Geophysical Abstracts 152 January–March 1953

(Numbers 14184–14388)

GEOLOGICAL SURVEY BULLETIN 1002-A

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By MARY C. RABBITT, S. T. VESSELOWSKY, *and others*

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

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GEOPHYSICAL ABSTRACTS 152, JANUARY–MARCH 1953

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GENERAL INFORMATION

Geophysical Abstracts attempts to provide informative abstracts of published material on the physics of the solid earth, the application of physical methods and techniques to geologic problems, and geophysical exploration. Related material of interest to individual geophysicists will also be found in other abstracting journals such as the Bibliography of Seismology, Chemical Abstracts, Meteorolgical Abstracts, Nuclear Science Abstracts, and Physics Abstracts.

The form of the bibliographic reference is believed to be self-explanatory. Abbreviations of journal titles are given in the List of Journals on succeeding pages. Unless specifically indicated otherwise, the language in which the article is written is the same as that given in the title. The system of transliteration used by the United States Board on Geographic Names is employed for transliteration of Russian names and titles. Translations of author's abstracts are indicated as "Author's Abstract" followed by the initials of the translator.

Geographic names included within parenthesis are those recommended by the Board on Geographic Names.

ABSTRACTORS

Geophysical Abstracts are prepared and compiled under the direction of Mary C. Rabbitt. Patent information is compiled by Louis C. Pakiser, Jr. Other abstracts in this issue have been prepared by the following: James R. Balsley, David F. Barnes, P. Edward Byerly, William J. Dempsey, Henry Faul, Roland G. Henderson, Henry R. Joesting, George V. Keller, S. T. Vesselowsky, Isidore Zietz.

LIST OF JOURNALS

The following list gives the full title of journals referred to in Geophysical Abstracts. The sponsoring organization and place of publication are also given where they are not part of the journal title. Changes and additions to this list will be published in succeeding issues.

Abbreviation	*Publication*
Acad. Aboensis Acta	Acta Academiae Aboensis. Abo, Finland.
Acad. Japan Proc	Proceedings of the Japan Academy. Tokyo.
Acad. Malgache Bull	Bulletin de l'Académie Malgache. Tananarive.
Acad. Royale Belgique Bull., Cl. Sci	Bulletin de la Classe des Sciences de l'Académie Royale de Belgique. Brussels.
Acad. Sci. Fenn. Annales	Annales Academiae Scientarum Fennicae. Helsinki.
Acad. Sci. Paris Comptes Rendus	Comptes Rendus Hebdomadaires des Séances de l'Académie des Sciences. Paris.
Accad. sci. fis. et mat. Napoli Rend	Rendiconti dell'Accademia delle scienze fisiche et matematiche. Societa nazionale di scienze, letteri ed arti in Napoli. Naples.
Acta Technica Acad. Sci. Hungaricae	Acta Technica Academiae Scientarum Hungaricae. Budapest.
Akad. Nauk SSSR Doklady	Akademii Nauk SSSR Doklady. Moscow.
Akad. Nauk SSSR Geofiz. Inst. Trudy	Akademii Nauk SSSR Geofizicheskii Institut Trudy. Moscow.
Akad. Nauk SSSR Izv. Ser. geofiz., Ser. geol., and Ser. fiz.	Akademii Nauk SSSR Izvestiya Seriya geofizicheskaya, Seriya geologicheskaya, Seriya fizicheskaya. Moscow.
Akad. Nauk SSSR Ural'skiy filial Trudy Gorno-Geol. Inst.	Academii Nauk SSSR Ural'skogo filiala Trudy, Seriya geologicheskikh nauk.
Am. Assoc. Petroleum Geologists Bull	Bulletin of the American Association of Petroleum Geologists. Tulsa, Okla.
Am. Geophys. Union Trans	Transactions American Geophysical Union. Washington, D. C.
Am. Inst. Min. Metall. Eng. Trans	Transactions of the American Institute of Mining and Metallurgical Engineers. New York.
Am. Jour. Sci	American Journal of Science. New Haven, Conn.
Am. Meteorol. Soc. Bull	Bulletin of the American Meteorological Society. Boston, Mass.
Am. Scientist	American Scientist. Society of the Sigma Xi. New Haven, Conn.
Annales des Mines	Annales des Mines. Paris.
Annales Géophysique	Annales de Géophysique. Centre Nationale de la Recherche Scientifique. Paris.
Annali Geofisica	Annali di Geofisica. Instituto Nazionale de Geofisica. Rome.
Archives des Sciences (Genève)	Archives des Sciences. Société de physique et d'histoire naturelle de Genève.

Abbreviation	*Publication*
Archiv Meteorologie [Geophysik u. Bioklimatologie].	Archiv für Meteorologié, Geophysik und Bioklimatologie. Wien.
Arkiv Geofysik	Arkiv för Geofysik. K. svenska vetenskaps akademien. Stockholm.
Atmos. Terrest. Physics Jour	Journal of Atmospheric and Terrestrial Physics. Pergamon Press, Ltd., London.
Australian Jour. Sci	Australian Journal of Science. Science House, Sydney.
Braunkohle Wärme und Energie	Braunkohle Wärme und Energie. Düsseldorf.
British Jour. Applied Physics	British Journal of Applied Physics. Institute of Physics, London.
Bull. géod.	Bulletin géodésique. International Association of Geodesy. Paris.
Bull. volcanolog.	Bulletin volcanologique. International Association of Volcanology. Naples.
Butsuri-Tanko (Geophys. Explor.)	Butsuri-Tanko (Geophysical Exploration) Society of Exploration Geophysicists of Japan, Kawasaki.
Canadian Inst. Min. Metallurgy Trans.	Transactions of the Canadian Institute of Mining and Metallurgy. Montreal.
Canadian Jour. Physics	Canadian Journal of Physics. Ottawa.
Canadian Min. Jour	Canadian Mining Journal. Gardenvale, Quebec.
Canadian Min. Metall. Bull	Canadian Mining and Metallurgical Bulletin, Montreal.
Chem. Metall. Min. Soc. South Africa Jour.	Journal of the Chemical Metallurgical and Mining Society of South Africa. Johannesburg.
Deutschen Akad. Wiss. Berlin Sitzungsber. Kl. math. naturw.	Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin. Klasse für mathematik und allgemeine naturwissenschaften.
Dominion Observatory Ottawa Pubs.	Publications of the Dominion Observatory. Ottawa.
Dublin Inst. for Advanced Studies, Geophys. Mem.	Geophysical Memoirs. Dublin Institute for Advanced Studies. School of Cosmic Physics. Dublin.
Econ. Geology	Economic Geology. Society of Economic Geologists. Urbana, Ill.
Eng. Min. Jour	Engineering and Mining Journal. McGraw Hill Publishing Co. New York.
Erdöl u. Kohle	Erdöl und Kohle, Berlin.
Földtani Közlöny	Földtani Közlöny. Magyar Földtani Társulat [Hungarican Geological Society.] Budapest.
France Bur. Recherches géol. et géophys. Pub.	Publications of the Bureau des Recherches géologiques et géophysiques. Paris.

Abbreviation	*Publication*
Geochimica et Cosmochimica Acta. Pergamon Press Ltd., London.	Magyar Földtani Társulat [Hungarican Geological Society.] Budapest. Geochimica et Cosmochimica Acta.
Geofisica Pura e Appl.	Geofisica Pura e Applicata. Milan.
Geofys. Pub.	Geofysiske Publikasjoner. Norske Videnskap Akademii. Olso.
Geog. Survey Inst. Japan Bull.	Bulletin of the Geographical Survey Institute. Tokyo.
Geol. Assoc. Canada Proc.	Proceedings of the Geological Association of Canada. Ottawa.
Geol. Fören. Stockholm Förh.	Geologiska Föreningens Stockholm Förhandlingen. Stockholm.
Geologie en Mijnbouw.	Geologie en Mijnbouw. Koninklijk Nederlandsch Geologisch Mijnbouwkundig Genootschap. The Hague.
Geol. Soc. America Bull.	Bulletin of the Geological Society of America. New York.
Geol. Soc. Japan, Bull.	Bulletin of Geological Society of Japan. Tokyo.
Geol. Soc. London Quart. Jour.	Quarterly Journal of the Geological Society of London. London.
Geol. Soc. South Africa Trans. and Proc.	Transactions and Proceedings of the Geological Society of South Africa. Johannesburg.
Geol. Survey Japan Bull.	Bulletin of the Japan Geological Survey. Tokyo.
Geophysics	Geophysics. Society of Exploration Geophysicists. Tulsa, Oklahoma.
Geophys. Mag.	Geophysical Magazine. Central Meteorological Observatory. Tokyo.
Gerlands Beitr. Geophysik.	Gerlands Beiträge zur Geophysik. Leipzig.
Glückauf	Glückauf - Bergmannische Zeitschrift. Essen.
Greece Inst. Geol. Ereunon Upedaphous Geol. Anag. Rept.	Institouton Geologias kai Ereunon. Upedaphous Geologikai Anagnoriseis. (Institute of Geology and Subsurface Research Geological Reconnaissance Report).
Greece Uperesia Ereunon Upedaphous Ereunai oruktou ploutou tes Ellados.	Greece. Uperesia Ereunon Upedaphous (Subsurface Research Department) Ereunai oruktou ploutou tes Ellados (The mineral wealth of Greece). Athens.
Indian Jour. Meteorology and Geophysics.	Indian Journal of Meteorology and Geophysics. New Delhi.
Inst. Geog. y Catastral Mem.	Memorias del Instituto Geografico y Catastral. Madrid.
Inst. Royal Colonial Belge Bull.	Institut Royal Colonial Belge Bulletin des Seances. Brussels.

Abbreviation	*Publication*
Isostatic Inst. Pub	Publications of the Isostatic Institute of the International Association of Geodesy. Helsinki.
Istanbul Univ. Fakultesi Mecmuasi	Istanbul Universitesi fen Fakultesi Mecmuasi. Istanbul.
Japanese Jour. Astronomy	Japanese Journal of Astronomy. Science Council of Japan. Tokyo.
Jour. Applied Physics	Journal of Applied Physics. American Institute of Physics. New York.
Jour. Geomagnetism and Geoelectricity	Journal of Geomagnetism and Geoelectricity. Kyōto, Japan.
Jour. Geophys. Research	Journal of Geophysical Research. Washington, D. C.
Jour. Petroleum Technology	Journal Petroleum Technology. American Institute of Mining and Metallurgical Engineers. New York.
Jour. Physique et Radium	Journal de Physique et le Radium. Paris.
Jour. Sci. Instruments	Journal of Scientific Instruments. Institute of Physics. London.
K. Danske Vidensk. Selsk. Mat.-fys. Meddel.	Det Kongelige Danske Vedenskahernes Selskab Matematisk-fysiske Meddelelser. Kobenhavn.
K. Nederland. Akad. Wetensch. Proc	Proceedings Koninklijke Nederlandse Akademie van Wetenschappen. Amsterdam.
Kyoto Univ. Faculty Eng. Mem	Memoirs of the Faculty of Engineering, Kyoto University.
La Ricerca Sci	La Ricerca Scientifica. Rome.
Mines Mag	Mines Magazine. Colorado School of Mines, Denver, Colo.
Mining Engineering	Mining Engineering. American Institute of Mining and Metallurgical Engineers. New York.
Mining Mag	Mining Magazine. Mining Publications Ltd. London.
Nat. Acad. Sci. Proc	Proceedings of the National Academy of Sciences. Washington.
Nature	Nature. Macmillan and Co. London.
New York Acad. Sci. Trans	Transactions of the New York Academy of Sciences. New York.
New Zealand Dept. Sci. Indus. Research Geophys. Mem.	Department of Scientific and Industrial Research Geophysical Memoirs. Wellington.
New Zealand Jour. Sci. Technology	New Zealand Journal of Science Technology. Department of Scientific and Industrial Research. Wellington.
Nucleonics	Nucleonics. McGraw-Hill Publishing Company. New York.

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Abbreviation	*Publication*
Oil and Gas Jour	Oil and Gas Journal. Petroleum Publishing Co. Tulsa, Okla.
Osservatorio Geofis. Trieste Pub	Osservatorio Geofisico Trieste Pubblicazione. (Reprints from scientific journals.)
Padova Univ. Ist. geod. e geofis. Pub	Istituto geodetico e geofisico Padova Universita Pubblicazione. (Reprints from scientific journals.)
Państwowy Inst. Geol. Biul	Państwowy Instytut Geologiczny. Warsaw.
Petroleum Engineer	Petroleum Engineer Publishing Company. Dallas, Tex.
Philos. Mag	Philosophical Magazine. Taylor and Francis. London.
Phys. Soc. London Proc	Proceedings of the Physical Society. London.
Physics today	Physics today. American Institute of Physics. New York.
Phys. Rev	Physical Review. American Institute of Physics. New York.
Potsdam geod. Inst. Veroffentl	Potsdam geodätisches Institut. Veroffentlichen. Berlin Akademie Verlag.
Precambrian	Precambrian. Winnipeg, Manitoba.
Priroda	Priroda. Akademiya Nauk SSSR. Moscow.
Producers Monthly	Producers Monthly. Bradford District Pennsylvania Oil Producers Association. Bradford, Pa.
R. Acad. Cien. y Artes de Barcelona Observatorio Fabra Bol	Real Academia de Ciencias y Artes de Barcelona, Sección Meterológica sismica del Observatorio Fabra Boletín. Barcelona.
Rev. gén. sciences pures et appl	Revue générale des sciences pures et appliquées. Societé d'Édition d'Enseignement supérieur. Paris.
Rev Geofísica	Revista de Geofísica. Madrid.
Rev. géomorphologie dynamique	Revue de géomorphologie dynamique. Strasbourg.
Rev. Sci. Instruments	Review of Scientific Instruments. American Institute of Physics. New York.
Riv. Geofisica Appl	Rivista da Geofisica Applicata. Milan.
Royal Astron. Soc. Monthly Notices Geophys. supp	Monthly Notices of the Royal Astronomical Society. Geophysical Supplement. London.
Royal Soc. Canada Trans	Transactions of the Royal Society of Canada. Ottawa.
Royal Soc. London Philos. Trans	Philosophical Transactions of the Royal Society. London.

Abbreviation	*Publication*
Royal Soc. London Proc	Proceedings of the Royal Society. London.
Royal Soc. New South Wales Jour. and Proc	Journal and Proceedings of the Royal Society of New South Wales. Sydney.
Science	Science. American Association for the Advancement of Science. Washington.
Sci. Am	Scientific American. New York.
Seismol. Soc. America Bull	Bulletin of the Seismological Society of America. Berkeley, Calif.
Servizio geol. Italia Boll	Bollettino del Servizio geologico d'Italia. Rome.
Soc. belge géologie Bull	Bulletin de la Société Belge de géologie, de paléontologie, et d'hydrologie. Bruxelles.
Soc. géol. France Bull	Bulletin de la Société géologique de France. Paris.
Tellus.	Tellus. Svenska Geofysiska Föreringer. Stockholm.
Tohoku Univ. Sci. Repts	Tohoku University Science Reports. Sendai.
Tokyo Univ. Earthquake Research Inst. Bull.	Bulletin of the Earthquake Research Institute, Tokyo University. Tokyo.
Tokyo Univ. Geophys. Inst. Geophys. Notes.	Geophysical Notes, Geophysical Institute, Tokyo University. Tokyo.
Türkiye Jeoloji Kurumu Bülteni	Türkiye Jeoloji Kurumu Bülteni. Ankara.
Univ. Brasil Escola de minas Rev	Revista da Escola de Minas Universidad de Brasil.
U. S. Bur. Mines Inf. Circ.; Rept. Inv	United States Bureau of Mines Information Circular; Report of Investigations. Washington.
U. S. Bur. Reclamation Geology Rept	United States Bureau of Reclamation Geology Report.
U. S. Coast and Geod. Survey Serial; Special Rept.	United States Coast and Geodetic Survey Serial; Special Report. Washington.
U. S. Geol. Survey Bull.; Circ.; Prof. Paper.	United States Geological Survey Bulletin; Circular; Professional Paper. Washington.
Western Australia Geol. Survey Bull	Western Australia Geological Survey Bulletin. Perth.
World Oil	World Oil. Gulf Publishing Co. Houston, Tex.
World Petroleum	World Petroleum. New York.
Zurich Inst. Geophysik Mitt	Eidgenössische Technische Hochschule Zurich Mitteilungen aus dem Institut für Geophysik.

GRAVITY

GENERAL AND THEORETICAL STUDIES, INCLUDING THOSE ON ISOSTASY

14184. Woollard, George Prior. The earth's gravitational field and its exploitation *in* Advances in Geophysics, v. 1, p. 281–311, New York, Academic Press, 1952.

This is a review of gravity measurements and their uses in both geodetic and geologic studies.—*M. C. R.*

14185. Heiskanen, W. The geophysical applications of gravity anomalies: Am. Geophys. Union Trans., v. 34, no. 1, p. 11–15, 1953.

This is a discussion of the uses and abuses of gravity anomalies in such geophysical applications as studies of isostasy, thickness of the crust, and behavior of the earth's interior.—*M. C. R.*

14186. Marussi, Antonio. Sulla curvatura e torsione del campo di gravita [The curvature and torsion of the gravitational field]: Annali Geofisica, v. 5, no. 2, p. 201–207, 1952.

