steel waterproof shell approximately 29 in. long and  $2\frac{1}{8}$  in. outside diameter.—*M. C. R.*

- 165-318. Dewan, J. T. Neutron log correction charts for borehole conditions and bed thickness: *Am. Inst. Min. Metall. Petroleum Engineers Trans.*, v. 207, *Jour. Petroleum Technology*, v. 8, no. 2, p. 50-58, 1956.

A model well was constructed to study the influence of borehole diameter, sonde centering, casing, cement, mud weight, and mud salinity on neutron logs. The well consisted of five layers of limestone with porosities from 4 to 40 percent. It was found that the centering of the sonde and variations in borehole diameter are critical, that the presence of casing or cement may affect the log appreciably, that variations in mud density and salinity are negligible except for highly saline muds, and that interpretation of neutron logs is difficult in empty holes of large diameter.—*G. V. K.*

Fuchida, Takato. Recent progress in well logging. See *Geophys. abs.* 165-138.

- 165-319. Stead, Frank W. Instruments and techniques for measuring radioactivity in the field: *Proceedings of the International Conference on Peaceful Uses of Atomic Energy*, Geneva, August 1955, v. 6, *Geology of uranium and thorium*, p. 714-722, 1956; and *U. S. Geol. Survey Prof. Paper* 300, p. 705-713, 1956.

A review, with extensive bibliography, of the principal instruments and surface, subsurface, and airborne techniques in the search for radioactive raw materials.—*M. C. R.*

- 165-320. Bisby, H., Franklin, E., and Taylor, D. Instrumental developments in the prospecting, mining and chemical processing of nuclear materials: *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy*, Geneva, August 1955, v. 6, *Geology of uranium and thorium*, p. 704-711, 1956.

A description of some of the instruments developed by the Electronics Division at the Atomic Energy Research Establishment, Harwell, England, since 1946. These include halogen-quenched Geiger counters, cold-cathode trigger and rate-meter circuits, and transistor circuits for prospecting and logging instruments.—*M. C. R.*

- 165-321. Milojevic, A., Kostic, V., and Petrovic, M. Radiation detectors with halogen counters for use in prospecting: *Proceedings of International Conference on Peaceful Uses of Atomic Energy*, Geneva, August 1955, v. 6, *Geology of uranium and thorium*, p. 712-713, 1956.

A description of halogen counters developed at the Institute of Nuclear Science "Boris Kidric." Circuit diagrams are given. The detectors have acoustical, optical, and instrumental indications.—*M. C. R.*

- 165-322. Davidson, C. F., and Bowie, S. H. U. Methods of prospecting for uranium and thorium: *Proceedings of the International Conference on the Peaceful Uses of Atomic Energy*, Geneva, August 1955, v. 6, *Geology of uranium and thorium*, p. 659-662, 1956.

In all radioactivity exploration, a field ratemeter is second in importance only to geologic knowledge. In countries where there is a good network of roads, much useful prospecting can be carried out by using a detector mounted on the roof of a

vehicle. Radiometric logging of drill holes is now routine in many areas where exploration for mineral deposits is in progress. Airborne radioactivity surveys are useful only in secondary prospecting to check whether or not abnormal radioactivity is present in areas considered geologically favorable for the occurrence of ore. Geochemical techniques may also be of value in exploration.—*M. C. R.*

- 165-323. Lenoire, André. Method of prospecting and surveying uranium deposits: Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 673-678, 1956.

This method was designed for prospecting of crystalline masses but has proved adaptable to prospecting of sedimentary formations also. Three types of field work are carried on: a preliminary survey (ground or airborne) to note abnormal radioactivity and determine areas for detailed prospecting; a semisystematic survey, used when the preliminary survey does not define the zone to be investigated by systematic prospecting, which defines the general appearance or size of a deposit. An important part of systematic surveying is the plotting of a "counter" or "isoactivity" map. An outline is also given of the French organization for exploration for uranium.—*M. C. R.*

- 165-324. Lang, A. H. Uranium prospecting in Canada—ground and aerial surveys: Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 663-672, 1956.

A summary of field techniques, including Geiger and scintillation counter measurements, both airborne and ground, with a brief history of their use in Canada. Government services, controls, and marketing are also described. Brief case histories are given of the Eldorado, Nicholson, Ace, Rix, Gunnar, and Pronto discoveries.—*M. C. R.*

- 165-325. Hatsuda, Zinichiro. Radioactive exploration [in Japanese with English summary]: Butsuri-Tankō, v. 6, no. 3-4, p. 265-271, 1953.

This is a review and bibliography of radioactivity surveying.—*D. B. V.*

- 165-326. Ippolito, Felice. Stato attuale delle prospezioni per uranio e torio in Italia [Present state of uranium and thorium prospecting in Italy]: Industria Mineraria, anno 6, no. 8, p. 421-427, 1955.

Exploration for uranium and thorium has been carried on in Italy by the Comitato Nazionale per la Ricerca Nucleare and by two independent mining societies in all areas from which radioactive minerals have been reported, even where indications seemed to be of purely mineralogic interest. Typical procedure involved first, gamma-ray field measurements in successively greater detail, followed by geological surveys, then petrographic and paragenetic study of specimens, and finally plotting of radioactive anomalies after correcting for topography. Results of these surveys show that the volcanic complex considered most promising is actually far more limited than shown on the official geologic map, and that the uranium mineralization is confined to a definite horizon, the upper Permian porphyritic schists. The three areas considered worthy of more detailed investigation, all in the Maritime Alps, are described and shown on a sketch map. The second phase of exploration will include excavating and drilling of these areas. Attention is also directed to the thorium-bearing sands along the Tyrrhenian coast.—*D. B. V.*

- 165-327. Bowie, S. H. U., Hale, F. H., Ostle, D., and Beer, K. E. Radiometric surveying with a car-borne counter: Great Britain Geol. Survey Bull., no. 10, p. 1-23, 1955.

Geiger-Müller and scintillation counters designed for car-borne use are operated from the car's battery and provided with audible alarm ratemeter and continuous recording mechanisms. Records indicate that the scintillometer has a performance factor about twice that of the Geiger counter but that the latter instrument is more stable and has a sensitivity adequate for prospecting purposes.

The effects of gamma-ray absorption, solid geometry, the time constant of the instruments, speed of traverse, road metal, cosmic rays, and weathering conditions are discussed.

In 1952 and 1953 reconnaissance surveys were carried out in West Africa, Norway, and South Africa. Field results on radioactivity of various formations agreed well with laboratory determinations carried out on grab samples of the same rocks.—V. S. N.

- 165-328. Boyle, Thomas L. Airborne radiometric surveying: Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 744-747, 1956.

The U. S. Atomic Energy Commission has used for airborne surveying a light two-place fixed-wing plane carrying a scintillation counter. Low-level flying is usually carried on only in the early morning hours. Approximately 620 hours of rim and grid flying over outcrops of the Morrison, Chinle, and Shinarump formations located 95 areas of anomalous radioactivity in the Colorado Plateau area.—M. C. R.

- 165-329. MacFadyen, D. A., and Guedes, Silvio V. Air survey applied to the search for radioactive minerals in Brazil: Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, v. 6, Geology of uranium and thorium, p. 726-739, 1956.

Air survey methods used in Brazil in exploration for radioactive minerals include air photography, photogrammetry, photogeology, and aeromagnetic surveying as well as airborne radioactivity surveys. Airborne magnetometry has been of value in locating and delineating anomalies associated with alkaline type of intrusive rocks. Planning and operation of surveys in Brazil are outlined, and typical results are shown.—M. C. R.

- 165-330. Baranov, V. I. Aeroradiometric prospecting for uranium and thorium deposits and the interpretation of gamma anomalies: Proceedings of the International Conference on the Peaceful Uses of Atomic Energy, Geneva, August 1955, v. 6, Geology of uranium and thorium, p. 740-743, 1956.

Airborne methods have aided in the discovery of several uranium and thorium deposits of industrial significance in the U. S. S. R. Both aero-ionization and aerogamma methods have been tested. The ionization method registers not only the radioactivity of uranium-bearing rocks but their emanating qualities as well. Tests show that clearly defined anomalies appear over known ore deposits, but there are a large number of pseudoanomalies due to foreign sources of ionization and space charges in the atmosphere, and determinations of the exact relations of the anomalies is complicated. The aerial gamma method has been most widely developed. The geophysical bases of both methods are given. In the organization

of aeroradiometric prospecting, the choice of districts is based on structural-metallogenic and paleogeographical analyses. The work is in three stages: search for anomalies, search for deposits based on anomalies, and evaluation of deposits.—*M. C. R.*

### SEISMIC EXPLORATION

- 165-331. Omote, Syun'itiro, and Tazime, Kyozi. Basic study on seismic prospecting (Summary) [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 186-191, 1953.

This is a review of fundamental studies on seismic exploration published from 1930 to 1950.—*D. B. V.*

- 165-332. Kosminskaya, I. P. Amplitudnyye krivyye i godography faz seysmicheskikh voln na svobodnoy granitse polyprostranstva [Amplitude curves and traveltime curves of seismic waves on the free boundary of semispace]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 1, p. 37-47, 1956.

In this paper the amplitudes and velocities are determined of the waves propagating on the surface of the earth caused by vertical harmonic impulses from electromagnetic or piezoelectric vibrators placed at the same surface. The ground is first assumed to be ideally elastic, and the propagation of waves combined with energy losses is considered.

In ideally elastic ground at relatively short distances from the source of impulses (about two or three wavelengths), the predominant waves are Rayleigh waves. When the propagation of waves is combined with energy losses, then the amplitudes of the longitudinal, transverse, and Rayleigh waves, decrease at different rates determined by the velocities of the individual waves and the damping properties of the medium. Transverse waves are not predominant in any zone. There are zones where the Rayleigh waves are dominant, beyond which the longitudinal wave becomes the dominant wave, as at very great epicentral distance.—*S. T. V.*

- 165-333. Berzon, I. S. Ob izmenenii preobladayushchikh chastot seysmicheskikh voln pri uvelichenii rastoyaniya ot istochnika kolebaniy [The change in the predominant frequency of seismic waves with increasing distance from the source of vibrations]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 1, p. 3-22, 1956.

The frequency spectrum of seismic waves propagating through a medium is determined by the nature of the shot producing the waves and by the properties of the medium. Absorption in the medium produces changes in the initial frequency spectrum, which become greater with increasing distance, some times discontinuously. As a rule lower frequencies are found with increasing distance.

When the strata forming the medium are thick enough that the coefficient of reflection is independent of frequency, then the reflected waves are of lower frequency with increasing depth of the reflecting boundary. Because damping decreases with depth, the opposite is true of refracted waves.

As the resolving capacity of seismic methods is best in the higher frequency range, it is important to select the shot conditions so that the desired spectrum is produced. If the conditions of the explosion are unfavorable and low frequency waves are produced, filtering cannot improve the situation. In selecting the proper conditions of the shot it is necessary to take into account the amount of

explosives, the depth of the charge, and the immediate surroundings of the shot. Both theoretical and experimental results are given.—*S. T. V.*

- 165-334. Anstey, N. A. Instrumental distortion and the seismic record: *Geophys. Prosp.*, v. 4, no. 1, p. 37-55, 1956.

The character of a Ricker velocity wavelet can be sharply distorted by narrow filter band widths or by high filter attenuation slopes; amplitudes may be modified, cycles may be added, and resolution of closely spaced reflections may be destroyed. An optimum filter would have a frequency response identical to the spectrum of the input signal. Filtering may also modify significantly the phase of constant time delay on the record relative to the phase of the input signal. In interpretation, picking the peak or trough nearest the maximum amplitude on the record minimizes error. Distortion of relative amplitudes can occur as a result of automatic-gain-control attack and release times that are not optimum for the circumstances. Second and third harmonics, particularly of low-frequency ground roll, may further distort recorded seismic events. Alinement of reflections is the most valid criterion of grading reflections.—*L. C. P.*

- 165-335. Yepinat'yeva, A. M. Nekotoryye tipy mnogokratnykh seysmicheskikh voln [Certain types of multiple seismic waves]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 1, p. 23-36, 1956.

A theoretical analysis shows that the wave reflected above the shot point is little changed, but is opposite in phase. The arrival time of the multiple reflected wave increases with the depth of the shot point. If the depth is small the records of the multiple reflected and the simply reflected waves are superposed and are difficult to interpret, but for sufficiently great depth the two waves are separated. The first (upper) reflection has a very high coefficient of reflection, 0.8 or higher, because the reflection takes place at a boundary characterized by a great change in acoustic rigidity. The phase inversion is typical when the wave is reflected from the medium of lower acoustic rigidity as the air or the weathered layer. Sometimes the double reflected wave is unnoticed because of energy losses during reflection and during the additional passage through the upper layer. Experimental data confirm the analytical results.—*S. T. V.*

- 165-336. Weber, Max. Die Laufzeitfläche einer mehrfach reflektierten Wellenfront in einem inhomogenen Körper mit beliebig gekrümmter Oberfläche [The travelttime surface of a multiply reflected wave front in an inhomogeneous body with arbitrarily curved surface]: *Geofísica Pura e Appl.*, v. 32, p. 12-18, 1955.

The travelttime surface for multiple reflections is calculated under the assumptions that the ground behaves as a completely elastic body, that the wave velocity is an arbitrary function of depth, and that the surface of the elastic body has an arbitrary curvature.—*D. B. V.*

- 165-337. Posgay, Károly, and Annau, Edgar. Szeizmikus rengéshullámok diffrakciója [Diffraction of seismic waves]: *Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények*, kötet 5, szám 1, p. 46-52, 1956.

This paper discusses the possibility of detecting diffracted waves in seismic investigation of intensely fractured structures from the seismograms and travel-time curves, with verification by calculations from travelttime data. Diffraction

arrivals in traveltime curves can be used to determine discontinuities more exactly.—*D. B. V.*

- 165-338. Barenboym, M. I. O dinami'cheskikh osobennostyakh prelomlennykh voln v oblasti sklonov solyanykh kupolov [Dynamic characteristics of the refracted waves on the slopes of salt domes]: *Prikladnaya geofiz.*, vypusk 10, p. 84-96, 1953.

Extensive investigations of the salt dome region of southern Emba River have been made by the method of correlation of refracted waves. The very complicated seismograms resulting from reflected and refracted waves, in part superposed, from the dome and from its almost vertical sides were deciphered only by the use of dynamic criteria. The seismic velocity of the waves refracted in the dome ranges from 4,000 to 4,500 m per sec, the same waves refracted from the sides have much lower velocities ranging from 2,700 to 3,500 m per sec. Several seismograms and geological profiles, constructed on the basis of the seismic data, are included.—*S. T. V.*

- 165-339. Puzyrev, N. N. O vliyani krivizny granitsy razdela pri opredelenii skorosti po godografam otrazhennykh voln [The effect of the curvature of the boundary in the determination of the velocity using the traveltime curves of the reflected waves]; *Prikladnaya geofiz.*, vypusk 13, p. 53-62, 1955.