Mathematical definitions of the curvature and torsion of the gravitational field of the earth are given, and equations are derived of the loci having zero curvature and zero torsion. The possibility of determining these quantities by measurements with the Eötvös torsion balance as well as of finding them from geodetic observations is explained.—*S. T. V.*

14187. Berroth, Alfred. Anwendungen des Tannischen Geoids auf Deutschland [Application of Tanni's geoid to Germany]: Gerlands Beitr. Geophysik, Band 61, Heft 4, p. 250–256, 1950.

Studies by Tanni on the continental undulations of the geoid and the regional rise of the geoid in central Europe (see Geophys. Abs. 11916 and 11917), presenting the results of the application of Stoke's formula to all available gravity measurements, are discussed. From these data, level lines were constructed on corresponding maps. Berroth concentrates his attention on the data referring to Germany as presented on the map of central Europe, emphasizing the very regular variation of level lines, ranging from +5.0 m in Sweden to +45.0 m in northern Africa, which increases the accuracy of interpolations for individual points.

Comparison is made between the data of Tanni's map and those of other geophysicists. Certain discrepancies are noted, but on the whole the regional shape of the geoid, as determined by Tanni, is to be considered as nearly correct. Future gravitational surveys will only increase the precision.—*S. T. V.*

14188. Egyed, L[ászlo]. Some notes concerning the question of isostasy: Acta Technica Acad. Sci. Hungaricae, tomus 4, fasc. 1–4, p. 75–84, 1952.

Assuming in principle the Airy-Heiskanen hypothesis of isostatic equilibrium, but also that: the earth's crust consists of two layers of different density; is partly covered with sediments of several kilometers thickness of a density less

than 2.67; has a certain rigidity; and that the depth of the equilibrium layer is about 50 km; and taking for the different layers the following densities: ocean water, 1.03; sedimentary layer, 2.40; granitic layer, 2.70; gabbroic layer, 3.00; peridotitic magma, 3.30, the following values for the pressure at a depth of 50 km are computed: at Helgoland 1,5290 kg per cm^2; at Haslach 1,5276 kg per cm^2; and under Atlantic Ocean 1,5287 kg per cm^2.

Similar computations show that over most of the earth's surface isostatic equilibrium exists. According to Egyed such equilibrium is impossible for oceanic areas deeper than 6 km. Such deep depressions form an unstable belt characterized by earthquakes, active volcanoes and isostatic anomalies.—*S. T. V.*

14189. Aquilina, C[armelo]. Le principali ipotesi sull' isostasia [The principal hypothesis of isostasy]: Annali Geofisica, v. 51, no. 3, p. 367–375, 1952.

This is a review of the Pratt, Airy, and Vening Meinesz theories of isostasy.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

14190. Gilbert, R. L. G. Gravity observations in a borehole: Nature, v. 170, no. 4523, p. 424, 1952.

Construction of a borehole gravimeter and preliminary tests in a borehole at Eakring, Nottinghamshire, are reported. The instrument is fundamentally a thin filament held in tension by a weight, with its transverse vibrations controlling the frequency of an electronic oscillator. The instrument and temperature control are housed in a pressure-tight steel container 5 in. by 8 ft. In the preliminary tests, the probable error was ±0.7 mgal; the error in density determinations ±1 percent compared with density determined in chip samples.—*M. C. R.*

14191. Erdöl und Kohle. Ein verbessertes Gravimeter [An improved gravimeter]: Jahrg. 6, Heft 1, p. 54, 1953.

An improved version of the Graf gravimeter is reported. This model has a wide scale and calibration arrangement which permits testing the instrumental constant in every part of the scale and unlike previous models is not an astatic instrument. A photoelectric arrangement increases the sensitivity of the gravimeter to better than 0.01 mgal. The instrument is thermally well insulated and is provided with adjustable thermostat.

According to E. Haalck who tested the new gravimeter its constant is better than 0.03 mgal per division of the scale; the average error of the first readings is about 0.01 mgal.—*S. T. V.*

14192. Heiland, C. A. Apparatus for aerogravimeter prospecting, U. S. patent 2,626,525, granted January 27, 1953. 4 claims.

An automatic leveling gravity measuring device adapted to be lowered to the ground from an aircraft for reading.

METHODS OF ANALYSIS AND INTERPRETATION

14193. Gougenheim, A. Étude pratique de la marée gravimétrique [Practical study of the gravimetric tide]: Bull. géod. no. 20, p. 170–188, 1951.

The gravimetric tide is defined as the oscillatory variation of gravity determined by continuous observation of gravity at one place by a high-sensitivity gravimeter.

Practical considerations of the making of such observations and their analysis and interpretation are considered in this paper.—*M. C. R.*

14194. Cizancourt, Henri de. Sur un mode de calcul des anomalies isostatiques [On a method of calculating isostatic anomalies]: Acad. Sci. Paris Comptes Rendus, tome 236, no. 8, p. 835–837, 1953.

A method of calculating isostatic anomalies based on the balancing of vertical tensions induced by topographic loads, in the hypothesis of relaxation, and the thrust due to the deformation of the adjacent medium, is presented. It defines the compensating masses without involving arbitrary coefficients and permits studying the physical nature of isostatic equilibrium or lack of equilibrium.—*Author's Abstract, M. C. R.*

14195. Lopez Arroyo, Alfonso. Calculo de los errores cometidos en las reducciones topografica e isostatica [Calculation of the errors associated with the determination of topographic and isostatic reductions]: Rev. Geofiisica, v. 11, no. 42, p. 173–178, 1952.

The three corrections applied to the gravity measurement when reducing it to a geoid surface, the free air, topographic, and isostatic corrections, are discussed and errors in their determination as affected by the procedure used, precision of available maps, geologic data, results of surveying, and other auxiliary data are analyzed. The precision of data necessary to attain the desired accuracy of reductions is also analyzed. In calculating isostatic reductions, auxiliary graphs are constructed to shorten the procedure.—*S. T. V.*

14196. Gel'fand, I. S. Pryamyye metody interpretatsii gravitatsionnykh i magnitnykh anomality ot dvukhmernukh tel [Direct methods of interpretation of gravitational and magnetic anomalies produced by two-dimensional bodies]: Akad. Nauk SSSR, Ural'skiy filial, Trudy Gorno-Geol. Inst., vypusk 19, Geofiz. sbornik 1, p. 51–63, 1950.

Formulas for direct interpretation of gravitational and magnetic anomalies, which give the mass of the disturbing body, position of its center, and other features, may be made more convenient for use by the simplification in the computations of pertinent integrals introduced here. (See also Geophys. Abs. 14092).—*S. T. V.*

14197. Rice, Donald A. Deflections of the vertical from gravity anomalies: Bull. géod., no. 25, p. 285–312, 1952.

Results are reported of an investigation by the U. S. Coast and Geodetic Survey of the accuracy with which deflections of the vertical can be obtained from analysis of gravity variations throughout a somewhat limited area. Data from about 40,000 gravity stations in an area of 800,000 sq mi were used. Agreements of the order of 1 second were obtained between astronomic-geodetic and gravimetric deflections using gravity fields limited to a radius of 150 km. In extension of the radius to 500 or 600 km, the gravimetric deflection changed by 1 to 2 seconds and at 600 km the gravimetric deflections appeared to approach absolute values within about 1 second. Residual differences are attributed to lack of adequate data outside the central area. Assuming the validity of gravity representation outside the central area, the latitude datum of the North American 1927 adjustment is about 1 second too large and the longitude datum is within about 0.3 second of the absolute value.—*M. C. R.*

14198. Aslakson, Carl I. Relative geoidal undulations from deflections of the vertical. Am. Geophys. Union Trans., v. 34, no. 1, p. 1–10, 1953.

Shoran trilateration in the Bahama Islands permits the determination of the deflection of the vertical with considerable accuracy. A striking correlation between deflections observed to date and both ocean-bottom gradients and free-air anomaly gradients suggests that deflection observations may be used in computing undulations of the geoid. Tanni's solution of the worldwide undulations indicates a geoidal rise of 3 meters between Cape Canaveral, Florida, and the ocean area east of southern Florida; the same value is obtained by the deflection method.—*M. C. R.*

OBSERVATION OF GRAVITY AND GRAVITY SURVEYS

14199. Sanders, P. Liaison gravimetrique Belgique-Congo belge [Gravimetric tying between Belgium and Belgian Congo]: Inst. Royal Colonial Belge Bull., tome 23, p. 905–918, 1952.

Absolute measurements of gravity were made at three base stations in the Belgian Congo, using bronze pendular apparatus of the Uccle observatory. The values obtained were: Léopoldville, 977919.0±0.9 mgal; Elisabethville, 977900.8± 0.7 mgal; Costermansville, 977601.5±0.8 mgal.—*S. T. V.*

14200. Coron, Suzanne. Valeur de la pesanteur à Paris déterminée à l'aide des liaisons internationales européennes [Value of gravity at Paris determined with the aid of European international ties]: Bull. géod., no. 16, p. 118–139, 1950.

The most probable value of gravity at Paris in the Potsdam system, calculated on the basis of old pendulum measurements and more modern gravimetric ties is indicated as not more than 980.9440 gals. The old value of 980.9430 gals will be retained as base of the French network.—*M. C. R.*

14201. Volet, Charles. Mésure de l'acceleration due à la pesanteur au Pavillon de Breteuil [Measurement of the acceleration of gravity at the Pavillon de Breteuil]: Acad. Sci. Paris Comptes Rendus, tome 235, no. 6, p. 442–444, 1952.

By the direct determination of the law of free fall of a body in vacuum, a value of g at "Point A" (48°49′45″ N. lat, 2°13′14″ E. long.) has been found which is 24 mgal less than that deduced in the Potsdam system. The average of 18 determinations was 980.916 gals.—*M. C. R.*

14202. Tomaschek, R. Tidal gravity observations at Winsford (Cheshire): Royal Astron. Soc. Monthly Notices, Geophys. supp. v. 6, no. 6, p. 372–382, 1952.

Tidal observations were made during April 1951 in the Imperial Chemical Industries, Ltd. salt mine at Winsford. The gravimetric factor was determined for both the over-all values and the principal harmonic constituents. There was no significant phase difference between the theoretical and observed curves. G' was determined as the weighted mean of regression coefficients of observed values upon the immediately nomographically determined values for hourly and half-hourly periods. The values of G' at Winsford is 1.20±0.04. Values of G' determined for constituents of the harmonic analysis yielded a mean of 1.20, an excellent agreement. The value is somewhat higher than that for Kirklington and Peebles (see Geophys. Abs. 13809, 13810.—*P. E. B.*

14203. Murphy, Thomas. Measurements of gravity in Ireland. Gravity survey of central Ireland: Dublin Inst. for Advanced Studies Geophys. Mem. 2, pt. 3, 31 p., 1952.

A gravity survey was made in central Ireland between the pendulum stations of Dublin and Galway, using a small Graf gravimeter. In all, 266 new stations were established. Bouguer anomalies range from −10 mgals near Galway to more than +40 mgals in the Carlingford peninsula, and are positive except in the Galway granite areas. Isostatic anomalies are also positive. Comparison of the Geological Survey's magnetic map and the gravity map indicates the low anomaly areas cannot be attributed to light sedimentary rocks and the possibility is suggested that the density of the lower Paleozoic or pre-Cambrian rocks is less than 2.67 g per cm^3 because of the existence of granite masses or granitization. Thirlway's suggestion that the Leinster granite extends westward beneath the Paleozoic sediments was confirmed, and the Galway granite was also found to be more extensive than the mapped outcrop. A large positive Bouguer anomaly north of Dundalk seems to be related to Tertiary igneous activity in the Carlingford peninsula. [See also Geophys. Abs. 12352 and 13104]—*M. C. R.*

14204. Cook, A. H., and Murphy, T[homas]. Measurements of gravity in Ireland. Gravity survey of Ireland north of the line Sligo-Dundalk: Dublin Inst. for Advanced Studies Geophys. Mem. 2, pt. 4, 36 p. 1952.

A gravity survey north of a line from Sligo to Dundalk extends Murphy's observations reported above. Values of gravity were determined at 350 stations to within ±0.4 mgal. The Bouguer anomalies are positive with a mean value of about 20 mgals except in two small areas of granite. Isostatic anomalies are also positive. Low Bouguer anomalies were found over granite, the density of which was measured as less than the surrounding rocks. The thicknesses of the larger granite masses are estimated to be between 14,000 and 43,000 ft. Large Bouguer anomalies in the Carlingford-Mourne area are attributed to bodies with densities of about 3.0 g per cm^3 at depths greater than 10,000 ft. A similarity between the Bouguer anomaly map and Wright's tectonic map of northeastern Ireland is pointed out.—*M. C. R.*

14205. Morelli, Carlo. Rilievo sperimentale gravimetrico-magnetico nell' avampaese dei Colli Euganei, Parte la. Misure eötyössiane e gravimetriche [Experimental gravimetric and magnetic exploration of the foreland of Colli Euganei, Part 1. Measurements with torsion balance and gravimeter]: Annali Geofisica., v. 3, no. 4, p. 523–566, 1950. Also in Padova Univ. Ist. geod. e geofis. Pub., nuova ser., no. 1–5. No date.

Gravimetric measurements in the plain bounded by Battaglía, Pontelongo and Ponte San Nicolò, made as a preliminary test of geophysical exploration of the foreland of Colli Euganei are reported. An Eötvös torsion balance, with Schweydar modifications in the design and equipped with photographic recording, was used at 20 stations, and 37 stations were occupied with the Western gravimeter. The results of gravimetric measurements confirm those obtained from the torsion balance survey; the agreement indicates the reliability of the determination of the elements of disturbing gravitational field. The applicability and advantages of the torsion balance of gravimeter are discussed with special reference to local conditions. Certain conclusions are suggested as to the roots of Colli Euganei from interpretation of the results.—*S. T. V.*

14206. Morelli, Carlo. Rilievo gravimetrico e riduzione isostatica nell Italia Nord Orientale [Gravimetric survey and isostatic reduction in northeastern Italy]: Tecnica Italiana, v. 6, nos. 3 and 4, 1951; reprinted in Univ. Padova, Ist. geod. e geofis., Pub. nuova ser., 6, 1951, and Osservatorio Geofis. Trieste Pub., no. 20, 1951.

A gravimetric survey of the northeastern part of Italy, north of the Po River and the east of longitude 10°10′ East was made during 1950–51. Of 181 stations included, 51 were reported by Cunietti in 1949–50 (see Geophys. Abs. 11931) 27 by Morelli in 1950 (see Abs. 12715), and the rest by Morelli in 1951. During 1951 a Worden gravimeter was used; during the 1949 and 1950 surveys a Western gravimeter was used. The astronomical observatory of Padua, [g=980.658 gal] was used as base station.

Airy-Heiskanen local anomalies were computed for equilibrium depths of compensation of 20, 30, 40 and 60 km. Assuming Vening-Meinesz hypothesis of regional isostatic equilibrium, the depth T was assumed equal to 30 km, with radii of affected regions of 29.05 km, 116.20 km, and 232.40 km. Probable values of density were taken from geologic maps of Italy.

It is pointed out that in spite of extreme care in computations and in measurements, a difference in assumed density of 0.4 involves an error in reduction of a station 1,000 m high above sea level of 17 mgal, making illusory the precision of initial measurements of ±0.3 mgal. No isostatic equilibrium extending over the whole area surveyed was found. The two main surfaces of seismic instability, found by Mintrop from the analysis of seismological data obtained from the Helgoland explosion of April 18, 1947, and Messina earthquake of December 28, 1908, corresponding to the maxima of gravitational gradient found here, suggesting the existence of discontinuities where isostatic equilibrium has not yet been reached.—*S. T. V.*

14207. Tribalto, Giuseppe, Zaccara, Gaetano and Beneo, Enzo. Misure gravimetriche nella Valle Latina (Lazio) con deduzioni geologiche [Gravimetric measurements in Valle Latina and their geologic interpretations]: Servizio geol. Italia Boll., v. 73, fasc. 2, p. 357–370, 1952.

This is a detailed report of a gravimetric survey in Valle Latina, Italy, consisting of 188 stations in an area of about 300 sq km. A western gravimeter was used, with Rome (g=980.3600 gal) as the base station. The surveyed area was divided into several closed polygons so that measurements were made twice at each station. Station altitudes were taken from precise geodetic maps or determined by topographic leveling. In computing Bouguer reductions, density values ranging from 1.9 to 2.3 were assumed in accordance with the geologic foundation of the stations.

The results of the survey are presented in a table and on four maps of Bouguer isoanomalies and residual gravity values. Geologic interpretations of the results are presented in a separate section.—*S. T. V.*

14208. Cooper, R. I. B., Harrison, J. C., and Willmore, P. L. Gravity measurements in the eastern Mediterranean: Royal Soc. London Philos. Trans., ser. A, v. 244, no. 889, p. 533–559, 1952.