By analytic geometry a solution is obtained for the determination of the boundary surface of the reflecting surface when this surface is not a plane and has double curvature. The case of great negative curvature, when the boundary surface is concave and can produce loops of the traveltime curve, is excluded. The problem is first solved in a general form, and discussed in detail for the two-dimensional case. It is shown that for not-too-great distances between the shot point and the seismograph, the traveltime curve can be assumed with good approximation to be a hyperbola.—*S. T. V.*

- 165-340. Weber, Max. Die Bestimmung einer beliebig Gekrümmten Schichtgrenze aus seismischen Reflexionsmessungen [The determination of an arbitrarily curved layer boundary from seismic reflection measurements]: *Geofisica Pura e Appl.*, v. 32, p. 7-11, 1955.

Assuming that the measuring surface  $z=\zeta(x,y)$  and the reflecting horizon of a structure  $z=f(x,y)$  have an arbitrary curvature, Weber develops mathematically a simple method of calculating the surface  $f$  from reflection data measured along the surface  $\zeta$  [see also *Geophys. Abs.* 161-85; 162-103].—*D. B. V.*

- 165-341. Kametani, Takuya. On reflection traveltime curves and their inclinations: *Butsuri-Tanko*, v. 7, no. 4, p. 174-178, 1954.

Dimensionless reflection traveltime curves for dipping strata and curves of angle of emergence were obtained assuming a linear increase of velocity with depth.—*M. C. R.*

- 165-342. Satō, Yasuo. How can we get rid of surface waves?: *Butsuri-Tankō*, v. 7, no. 4, p. 165-173, 1954.

A discussion from the viewpoint of a theoretical classical seismologist.—*M. C. R.*

- 165-343. Smith, Mark K. Noise analysis and multiple seismometer theory: *Geophysics*, v. 21, no. 2, p. 337-360, 1956.

The purpose of this paper is to present a general theory and some techniques for analyzing, estimating, and displaying the characteristics of wave noise, random noise, and reflection signal, in a form convenient for designing and evaluating multiple seismometer arrays and filters. Modifications of the characteristics resulting from weathering and elevation variations, and modifications of the array responses resulting from variations in plant and seismometer spacing are discussed. Criteria for the design of arrays are presented along with a multiple seismometer nomogram based on a specific set of criteria.—*Author's abstract*

- 165-344. Dyk, Karl. A comparison of additive and multiplicative compounding: *Geophysics*, v. 21, no. 2, p. 361-367, 1956.

Additive and multiplicative compounding of seismometer outputs are compared. In the equations developed for multiplicative compounding some terms involve products of signal and noise, and an arbitrary division of these terms between signal and noise is made to facilitate handling. Under the assumptions made it is developed that for low signal-to-noise ratios (less than 0.8) additive compounding provides a greater improvement in signal-to-noise ratio than does multiplicative compounding unless large numbers of units are compounded.—*Author's abstract*

- 165-345. Kilczer, Gyula. Átlőtt és inverz réteg kimutatásának lehetősége szeizmikus refrakciós méréssel [Possibility of the detection of shot and inverse layers by means of seismic refraction measurements]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 4, szám 2, p. 57-64, 1955.

A method is presented for determining the dip and velocity of a discordant layer where the dip and velocity of the layers above and below are known.—*W. H. D.*

- 165-346. Kilczer, Gyula. Transzformált közvetítő megfigyelések kiegyenlítése [Equalization of transformed observation data]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 4, szám 2, p. 65-70, 1955.

The procedure of Schwerdt are generalized. Observed data are smoothed with an arbitrary rather than a linear function. The procedure is illustrated using  $T$ -delta  $T$  data and a function of the second degree.—*W. H. D.*

- 165-347. Ivanhoe, L. F. Integration of geological data on seismic sections: *Am. Assoc. Petroleum Geologists Bull.*, v. 40, no. 5, p. 1016-1023, 1956.

Surface geologic data can be readily integrated with seismic sections. However, the integration of subsurface geologic data (from wells) with seismic sections must take into account possible well-point, velocity, geometric, and projection errors.—*L. C. P.*

- 165-348. Ivanhoe, L. F. Geometric analysis of seismic fault evidence: *Am. Assoc. Petroleum Geologists Bull.*, v. 39, no. 5, p. 753-761, 1955.

Seismic sections are usually plotted on the assumption that they are in a vertical plane. They are actually "tilted" at approximately the complement of the angle of the cross dip of the bedding planes. Therefore, wherever a seismic fault is critical in an interpretation, the seismic sections must be treated as tilted and the effects thereof analyzed. The differences in fault interpretation between what is expected (from a vertical section) and what should be expected on a tilted section

are often startling. Three-dimensional geometric analysis of faults, use of the meridian stereonet, and contouring of fault planes and "seismic section tilt" are helpful in the geometric analysis of seismic faults.—*L. C. P.*

- 165-349. Sarrafian, George P. A marine seismic model: *Geophysics*, v. 21, no. 2, p. 320-336, 1956.

A model for the study of marine seismic phenomena consists of a  $30 \times 90 \times 30$  in. steel tank filled with water, a spark gap acoustic source, and a barium titanate receiver. Bubble pulses and multiple reflections within the water layer are duplicated in the model. Multiple reflection problems are studied in which the bottom of the water layer is tilted or thin. A mass of air bubbles at the surface of the water is shown to be of use in attenuating multiple reflections.—*W. H. D.*

- 165-350. Woods, J. P. The composition of reflections: *Geophysics*, v. 21, no. 2, p. 261-276, 1956.

When the traces on a seismic reflection record all show about the same deflection at about the same time, the line-up is marked and called a seismic reflection. An important fact is forgotten. The fact is that the reflection seen on the record is nearly always a composite of the various reflections caused by a set of closely spaced reflecting layers. When the arrangement of the layers in the set changes, then the various reflections add together in a different way, and the character of the composite reflection seen on the record changes.

A series of artificial seismic records have been made to show this composition of reflections. The records were made by connecting a standard reflection seismograph to an acoustic model. The model was a three hundred foot length of steel pipe with input and output transducers at one end. Records were made for a wedge, a pinch-out, a complex of thin layers, a sand bar, layers corresponding to well resistivity logs, and a regular layer system.—*Author's abstract*

- 165-351. Bereza, G. V., Slutskovskiy, A. I., Polshkov, M. K. Chastotnyy analiz seysmicheskikh kolebaniy [Frequency analysis of seismic vibrations]: *Prikladnaya geofiz.*, vypusk 11, p. 92-123, 1954.

The principal elements of the setup for frequency analysis of seismic waves are a set of 24 sharply tuned galvanometers, each with different resonant frequency, and very weak damping. These galvanometers receive current from a common, very broadly tuned amplifier. When the set receives electric oscillations, only those of the galvanometers will be affected that are tuned to frequencies contained in the spectrum of the oscillations, the other remain dead. The procedure of testing is described in detail and is illustrated by several oscillograms and graphs.—*S. T. V.*

- 165-352. Kleyn, A. H. On seismic wave propagation in anisotropic media with applications in the Betun Area, South Sumatra: *Geophys. Prosp.*, v. 4, no. 1, p. 56-69, 1956.

An analytical solution of refraction problems in anisotropic media is based on the expression for the refraction angle in an uniaxial anisotropic medium with vertical axis and elliptic anisotropy. The theory is applied to a test on the anisotropic behaviour of the sedimentary section in the vicinity of Betun, South Sumatra, employing the results from a refraction profile, a well velocity survey and a radial well survey. It is concluded that, in the Betun area, the anisotropy factor is variable with depth. Its maximum value may be as high as 1.15 in the middle part of the section.—*Author's abstract*

- 165-353. Kaneko, T[etsuichi], and Tazime, K[yozu]. An experimental study on seismic waves: Butsuri-Tank6, v. 7, no. 4, p. 179-185, 1954.

Four waves were observed in experimental observations within 30 m. Two are believed to be surface waves. Motion in these at several distances has been sketched from the seismograms.—*M. C. R.*

- 165-354. Ormea, G. B. Circuiti equivalenti dell'effetto sismoelettrico [Circuit equivalents of the seismic-electric effect]: Geofisica Pura e Appl., v. 32, p. 54-70, 1955.

The circuit model of approximate equivalence to the seismic-electric effect of Thompson and Slotnick is reexamined in this paper, both in the original form of those authors and in simpler forms with ohmic resistance set in series in the circuit. When the ohmic resistance assumes an oscillating form (theoretically the equivalent of oscillating elastic impulses) the steady state of electric current which is determined has one component independent of time and one dependent on time, with infinite harmonics. This explains, among other things, one of the experimental results characteristic of the seismic-electric effect. It does not reproduce in terms of current intensity the forms of mechanical oscillation imparted to the ground, but rather the mechanical frequency which can be picked up oscillographically.—*D. B. V.*

- 165-355. Pakiser, L. C., and Warrick, R. E. A preliminary evaluation of the shallow reflection seismograph: Geophysics, v. 21, no. 2, p. 388-405, 1956.

Following successful tests of a specially constructed shallow reflection seismograph in early 1954, new experimental work has been conducted on the Colorado Plateau, in the Upper Mississippi Valley zinc-lead district, and in Portage County, Ohio. Although reflections were recorded in all of these areas, they were not continuous and correlatable on the Colorado Plateau and in the Upper Mississippi Valley. In Ohio, on the other hand, reflections were recorded from horizons within the Pleistocene overburden as well as from bedrock and horizons within the consolidated rock section. Conditions favoring good reflections are similar for both shallow- and deep-reflection work; they differ only in scale.—*Authors' abstract*

- 165-356. Voyutskiy, V. S., and Slutskovskiy, A. I. Seysmicheskaya stantsiya so skorostnymi fil'trami [Seismic station with velocity filters]: Prikladnaya geofiz., vypusk 13, p. 131-142, 1955.

In the circuit of a seismic station with velocity filters two geophones are usually connected to one galvanometer, and between one geophone and the galvanometer there is inserted a retardation element, producing a timelag of  $t$  seconds. Two parallel lines of geophones are laid out on one side of the station, one being shifted in relation to another through a distance  $l=vt$ , where  $v$  is the apparent velocity of the propagation of the disturbance. Interference of the impulses produced by the two geophones, when  $v$ , and consequently  $l$ , is correctly estimated, produces a wave free of disturbing effect. It is sometimes necessary to try several displacements  $l$  to determine the correct one. It is also possible to produce a change in  $v$  by burying the geophones at different depths. The automatic volume control must be cut out during the preliminary tests. Several seismograms, obtained with different arrangements of the geophones and showing the effect of various elements of the scheme are included.—*S. T. V.*

- 165-357. Waldie, Alan D. Weight-drop technique—how it's working: *World Oil*, v. 142, no. 5, p. 148-158, 1956.

This is a review of results of the weight-drop seismic method developed by the McCollum Exploration Co. since it was introduced 3 years ago. Successful operations have been carried out in more than 25 counties in Texas, and in New Mexico, Kansas, Florida, and Mississippi. The method has been recently adapted for water operations.—*L. C. P.*

- 165-358. Lopes Paradela, Pedro. Uma alteração na aparelhagem de prospecção sísmica do Serviço de Fomento Mineiro [A modification in the seismic prospecting apparatus of the Serviço de Fomento Mineiro (with English summary)]: *Portugal Serviço Fomento Mineiro Estudos, Notas e Trabalhos*, v. 10, fasc. 1-2, p. 27-36, no date.

In a modification of the shot control box designed to eliminate errors due to delay in blasting caps, the instant of explosion is recorded as the breaking of a wire wound around the charge, rather than the explosion of the cap itself. This wire is connected to the circuit at the point where the caps formerly were connected, and the caps are connected to a new circuit supplied by the same battery. Photographs and wiring diagrams are included.—*D. B. V.*

- 165-359. Salter, R. E. Magnetic tape recorder spells progress: *World Oil*, v. 142, no. 5, p. 142-146, 1956.

This is a general review of magnetic tape recording in seismic exploration.—*L. C. P.*

- 165-360. Tamano, Toshiro, and Kaneko, Tetsuichi. Seismic field techniques and some other problems [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 199-205, 1953.

This is a description of recent developments in Japan in seismic field operations and analysis of results. Since the war, the reflection method has augmented refraction surveys of coal and oil fields.—*D. B. V.*

- 165-361. Hayakawa, Masami, and Sasaki, Tsuneo. On "S. S. C." and "E. T. L." seismograph [in Japanese with English summary]: *Butsuri-Tankō*, v. 6, no. 3-4, p. 192-198, 1953.

This description of two American reflection seismographs used in Japan since the war in coal and gas fields includes photographs and schematic diagrams.—*D. B. V.*

- 165-362. Gálf, János, Gellert, Ferenc, and Sédy, Loránd. Nyomáshullám kialakulása légrobbantásnál [Pressure wave formation in air shooting]: *Magyar Allami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények*, kötet 4, szám 2, p. 41-44, 1955.

The relative distribution of pressures around freely exploding charges is studied by means of photographs taken in the dark. The flash as photographed represents, or is at least proportional to, the pressure wave front. Photographs of five different explosions are accompanied by descriptions of the conditions under which they were set off.—*D. B. V.*

- 165-363. Gidon, Paul. Résultats géologiques d'une prospection géophysique aux environs de Chambéry [Geologic results of geophysical exploration in the vicinity of Chambéry]: Soc. géol. France Comptes Rendus, no. 2, p. 14-15, 1956.

Seismic refraction surveys and electrical depth profiles have been made in the area south-southwest of Chambéry, at the northern tip of the Jacob-Bellefonte anticline. Refraction profiles on the Würm moraine indicate a surface layer (moraine) in which the velocity is 300-600 m per sec, underlain by a layer in which velocity increases with depth from 2,000-3,000 m per sec (probably interglacial alluvium), and, at a depth of more than 125 m, limestone in which the velocity of 4,700 m per sec. The electrical measurements confirm the seismic results, the increase in resistivity probably indicates the presence of the limestone at a depth of about 150 m. The Jacob-Bellefonte anticline apparently represents the frontal fold of sub-Alpine compression in northern Chartreuse. The area west of Chartreuse belongs to the Jura province.—*D. B. V.*

- 165-364. Hattori, Yasumasa. Recent application of geophysical prospecting to civil engineering [in Japanese with English summary]: Butsuri-Tankō, v. 6, no. 3-4, p. 172-178, 1953.

The seismic refraction method has been used in investigation of the submarine tunnel connecting Honshu and Hokkaido and of the foundations of the bridge between Wakamatsu and Tobata. The relation between seismic velocity and bearing power or porosity of foundations is also being studied; correlation with actual measurements indicates that a velocity of 2.5 km/s is the safe limit for construction of all kinds.—*D. B. V.*

- 165-365. Sasa, Kenzo. Geophysical prospectings applied to engineerings for disaster prevention [in Japanese with English summary]: Butsuri-Tankō, v. 6, no. 3-4, p. 167-171, 1953.

Seismic surveys are used to determine the visco-elastic properties of the foundations of earthquake-proof construction, and to investigate the nature of the ground in the vicinity of the dams and drainage wells designed to prevent landslides.—*D. B. V.*

- 165-366. Evison, F. F. A coal seam as a guide for seismic energy: *Nature*, v. 176, no. 4495, p. 1224-1225, 1955.