During 1950 measurements of gravity at sea were made in the submarine *Talent* in the eastern Mediterranean. Forty-six stations were occupied in the neighborhood of Malta and [Isola di] Pantelleria, 73 stations in the part of the basin east of a line from Cape Matapan (Ákra Taínaron) to Benghazi (Bengasi)

and in the southern part of the Aegean sea, and 6 stations on 2 east-west lines between Malta and Crete. Measurements were also made in the harbors of Malta, Tunis, Famagusta, and Candia (Iráklion) and at 6 sea stations which had been occupied by previous observers. A critical discussion is given of the accuracy of the results, which are presented both in tabular form and as maps of isostatic anomalies. No attempt is made in this paper to interpret their significance.—*P. E. B.*

14209. Hofman, B. J. The gravity field of the West-Mediterranean area: Geologie en Mijnbouw, jaarg. 14, no. 8, p. 297–306, 1952.

Gravity profiles were computed on the basis of van Bemmelen's geologic map and profiles on indicated densities and compared with gravity measurements at sea, in Spain, northern Africa, France, Italy, and the Balkan Peninsula by different investigators. The agreement between the computed and measured profiles was close. An isogam map on a scale of 1 : 10,000,000 shows the Hayford-Bowie isostatic anomalies of the western Mediterranean area.—*S. T. V.*

14210. Hatherton, T. Gravity profiles across the Canterbury Plains: New Zealand Jour. Sci. Technology, sec. B, v. 34, no. 1, p. 13–20, 1952.

Four gravity profiles were run across the Canterbury Plains on the eastern coast of South Island, New Zealand. Extending seaward from this area is the Chatham Rise which separates the Kermadec Trench to the north from the Bounty Basin to the south. The gravity maps and profiles indicate a saddlelike configuration of the basement topography separating landward extensions of the structural trends of the Kermadec Trench and Bounty Basin. These extensions modify the general structure of the Canterbury Plains syncline. The basement in this area is greywacke, of apparent density 2.65, and is overlain by late Tertiary and Recent sediments with a mean density of 2.15.

Presumably the igneous rocks of Banks Peninsula do not affect the gravity distribution significantly for the basement density is said to be about 2.65.—*P. E. B.*

14211. Medi, Enrico, and Morelli, Carlo. Rilievo gravimetrico della Sicilia [Gravimetric survey of Sicily]: Annali Geofisica, v. 5, no. 2, p. 209–245, 1952.

This is a report on a gravimetric survey of Sicily in the spring of 1952. The network included 299 stations, of which 6 were of first order, and 7 of second. The principal instruments were 2 Worden gravimeters, accurately calibrated and tested before the measurements. The results of the survey are presented as a map of Bouguer anomalies that shows a wide negative anomaly in the central zone of the island and extending into the sea toward the south, surrounded by positive anomalies especially marked toward the southeast. The negative anomaly probably corresponds to a depression in which a great thickness of clays has accumulated. The depression is surrounded by a zone in which the dense substratum is close to the surface or at it in the southeastern part of the island. As the massive flows of Etna have almost no effect on the gravimetric anomalies, it can be concluded that they are confined to the outermost layers of the crust.—*S. T. V.*

14212. Crenn, Yvonne. Mesures gravimétriques en Nouvelle-Calédonie [Gravimetric measurements in New Caledonia]: Acad. Sci. Paris Comptes Rendus, tome 236, no. 1, p. 105–107, 1953.

A gravimetric survey of New Caledonia with about 1800 stations occupied, was made using a North American gravimeter. Nouméa [g=978.882 gals] was used as base station; topographic corrections were computed to a radius of 166 km from stations; density of 2.67 was assumed.

Results of the survey are presented as a map of Bouguer anomalies. The anomalies are all positive and range from 60 to 170 mgals. A minimum elongated parallel to the main axis of the island and increasing under the more mountainous terrain suggests at least partial isostatic compensation. Other anomalies may be associated with peridotitic rocks.—*M. C. R.*

14213. Murakami, Y., and Katayose, K. Gravitational prospecting at Honjo-Fujioka district, northwest side of Kantō plain [In Japanese with English summary]: Geol. Survey Japan Bull., v. 2, no. 11, p. 44–63, 1951.

A gravity survey of the northwest part of the Kantō plain indicated that in general the basement dips toward the north with some irregularities.—*M. C. R.*

14214. [Japan] Geophysical Exploration Department. Isogal map of western area in Tohoku region [in Japanese with English summary]: Geol. Survey Japan Bull., v. 3, no. 2, p. 50–51, 1952.

A gravity survey in parts of Aomori-ken and Akita-ken is described, and results presented as a map.—*M. C. R.*

14215. Chamberlain, N. G. Preliminary report on the geophysical survey of the Collie coal basin: Western Australia Geol. Survey Bull. no. 105, p. 157–163, 1952.

A gravimetric survey was made, using the Humble-Truman gravimeter, of an area of more than 100 sq mi, with 767 stations occupied.

The results of the survey are presented on a map with contour interval of 1 mgal. The configuration of the basin was clearly delineated by the survey.—*S. T. V.*

MAGNETISM

MAGNETIC FIELD OF THE EARTH

14216. Alsdradge, L. R. Keeping track of the earth's magnetic field: Physics today, v. 5, no. 11, p. 8–12, 1952.

This is a general review of the characteristics of the earth's magnetic field and methods of measuring it, including aeromagnetic surveys.—*M. C. R.*

14217. Baños, A. Jr., and Golden, R. K. The electromagnetic field of a rotating uniformly magnetized sphere: Jour. Appl. Physics, v. 23, no. 12, p. 1294–1299, 1952.

The problem discussed here is a first step towards a more complete understanding of the modern theories of geomagnetism which are based on the differential rotation of the earth's crust with respect to its inner core and on magneto-hydrodynamical effects in the core. This paper considers first the computation of the electric and magnetic fields that a stationary observer at-

tributes to a uniformly magnetized sphere which, in his frame of reference, rotates at constant angular velocity about an axis parallel to the direction of magnetization. It is found that, neglecting the terms of order v^2/c^2, the observed magnetic fields are identical to the fields of a stationary sphere, but in addition there is an external electric field identical to that produced by an axial quadrupole located at the origin. The interior electric field is directed towards the axis of rotation and its magnitude is proportional to the distance from the axis. Next, when the rotating magnet is surrounded by a stationary concentric shield, it is found that the electric fields vanish in the interior of the shield and in outer space in contrast to the results that one would find on the assumption that the shield was being "cut" by the lines of magnetic induction of the rotating magnet. Finally, the limiting case is considered in which the inner radius of the shield approaches the radius of the sphere, an insulating layer still being maintained between them. Here, again, no electric fields are found outside the rotating magnet.—*Authors' Abstract*

14218. Macht, H. G. Die Potentialanteile zweiter and höherer Ordnung des Erdmagnetfeldes [Contributions of the members of the second and higher order to the potential of the geomagnetic field] : Gerlands Beitr. Geophysik, Band 62, Heft 2, p. 127–153, 1952.

The nature and geophysical meaning of higher harmonics in the expansion of a potential function of the geomagnetic field is analyzed, especially that of the second order. An expansion of the potential function both in geographic and geomagnetic system of coordinates is carried out. The physical and purely analytical interpretation of the coefficients of this development is discussed, treating them as abstract multipoles.

The formal analytical character of individual component members of the potential function so represented, as well as that of multipolar aggregates of the geomagnetic field, is emphasized. But the special nature of the second order terms is stressed and the suggestion made that their quadrupole components, together with the terrestrial dipole, probably have definite geophysical significance.

The possibility of representing higher harmonics of the geomagnetic field as an eccentric dipole, as suggested by J. Bartels, is analyzed.

This theory more or less portrays the physical significance of the members of the second order, but that of the third and higher orders cannot be represented in this manner. Therefore the conclusion is admissible that the component members of the third and higher orders as well as their contribution in producing local and regional anomalies are caused not by magnetic effects taking place in the interior of the earth, but primarily by heterogeneities in the earth's crust.

The intricate character of the second order harmonics is clearly seen in a geomagnetic system of coordinates. Here the "non-sectorial" surface harmonics, together with the parameters of the dipole, determine the position and the direction of the equivalent eccentric dipole as well as the position of the magnetic center of the earth. On the other hand the sectorial surface harmonics cannot be represented by a similar eccentric dipole although the invariability of its coefficient in the case of translatory displacement of magnetic axis suggests a real physical significance of this quadrupole.

The problem of finding the physical interpretation of this and further spherical harmonics remains unsolved. Up to now we visualize them just as a pure analytical abstraction in the form of multipoles.—*Author's summary, S. T. V.*

14219. Runcorn, S. K., Benson, A. C., Moore, A. F., and Griffiths, D. H. Measurements of the variation with depth of the main geomagnetic field: Royal Soc. London Philos. Trans., ser. A, v. 244, no. 878, p. 113–151, 1951.

The main geomagnetic field is attributable either to phenomena within the core or to a fundamental property of rotating matter in which the source of the field is distributed throughout the earth. Core theory predicts an increase in the horizontal component with depth while the distributed theory predicts a decrease. This paper reports experiments made in 5 deep mines in England in an attempt to distinguish between the 2 theories. A detailed discussion is given of the geologic factors affecting the problem and of corrections applied to account for local anomalies and anomalous gradients. The results provide evidence preponderantly in favor of core theory.—*R. G. H.*

14220. Lowes, F. J., and Runcorn, S. K. The analysis of the geomagnetic secular variation: Royal Soc. London Philos. Trans., ser. A, v. 243, no. 871, p. 525–546, 1951.

A graphical method is described for the analysis of the geomagnetic secular variation in terms of dipoles of arbitrary orientation. The results show that the field for epoch 1922.5 may be approximated by 12 vertical dipoles located below the surface of the core. This analysis compares favorably with that of McNish, although McNish made no attempt to determine if inclined dipoles would adequately fit the field. There are discrepancies between the location of dipoles resulting from the 2 analyses. This may be attributed to the inaccuracy of the field data used.

Lowes and Runcorn agree with Elsasser that horizontal currents or equivalent vertical dipoles which produce the secular variations originate in a thin shell at the surface of the core. They assume, with Bullard, that the shell has a conductivity of 500 ohm^{-1} cm^{-1} with a skin depth of 40 km.

The presence of vertical dipoles near the equator does not support the assumption of a large toroidal field within the core which is an essential feature of Bullard's dynamo theory.—*I. Z.*

14221. Fukushima, Naoshi, and Ono, Hironori. World-wide character of the progressive change in the disturbance forces of geomagnetic bays: Jour. Geomagnetism and Geoelectricity, v. 4, no. 2, p. 57–62, 1952.

The magnetograms of the Cheltenham, Tucson, Sitka, and Honolulu observatories for a period of several years were analyzed and the vector diagrams illustrating the variation of the disturbance forces during the whole duration of geomagnetic bays were found to be similar everywhere in the middle-latitude regions. The disturbance-force vector rotates clockwise with time in the forenoon and counterclockwise in the afternoon. This characteristic corresponds to broadening of the positive bay area over the earth's surface during the course of the bay. For the disturbance force of bays observed at Sitka, the influence of the auroral-zone current is clear; the magnitude of disturbance force at Honolulu is very small, so that its variation with time is less pronounced.— *S. T. V.*

14222. Kalashnikov, A. G. Magnitnyy effekt meteorov [Magnetic effect of meteors]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 6, p. 7–20, 1952.

During the fall and winter of 1950–51, observations were made at magnetic observatories near Moscow and in Garmskaya Oblast', on the northern slope of the Pamirs, to investigate the effect of meteors as a possible cause of certain geo-

magnetic disturbances. Magnetoinductive equipment of high sensitivity, capable of registering variations of the vertical magnetic component as small as 10^{-8} oersted, was used.

As meteors reaching the earth's atmosphere produce large electric charges, they were traced and observed by radar instruments that permitted their observation both night and day.

A magnetic effect of meteors on the regional geomagnetic field was established in about 30 percent of the observed cases. More sensitive equipment might improve this correlation, but some of the meteors are too small and their distance too great to produce a noticeable effect.—*S. T. V.*

14223. Kirkpatrick, C. B. On current systems proposed for S_D in the theory of magnetic storms: Jour. Geophys. Research, v. 57, no. 4, p. 511–526, 1952.

A theoretical current system, similar to the models proposed by Birkeland and Alfvén as sources of geomagnetic disturbance, is analyzed, and the magnetic field produced by it is compared with the observational data and the fields of other theoretical models. The results indicate that the Birkeland model, which has been rejected by Vestine and Chapman, and Alfvén's model are unsatisfactory as sources of the daily variation (S_D) of geomagnetic disturbance. Some general principles are developed for use in the field analysis of current systems.—*Author's Abstract*

MAGNETIC PROPERTIES OF ROCKS AND MINERALS

14224. Nagata, Takes[h]i, Akimoto, Syun'iti, and Uyeda, Seiya. Reverse thermoremanent magnetism: Acad. Japan Proc., v. 28, no. 6, p. 277–281, 1952.

A previous article (see Geophys. Abs. 14028) discussed the observed self reversal of thermoremanent magnetization of a hypersthene hornblende dacitic pumice from Volcano Hasuna, Japan. This rock when subjected to a magnetic field while being cooled from 500 to 450 C shows normal thermoremanent magnetization but when reheated exhibits an abnormal increase of magnetization at 450 C similar to that proposed by Neél for P-type ferrites. When subjected to a magnetic field while being cooled from 300 to 250 C the rock demonstrates reverse thermoremanent magnetization with a positive temperature coefficient of magnetization marked by larger than the negative temperature coefficient of the normal thermoremanent magnetization. This suggests that N- or V-type ferrites exist in the specimen and possibly are responsible for the reverse thermoremanent magnetization.—*J. R. B.*

14225. Nagata, Takes[h]i, Uyeda, Seiya, and Akimoto, Syun'iti. Self-reversal of thermoremanent magnetism of igneous rocks: Jour. Geomagnetism and Electricity, v. 4, no. 1, p. 22–28. 1952.

The general conclusions reported in previous articles (*see* Abs. 14026, 14028, and above) are presented in more detail.—*J. R. B.*

14226. Néel, Louis, and Pauthenet, René. Étude thermomagnétique d'un monocristal de $Fe_2O_3\alpha$[Thermomagnetic study on a single crystal of αFe_2O_3]: Acad. Sci. Paris Comptes Rendus, tome 234, no. 22 p. 2172–2174, 1952.

Measurements have been made in the range 20.4 to 950 K of the variation with temperature of the specific magnetization and susceptibility along the

ternary axis and basal plane of a single crystal of α hematite. The susceptibility in the basal plane is relatively constant (20×10^{-6}) but along the ternary axis it increases from about 1.8×10^{-6} at 20.4 to about 4×10^{-6} at 250 K then rises sharply to 22×10^{-6} at 300 K. This verifies a theory developed earlier that the material is antiferromagnetic with an axis of antiferromagnetism that is parallel to the ternary axis below 250 K but which shifts into the basal plane above that temperature. The constancy of the susceptibility in the basal plane shows that the axis of antiferromagnetism turns freely in the plane and is always perpendicular to the applied field.—*J. R. B.*

14227. Akimoto, Syun'iti. Magnetic susceptibility of ferromagnetic minerals contained in igneous rocks: Jour. Geomagnetism and Geoelectricity, v. 3, no. 4, p. 47–58, 1951.

The ferromagnetic minerals separated from 15 specimens of Japanese volcanic rocks were analysed chemically and the variation of their magnetic susceptibility with temperature measured. All the samples had a characteristic curve, a gentle increase of susceptibility with increasing temperature to about 400 C and then a sharp drop to the Curie point at about 500 C or 600 C. Minerals from those rocks which cooled slowly from a low temperature had high susceptibility (0.10–0.12 cgs) and the curve of descending temperature matched that of ascending temperature (a reversible curve). Minerals from the rocks which cooled rapidly from a relatively high temperature had low susceptibility (0.02–0.03 cgs) and demonstrated both reversible and irreversible curves. Intermediate samples showed high susceptibility of the irreversible type. The irreversible characteristic of the curves is attributed to the redistribution of the FeO, Fe_2O_3, and TiO_2 in complex ferromagnetic numerals other than the magnetic and ilmenite which produce reversible curves.

Measurements on powders of different grain size prepared from the same specimen show that the susceptibility decreases by a factor of about 2 for a decrease in the grain size of 100. The susceptibility is also reduced as the amount of TiO_2 is increased (see Geophys. Abs. 12363).—*J. R. B.*

14228. Willis, B. T. M. and Rooksby, H. P. Crystal structure and antiferromagnetism in haematite: Physical Soc. London Proc., sec. B, v. 65, pt. 12, p. 950–962, 1952.

The crystal structure of haematite [α–Fe_2O_3] has been investigated by X-ray analysis in the temperature range 20 C to 950 C. On cooling through a temperature of approximately 675 C the rhombohedral unit cell undergoes a sudden expansion along the triad axis direction. The results are interpreted in terms of an antiferromagnetic behavior of pure haematite, with a Curie point at approximately 675 C. It is shown that the behavior is analagous to that of the cubic oxides FeO and Fe_3O_4, which exhibit structure cell deformations or cooling through certain critical temperatures.—*Authors' Abstract*

14229. Kendall, J. T., and Yeo, D. Magnetic susceptibility and anisotropy of mica: Physical Soc. London Proc., v. 64, pt. 2, p. 135–142, 1951.