A dispersive train of vibrations resembling an internal Love wave was observed during seismic experiments in the Mangapehi state coal mine, New Zealand. Comparison with theoretical Love wave curves computed for a density ratio (rock/coal) of 1.6 shows satisfactory agreement if the rigidity ratio is 2.0, the thickness of the coal 17.6 ft, and the shear velocity in coal 1,900 fps, values which from other data are approximately correct. The observation suggests that coal mines may provide especially favorable conditions for the study of guided waves, and that guided waves may have useful applications in mining.—*M. C. R.*

- 165-367. Hellbardt, G. Seismische Versuche auf einer Eisplatte [Seismic investigations on an ice sheet]: *Zeitschr. Geophysik*, Jahrg. 21, Heft 1, p. 41-47, 1955.

This presents the results of seismic investigations of ice covering the Kiessee near Göttingen in February, 1954. Three sharp arrivals are noted on the seismo-

grams before the transverse waves: the symmetrical longitudinal waves, with a boundary velocity of  $3,410 \pm 70$  m per sec; *SH* (Love) waves, with a boundary velocity of  $1,770 \pm 90$  m per sec; and an unidentified wave with large amplitude, apparently polarized perpendicularly to the surface of the ice, having a measured velocity of  $770 \pm 20$  m per sec. Group velocity, phase velocity, and dispersion of the transverse waves agree well with theoretical values. The elastic constants calculated from measured velocities (Young's modulus:  $8.4 \times 10^{10}$  dynes per  $\text{cm}^2 \pm 10$  percent; rigidity:  $2.9 \times 10^{10}$  dynes per  $\text{cm}^2 \pm 10$  percent; Poisson's ratio:  $0.46 \pm 17$  percent) agree well with results obtained by others.—*D. B. V.*

165-368. Drysdale, William S. Firth of Forth seismic refraction survey: *Colliery Guardian*, v. 191, no. 4935, p. 379-384, 1955.

A seismic refraction survey to determine the depth to bedrock beneath Firth of Forth and to locate any preglacial channel was made in 1954. Reversed profiles were shot on land using a 12-channel portable seismograph. For measurements under water, a special seismometer arrangement ("sea snake") was used, comprising 24 seismometers and connecting cables arranged on a towline 1,300 ft long. The seismometers were spaced at predetermined intervals along the towline which was floated on spaced buoys and suitably weighted to maintain it at a given height above the seabed. Shots were fired near each end seismometer of the sea snake, and at every fifth station there were two additional shots 400 to 800 ft from the end seismometers.

The velocity in the surficial deposits under water was 5,000-6,000 fps, appreciably less than the velocity in bedrock. The configuration of bedrock beneath the Forth coalfield undulates gently through wide channels beneath the islands and rock exposures.—*M. C. R.*

165-369. Khalevin, N. I. Granichnyye skorosti dlya nekotorykh porod fundamenta Turgayskoy nizmennosti [Boundary velocities in basement formations of the Turgay lowland]: *Akad. Nauk SSSR Izv. Ser. geofiz.*, no. 2, p. 165-171, 1956.

The velocities of refracted waves in the basement rocks of the Turgay lowland in northwestern Siberia were determined by measurements along a seismic profile, with 15 geophones, at 15 m intervals. In sedimentary formations the velocity was 3,000-3,600 m per sec, but in eruptive rocks was as high as 6,000 m per sec.

The seismic refraction method can be used to determine the kind of refracting rock and also certain structural details. Several synclines determined in this way were later confirmed by magnetic and gravimetric measurements.—*S. T. V.*

165-370. Laubscher, Hans P. Structural and seismic deformation along normal faults in the Eastern Venezuelan basin: *Geophysics*, v. 21, no. 2, p. 368-387, 1956.

Seismic and drilling data indicate the presence of troughs on the downthrown side of normal faults in the Eastern Venezuelan basin. Reflections from above the faults approximately represent the true structure, but reflections below the faults are distorted and repeat the structure above the faults. The distortion below the faults is attributed to anomalous velocities in the vicinity of the faults. The influence of the fault zone on the velocity consists of displacement of "velocity strata," possibly with the thickening of some of the strata on the downthrown side due to syntectonic sedimentation, and plastic alteration of the rocks in the zone of structural deformation. The observed structures are compared with model structures.—*W. H. D.*

## STRENGTH AND PLASTICITY

- 165-371. Shimozuru, Daisuke. Elasticity of rocks under the initial stresses, with special reference to the fracture problem: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 3, p. 437-448, 1955.

The velocities of dilatational waves measured in three marble specimens subjected to uniaxial pressure increased with pressure in the range from 0 to 300 kg per cm<sup>2</sup>, decreased slowly from 300 to 400 kg per cm<sup>2</sup>, and decreased rapidly from 400 to 520 kg per cm<sup>2</sup>, at which pressure the specimens fractured. The change thus indicates three regions in which elastic strain, plastic deformation, and fracture predominate.—*M. C. R.*

## SUBMARINE GEOLOGY

- 165-372. Officer, C. B. [Jr.]. Geologic interpretation of a series of seismic reflection profiles from Bermuda to the continental margins: Deep-Sea Research, v. 2, no. 4, p. 253-260, 1955.

Five seismic reflection profiles, one over the Bermuda rise, two over the abyssal plain north and northwest of Bermuda, and two on the continental rise, illustrate the differences in sediment structure in different parts of the Atlantic. Two persistent reflections mark the top of the volcanic rocks under the Bermuda rise thinning outward under the abyssal plain, and a horizon near the base of the sediments.—*M. C. R.*

- 165-373. Frederiksson, Kurt. Cosmic spherules in deep-sea sediments: Nature, v. 177, no. 4497, p. 32-33, 1956.

Spherules magnetically separated from cores obtained during the Swedish deep-sea expedition have been mounted in plastic and polished. In many there is a metallic nucleus inside a superficial layer of magnetite, presumably due to oxidation during flight through the atmosphere. In most of the spherules with a metallic nucleus the metal reduces acid copper sulfate solution, indicating metallic iron. In a few, structure was observed, probably due to consolidation from the molten state. As a volcanic origin is not likely, these facts support the cosmic origin of the black spherules.—*M. C. R.*

- 165-374. Hill, M. N. Notes on the bathymetric chart of the N. E. Atlantic: Deep-Sea Research, v. 3, no. 3, p. 229-231 and chart, 1956.

A bathymetric chart of the Atlantic Ocean between latitudes 42° and 60° N. and from 28.5° W. longitude to the 100-fathom contour off the coasts of the British Isles, France, and Spain has been compiled from sounding data obtained during geophysical and oceanographic cruises during the past 10 years combined with previously available information. The area covered by this chart can be divided into distinct topographic regions: the rugged area of the Mid-Atlantic Ridge in the western part; a deepwater area between the Mid-Atlantic Ridge, the continental shelf, and south of a comparatively shallow area which extends from the north of Ireland to south of Greenland; and abyssal plains with gradients of less than 1:1000 in the Bay of Biscay and northwest to about 52° N. latitude.—*M. C. R.*

## VOLCANOLOGY

- 165-375. Imbò, Giuseppe]. Énergies éruptives pendant la paroxysme du Vésuve du Mars 1944 [Eruptive energies during the eruption of Vesuvius of March 1944]: Bull. volcanolog., sér. 2, tome 16, p. 171-175, 1955.

Statoscope observations during the 1944 eruption of Vesuvius contributed toward an understanding of the relation between eruptive and seismic activity, showed that luminous exhalations can be explained by excess energy from pressure waves, and gave an approximate idea of the energy involved in the explosive phenomena ( $60,000 \times 10^8$  joules).—*D. B. V.*

- 165-376. Imbò, G[iuseppe]. Considérations relevées de l'étude séismique du dernier paroxysme vésuvien [Considerations arising from the seismic study of the last paroxysm of Vesuvius]: *Bull. volcanolog., sér. 2*, tome 16, p. 161-169, 1955.