The magnetic susceptibility and anisotropy of natural muscovite and synthetic fluorphlogopite has been measured. These minerals contain small quantities of iron which cause paramagnetic and ferromagnetic effects. To a fair approximation the mean susceptibility is found to vary linearly with the total iron content, and the paramagnetic anisotropy to be proportional to one ferrous iron content. At low field strengths ferromagnetic impurities (probably sub-

microscopic inclusions of magnetite) cause anomalous results. It is shown that such inclusions are present in all the micas examined, and account for the apparent paramagnetism of synthetic mica. The inclusions are probably oriented with their magnetic axes in a preferred direction relative to the crystallographic axes of the mica.—*Authors' Abstract*

14230. Le Borgne, Eugène. Sur le susceptibilité magnétique du sol [On the magnetic susceptibility of soil]: Acad. Sci. Paris Comptes Rendus, tome 235, no. 18, p. 1042–1043, 1952.

The magnetic susceptibility of samples of granite, schist, and soil from areas around Pontivy and between Quimper and Quimperlé were determined. The susceptibility of the schist ranged from 8 to 18×10^{-6}, and of the granite from 5 to 14×10^{-6}. The susceptibility of the soil was in general greater than that of the underlying rocks, being of the order of 10^{-4} and sometimes reaching 10^{-3} cgs.—*M. C. R.*

14231. Roche, Alexandre. Sur l'origine des inversions d'aimantation constatées dans les roches d'Auvergne [On the origin of inverse magnetization observed in the rocks of Auvergne]: Acad. Sci. Paris Comptes Rendus, tome 236, no. 1, p. 107–109, 1953.

Rocks from the Monts d'Auvergne, France, showing reverse remanent magnetization have been heated to the Curie point and then cooled in a magnetic field. The rocks showed a slow steady decrease of magnetization with increased temperature and when cooled took on a magnetization of the same direction as that of the applied field. In addition to claystone beneath basalt flows and the calcareous marl adjacent to a basalt dike have the same reverse remanent magnetization as the basalt. In two of these instances it has been shown that the minerals contained in the claystone are syngenetic and are not related to the vulcanism. Apparently these reverse magnetizations cannot have been produced by the mechanisms proposed by Néel (Geophys. Abs. 13319) but must represent real reversals of the earth's magnetic field at the time these rocks cooled.—*J. R. B.*

INSTRUMENTS AND METHODS OF OBSERVATION

14232. Balsley, James R. [Jr.] Aeromagnetic surveying *in* Advances in Geophysics, v. 1, p. 314–349, New York, Academic Press, 1952.

Instrumentation, field and office techniques, interpretation of results, advantages and limitations, and uses of aeromagnetic surveying are reviewed.—*M. C. R.*

14233. Koulomzine, T. Magnetometer, U. S. patent 2,627,542, granted February 3, 1953. 6 claims.

A permanent magnet suspended from a float and emersed in a fluid so that the center of gravity of the magnetometer balance system is below its center of buoyancy.

14234. Haalck, F. Magnetometer, U. S. patent 2,629,003, granted February 17, 1953. 16 claims. Assigned to Askania-Werke A. G.

A magnet suspended from horizontal torsion wires.

14235. Richardson, Max S. Magnetometer system, U. S. patent 2,632,883, granted March 24, 1953. 1 claim. Assigned to the United States of America, represented by the Secretary of Navy.

A means of measuring magnetic fields inductively.

14236. Nedzel, V. A. Apparatus and method for measuring magnetic flux, U. S. patent 2,624,783, granted January 6, 1953. 10 claims. Assigned to United States of America, represented by the U. S. Atomic Energy Commission.

The magnetic flux is measured by rotating a coil in a magnetic field, the effects of which are compared to a known magnetic field.

14237. Schmitt, O. H. Method of magnetic investigation, U. S. patent 2,626,308, granted January 20, 1953. 2 claims. Assigned to United States of America, represented by the Secretary of Navy.

A means of investigating the magnetic field of a body by substituting for it three coils mutually at right angles.

14238. Broding, R. A. Magnetic induction well-logging instrument, U. S. patent 2,625,583, granted January 13, 1953. 15 claims. Assigned to Schlumberger Well Surveying Corp.

A system for measuring magnetic susceptibility and electrical conductivity.

METHODS OF ANALYSIS AND INTERPRETATION

14239. Andreyev, B. A. Raschety prostranstvennogo raspredeleniya potentsial'nykh poleye i ikh ispol'zovaniye razvedochnoy geofizike [Computations of spatial distribution of potential fields and their utilization in geophysical exploration] : Akad. Nauk SSSR Izv., Ser. geofiz., no. 2, p. 22–30, 1952.

In preceding studies procedures have been presented for calculating patterns of potential fields in the upper semispace (see Geophys. Abs. 9629) and in the lower (see Geophys. Abs. 11605), where the potential sources are located. In the present study the latter problem is considered again, using the method of lattices. In this procedure the Laplace equation is written in the following form, using finite differences: $\frac{1}{4}[U(x'+h, 0)+U(x'-h, 0)+U(x' h)+U(x',-h)]$ $U(x', 0)=0$. U is the potential function at the point $(x, 0)$: its value at adjacent points can be calculated with good accuracy by selecting appropriate value for h.

The suggested method can be used to good advantage for determinations of the intensity and shape of magnetic anomalies on the ground from the data of an aeromagnetic survey. By having a sufficient number of master charts representing potential fields corresponding to different positions of underground sources, it is possible to interpret the results of a new survey by comparison.

Several examples of the use of this procedure are given.—*S. T. V.*

14240. Mikov, D. S. Opredeleniye velichiny i napravleniya intensivnosti namagnicheniya vozmushchayushchikh tel po rezul'tatam magnitnoy i gravitatsionnoy s'emki [Determination of the intensity and direction of

the magnetization of disturbing bodies from the data of magnetic and gravimetric surveys]: Akad. Nauk SSSR Izv., Ser. geofiz., no. 5, p. 55–56, 1952.

A method is presented of finding by theoretical calculations the intensity and the direction of the magnetization of a buried body from the data obtained by gravity and magnetic measurements. The disturbing body is assumed to be homogeneously magnetized.

Necessary formulas are derived correlating magnetic and gravity anomalies, first for 3- and 2-dimensional bodies with vertical magnetization, later extended to a 2-dimensional body with inclined magnetic axis. Such relations can be established for any point on the surface of the earth. By repeating the procedure for several points and averaging the results, it is possible to improve the accuracy.—*S. T. V.*

Gel'fand, I. S. Direct methods of interpretation of gravitational and magnetic anomalies produced by two-dimensional bodies. See Abstract 14196.

MAGNETIC OBSERVATIONS AND SURVEYS

14241. Hermans, L. Résultats des observations magnétiques effectuées de 1934 à 1938 pour l'établissement de la carte magnétique du Congo belge [Results of magnetic observations made between 1934 and 1938 for the setting up of the magnetic map of Belgian Congo]: Inst. Royal Colonial Belge Mém., tome 5, fasc. 3, 67 p., 1951.

This report contains data on stations occupied and magnetic observations in the region between longitudes 22.5 and 27.5 east and between latitude 0.5 south and the southern border of the Belgian Congo.—*M. C. R.*

14242. Baird, H. F., and Cullington, A. L. Magnetic resurvey of New Zealand at epoch 1st July, 1945: New Zealand, Dept. Sci. Indus. Research, Geophys. Mem. 1, 54 p., 1952.

The results of magnetic resurvey of New Zealand and its outlying islands are presented. The field observations were made between May 1941 and December 1948 using an earth inductor magnetometer, lent by Carnegie Institute of Washington. Declination, horizontal force, and inclination were observed and collated with simultaneous *D*, *H*, and *I* traces on the Amberley magnetograms from Amberley. A list of 219 stations, with their data, is given; 7 isomagnetic charts for declination and inclination, and for horizontal, vertical, total, northerly, and easterly forces are appended.—*S. T. V.*

14243. Mayaud, Pierre-Noël. Champ magnétique moyen et variation séculaire en Terre Adélie au 1er janvier 1952 [The average magnetic field and secular variation in Adélie Land on January 1, 1952]: Acad. Sci. Paris Comptes Rendus, tome 236, no. 9, p. 954–956, 1953.

Magnetic elements at Port-Martin on January 1, 1952 were: H=1,063γ; D=37°24′ E; I=89°06′ S.—*M. C. R.*

14244. Bahnemann, Fr. Magnetic measurements in the area of the emery deposits on the island of Náxos: Greece Uperesia Ereunon Upedaphous Ereunai oruktou ploutou tes Ellados (The Mineral Wealth of Greece) tomos 1, p. 69–94, 1951.

During the summer of 1949 different parts of Náxos island were explored for emery deposits. Magnetic surveys, both vertical and horizontal were made,

using a Schmidt field balance, to determine whether the emery deposits could be detected under existing conditions (presence of varying amounts of magnetite in the emery as well as isolated magnetite and hematite bodies) and whether magnetic methods could be employed to direct future development. Several large emery ore bodies were discovered. It was found that the magnetic effect produced by the superposition of several smaller bodies buried at a depth of 30 to 40 m could not be detected; their total effect being often smaller than the daily variation of geomagnetic field. Observations in tunnels in the mining district showed that ore bodies had been missed by only a few meters. The direction of development work by the magnetic method seems therefore feasible. The article contains numerous magnetic profiles and a magnetic contour map. —*S. T. V.*

14245. Zachos, K[yriakos]. Geophysical research of Sériphos Island [in Greek with English summary] : Greece Uperesia Ereunon Upedaphous Ereunai oruktou ploutou tes Ellados (The Mineral Wealth of Greece) tomos 1, p. 129–152, 1951.

A geomagnetic survey of parts of the island of Sérifos disclosed strong vertical magnetic anomalies traversing the northern and southern parts which were attributed to buried magnetite bodies. The total amount of magnetite is estimated to be more than half a million tons. The report contains several magnetic profiles and maps.—*S. T. V.*

14246. Zachos, K[yriakos], Maratos, G., and Papanikolaou, N. Geological and geophysical reconnaissance on the metalliferous area of N. E. Chalkidiki (Stavros) [In Greek with summary in English]: Greece, Inst. Geol. Ereunon Upedaphous Geol. Anag., Rept. 15, 14 p., 1952.

This is a report of a geologic and geophysical survey of the northeastern part of Khalkidhiki, Greece. Both magnetic and electrical methods were used. Geophysical results are presented as maps of magnetic anomalies and equipotential lines, and as resistivity curves.—*S. T. V.*

14247. Canada Geological Survey. Aeromagnetic maps of Province of Ontario: Dept. of Mines and Tech. Surveys, Geophysics Papers 95, 96, 99, 100, 102, 103, 104, 1952.

This is a continuation of the series listed in Geophys. Abs. 13000 and 13931. The following quadrangles in the Province of Ontario have been published as blue line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 ft above ground level: G. P. 95, Kaladorin, in Hastings, Frontenac, Lennox, and Addington Counties; G. P. 96, Denbigh, in Renfrew, Frontenac, Hastings, Lennox, and Addington Counties; G. P. 99, Minden, in Victoria, Haliburton, and Peterborough Counties; G. P. 100, Brudenell, in Renfrew County; G. P. 102, Kawagama Lake, in Haliburton County; G. P. 103, Burleigh Falls, in Peterborough County; and G. P. 104, Halls Lake, in Haliburton and Muskoka Counties.—*M. C. R.*

14248. Canada Geological Survey. Aeromagnetic maps of the Province of Quebec: Dept. of Mines and Tech. Surveys, Geophysics Papers 114, 115, 1952.

The is a continuation of the series listed in Geophys. Abs. 13004, 13006, 13454, 13706, 13930, and 14100. The following quadrangles have been published as

blue line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 ft above ground level: G. P. 114, Rosaire, L'Islet, and Montmagny Counties; G. P. 115, St. Magloire, Montmagny, Bellechasse, and Dorchester Counties.—*M. C. R.*

ELECTRICITY

GENERAL AND THEORETICAL STUDIES

14249. Tikhonov, A. N., and Lipskaya, N. V. O variatsiyakh zemnogo elektricheskogo polya [On the variations of the terrestrial electric field]: Akad. Nauk SSSR Doklady, tom 87, no. 4, p. 547–550, 1952.

Relations between the components of the geomagnetic field and those of the geoelectric field are derived starting from the fundamental Maxwell equations connecting vectors of the terrestrial electromagnetic field. These equations contain the velocity of terrestrial rotation at the point of observation, and characteristics of the upper formations, their electric conductivity, and the thickness of this formation, resting, as assumed by the authors, on an ideally conductive medium.— *S. T. V.*

Rikitake, Tsuneji. Electrical conductivity and temperature in the earth. See Abstract 14353

14250. Wait, James R. The electric fields of a long current-carrying wire on a stratified earth: Jour. Geophys. Research, v. 57, no. 4, p. 481–485, 1952.

A solution is obtained for the electrical field parallel to an infinite current-carrying wire over a flat earth represented as a 2-layer structure with a relatively high conducting zone at depth. The solution shows the field is appreciably influenced by the presence of a conducting zone at a depth of 500 m for a frequency of 500 cycles per second. Such zones should therefore be detectable by a geophysical exploration technique involving measurement of electrical field components in phase and in quadrature with the source current in the primary wire.—*M. C. R.*

14251. Wait, James R. Electromagnetic fields of current-carrying wires in a conducting medium: Canadian Jour. Physics v. 30, no. 5, p. 512–523, 1952.

Electromagnetic field components of linear current-carrying wires in a conducting medium are investigated. It is hoped the results will be applicable to electrical well-logging methods. Formulas are derived for the field components for a linear wire carrying a sinusoidal current embedded in an infinite homogeneous and conducting medium. It is shown that the cylindrical insulated covering for the wire does not alter the field appreciably.

Calculations are made for an insulated vertical current-carrying wire placed in a horizontal conducting slab where the lower region is highly conducting and where the lower layer is a good insulator. Mutual impedance is determined between a vertical grounded wire in the slab and a horizontal wire element of the same length on the surface of the slab. Graphs are constructed with impedance plotted against frequency for a homogeneous conducting half space and also for the two additional cases where the slab is terminated by a high conducting and a highly insulating lower medium.—*I. Z.*

14252. Wait, James R. Transient coupling in grounded circuits: Geophysics, v. 18, no. 1, p. 138–141, 1953.

The electrical field in an infinite isotropic medium caused by a step-function current flowing through a wire ground at both ends is considered. The problem is solved to determine the voltage which is induced in a second insulated circuit, also grounded at both ends, but having infinite resistance. The solution is applied to electrical well logging when a commutated or square wave is used. The particular electrode configuration considered consists of a single current electrode in a drill hole and two potential electrodes in line with the current electrode at distances l and $2l$. The second current electrode is at the surface. In such a case, the voltage between the pickup electrodes reaches 97 percent of its maximum value in $10^{-5}\ \sigma$ seconds, where σ is the conductivity of the medium.—*G. V. K.*

ELECTRICAL PROPERTIES OF ROCKS AND MINERALS

14253. Cownie, A., and Palmer, L. S. The effect of moisture on the electrical properties of soil: Physical Soc. London Proc., sec. B, v. 65, no. 4, p. 295–301, 1952.

Measurements of the dielectric constant of soil containing different known percentages of moisture were made at a fixed frequency of 430 megacycles per second. The method adopted involved the use of a coaxial transmission line terminated with a sample of the soil under text. The line consisted of a central rod with a concentric tube about 2½ meters in length. Measurements were made with soil samples containing from 4.1 to 47.7 percent moisture. The dielectric constant was found to vary from 4.0 to 31.4. The values are shown graphically and compared with those obtained by nine other authors. The conductivity could not be measured accurately with the method used, but it was estimated to vary from about 1.5×10^{9} e. s. u. with 4 percent moisture to 4×10^{10} e. s. u. with 50 percent moisture.—*Authors' Abstract*

14254. Keller, G. V. Effect of wettability on the electrical resistivity of sand: Oil and Gas Jour., v. 51, no. 34, p. 62–65, 1953.

Experiments show that for conditions which may conceivably be representative of rock in place, the exponent n of Archie's equation may vary from 1.5 to 11.7 for the same rock sample and the form of the equation is inadequate to explain the resistivity of rock at the low water saturations in many oil reservoirs. Experiments show that for the same water saturation, resistivity can vary a thousandfold for different wetting conditions.—*M. C. R.*

14255. Sakuma, Shūzō. Earth-current potentials near boundaries of various geological formations: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, p.t 1, p. 25–30, 1952.

Natural-potential measurements were made in several areas to determine the relations, if any, between geologic structures and earth-current potentials. Near the active Tanna fault, a zone of negative potentials was found along the fault line superposed on the general east-west earth current although rocks on both sides of the fault are petrologically similar. Similar disturbances of the earth current were noted near other faults. Earth-current potentials differed obviously among formations of strongly contrasting physical and chemical properties.—*M. C. R.*

14256. Garlick, J. K. Reflexion coefficient of radio waves from frozen terrains: Nature, v. 171, no. 4345, p. 259, 1953.

To determine the reflection coefficient of radio waves for normal incidence from deeply frozen land and sea, measurements were made in northern Canada, transmitting a 1,600 megacycle linearly-polarized signal vertically downward from aircraft at heights of 10,000 to 20,000 ft and recording on suitable receiver. Reflections from open water in Hudson Bay or the Great Lakes were used as the standard of comparison. On the basis of a reflection coefficient of sea water 0.83, the following reflection coefficients were calculated: from deep ice on sea, 0.20; frozen muskeg or barren gravel, 0.20 to 0.25; frozen lakes, 0.25; frozen snow covered forest, 0.08.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

14257. Lehmberg, A. E. A new electromagnetic device for the surveying of subsurface conductors: Canadian Min. Metall. Bull. v. 45, no. 485, p. 555–560, 1952.

An inductive instrument having a transmitting and receiving coil operating at low frequency is described. The secondary, resistive, component is detected by the receiving coil whereas the primary inductive signals due to coupling, and the secondary inductive signals due to skin effects and the magnetic material in the ground are cancelled out by special circuits. A 4-man crew with the coils 100 feet apart can traverse 2 to 4 miles a day at 50-foot stations.

Model experiments at a 30-to-1 reduction were made with powdered graphite as the model conductor in a 4 x 16 x 49 inch box. Traverses were made perpendicular to the long dimension of the box using dips of the box from vertical to horizontal. Sample curves were prepared. Field interpretation is made on the basis of these curves and geologic information.

Surveys and interpretation were made on the Barrmont mines in Barraute township, and on the property of Quebec Copper Corp. in Eastman township, Province of Quebec. Correlation between the geophysical data and geologic information is shown with the possibility that an extension of the mineralized zone was located on the latter property.—*W. J. D.*

14258. Evjen, H. M. Surface electrical method detects oil directly: World Oil, v. 136, no. 2, p. 93–96, 1953.

The high resistivity of oil makes possible its direct detection by electromagnetic methods, if attenuation is avoided by using wavelengths as large as 4 times the depth of penetration. The amplitude of the reflection depends on the average ground resistivity, the depth explored, and the resistivity contrast of the reflecting horizon; but reflections are also obtained from oil bearing strata that are not porous enough to produce. Tests in Kay County, Okla., where the depth of penetration was controlled by frequency variation, showed that all producing wells lie wthin a given impedance contour.—*D. F. B.*

14259. Krueger, R. F. Electric logging with oil-base drilling fluids, U. S. patent 2,626,305, granted January 20, 1953. 10 claims. Assigned to Union Oil Co. of California.

14260. Oberlin, L. M. Apparatus for determining permeability, U. S. Patent 2,632,324, granted March 24, 1953. 9 claims. Assigned to Phillips Petroleum Co.

An electrical potential apparatus for determining permeability of rock formations from a borehole.

14261. Boucher, F. G. Retractable electrode for well-casing measurements, U. S. patent 2,632,795, granted March 24, 1953. 4 claims. Assigned to Standard Oil Development Co.

Broding, R. A. Magnetic induction well-logging instrument. See Abstract 14238.

METHODS OF ANALYSIS AND INTERPRETATION

14262. Unz, M. Apparent resistivity curves for dipping beds: Geophysics, v. 18, no. 1, p. 116–137, 1953.

The problem of resistivity measurements over dipping beds is studied, using the method of images. Using the analog of mirrors replacing the resistivity contrasts, Unz points out that the method of images satisfies the boundary conditions of the electrical problem only when the distribution of images is symmetrical about the point of intersection of the dipping bed with the surface. Thus, accurate calculations of potential may be made only when the lower bed has infinite conductivity or resistivity, and only for certain dip angles. With intermediate resistivity contrasts, solutions by the method of images are incorrect, but the errors are small for small values of resistivity contrast and for large dip angles. A number of examples of calculated curves are presented. An example is given also of the application of the curves to practical problems.—*G. V. K.*

14263. Palmer, L. S., and Hough, J. M. Geoelectrical resistivity measurements: Mining Mag., v. 88, no. 1, p. 16–22, 1953.

The theoretical relationship is obtained between inflection points of resistivity and current-electrode-spacing curves and depth of boundaries. This relationship is used to interpret inflection points of experimental curves obtained on the Holderness Plain in Yorkshire, where chalk beds are covered by glacial boulder clays of low resistivity. Results were found to be better than those obtained from empirical formulae and were generally in agreement with borehole information.

The theoretical relationship between minimum (or maximum) resistivity and electrode spacing was obtained from simplifying assumptions and was found to have limited application to three-layer curves.—*H. R. J.*

14264. Gorelik, A. M. Opredeleniye napravleniya techeniya podzemnykh vod po noblyudeniyam elektricheskogo polya fil'tratsii [Determination of the direction of streaming underground water from the observed electric field caused by filtration]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 6, p. 55–56, 1952.

A study was made to determine the direction of an underground stream of water from the electric field caused by electrofiltration, as it is observed on the ground. The basic law of diffusion potential produced by porous formations through which a fluid is flowing can be stated as $E=Pk\zeta/4\pi\omega\sigma$; that is the gradient

of the potential E is determined by the pressure drop P, dielectric constant k, viscosity w of the fluid, its electric conductivity σ, and ξ the electrokinetic potential. The greatest gradient of potential is observed in the direction of streaming water, the least in the direction perpendicular to it. The graph obtained from measurements is an oval, elongated in the direction of the stream.

To check this conclusion a hole was drilled in the center of the oval and filled with an electrolyte. Initially the equipotential lines had an almost circular shape, but after 9 hours, spreading of electroconductive liquid changed their shape, elongating them in the direction of the stream. This direction coincided with that determined by the measurements.—*S. T. V.*

ELECTRICAL SURVEYS AND WELL LOGGING

14865. Suyama, J., Saito, T., and Sugayama, K. Report of the geophysical prospecting at Yuryō mine, Ehime Prefecture [in Japanese with English summary]: Geol. Survey Japan Bull., v. 3, no. 2, p. 45–50, 1952.

Self-potential and resistivity surveys for the cupriferous pyrite deposit are reported.—*M. C. R.*

14266. Aronis, G. Research on the iron-pyrite deposits in the Hermioni mining district (in Greek with English summary): Greece Uperesia Ereunon Upedaphous Ereunai oruktou ploutou tes Ellados (The Mineral Wealth of Greece) tomos 1, p. 175–188, 1951.

In 1949 a combined geological and geophysical survey of the mineralized area near the village of Karakassi was made to determine the probability of the existence of pyrite ore lenses. The geophysical survey consisted of resistivity measurements using both Wenner and Schlumberger techniques. Results are presented as maps. No ore was found.—*S. T. V.*

14267. Manfredini, Antonio. Studio dell'alveo dei fiumi a messo di sondaggi elettrici [Investigation of river beds by electric soundings]: Servizio geol. Italia Boll., v. 73, fasc. 2, p. 371–395, 1952.

Electric sounding of river beds to determine geologic structure and suitability for the erection of bridges or similar engineering structures is described. The Wenner arrangement of electrodes was most frequently used, but in few places the Lee partitioning was also used. Several examples are discussed and special attention is given to correct interpretation of measurements. Resistivity curves and probable geology of the investigated sites are appended.—*S. T. V.*

14268. Ferreira Gomes, José Carlos. A geologia nas barragens [Geology of dam sites]: Univ. Brasil Escola de Minas Rev., ano 17, no. 4, p. 3–18, 1952.

Investigations of dam sites by geologic and geophysical methods are discussed. The Schlumberger method is especially emphasized. Examples of the use of the method in the United States and Brazil are cited.—*S. T. V.*

14269. Teichmüller, Rolf, and Weber, Reinhold. Sur physikalischen und geologischen Untersuchung von Steinkohlenbohrungen [On the physical and geologic investigation of drillholes in coal]: Glückauf, Jahrg. 86, heft 11/12, p. 193–204, 1950.

The use of electric well-logging methods in exploration for coal is discussed and the results of measurements in drill holes in the coal mines of German

Silesia are presented, and compared with geologic evidence. Further development of such investigations and their practical value is advocated.—*S. T. V.*

14270. Teichmüller, Rolf, and Wolff, Wilhelm. Der geophysikalische Nachweis von Kohlenflözen in Tiefbohrungen [Geophysical identification of coal seams in deep drill holes] : Glückauf, Jahrg. 89, heft 3/4, p. 78–82, 1953.

By use of Schlumberger well-logging techniques applied to exploration for coal, seams of only 10 cm thickness can be detected; electrical methods can be supplemented to great advantage by gamma-ray measurements, because the coal layers do not contain radioactive substances, and the surrounding formations usually contain K^{40}.—*S. T. V.*

14271. Wyllie, M. R. J., and Morgan, Frank. Comparison of electric log and core analysis data for Gulf's Frank no. 1, Velma pool, Stephens County, Okla.: Producers Monthly, v. 16, no. 12, p. 31–43, 1952.

See Geophys. Abs. 13972.—*M. C. R.*

SEISMOLOGY

ELASTIC WAVES

14272. Dungen, F. H. Van den. Formules pour l'integration numérique de l'equation des ondes [Formulas for the numerical integration of the wave equation] : Acad. royale Belgique Bull., Cl. sci., 5 ° ser., tome 38, p. 669–684, 1952.

Approximate formulas for the numerical integration of the wave equation for 2- and 3-dimensional cases are derived and their application discussed.—*S. T. V.*

14273. Haskell, N. A. The dispersion of surface waves on multilayered media: Seismol. Soc. America Bull., v. 43, no. 1, p. 17–34, 1953.

A matrix formalism developed by W. T. Thomson is used to obtain the phase velocity dispersion equations for elastic surface waves of Rayleigh and Love type on multilayered solid media. The method is used to compute phase and group velocities of Rayleigh waves for two assumed three-layer models and one two-layer model of the earth's crust in the continents. The computed group velocity curves are compared with published values of the group velocities at various frequencies of Rayleigh waves over continental paths. The scatter of the observed values is larger than the difference between the three computed curves. It is believed that not all of this scatter is due to observational errors, but probably represents a real horizontal heterogeneity of the continental crusts.—*Author's Abstract*

14274. Kosminskaya, I. P. Amplitudnyye krivyye i godografy faz seysmicheskikh voln, vyzvannykh tochechnym istochnikom rasshireniya v odnorodnom ideal' no uprugom bezgranichnom prostranstve [Amplitude curves and travel times of seismic waves, produced by a distending point-source in a homogeneous perfectly elastic infinite space] : Akad. Nauk SSSR Izv., Ser. geofiz. no. 6, p. 39–47, 1952.

On the assumption of a perfectly elastic infinite medium, amplitudes and travel times are computed for seismic waves produced by a point source which is the center of harmonic extensions and compressions with amplitudes A_0. Such a

point source can be approximated by an explosion at a sufficient depth. Proof is presented that for distances r, greater than the length λ of the wave, the amplitude of seismic wave can be represented by the formula $A=A_0/r$. Travel-time curves in the vicinity of the point source, for $r<\lambda$ are curvilinear, but for $r>\lambda$ they can be assumed to be rectilinear. These fundamental relations derived for amplitudes and travel-time curves of waves caused by harmonic source, can be extended to waves produced by impulses, generating quasi-sinusoidal vibrations.—*Author's summary, S. T. V.*

14275. Kosminskaya, I. P. Interferentsiya seysmicheskikh voln, vyzyvayemykh garmonicheskim istochnikom [Interference of seismic waves from a harmonic source]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 4, p. 33–54, 1952.

The interference of two seismic waves, sufficiently distant from the source of vibrations to be considered as plane, is discussed and formulas are given for the resulting amplitudes and for the phase of the composite wave. The derived formulas are then extended to the case of several waves, and a graphoanalytic method is suggested for construction of the resulting amplitudes and travel-time curves.

By analysis of different shapes of the travel-time curves and of the curves of amplitudes of composite waves, examples can be shown of the dominant wave that has a greater or smaller velocity than the others. In certain cases this procedure makes it possible to find individual components from the seismograms. Master charts are suggested for such analysis. Indices are also established which show when a recorded seismic wave is a composite one, resulting from the interference of several simple waves.—*S. T. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

14276. Borisevich, Ye. S. Registriruyushchiye pribory dlya seysmicheskikh stantsiy [Recording apparatus for seismic stations]: Akad. Nauk SSSR Geofiz. Inst. Trudy no. 14 (141), p. 53–58, 1952.

This is general discussion of good recording equipment. The most important feature is said to be uniform rotation of the drum; variation in the length of the minute must be not greater than 0.3 percent. It is important to have both mechanical and optical recording. Precautions in installation and rules to be followed in the maintenance of the apparatus are given. Most of the article is devoted to a description and criticism of recording apparatus of Russian origin.—*S. T. V.*

14277. Ewing, Maurice, and Press, Frank. Further study of atmospheric pressure fluctuations recorded on seismographs: Am. Geophys. Union Trans., v. 34, no. 1, p. 95–100, 1953.

The predominant background disturbance on a long-period vertical seismograph is removed by providing compensation for atmospheric pressure fluctuations. A seismically-compensated, long-period microbarovariograph for study of pressure oscillations in the range 20–2000 sec is described. Comparison of records from the pressure-compensated seismograph and the seismically-compensated microbarovariograph indicates that no significant ground motion is caused by direct coupling of atmospheric pressure fluctuations to the earth. Sample records are shown.—*Authors' Abstract*

14278. Honnell, Pierre M. An electromechanical transducer system for the transient testing of seismographs: Geophysics, v. 18, no. 1, p. 160–187, 1953.

Shaking tables constructed to test the dynamic response of seismometers have been limited by being unable to produce any transient motion other than their own natural oscillations. An electromechanical device which can mechanically reproduce voltage wave forms having sinusoidal, square, or other complex shapes has been constructed. A horizontal platform is attached to leaf springs so that vertical motion is permitted. To the underside of the platform is attached a vertical bar to which force coils are affixed concentrically. Field coils which are normally energized are also concentrically positioned about the vertical bar and are fixed to the chassis. By energizing the force coils with various voltage forms, vertical displacements of the platform of similar wave form can be produced. To accomplish this it is necessary to supplement the system by a velocity sampling coil to provide feedback intelligence and a photoelectric displacement-measuring device to provided displacement feedback.

A mathematical analysis of the system transfer function of the device is made and it is concluded that varying the amount of velocity and displacement feedback, makes it unnecessary to vary the fixed parameters of the system in order to attain a smooth and facile system response. A graphic presentation of the transfer response with different feedback settings is shown. Seismometers of four companies were tested and the results are shown.—*W. J. D.*

14279. Olson, R. W. Variable resistance distributed seismometer, U. S. patent 2,626,381, granted January 20, 1953. 1 claim. Assigned to Texas Instruments, Inc.

14280. Woods, J. P. Apparatus for underwater seismic operations, U. S. patent 2,627,930, granted February 10, 1953. 4 claims. Assigned to the Atlantic Refining Co.

14281. Sewell, B. W. Seismograph cable handler, U. S. patent 2,630,618, granted March 10, 1953. 4 claims. Assigned to Standard Oil Development Co.

14282. Silverman, D[aniel], Eisler, J. D., and Lash, C. C. Marine seismic surveying, U. S. patent 2,632,150, granted March 17, 1953. 3 claims. Assigned to Stanolind Oil and Gas Co.

A seismometer spread suspended between 5 and 15 feet below the water surface.

14283. Hintze, A. J. Apparatus for producing seismic waves in a body of water, U. S. patent 2,632,520, granted March 24, 1953. 1 claim. Assigned to Phillips Petroleum Co.

A method of shooting spaced charges in air above the bottom of a boat.

14284. Riznichenko, Yu. V., Ivakin, B. N., and Bugrov, V. [R.] Modelirovaniye seysmicheskikh voln pri pomoshchi ultrazvukovykh impulsov [Modeling of seismic waves using ultrasonic impulses]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 3, p. 58–69, 1952.

An arrangement for the model studies of seismic waves observed in seismic prospecting or in earthquake investigations is described.

An electric impulse from a radio generator producing electrical impulses of a frequency between 100 to 500 kilocycles per second goes to a piezoelectric transducer through a special retarder. The arrangement is completed with receivers of the impulse (seismographs) and a cathode-ray oscillograph. A time marker producing from 2 to 50 marks per second is also operated from the generator. Because of the action of the retarder, the mechanical impulse from the transducer is produced only after the oscillograph is already in operation, thus accurately recording the oscillations in different points of the model. Models can be made of fluids (for instance, water), solid substances (plastics) or even of gas.

Examples are cited of the use of this model arrangement in studying classical problems of seismology, such as Lamb's 2-dimensional problem, the determination of refracted frontal waves under different conditions, or the determination of elastic properties of sand under varying pressure.—*S. T. V.*

14285. Veitsman, P. S. O podbore rasstoyaniy mezhdu seysmografami pri gruppirovanii s tsel'yu umen'sheniya fona pomekh [Selection of distances between seismographs subdivided into groups for weakening of disturbing background noise] : Akad. Nauk. SSSR Izv., Ser. geofiz., no. 3, p. 48–54, 1952.