This describes how the various aspects of seismic activity recorded during eruptions provide evidence as to the origin of the different phenomena. Details of the four phases of the 1944 eruption of Vesuvius—effusive, fountain, mixed explosion, and seismoexplosion—are here interpreted with the aid of the seismic record.—*D. B. V.*

- 165-377. Kulakova, L. S., and Rikhter, V. G. Podvodnyy gryazevoy vulkan na Kaspiyskom more [A submerged mud volcano in the Caspian Sea]: *Priroda*, no. 2, p. 113-114, 1955.

In the southern part of the Caspian Sea several shoals opposite the Cheleken Peninsula are interpreted as the remainders of mud volcanoes. One of them, Livanov Bank, appeared above the surface of water as a result of the violent eruption of September 23, 1930, but at present, as a result of wave erosion, is just a shallow sandbank. Along a structural line from Livanov Bank through Zhdanov Bank and several mud cones of the Cheleken Peninsula line, remainders of a new mud cone nearer the shore was discovered in September 1951. By echo sounding it was found that this bank is some 200 m long and has near one end a typical mud cone rising some 10-15 m over the level of the sandbank.—*S. T. V.*

- 165-378. Vlodavez [Vlodavets], V. I. Alcuni risultati delle ricerche vulcanologiche nell'URSS [Some results of the volcanological research in the U. S. S. R.]: *Bull. volcanolog., sér. 2*, tome 16, p. 147-159, 1955.

Recent volcanic activity in the U. S. S. R. is limited to the Kurile-Kamchatka volcanic-tectonic arc, about 2,000 km long and from 10 to 40 km wide. Volcanological studies were made as early as 1737-41, but systematic research began with the establishment of a station near Klyuchevskoy volcano (or Klyuchevskaya Sopka) in 1935, and particularly with the founding of the Laboratory of Volcanology of the Academy of Science of the U. S. S. R. in 1945.

There are 20-23 active volcanoes in Kamchatka, of which 13 have erupted during the past 250 years, 7 are solfataric, and possibly 3 very weakly solfataric. In the Kuriles there are 40, of which 33 (including 2 submarine volcanoes) have erupted in the past 250 years and 7 are solfataric. In 1941 a geyser area was discovered in Kamchatka including 20 large and 100 small geysers.

A brief summary is given of the activity of the important volcanoes and the location of all 63 active volcanoes in the chain is shown on a map, together with dates of eruptions since 1700. Russian volcanological research also includes the problems of composition and differentiation of the lavas, the origin of tuffs, and study of subterranean magma movements by seismic and gravity methods.—*D. B. V.*

- 165-379. Zavaritskiy, A. N., Piyp, B. I., and Gorshkov, G. S. *Izucheniye vulkanov Kamchatki* [The investigation of the Kamchatka volcanoes]: Akad. Nauk SSSR Lab. vulkanol. Trudy, vypusk 8, p. 17-57, 1954.

This is the summary of present knowledge of the Kamchatka volcanic region. The most important volcanoes are near the junction of the Aleutian and Kurile Islands, including the greatest and also the most active volcano, the Klyuchevskaya Sopka. The other volcanoes and several hot springs are along two lines trending northeastward and northwestward.

The nine most important volcanoes: Avaka (272 m), Uzon, Klyuchevskaya Sopka (4,850 m), Tolbachik (3,628 m), Sheveluch (3,335 m), Karymskiy (1,486 m), Malyy Semyachik, Gorelyy Khrebet (1,829 m), and Kizimen or Shchapyanskaya Sopka (2,375 m) are described. Most of the article is devoted to the description of Klyuchevskaya Sopka. During the last 200 years there have been 20 violent eruptions of this volcano, and it is continuously slightly active, erupting significant amounts of gases and often cinders. Shorter descriptions are given of other volcanoes and of numerous thermal sources and geysers. The temperature of emanating gases in some places is as much as 300°. Springs are rather strongly mineralized, containing 4-7 g of residue per liter; their temperature is 50°-70°. There are 90 groups of thermal springs; in some valleys they moderate the severe climate of Kamchatka. Geysers of Kamchatka are not as spectacular as those of Yellowstone Park and Iceland, but are numerous.—S. T. V.

- 165-380. Lyustikh, Ye. N. *O roli vulkanov i term v energetike zemnoy kory* [The role of volcanoes and thermal springs in the energy balance of the crust of the earth: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 92-94, 1956.

Heat loss from the earth into interstellar space is usually estimated to be  $10^{28}$  ergs per year, but energy losses from the eruption of incandescent lava, hot gases, superheated steam, or in solfataric regions, such as Larderello in Italy, geysers in Iceland, Yellowstone Park, and others, may increase this to about  $10^{30}$  ergs per year.—S. T. V.

- 165-381. Cahen, L[ucien]. *Géologie du Congo belge* [Geology of the Belgian Congo]: 577 p., Liège, H. Vaillant-Carmanne, 1954.

Chapter 17 (p. 457-486) describes the rift valleys and recent volcanism of the Belgian Congo, with discussion of their origin and relationships. The tension theory explains the grabens most simply. These structural dislocations brought on the volcanism by creating conditions favorable for melting in magma centers in the substratum.—D. B. V.

- 165-382. Weyl, Richard. *Geologische Wanderung durch Costa Rica*. 1. Die Vulkane der Cordillera Central [Geologic travels through Costa Rica. 1. The volcanoes of the Cordillera Central]: Natur u. Volk, Band 86, Heft 1, p. 13-24, 1956.

This is a description of the three principal volcanoes in the central cordillera of Costa Rica. Irazú, the largest and highest in southern Central America, at present shows only very mild solfataric activity. Turrialba, which last erupted in 1864-66, is also in the solfataric stage. Poás, most active at present, was

erupting ash in January 1955. No other volcanoes of the cordillera have been known to show anything stronger than mild solfataric activity in historic times.—*D. B. V.*

- 165-383. Macdonald, Gordon A., and Eaton, Jerry P. The 1955 eruption of Kilauea Volcano: Volcano Letter, nos. 529 and 530, p. 1-10, 1955.

The 1955 eruption of Kilauea Volcano began in eastern Puna in the vicinity of the east rift zone on February 28 and continued, with interruptions, until May 26.

Flows and cones of the eruption cover approximately 6.1 square miles and the total volume of material extruded was approximately 120 million cubic yards. Seismic activity in the east rift zone began with two big earthquakes near Kalapana on March 30, 1954, followed by persistent, tiny, shallow quakes through the fall of 1954, increasing in frequency late in the year and sharply increasing from February 23 to February 28, 1955 when the first harmonic tremor marked the beginning of eruption. Thereafter when lava poured freely at the surface, few earthquakes were recorded but with diminishing flow and the opening of new fissures, swarms of shallow earthquakes occurred. Subsidence of the top of Kilauea caldera began on March 7 accompanied by the inflation of the east rift zone south of Pahoa suggesting that plastic magma at depth oozed from under the caldera and welled up beneath the fractured east rift zone. Swarms of earthquakes in the summit area continued until mid-April when major subsidence stopped. Slow subsidence continued until the end of the year.—*V. S. N.*

- 165-384. Morimoto, Ryōhei, and Ossaka, Joyo. The 1952-1953 submarine eruption of the Myōjin reef near the Bayonnaise rocks, Japan (I): Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 2, p. 221-250, 1955.