Experiments are described which had for the purpose of determining the optimum distance between individual seismographs or groups of seismographs placed along a seismic profile so that the disturbing background becomes a minimum. It was found that, when the seismic reflection method is used the greatest disturbance is caused by microwaves propagating within the shallow upper layer of the earth. These waves may be produced by industrial causes, small water streams, or most often by wind.

In the area investigated, in the foot hills of the northern Tien Shan, the length of these microwaves was found to be about 16 meters; thus by placing seismographs at a distance of 8 meters the accidental effect of microwaves was almost completely eliminated; the amplitudes recorded on seismographs connected in series were almost doubled. These relations were found to be quite general, with the exception of disturbances caused by wind. Evidently the spectrum of those microseisms is very complex. The article contains numerous seismograms obtained with different arrangements and positions of seismographs.—*S. T. V.*

METHODS OF ANALYSIS OF EARTHQUAKE OBSERVATIONS

14286. de Paz Fernandez, Reginaldo. Acerca de los sismos de foco lineal [On earthquakes with a linear focus] : Rev. Geofísica, v. 11, no. 42, p. 179–182, 1952.

It is usual in seismic investigations to assume the focus of an earthquake as a point source, but this is correct only for tremors of volcanic origin. In other earthquakes, the faults often have appreciable length. This may result in errors in computations, especially for shallow earthquakes.

Assuming the upper surface of the affected area to be a plane and the overburden isotropic and no damping of propagating seismic waves, the total energy of the earthquake is computed as a quantity proportional to epicentral distance, depth of focus, and the length of the fault producing the earthquake. This relation makes it possible to write the necessary number of equations for determination of focal depth and the length of initial fault.—*S. T. V.*

14287. Hodgson, J. H., and Storey, R. S. Tables extending Byerly's fault-plane technique to earthquakes of any focal depth: Seismol. Soc. America Bull., v. 43, no. 1, p. 49–61, 1953.

Byerly's method of determining the direction of faulting in an earthquake by analysis of the distribution of initial motions at distant stations has been extended to deep-focus earthquakes. By making use of Stechschulte's method for obtaining travel-time curves for an earth stripped to any focal depth, the problem is reduced to the original case of a surface focus except that the radius of the earth would be appropriately reduced, and Byerly's original procedure may be applied directly. Values of the extended distance for all depths of focus given in the Jeffreys-Bullen tables are given. The technique has been applied to 19 earthquakes and reasonable solutions have been obtained for 15.—*M. C. R.*

14288. Carrasco, Esteban Luis. Sobre la determinación de epicentros por el método de Pietro Caloi [On the determination of epicenters by Pietro Caloi's method]: Rev. Geofísica, v. 11, no. 43, p. 213–218, 1952.

The graphical method suggested by Caloi for the determination of epicenters (see Geophys. Abs. 8840) is analyzed and certain refinements proposed, which also give more accurate value of the velocity of *Pg*.—*S. T. V.*

14289. Treskov, A. A., and Golenetskiy, S. I. Metod gipotsentraley [The hypocentral method]: Akad. Nauk SSSR Geofiz. Inst. Trudy no. 14 (141), p. 13–20, 1952.

The procedure by which an epicenter may be determined from observations at 2 stations is discussed. By varying the assumptions on the depth of focus, a curve of corresponding epicentral points, called the hypocentral curve, is obtained. Another pair of stations gives another hypocentral line; the intersection with the first curve gives a solution, as to the depth and epicentral distance of the earthquake, satisfying the observations of 3 stations. By adding more stations, slightly different points of intersection of the hypocentral curves will be obtained. Using the records from 21 Russian stations, the epicenters and the depths of foci of several earthquakes were determined by using the most common points of intersection of the hypocentral curves. The results seem to be in good agreement with available data.—*S. T. V.*

14290. Gamburtsev, G. A. Ob opredelenii azimuta na epitsentr pri registratsii mestnykh zemletryaseniy [Determination of the azimuth directed toward the epicenter when recording local earthquakes]: Akad. Nauk SSSR Doklady, tom 87, no. 2, p. 205–206, 1952.

The azimuthal angle α from a seismic station towards the epicenter of an earthquake can usually be accurately determined for sufficiently remote epicenters. But for local earthquakes, especially when the station is located in a mountainous and seismically active region, there are difficulties because the refracting boundaries are not horizontal and because of interference of several seismic waves.

The angle α can be determined from its relation to the azimuth ω of the arriving longitudinal wave; ω can be found from kinematic or dynamic relations, using formulas $\tan \omega = V_x/V_y$ and $\tan \omega = A_y/A_x$ where V_x and V_y are the apparent velocities in the direction of the X and Y axes; A_x and A_y are the amplitudes recorded on horizontal seismograph oriented in these directions. These formulas

can be used if there are two groups of seismographs along the perpendicular lines *X* and *Y*.

The importance of simple geologic structure around the seismic station is emphasized and an experimental arrangement for the investigation of this structure by seismic shots is described.—*S. T. V.*

14291. Keylis-Borok, V. I., and Kogan, S. D. K voprosu ob opredelenii azimuta na epitsentr [On the determination of epicentral azimuth]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 14 (141), p. 21–28, 1952.

A method is suggested for determining the azimuth α from seismic station to the epicenter of an earthquake, when the angle of emergence and the displacement of the transverse wave are given.

Direct observations give only the 3 components of the displacement of the crust at the station, so a system of 3 equations is first derived relating the observed values and the angle α. The angle of emergence is determined from the vertical component by Benndorf's relation, when the travel time of the *S* wave, epicentral distance and velocity are known. From these values, the angle α can be determined graphically.

The suggested method is applied to several earthquakes and the angle α determined. The results obtained are in good agreement with those computed in the usual manner from longitudinal waves.—*S. T. V.*

14292. Gamburtsev, G. A. O novom vide fasovoy korrelyatsii pri seysmicheskikh nablyudeniyakh [A new kind of phase correlation in seismic observations]: Akad. Nauk SSSR Doklady, tom 87, no. 1, p. 37–40, 1952.

When the phase correlation method was extended from seismic prospecting with artificial explosions to seismological investigations, a new kind of correlation was introduced. This is the azimuthal correlation, or the tracing of the phases of seismic waves coming to station from a given azimuthal angle. The azimuthal correlation method is used for studying "migrating foci", the dynamic characteristic of foci, and similar problems. Readings from a horizontal seismograph are taken as a function of the angle and a polar diagram constructed.

Gamburtsev discusses the correlation of simple waves, and indicates zones of interference when a sharp change in wave form can be detected or even circular or elliptic polarization may be produced. Specially mentioned are conditions in which correlation should be made among waves with great differences in amplitudes or direction of vibration or when the waves are registered against a background of microseisms. Use of several seismographs connected in series is recommended in this case.—*S. T. V.*

METHODS OF ANALYSIS OF SEISMIC SURVEY DATA

14293. Bugaylo, V. A. Paletki teoreticheskikh godografov dlya nekotoryh sloistykh tel [Master charts of theoretical travel times for some stratified media]: Akad. Nauk SSSR, Ural'skiy filial, Trudy Gorno-Geol. Inst., vypusk 19, Geofiz. Sbornik no. 1, p. 26–32, 1950.

The elementary theory of the use of logarithmic master charts to determine travel times of direct, refracted, and reflected waves is presented. With these charts it is not necessary to assume constant velocity in individual layers. Several cases of the variation of seismic velocity are discussed in this treatment:

velocity linearly increasing with depth; velocity an exponential function of depth; velocity a linear function of the distance from the observation point to shot point. Travel-time curves can be constructed on ordinary coordinate paper, (as Zlotnik's curves) or transformed to bilogarithmic scale, the method followed by Bugaylo. The advantages of the latter method are greater precision and ease of construction. Sample charts are included in the study.—*S. T. V.*

14294. Yepinat'yeva, A. M. O nekotorykh seysmicheskikh volnakh s bol'shimi vremenami prikhoda [On some seismic waves with late times of arrival]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 6, p. 21–38, 1952.

In seismic reflection surveys, quite often waves are recorded with exceedingly late times of arrival. If such waves are interpreted as simple reflections, the reflecting boundaries should be at depths of 200 km or more, which is improbable. The author analyses dynamic characteristics of these waves, primarily the variation of amplitudes with distance, using as a criterion the expression At (where A=amplitude and t=time of arrival). If this product increases or remains constant over a short distance, then it can be concluded that the waves are not simple reflections. As an additional criterion the function $\log At$, constructed for different values of distance, can be also very useful. Only strong waves which can be clearly traced over long distances should be considered. In absence of such waves of stable character, not much reliance is to be placed on the seismic reflection method.—*S. T. V.*

14295. de Caleya, Juan, Closs, Hans, and Dürbaum, Hansjürgen. Zur Berücksichtigung der Brechung in de Reflexionsseismik [The recognition of refraction in seismic reflection surveying]: Erdöl u. Kohle, jahrg. 5, heft 12, p. 765–768, 1952.

A new graphoanalytic method of analyzing seismic reflection data is presented that takes into account the variation of seismic velocity and is applicable to inclined strata. The method is discussed first for the case of two formations with different seismic velocities and later extended to any number of layers. It is illustrated by an example of a profile composed of four layers with different velocities in each.—*S. T. V.*

14296. Mota, Lindonor. Correção dos tempos em refração sismica [Weathering corrections in seismic refraction]: Univ. Brasil Escola da Minas Rev., ano 16, no. 5, p. 35–38, 1951.

Calculation of weathering corrections for cases of one or more inclined refracting layers is described.—*M. C. R.*

14297. Bediz, P. I. Interpretation of seismic data on locating reefs in Alberta: World Oil, v. 136, no. 2, p. 86–90, 1953.

Specialized instrumental, shooting, and interpretive techniques are required to locate reefs in the Alberta Devonian formations, which usually give poor reflections characterized by phasing and splitting, abnormal step-out, and the appearance and disappearance of reflections. Pre-Devonian faulting, the lack of Devonian reflections in areas of other good reflections, and isopach maps for time differences between Cretaceous horizons and the top of the Devonian may all indicate reefs. However, similar conditions can be caused by other sources such as the Paleozoic unconformity.—*D. F. B.*

14298. Musgrave, Albert W. Wavefront charts and raypath plotter: Mines Mag., v. 43, no. 2, p. 27–31, 54, 1953.

A seismic ray-path plotter based on a linear increase of velocity with time has been designed and constructed by Musgrave. Wave-front charts, using various velocity combinations, may be constructed from the plotter. They are available from the Colorado School of Mines, Golden, Colo. This paper was taken from Mr. Musgrave's doctorate thesis which is to be published in the Colorado School of Mines quarterly in the near future.—*L. C. P.*

OBSERVATIONS OF SEISMIC WAVES

14299. Jeffreys, Harold. The times of *P* up to 30°: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 6, p. 348–364, 1952.

Times of *P* in Mediterranean, Japanese and Californian earthquakes are analysed with the objects of testing the generality of the increase of the velocity at short distances found in Europe and the evidence for Gutenberg's layer of low velocity. The Mediterranean earthquakes do confirm the increase at short distances, but the Japanese ones agree with the tables in use, and there is clear evidence of a regional difference. The evidence from North American earthquakes is conflicting. It does not definitely indicate any change from the present travel times, but the uncertainties are larger than in the other regions, chiefly because there are rarely enough stations in approximately the same azimuth and at greatly different distances to give much information.

The difference of the times at 2° and 25° is about the same in Europe and Japan, but in comparison with them the times in Europe at 8° are about 3s earlier. The time-curve in Europe is nearly linear up to 14°. There is evidence in both regions for a strong curvature of the time-curve between 15° and 20°, but it does not decide whether $dt/d\Delta$ is continuous or discontinuous in this interval.

The curvature of the time-curve is in any case surprisingly small, because laboratory studies of the variation of elastic moduli with pressure indicate an increase of velocity with depth several times that given by any set of travel times. Increase of temperature with depth would presumably reduce the rate of increase but does not appear sufficient to account for the discrepancy.—*Author's Abstract*

14300. Gutenberg, B[eno]. Wave velocities in the outer part of the earth's mantle: Nature, v. 170, no. 4320, p. 289, 1952.

Using Mohorovičić's method, the travel times of longitudinal and transverse waves were computed from the data of about 80 earthquakes with foci at depths of 20 to 600 km. The values are in good agreement with previous results but give no evidence of a discontinuity, although supporting the idea of a low-velocity layer near 100 km.—*M. C. R.*

14301. Di Filippo, D[omenico], and Marcelli, L. Dromocrone per terremoti vicini e velocità delle onde nell 'Italia Centrale [Travel times for near earthquakes and the velocity of seismic waves in central Italy]: Annali Geofisica, v. 5, no. 2, p. 293–310, 1952.

From analysis of the seismograms of the strong earthquake of September 5, 1950, which was clearly recorded at more than 30 European seismic observatories, the travel times of *Pn*, *Pg*, *P**, *Sn*, and *Sg* were determined. Velocities of these

waves were determined as follows: P_n, 8.19 kmps; P_g, 5.46 kmps; P^*, 6.38 kmps; S_n 4.39 kmps; and S_g, 3.01 kmps. Two new waves of mixed character, denoted as P_x, and P_{x_2} were discovered. These latter apparently start from the focus in the granitic layer as transverse waves; at the boundary between basalt and granite, P_x is transformed into a longitudinal wave and arrives as such at the surface, while P_{x_2} is transformed into longitudinal at the Mohorovičić discontinuity. Another wave *Ri Pg*, (the reflected *Pg* wave), was also traced. This is a longitudinal reflected from Mohorovičić discontinuity without change in character. Two transverse waves and two transverse surface waves were also discovered.—*S. T. V.*

14302. Ergin, Kazim. Amplitude of *PcP*, *PcS*, *ScS*, and *ScP* in deep-focus earthquakes: Seismol. Soc. America Bull., v. 43, no. 1, p. 63–83, 1953.

A systematic study has been made of the ratios of (displacement/period) of *PcP*, *PcS*, *ScS*, and *ScP* to that of the corresponding incident wave (for example, (displacement/period) $_{PcP}$/ (displacement/period) $_P$), using intermediate and deep-focus earthquake seismograms. The results indicate that the observed ratios of the horizontal components of the waves that are reflected as *P* waves (i. e., *PcP/P* and *ScP/S*) and that of the vertical component of the waves that are reflected as *S* waves (i. e., *ScS/S* and *PcS/P*) at the mantle-core boundary are considerably larger than the theoretical ones, whereas the observed ratios of the vertical component of the first group and that of the horizontal component of the second group are in fairly good agreement with the theoretical values. Theoretical computations were based on the assumption that in the case of a longitudinal wave the vibration is in the direction of propagation and in the case of a transverse wave the vibration is perpendicular to the direction of propagation. It is further found that the behavoir of the direct *P* and *S* waves is in accord with the theory, but the vibration of the ground is not in the direction of propagation for *PcP* and *ScP* and is not perpendicular to the direction of propagation for *PcS* and *ScS*.—*Author's Abstract*

14303. Bullen, K. E., and Burke-Gaffney, T. N. Detection of *S* waves in the earth's inner core: Nature, v. 170, no. 4324, p. 455, 1952.

Examination of Riverview records since 1909 and International Seismological Summary data has demonstrated chiefly the relatively small number of records on which the existence of *PKJKP* is likely to be verified. Apparently unless records on which microseisms are negligible are available, the amplitude of *PKIKP* must be at least 20 μ in order that *PKJKP* be observed.—*M. C. R.*

14304. Kisslinger, Carl. The effect of variations in chemical composition on the velocity of seismic waves in carbonate rocks: Geophysics, v. 18, no. 1, p. 104–115, 1953.

To study variations in velocity in carbonate rocks, field measurements were made in dense, crystalline to lithographic, calcitic and dolomitic limestones in the St. Louis formation. Twelve geophones were used at a spacing of 50 centimeters. Comparison of chemical and velocity data indicates dolomitization may have an effect on velocity, but the effect apparently depends on the dolomitization process. Volume for volume replacement of calcite by dolomite tends to increase the velocity, but dolomitization giving rise to local porosity tends to decrease the velocity.—*M. C. R.*

14305. White, J. E., and Sengbush, R. L. Velocity measurements in near-surface formations: Geophysics, v. 18, no. 1, p. 54–69, 1953.

Compressional and shear-wave velocities determined from shallow boreholes in the Austin chalk and Eagle Ford shale, Dallas County, Tex., show that these formations are anisotropic. Measurements made of the velocities of a vertically-travelling compressional wave, a compressional wave in the borehole fluid, and horizontally-travelling compressional and *SV* shear waves permit the computation of the elastic constants (and the *SH* shear-wave velocity) which describe the materials. Direct measurements on loose sand show a smooth increase of these velocities with depth except for an abrupt increase in compressional-wave velocity at the water table. An approximate theory derived for wave propagation in packings of spheres shows agreement with the measured results.— *L. C. P.*

14306. Dyk, Karl, and Swainson, O. W. The velocity and ray paths of sound waves in deep sea water: Geophysics, v. 18, no. 1, p. 75–103, 1943.

In 1933 and 1934 the U. S. Coast and Geodetic Survey made time-distance, frequency, and amplitude measurements to determine the ray paths of sound in deep and shallow sea water off the California coast. Direct waves from shallow bombs were recorded at distances to 21 km; and the sound traveling along the thin constant-velocity layer at 100 fathoms was recorded at distances of 17½ km for shallow bombs and hydrophones, and at 26½ km for 100 fathom bombs and hydrophones. A maximum of 5 reflections was observed; the first was recorded at distances of 73 km, although the last 35 or 40 km of travel depended on diffraction. The sound velocities obtained checked very well with theoretical values. The gradual change of sign of the first motion was interpreted as evidence of dispersion.—*D. F. B.*

EARTHQUAKE OCCURRENCES AND EFFECTS

14307. Cooms, Howard A. A summary of Washington earthquakes: Seismol. Soc. America Bull., v. 43, no. 1, p. 1–5, 1953.

Data on earthquakes in Washington for the period 1927–1951 are presented to supplement the Townley-Allen catalog. The intensities of earthquakes from 1865–1951 are shown on an outline map.—*M. C. R.*

14308. Milne, W. G., and Lombardo, F. Canadian west coast earthquakes, 1951: Dominion Observatory Ottawa Pubs., v. 16, no. 3, p. 81–89, 1953.

A 3-station network for study of local earthquakes in the coastal regions of British Columbia was established in August 1951 with the installation of Willmore seismographs at Alberni and Horseshoe Bay to supplement the existing station at Victoria. In a 5 month period 74 earthquakes were recorded; epicenters of 27 were determined and are shown on maps. Preliminary study suggests no definite pattern of activity although certain areas are somewhat more active than others. The strongest earthquakes are near the presumed edge of the continental shelf. One group of shocks is related to a group of coal mines southeast of Nanaimo.—*M. C. R.*

14309. Fontseré, Eduardo. Los temblores de tierra Catalones del año 1950 [Earthquakes in Catalonia during 1950]: R. Acad. Cien. y Artes de Barcelona Observatorio Fabra Bol. 39, p. 343–347, 1952.

Data on the earthquakes of January 31, June 21, June 28, and October 20–23 and the explosion of June 6 are given. Isoseismal maps are included for the shocks of January 31 and June 28.—*M. C. R.*

14310. Monakhov, F. I. Kharakteristika afganskikh glubokofokusnykh zemletryaseniy [The characteristics of deep focus earthquakes in Afghanistan]: Akad. Nauk SSSR Geofiz. Inst. Trudy no. 14 (141), p. 3–12, 1952.

Epicenters and depths of focus of 37 earthquakes which occurred in different regions of Afghanistan between November 1946 and December 1948 were determined from seismograms of the observatories of Kulyab, Stalinabad, Obi-Garm, and Murgab. The depths ranged from 100 to 250 km. The direction of initial shock at the focus was also determined. The results are in good agreement with generally accepted ideas on tectonic movements in this region.—*S. T. V.*

14311. Burke-Gaffney, T. N. Seismicity of Australia: Royal Soc. New South Wales Jour. and Proc., v. 85, pt. 2, p. 47–52, 1952.

Seismological data on about 75 earthquakes which occurred in Australia from 1883 till 1949 are presented, only including those tremors which originated within the Australian continental shelf; epicenters and the Gutenberg-Richter magnitudes of all shocks are given. The greatest intensity of observed earthquakes was 7 (modified Mercalli scale). It is concluded that Australia is one of seismically stable regions of the earth.—*S. T. V.*

14312. Dungen, F. H. Van den, Cox, J. F., and Mieghem, J. Van. Fluctuations de la rotation de la terre et seismicité [Fluctuations of the rotation of the earth and seismicity]: Acad. Royale Belgique Bull., Cl. sci., 5° ser., tome 38, p. 607–611, 1952.

In continued studies of the correlation between seasonal fluctuations of the earth's rotation and earthquake frequencies an analysis was made of statistical data on earthquakes collected by several seismologists and the study of the variation of the rotation of the earth by Stoyko (see Geophys. Abs. 13291) and the conclusion drawn that the frequency of earthquakes becomes greater during the periods when decreasing rotational velocity changes to increasing. The change of rotation seems to be the primary factor, but displacement of masses resulting from ensuing earthquakes in turn changes the velocity of rotation because of the variation in the moment of inertia.—*S. T. V.*

14313. Dungen, F. H. Van den, Cox, J. F., and Mieghem, J. Van. Sur la période annuelle de la fréquences des séismes [On the annual periodicity of the frequency of earthquakes]: Acad. Royale Belgique Bull. Cl. sci., 5° ser., tome 37, p. 1037–1043, 1952.

Statistical data on earthquakes collected at Uccle during the years 1910–1945 were analyzed and a curve of average frequency of earthquakes for different months of the year was constructed. A pronounced maximum is observed in August and a minimum in the last week of February. Spanish seismologists have previously established a similar periodicity with a maximum in July and a minimum in January. It is suggested as a contributing factor that the crust rotates slightly faster (0.001 second per day) than the substrata.—*S. T. V.*

14314. Ramachandra Rao, M. B. Symposium on the Assam earthquake of August 15, 1950: Indian Jour. Meteorology and Geophysics, v. 3, no. 4, p. 258–263, 1952.

This is a summary of a symposium on the earthquake held at the Geological Survey of India, under the auspices of the Central Board of Geophysics. Eleven papers were presented; geophysical aspects were considered in papers by S. K. Banerji, S. K. Pramanik and S. M. Mukherjee, B. L. Gulatee, and S. Ray. Banerji discussed the magnitude, causes, and effect of geologic material on the transmission of seismic waves. He estimated the energy was of the order of 10^{27} ergs, and must have been produced by a large volume of rock subjected to gradually increasing strain reaching the yielding point; and the depth of focus 15 kilometers. Gulatee discussed the relation of gravity anomalies to the earthquakes. The 1950 shock occurred in a markedly negative region. Pramanik and Mukherjee presented factual data on time of occurrence, epicenter, acceleration, and so forth. Ray discussed the macroseismic data. He concluded the earthquake probably originated along a major fault striking northeast for about 100 miles.—*M. C. R.*

14315. Mukherjee, S. M. Landslides and sounds due to earthquakes in relation to the upper atmosphere: Indian Jour. Meteorology and Geophysics, v. 3, no. 4, p. 240–257, 1952.

This is a review of landslides and explosive sounds associated with violent tectonic earthquakes in India and adjacent countries during the past 125 years, and with special reference to the violent earthquake of 1950. Earthquake sounds originate in the focal region of the disturbance, travel in the rock with the speed of elastic waves and after refraction into the air proceed at a very small angle with the vertical, thus not returning to the ground. Explosive sounds heard at large distances from the epicenters long after the earthquakes are produced by landslides. These sounds travel at small angles to the horizontal and can be refracted into the atmosphere and reflected back to the ground. Thus they may be audible at different distances from the epicenters and have been observed at distances of many hundred kilometers. The explosive sounds due to submarine earthquakes appear to owe their origin to some volcanic phenomena. These sounds also can be audible at great distances.—*S. T. V.*

14316. Medvedev, S. V. Otsenka seysmicheskoy ball'nosti v zavisimosti ot gruntovykh usloviy [Estimation of seismic intensity as influenced by conditions of weathered layer]: Akad. Nauk SSSR Geofiz. Inst. Trudy no. 14 (141), p. 29–52, 1952.

Information collected by many seismological surveys on the variation of earthquake intensity at adjacent sites caused by differences in the properties of the foundation rock makes it necessary to apply corrections to regional evaluations of seismicity on the basis of seismic zoning of Soviet Union. From analysis of the available data, an empirical formula for this correction n was found as $n=1.67\ [\log(v_o\rho_o)-\log\ (v_n\rho_n)]+ae^{-0.04h^2}$. Here n is the increase of seismic evaluation to be applied to the ground characterized by seismic velocity V_n and density ρ_n as compared with the ground with characteristics V_o and ρ_o; h is the depth of water table measured in meters and a a coefficient ranging from 0.5 for gravel to 1.0 for sandy loam, argillaceous soil, and fine sand.

A curve is given for suggested correction to be applied for 23 different kinds of foundations, from 0 for granite, larger values for limestone, gypsum, sandstone to a value of 3 to 4 for water soaked alluvium.

Similar corrections should be applied to the formula $r_c=kc$ which defines the endangered zone is explosions (where r_c is the radius of the endangered zone, g the amount of explosives in kilograms and kc a coefficient, equal to 1.5–3.0 for granite, 5–10 for weaker rocks, and 15–20 for alluvium)—*S. T. V.*

SEISMIC SURVEYS

14317. Tolstoy, Ivan, Edwards, Richard S., and Ewing, Maurice. Seismic refraction measurements in the Atlantic Ocean, Pt. 3: Seismol. Soc. America Bull., v. 43, no. 1, p. 35–48, 1953.

Four fully or partly reversed seismic refraction measurements were made during the winter of 1950 in the North Atlantic Basin by the whaleboat method. Velocities of 2.61 km/sec and 3.85 km/sec were found offshore from Martinique at a depth of about 1,000 fathoms. Velocities of 6.05 km/sec in 3,160 fathoms and 7.07 km/sec in 3,300 fathoms at lat 22°55′ N, long. 64°23′ W and lat 28°28′ N, long. 56°28′ W respectively were found in the deep area south and southeast of Bermuda. Assuming that the sediment velocity lay between 1.0 and 1.2 times that of sound in water, this gave sedimentary thicknesses between 0.76 and 0.93 km and 0.34 and 0.42 km respectively. At a point 150 miles east of Bermuda (lat 32°20′ N, long. 62°02′ W) two distinct velocities were found: 4.12 km/sec (2.36 km thick) and 5.97 km/sec. The thickness of unconsolidated sediment would be of the order of 200 m. The velocities of 6.05 km/sec and 5.93 km/sec could correspond either to granitic or to low-velocity basic rocks. 7.07 km/sec is definitely in the ultrabasic range.

Owing to limitation on profile length of the whaleboat method, the thickness of the high-velocity rocks of the latter three was not determined. Recent data obtained in the same general area show that they are underlain by rocks with velocity of about 8 km/sec and are of the order of 5 km thick.—*Authors' Abstract*

14318. Katz, Samuel, Edwards, Richard S., and Press, Frank. Seismic refraction profile across the Gulf of Maine: Geol. Soc. America Bull., v. 64, no. 2, p. 249–252, 1953.

One partially reversed refraction profile across the northern Gulf of Maine has been interpreted as indicating a surface layer 5.1 km deep east of Falmouth, in which the compressional wave velocity is 5.3 kmps, thinning to the east over a distance of about 50 km. The underlying material has a velocity of about 6.25 kmps.—*M. C. R.*

14319. Gaskell, T. F., and Swallow, J. C. Seismic refraction experiments in the Pacific: Nature, v. 170, no. 4337, p. 1010–1012, 1952.

Results of the seismic investigations during the Challenger expedition of 1950–52 are summarized. The main part of the northern Pacific basin apparently consists of at least 8,000 feet of material in which the velocity of sound is 20,500 fps (probably gabbro or basalt) overlain by 1 or 2 thousand feet of sediments. The elevated parts of the ocean bed are characterized by a lower velocity, about 13,000 fps, probably corresponding to eruptive volcanic rocks. Near deep trenches there is some evidence of a 27,000 fps velocity.—*M. C. R.*

14320. Robin, G. de Q. Measurements of ice thickness in Dronning Maud Land, Antarctica: Nature, v. 171, no. 4341, p. 55–58, 1953.

Using standard seismic reflection techniques, a profile across the ice cap was determined. In order, the following features were observed: floating ice shelves, coastal ice hills, mountain ice sheet, and mountain inland plateau. The velocities in ice were: longitudinal, 3,800 m per sec; shear (?), 1,650 m per sec, and Rayleigh, 1,050 m per sec.—*M. C. R.*

14321. Conwell, C. L. Seismic investigations of areas near Ephrata, Washington—Columbia Basin project: U. S. Bur. Reclamation Geology Rept. G–120, 23 p., 1952.

Seismic refraction surveys were made in four areas near Ephrata to determine depth to the top of the basalt bedrock as part of a program of ground water investigations. The areas chosen were south and southeast of Soap Lake, between Soap Lake and Lake Lenore, along the west abutment of Long Lake Dam, and west of the town of Quincy. Two bedrock contour maps were drawn on the basis of the seismic data. These indicate that a bedrock divide separates Soap Lake from Lake Lenore, that a bedrock channel exists starting near the southwest corner of Soap Lake and trending toward Rock Ford Creek southeast of Soap Lake, and that a bedrock ridge exists, trending north and south, in the area southeast of Soap Lake. Depths to bedrock estimated on the basis of seismic data in the right abutment of Long Lake Dam were found to be inaccurate because of the broken fractured condition of the bedrock.—*M. C. R.*

14322. Innes, Arland I. The seismic history of southwestern New Mexico: Geophysics, v. 18, no. 1, p. 142–159, 1953.

Seismic exploration for oil in southeastern New Mexico was begun by the Amerada Petroleum Corp. and the Gulf Oil Co. early in 1928 when two crews of the Geophysical Research Corp. initiated seismic refraction profiling. Refraction profiling continued through 1931, and in 1932 a program of correlation refraction shooting was initiated when it was found that a deeply buried lime could be mapped on second arrivals. Correlation refraction shooting was continued into 1935. From 1934 to 1950 reflection shooting was dominant. The early refraction profiling detailed the Hobbs structure and led to the discovery of the Monument field early in 1935. Reflection profiling was credited in the American Association of Petroleum Geologists Bulletin for June 1950 with locating the Knowles, Bagley, Hightower, Cross Roads, Denton and Bough oil fields. Three other oil fields were also probably located by the reflection seismograph.—*L. C. P.*

MICROSEISMS

14323. Gilmore, M. H. Frontal microseisms: Am. Meteorol. Soc. Bull., v. 32, no. 11, p. 346, 355, 1951.

The data presented in this paper concerning frontal microseisms, together with data previously published concerning tropical storm microseisms, lead to the conclusion that most microseismic storms are a direct function of the wind force, the density of the air mass involved and the area over which the force acts. Most reliable sources of information also lead to the conclusion that microseismic storms are generated on the ocean bottom directly under the storm area, probably by means of compressional water waves set up by the storm.—*Author's Abstract*

RADIOACTIVITY

INSTRUMENTS AND METHODS OF OBSERVATION

14324. Healy, J. W. Measurement of natural radioactivity background: Nucleonics, v. 10, no. 10, p. 14–19, 1952.

This is general description of the techniques of measuring natural radioactivity in the atmosphere, water, and soil.—*M. C. R.*

14325. Heydenrych, J. C. R., and du Plessis, C. B. M. Instruments for radioactivity and temperature measurement in narrow boreholes: Easa, v. 9, 11 p., June 1952 [Seen as reprint only].

The instrument consists of a temperature feeler unit, radioactivity pick-up unit, temperature indicator, and radioactivity indicator and recorder. The temperature feeler unit consists of a steel wire stretched and rigidly fixed at two ends to a brass container. Increased temperature causes expansion of the cylinder, greater tension on the wire, and an increase in the frequency of the continuous signal being transmitted up the wire. The radiation pick-up unit transmits a constant frequency signal modulated to zero by pulses from a Geiger-Müller counter. The instrument can be lowered to 10,000 ft. or more and will withstand water pressures of as much as 5,000 pounds per square inch. Outside dimension is $1\frac{5}{16}$ in. A circuit diagram is given.—*M. C. R.*

14326. Kanne, W. R. Monitoring gas for radioactive Xenon. U. S. patent 2,625,657, granted January 13, 1953. 8 claims. Assigned to United States of America, represented by U. S. Atomic Energy Commission.

14327. Bulashevich, Yu. P. K teorii neytronnoge karottazaha [On the theory of neutron logging]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 3, p. 31–36, 1951.

This is a supplement to a previous article on the theory of neutron logging of drill holes (see Geophys. Abs. 10624). Discussed here are the slowing down of rapid neutrons and the effect of this phenomenon on the widening of the volume of scattering of thermal neutrons and the increase of the zone of capture in different formations. Rapid neutrons are more often met in geophysical exploration, because they are found, for instance, in logging of holes filled with water. The case of dry drill holes, treated previously, is rather exceptional.

A solution of the problem of the diffusion of thermal neutrons is given. Slowing down of neutrons and the increase of scattering are computed under the simplifying approximations that these phenomena are determined only by atomic weight and the number of atoms in a unit volume of the formation. The influence of crystalline and chemical bonds on the behavior of high energy neutrons is neglected.

The results of computations are presented in graphs with different curves corresponding to different media of scattering, such as limestone, gypsum, sands of varying moisture content, oil and others.

The influence of the length of the detector on the shape of the curves is also discussed and recommendations are given for optimum conditions.—*S. T. V.*

RADIOACTIVITY CONSTANTS

14328. Lewis, G. M. The natural radioactivity of rubidium: Philos. Mag., v. 43, no. 345, p. 1070–74, 1952.

The radioactive decay of Rb^{87} has been studied using the scintillations from a crystal of rubidium iodide activated with thallium, some fluorescent properties of which are described. This method, free from source absorption and scattering troubles, indicates a β-spectrum with an end point of 275 KEV. The Fermi plot gave a forbidden shape, for the most part close to that given by recent proportional counter work using a 2π geometry, but having slightly more counts at the high energy end, and fewer at the low energy end; the half-life has been determined at $(5.90\pm0.3)\times10^{10}$ years. The theoretical interpretations are indicated.—*Author's Abstract*

14329. Fleming, E. H. Jr., Ghiorso, A., and Cunningham, B. B. The specific alpha-activities and half-lives of U^{234}, U^{235}, and U^{236}: Phys. Rev., v. 88, no. 3, p. 642–652, 1952.