A detailed account with many photographs of the eruption from the first observation on September 17, 1952 to the collapse of the island in September 1953.—*M. C. R.*

# INDEX

	Abstract		Abstract
Adlung, Alfred.....	54	Chapman, N. G.....	301
Agocs, W. B.....	282	Chapman, R. W.....	10
Alcaraz, Arturo.....	28	Chernyavkina, M. K.....	35
Aldrich, L. T.....	17	Chetayev, D. N.....	107, 109
Allan, D. W.....	211	Chudoba, Vratislav.....	194
Allen, J. F. J.....	60	Chukin, V. T.....	136
Ambolt, N. P.....	249	Chuman, R. W.....	139
Annau, Edgar.....	337	Cipa, W.....	285
Anstey, N. A.....	334	Cizancourt, Henri de.....	205
Aoki, Harumi.....	80	Clark, A. R.....	121
Arakawa, Y.....	293	Colbert, L. O.....	157
Argentière, Rômulo.....	309	Collins, T. L., Jr.....	235
Armbrust, B. F., Jr.....	307	Comstock, S. S.....	317
Asano, Shûzô.....	51	Coron, Suzanne.....	203
Ault, W. U.....	244	Cortes, H. C.....	151
		Cowper, G.....	236
Bacon, L. O.....	118	Crosthwait, L. B.....	300
Baird, P. D.....	166	Cruikshank, A. J.....	236
Ball, G. M.....	180	Custodio de Moraes, J.....	214
Baranov, V. I.....	330		
Barenboym, M. I.....	338	Davidson, C. F.....	18, 322
Barsukov, O. M.....	127	Davydov, B. I.....	221
Báth, Markus.....	222	Day, A. A.....	196
Beals, C. S.....	158	De Bremeaeker, J. Cl.....	57
Beer, K. E.....	327	Denson, M. E., Jr.....	153
Belluigi, Arnaldo.....	108, 115, 116	Deutsch, Sarah.....	306
Bendefy, László.....	182	Dewan, J. T.....	318
Bennema, J.....	233	Dobrin, M. B.....	100, 144
Bereza, G. V.....	351	Doell, R. R.....	268
Berzon, I. S.....	333	Doke, Tadayoshi.....	302
Besairie, Henri.....	14	Donohoo, H. V. W.....	145
Bisby, H.....	320	Dowling, J. J.....	69
Black, R. A.....	152	Driver, G. E.....	241
Blackwell, J. H.....	219	Drysdale, W. S.....	368
Bod, Magdolna.....	141	Due Rojo, Antonio.....	21
Bøgvad, R.....	216	Dyer, W. B.....	193
Bondam, J.....	216	Dyk, Karl.....	344
Bonini, W. E.....	188		
Bowie, S. H. U.....	322, 327	Eason, G.....	78
Boyle, T. L.....	328	Eaton, J. P.....	383
Bradley, W. C.....	6	Eckermann, H. von.....	19
Brannon, H. R., Jr.....	316	Egedal, J.....	249
Broding, R. A.....	137	Egyed, László.....	172
Brown, R. M.....	240	Emiliani, Cesare.....	243
Brundage, H. T.....	281	Engineering and Mining Journal.....	117
Brynjólfsson, Ari.....	269	Erkel, András.....	141
Bulanehe, Yu. D.....	184	Evans, H. T., Jr.....	10
Burdon, D. J.....	270	Evison, F. F.....	366
Burwash, R. A.....	13	Ewing, Maurice.....	62, 207, 228, 287
Butterlin, Jacques.....	229		
Bycroft, G. N.....	77	Fair, D. R. R.....	310
Byus, Ye. I.....	29	Falini, Filippo.....	200
		Fanselau, Gerhard.....	258
Cahen, Lucien.....	381	Fedynskiy, V. V.....	147
Carabelli, E.....	149	Feely, H. W.....	244
Carey, S. W.....	163, 165	Förtsch, Otto.....	169
Carpenter, E. W.....	120	Franklin, E.....	320
Cattala, Louis.....	204		

	Abstract		Abstract
Frantti, G. E.	209	Ichikawa, M.	36, 56
Fredriksson, Kurt.	373	Iida, Kumizi.	80, 155, 234
Fritsch, Volker.	128	Imbò, Giuseppe.	375, 376
Fritze, K.	294	Innes, M. J. S.	158
Frohlich, Friedrich.	258	Ippolito, Felice.	326
Fuchida, Takato.	138	Isaacs, K.	282
Fulton, J.	78	Isakova, L. I.	263
		Ishkov, P. K.	81
Gálfi, János.	362	Ivanhoe, L. F.	347, 348
Garland, G. D.	191, 192		
Garvitch, Z. S.	218	Jacobs, J. A.	211
Gapskiy, V. N.	55	Jaffe, H. W.	10
Gellert, Ferenc.	362	Jarmell, Sol.	210
Gerard, V. B.	255	Jarovoy, Michel.	295
Gerasimov, I. P.	50	Jitsukawa, Akira.	201, 202
Gerling, E. K.	16	Joesting, H. R.	150
Gibbs, H. S.	312		
Gidon, Paul.	363	Kametani, Takuya.	341
Gill, E. D.	4	Kanai, Kiyoshi.	46, 63
Gloden, Albert.	203	Kaneko, Tetsuichi.	353, 360
Goguel, Jean.	173, 175	Karapetyan, N. K.	31
Goldman, J. E.	260	Kárník, Vít.	58
Golenetskiy, S. I.	55	Karplus, W. J.	135
Gorshkov, G. S.	379	Kashpur, Ya. N.	217
Gott, G. B.	308	Kato, Yoshio.	247
Gottfried, David.	11	Katō, Yoshio.	280
Grabovskiy, M. A.	263, 264, 275	Kats, A. Z.	47, 64
Groshevoy, G. V.	103	Katz, J. J.	245
Grummitt, W. E.	236, 240	Katz, Samuel.	228, 230
Gsell, R. N.	151	Kennel, J. M.	96
Guedes, S. V.	329	Kertz, Walter.	253
Gurevich, G. I.	38, 76, 162, 220	Keylis-Borok, V. I.	84
Gutenberg, Beno.	72	Khalevin, N. I.	369
Gwinner, M. P.	25	Khovanova, P. I.	101
		Kilcer, Gyula.	345, 346
Haáz, I. B.	177	Kimura, Koichi.	114
Habberjam, G. M.	120	Kintanar, R. L.	28
Hahn, Otto.	1	Kirillova, I. V.	30
Hale, F. H.	327	Kishi, Haruo.	143
Hammer, Sigmund.	146	Kishinouye, Fuyuhiko.	45
Hansen, Miller.	290	Kiyono, Takeshi.	114, 122
Harrison, J. C.	206	Kleyn, A. H.	352
Haseba, T.	59	Kobayashi, Keiichi.	114
Hasegawa, Hiroshi.	42	Kohman, T. P.	314
Hasegawa, Kazuo.	131	Kolosenko, M. N.	53
Hatsuda, Zinichiro.	325	Komarov, S. G.	136
Hattori, Yasumasa.	364	Kosminskaya, I. P.	79, 85, 332
Hayakawa, Masami.	361	Kostic, V.	321
Hayashi Hajime.	154	Kruglyakova, G. I.	265
Hector, F. S.	254	Kulakova, L. S.	377
Hée, Arlette.	295	Kulp, J. L.	244
Helbig, K.	82	Kume, Shoichi.	262
Hellbardt, G.	367	Kunetz, Géza.	119
Higuti, T.	68	Kunori, Shoichi.	124
Hill, H. J.	142	Kurata, Nobuo.	130
Hill, M. N.	374	Kuroda, P. K.	12, 307
Hodgson, J. H.	60, 158, 227	Kutasheva, E. V.	37
Hoekstra, H. R.	245		
Holmes, Arthur.	14	Lang, A. H.	324
Horne, J. E. T.	18	Larsen, E. S., Jr.	11
Houtermans, F. G.	306	Latta, T. E.	315
Howe, H. H.	110	Laubscher, H. P.	370
Howells, H.	310	Lauterbach, Robert.	286
Hughes, D. S.	96, 97	LeBorgne, Eugène.	271
Humphrey, R. W.	301	Leighton, M. M.	7
Hurley, P. M.	11, 297, 298	Lenoble, André.	323

	Abstract		Abstract
Leric, C. M.....	148	Opdyke, N. D.....	272
Levi, Hilde.....	2	Opp, A. G.....	289
Li, Y.-Y.....	259	Ormea, G. B.....	354
Lisowski, Bolesław.....	251	Osada, Kaio.....	63
Loewe, Fritz.....	167	Osoba, J. S.....	316
Lopes Paradela, Pedro.....	358	Ossaka, Joyo.....	384
Lotze, Franz.....	22	Ossaka, Justo.....	247
Lozano Calvo, Luis.....	185	Ostle, D.....	327
Lyubimova, Ye. A.....	212	Ostrovskiy, M. I.....	274
Lyustikh, Ye. N.....	171, 197, 232, 380	Oszlaczky, Szilárd.....	176
		Ozawa, Takeo.....	131
McCallum, G. J.....	3, 312	Özdoğan, İhsan.....	257
Macdonald, G. A.....	383	Ozerskaya, M. L.....	231
MacFadyen, D. A.....	329		
Madill, R. G.....	158	Pakisier, L. C.....	355
Magnitskiy, V. A.....	223	Pasechnik, I. P.....	66
Makino, Naofumi.....	113	Pekeris, C. L.....	88
Manfredini, Antonio.....	129	Petrova, G. N.....	263, 264, 283
Manley, Horace.....	270	Petrovic, M.....	321
Marshall, C. E.....	190	Petrushevskiy, B. A.....	49
Martin, G. R.....	242	Phillips, G. A.....	256
Martynova, T. A.....	274	Picciotto, E. E.....	306
Matorina, T. V.....	65	Pierce, A. P.....	308
Matschinski, Matthias.....	83, 159	Piyp, B. L.....	379
Matsuda, Takeo.....	186	Polshkov, M. K.....	351
Matsuzawa, Akira.....	178	Ponsford, D. R. A.....	311
Matuzawa, Takeo.....	39, 42	Popov, E. I.....	184
Maurette, Christian.....	97	Poritsky, H.....	111
Mayne, K. I.....	239	Posgay, Károly.....	337
Meek, J. H.....	254	Press, Frank.....	62, 100
Meisser, Otto.....	284	Puehkov, S. V.....	47
Melchior, P. J.....	71	Pudovkin, I. M.....	248
Melchiori, Jorge.....	291	Purkayastha, B. C.....	242
Mikov, D. S.....	278	Puzyrev, N. N.....	339
Milburn, J. D.....	142		
Miller, E. T.....	287	Quema, J. C.....	28
Milne, W. G.....	23		
Milojevic, A.....	321	Raman, C. V.....	93
Molodenskiy, M. S.....	224	Reiter, Reinhold.....	303
Morelli, Carlo.....	174	Rikhter, V. G.....	377
Morimoto, Ryōhei.....	384	Rikitake, Tsuneji.....	246
Mukherjee, S. M.....	27	Rocha Gomes, A. A.....	132
Müller, Iván.....	170	Roquet, Juliette.....	266
Munk, W. H.....	73	Rose, J. C.....	188
Münlich, K. O.....	5	Ross, J. E. R.....	160
Munuera Quiñonero, Jose.....	252	Rourke, F. M.....	235
Murai, Isamu.....	94	Rudnick, Philip.....	74
Murphy, Thomas.....	287	Ruhe, R. V.....	7
Mytton, J. W.....	308	Rummerfield, B. F.....	137
		Runcorn, S. K.....	272, 273
Nakabayashi, Kazutaka.....	124	Russell, R. D.....	313
Narain, H.....	190		
Nechay, A. M.....	134	Sakakura, A. Y.....	296
Nersesov, I. L.....	161	Salter, R. E.....	359
Nikitin, P. N.....	37	Santo Akima, Tetsuo.....	61
Noguchi, Takashi.....	123	Sarraffian, G. P.....	349
		Sasa, Kenzo.....	365
Oborina, S. F.....	65	Sasaki, Tsuneo.....	361
Ochiai, Toshiro.....	131	Satō, Konosuke.....	156
Officer, C. B., Jr.....	372	Satō, Yasuo.....	40, 89, 90, 92, 181, 342
Ogawara, M.....	48	Sauer, Walther.....	24
Okuda, Mitsunao.....	247	Savarenskiy, Ye. F.....	65, 226
Omote, Syun'itōro.....	331	Scheidegger, A. E.....	164
Onozaki, S.....	68	Schumacher, E.....	15

	Abstract		Abstract
Schumann, G.	304	Tikhonov, A. N.	104, 107
Schuyler, G. L.	292	Tilton, G. R.	9
Schwarzbach, M.	5	Toulis, W. J.	98
Sebestyén, Károly	102	Tribalto, Giuseppe	198
Sédy, Loránd	362	Tskhakaya, A. D.	34
Shakhshvarov, D. N.	104	Tsuboi, Chuji	187, 201, 202
Sharp, R. P.	166	Tsukada, Tadashi	131
Shebalin, N. V.	67	Urey, H. C.	213
Shibatō, Kihel	124, 143	Urquhart, H. M. A.	260
Shillibeer, H. A.	13	Uyeda, Seiya	287
Shimazu, Yasuo	225	Válek, Rostislav	195
Shimozuru, Daisuke	94, 95, 371	Vaněk, Jiří	58
Shokin, P. F.	183	Van Nostrand, R. G.	144
Shumway, George	99	Vassy, Étienne	305
Shurbet, G. L.	189, 207	Vidal, H.	169
Silva, F. J. da	132	Vlodavets, V. I.	378
Sima, Hiromu	86	Voyutskiy, V. S.	356
Skuridin, G. A.	75	Vvedenskaya, N. A.	33, 52
Slutskovskiy, A. I.	351, 356	Wada, Tatsuhiko	234
Smith, D. O.	261, 276	Wait, J. R.	105, 106, 110, 112
Smith, M. K.	343	Waldie, A. D.	357
Smith, O. J. M.	135	Warrick, R. E.	355
Sneddon, I. N.	78	Waters, G. S.	256
Sokhranov, N. N.	136	Webb, John	215
Solov'yev, S. L.	41	Weber, Max	336, 340
Solov'yev, V. N.	70	Wegener, Kurt	168
Stackler, W. F.	179	Weyl, Richard	382
Stead, F. W.	319	White, F. A.	235
Stern, T. W.	20	Wickman, F. E.	19, 237
Stieff, L. R.	20	Wilckens, Friedrich	125
Stoneley, R. S.	87	Wilkening, M. H.	299
Strakhov, V. N.	277	Winsberg, Lester	238
Strassmann, F.	294	Woods, J. P.	350
Stuart, M. R.	140	Woollard, G. P.	188
Subbotin, M. I.	161	Worzel, J. L.	189
Suess, H. E.	8	Yamaguchi, Rinzo	92
Suyama, Junji	126	Yamaguti, Seiti	44
Suzuki, Tomisaburo	46	Yepinat'yeva, A. M.	335
Suzuki, Ziro	86	Yokoyama, Izumi	250, 288
Tajima, Eizo	302	Yoshizawa, Shizuyo	63
Tajima, Hirokazu	201, 202	Yüngül, Sulhi	208
Takagi, Shinichiro	143	Yurkevich, O. I.	32
Takahasi, Takehito	91	Zaccara, Gaetano	199
Tamano, Toshiro	360	Zavaritskiy, A. N.	379
Tanaevsky, Olga	305	Zmuda, A. J.	279
Tandon, A. N.	26, 27	Zvolinskiy, N. V.	75
Taylor, D.	320		
Tazime, Kyozi	331, 353		
Terrones L., A. J.	133		