The material used for each determination was uranium very highly enriched in the isotope under investigation. Accurate volume aliquots of U^{235} were electrodeposited quantatively on to platinum disks and were counted in a medium geometry chamber. Accurate weight aliquots of U^{234} and of U^{236} were pipetted on to platinum disks, evaporated to dryness in an induction furnace, and counted in a medium geometry chamber. The specific activities and half-lives found are (in disintegrations/minute/milligram and years respectively): U^{234}, $(1.370\pm0.009)\times10^7$ and $(2.475\pm0.016)\times10^5$; U^{235}, $(4.74\pm0.10)\times10^9$ and $(7.13\pm0.116)\times10^8$; U^{236}, $(1.406\pm0.011)\times10^5$ and $(2.391\pm0.018)\times10^7$.—*Authors' Abstract*

ISOTOPE STUDIES AND DETERMINATIONS

14330. Aldrich, L. R., Herzog, L. F., Folyk, W. K., Whiting, F. B., and Ahrens, L. H. Variations in the isotopic abundances of strontium: Phys. Rev., v. 89, no. 3, p. 631–632, 1953.

Isotopic abundances of mineral sources of Sr have been measured. Variations in the ratio Sr^{86}/Sr^{88} of unknown origin have been found from 0.1160 to 0.1220. In Rb free minerals, the variation of the ration Sr^{87}/Sr^{88} (0.0832 to 0.868) is small enough to be completely attributable to the decay of Rb^{87} in geologic time. The large Sr^{87}/Sr^{88} variation in Rb minerals (biotite) from 0.0840 to 0.2629 indicates their suitability for use in the determination of mineral age.—*Authors' Abstract*

14331. Collins, C. B., Farquhar, R. M., and Russell, R. D. Variations in the relative abundances of the isotopes of common lead: Phys. Rev., v. 88, no. 6, p. 1275–1276, 1952.

Estimates of 3.5 billion years for the time of formation of the earth's crust and of 5.5 billion years for the maximum time of formation of the elements have been made from new mass-spectrometer measurements of the relative isotopic abundances of lead ore from Archean-type rocks in combination with Nier's data.—*M. C. R.*

14332. Collins, C. B., Russell, R. D., and Farquhar, R. M. The maximum age of the elements and the age of the earth's crust: Canadian Jour. Phys., v. 31, no. 3, p. 402–418, 1953.

The time of the formation of elements is estimated at 5.5 billion years ago, and the time of formation of the earth's crust at 3.5 billion years ago. The estimates are based on the isotopic constitution of lead ores dated by isotopic analysis of radiogenic leads from uranium minerals. Calculations follow the methods of Alpher and Herman and of Holmes as modified by Bullard and Stanley. Isotopic analyses were made by the lead tetramethyl method. Twenty-six isotopic analyses of lead are reported, 12 of them on samples previously analyzed by Nier. Sixteen new isotopic lead age determinations on uranium minerals are given.—*H. F.*

14333. Pekarskaya, T. B. Opredeleniye absolyutnogo vozrasta geologicheskikh porod po radioaktivnym mineralam [Determination of the absolute age of geologic formations using radioactive minerals]: Priroda, no. 1, p. 60–63, 1953.

This is a discussion of the different radioactive methods of age determinations. The various reactions are described, and the conditions for which each is applicable are analyzed. A table of ages as found by the different methods is included.—*S. T. V.*

14334. Cahen, L. Les déterminations d'âge absolue de la pechblende de Shinkolobwe (Katanga) [Determination of the absolute age of the Shinkolobwe (Katanga) pitchblende]: Soc. belge géologie Bull., tome 60, fasc. 1, p. 80–87, 1951.

The age of the Shinkolobwe pitchblende is 600±20 million years. Isotopic analyses by Nier indicate that the lead in the secondary minerals in the Shinkolobwe ore is radiogenic lead.—*M. C. R.*

14335. Anderson, Ernest C., and Levi, Hilde. Some problems in radio-carbon dating: K. Danske Vidensk. Selsk. Mat.-fys. Meddel. bind 27, nr. 6, 22 p., 1952.

General conclusions regarding the range of the method, its accuracy, possible sources of error and the instrumentation are presented from the theoretical viewpoint.—*M. C. R.*

RADIOACTIVITY OF ROCKS, WATERS, AND AIR

14336. Rona, Elizabeth and Urry, William D. Radioactivity of ocean sediments. VIII. Radium and uranium content of ocean and river waters: Am. Jour. Sci., v. 250, no. 4, p. 241–262, 1952.

New determinations of radium and uranium content of waters are presented. The radium analysis was made by concentrating the radium by coprecipitation with barium sulfate, removal of the latter, and measurement in an ionization chamber. Uranium analysis was by the method of Hernegger. Radium contents ranged from 0.07×10^{-16} to 0.58×10^{-16} g per cc; uranium ranged from 0.30×10^{-9} to 1.00×10^{-9} g per cc. Variations are attributed to the presence of separate water masses. The new measurements indicate no increase in Ra or U with depth, but do indicate a minimum of Ra between 300 and 700 m.

Open ocean waters contain only about 16 percent of the Ra that would be in radioactive equilibrium with the U content.—*M. C. R.*

14337. Ross, Virginia F. Autoradiographic study of marine shales: Econ. Geology, v. 47, no. 8, p. 783–793, 1952.

Autoradiographic study of several marine shales indicated that the radioactivity is associated with both organic and inorganic matter, the latter being, on the average, about 72 percent more radioactive.—*M. C. R.*

14338. Miholić, Stanko. Radioactivity of waters issuing from sedimentary rocks: Econ. Geology, v. 47, no. 5, p. 543–547, 1952.

Radioactivity has been determined in a number of Jugoslav mineral waters issuing from sedimentary rocks. Waters from Carboniferous and Cretaceous strata show a distinctly higher radioactivity than those issuing from sediments belonging to other periods. The possibility of a biogenic accumulation of uranium by organisms particularly abundant in the Carboniferous and Cretaceous is pointed out.—*Author's Abstract*

14339. Blifford, Irving H., Lockhart, Luther B. Jr., and Rosenstock, Herbert B. On the natural radioactivity in the air: Jour. Geophys. Research, v. 57, no. 4, p. 499–509, 1952.

The concentrations of the various radioactive decay products of radium in the air have been determined by observing the beta activity of pieces of filter paper through which air has been passed, and of chemically separated isotopes obtained from such filter papers. The relative amounts of long-lived and short-lived products found indicate that, besides the radioactive decay of the substances, some other process which removes radioactive particles from the air is active. The mean life of the particles with respect to this removing process is found to be about 10 days. The hypothesis that this process is the capture of the radioactive particles by rain droplets (clouds) is consistent with measurements made of the radioactive content of rain-water. On the other hand, the removal of the ionized radioactive particles by the electric field of the earth leads to a much smaller effect.—*Authors' Abstract*

14340. Garrigue, Hubert. Sur la radioactivité anormale de l'atmosphère [On the abnormal radioactivity of the atmosphere]: Acad. Sci. Paris Comptes Rendus, tome 235, no. 23, p. 1498–1500, 1952.

Evidence is presented for the existence at 1,400 m above the ground of non-local dust and a radioactive substance with half life of 25 hours. At 4,000 m, a radioactive substance with half life of 100 to 400 hours was observed.— *M. C. R.*

RADIOACTIVITY EXPLORATION SURVEYS

14341. Gross, W. H. Radioactivity as a guide to ore: Econ. Geology, v. 47, no. 7, p. 722–742, 1952.

A prospecting method based on the occurrence of higher-than-normal radioactivity in igneous rock in the vicinity of ore structures. In the 9 intrusives examined, high radioactive anomalies were found in the neighborhood of associated ore bodies, but no anomaly in 2 intrusives barren of ore. The distribution of zirconium, silica, and the heavy metals can be used in much the same way as radioactivity, although zirconium seems to be less reliable in granitized sediments, and silica is more important in the more basic rocks.—*M. C. R.*

14342. Iwasaki, S., Kanai, K., and Futsakaichi, H. Gamma ray measurements on some radioactive deposits (preliminary report) [In Japanese with English summary]: Geol. Survey Japan Bull., v. 3, no. 3, p. 57–60, 1952.

Measurements of gamma-ray intensity five to seven times normal near two radioactive deposits in Kyōto and Yamaguchi-ken are reported.—*M. C. R.*

THERMOLUMINESCENCE

14343. Saunders, Donald F. Thermoluminescence and surface correlation of limestones: Am. Assoc. Petroleum Geologists Bull., v. 37, no. 1, p. 114–124, 1953.

Nearly all limestones emit light when heated to a temperature below that of incandescence. This thermoluminescence is a natural property of the calcium and magnesium carbonate minerals in the rock. It can also be induced artificially by irradiating specimens with gamma rays or X-rays. The natural thermoluminescence has been produced by radiation from radioactive impurities in the rock.

The light emission is measured by a photomultiplier tube circuit as the temperature of the specimen is increased. Both of these variables are recorded simultaneously by means of a two-point potentiometer recorder. A plot of the light intensity as a function of temperature is termed the "glow curve." This shows a series of light-intensity maxima which depend on the amount of radiation that the minerals have received, their impurity content, and their crystallization history.

The glow curves of the artifically induced thermoluminescence of many different limestones have been measured, and the shapes of these curves have been found to be characteristic of the limestone stratum from which the specimens were obtained.

Preliminary tests of the use of this property as a tool in surface correlation of limestones have shown it to be applicable under closely controlled sampling in thick limestones. It has also been indicated that certain well known Pennsylvanian limestones can be differentiated over a county-wide area by the amounts of thermoluminescence as measured from their glow curves.—*Author's Abstract*

14344. Parks, James M., Jr. Use of thermoluminescence of limestones in subsurface stratigraphy: Am. Assoc. Petroleum Geologists Bull., v. 37, no. 1, p. 125–142, 1953

The thermoluminescence of the limestones of the Meramecian and Chesteran series (middle and upper Mississippian) of the Illinois basin was studied in an attempt to develop the thermoluminescence of limestones into a useful research tool in subsurface geology.

A powder method of sample preparation is described which makes accurate quantitative measurements of thermoluminescence possible. The apparatus used in measuring and recording thermoluminescence is described briefly.

The analysis of patterns of variation in intensity of thermoluminescence and in glow-curve shapes vertically through a formation appears to have some usefulness in subsurface stratigraphy in identifying and characterizing a formation, assisting in recognizing tops and bottoms of limestone formations where lithologic breaks are not present, splitting thick carbonate rock sequences into small units useful in correlation, and recognizing erosion or nondeposition of zones by absence of parts of the typical pattern of variation.

Within certain limitations, the variations in radioactivity of the limestones appear to be the dominant factor in the cause of variations in thermoluminescence.—*Author's Abstract*

HEAT

GENERAL AND THEORETICAL STUDIES

14345. Lapwood, E. R. The effect of contraction in the cooling by conduction of a gravitating sphere, with special reference to the Earth: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, p. 402–407, 1952.

The equation of heat conduction is given for a contracting, gravitating sphere. An associated energy equation is interpreted in terms of interchanges of gravitational potential, strain, and heat energy. The heat equation is applied to the case of the earth, and with some simplifications it has been solved by the method of successive approximations. Three conclusions are offered: It is probable that the heating effect of contraction is more than counteracted by the speedier outflow of heat due to increased temperature gradients. It is probable that the corrections demanded by departures of the earth's crust from homogeneity as regards density, specific heat, and thermal conductivity are larger than those that allow for contraction. None of these effects is large enough to make fundamental changes in the picture of the earth's thermal history that is derived from discussion of the cooling of a rigid uniform sphere, with allowance for radioactivity.—*P. E. B.*

14346. Chandrasekhar, S. The thermal instability of a fluid sphere heated within: Philos. Mag., v. 43, no. 347, p. 1317–1329, 1952.

In this paper the problem of the thermal instability of an incompressible fluid sphere heated within and in equilibrium under its own gravitation is considered. A general disturbance is analysed into modes in terms of spherical harmonics of various orders, l, and the criterion for the onset of convection for the first fifteen modes is found both when the bounding surface is free and when it is rigid; and it is shown that in both cases the mode $l=1$ is the first to be excited.—*Author's Abstract*

14347. Chandrasekhar, S. The onset of convection by thermal instability in spherical shells: Philos. Mag., v. 44, no. 350, p. 233–241, 1953.

In this paper the problem of the thermal instability of an incompressible sphere consisting of an inviscid core and a viscous mantle is considered, and it is shown that the pattern of convection which sets in, at marginal stability, in the mantle shifts to harmonics of the higher orders as the thickness of the mantle decreases. Thus, when the mantle extends to a depth of half the radius of the sphere, the harmonics of orders three and four set in about simultaneously, while the harmonic of order five follows very soon afterwards. The bearing of this result on the problem of convection in the earth's mantle and of the interpretation of the earth's topographic features is indicated.—*Author's Abstract*

14348. Urey, H. C. Comments on planetary convection as applied to the earth: Philos. Mag., v. 44, no. 349, p. 227–230, 1953.

Chandrasekhar has shown that first order spherical harmonic convection in a sphere can occur if the sphere has a liquid core with a diameter not larger than 18 percent of the sphere diameter. Successively higher harmonics appear

as the core increases in size. If this single cell convection along an axis through the sphere and back along the surface is responsible for the major land areas of the earth, then the earth must have been formed in a highly viscous condition. The core of the earth must have grown during an appreciable fraction or the whole of the time since the earth was formed. The general assumption of a very hot, rapidly changing earth during a short time of formation, followed by relatively small changes since then does not seem plausible.—*H. F.*

14349. Jacobs, J. A. Temperature-pressure hypothesis and the earth's interior: Canadian Jour. Physics, v. 31, p. 370–376, 1953.

Bullen and Ramsey have shown that the reciprocal of the compressibility is a linear function of the pressure both in the Earth's core and in the mantle below 1,000 km. In view of this result, it seems reasonable to suppose that a similar relationship exists between the reciprocal of the volume coefficient of thermal expansion and pressure. Support for this hypothesis is obtained by two independent methods (a) using Uffen's results based on the theory of solids, (b) using Murnaghan's theory of finite strain. Assuming the validity of the hypothesis, an estimate is made of the adiabatic gradient throughout the Earth. Taking the temperature at 1,000 km. to be 3,600° K., values of the temperature at greater depths are estimated. In particular it is found that the temperature at the boundary of the core is 4,350° K., and at the center of the Earth a little over 4,800°K. These results have considerable interest and bearing on Bullard's theory of the transfer of heat from the core.—*Author's Abstract*

14350. Uffen, R. J., and Misener, A. D. On the thermal properties of the earth's interior: Physical Soc. London Proc., sec. B., v. 65, no. 9, p. 742, 1952.

By combining the molecular theory of solids and known seismic data, estimates may be made of the thermal properties of the earth's interior. Computed values of the adiabatic gradients agree with Verhoogen's work. Assuming reasonable values for the material in the mantle the melting point at 100 km is 1,730° K and at the core 5,000° K. The data suggest that convection currents could be maintained by the heat generated in an inner core with a radioactive content equal that of iron meteorites.—*M. C. R.*

14351. Jacobs, J. A. A temperature of the interior of the earth: Nature, v. 170, no. 4333, p. 838, 1952.

An equation for the adiabatic temperature gradient in terms of density and specific heat at constant pressure, valid for depths greater than 1,000 km, may be determined by assuming a linear relationship between the reciprocal of bulk compressibility, volume coefficient of thermal expansion, and pressure. On this basis the temperature at the core boundary is of 350° K and at the center of the earth 4,800° K or higher.—*M. C. R.*

14352. Lyubimova, Ye A. Vliyaniye radioactivnoyo raspada na teplovoy rezhim zemli [The effect of radioactive distintegration on the thermal conditions of the earth]: Akad. Nauk SSSR Izv., Ser. geofiz. no. 4, p. 3–14, 1952.

An analytical study is presented of thermal processes in the interior of the earth caused by the radioactive disintegration of such substances as uranium, thorium actinouranium, and potassium, assumed to be homogeneously distributed throughout the whole mass of the earth. The composition of the earth is assumed

to be the same as that of meteors, one-third iron, uranium, thorium, potassium, and actinouranium, and two-thirds stony material. As the basic premise the earth is assumed to have been formed by a cold process, so a homogenous distribution of radioactive substances in the initial phase of the process seems quite probable. Constant density and heat capacity of the earth, independent of the depth, are also assumed.

The intensity of radioactive heat production computed from recent determinations of decay constants, resulted in greater heat generation in the beginning of geologic history than at the present time. Applying the method of images, expressions were derived for the temperature in the center of the earth for the past time, for different assumed ages of the earth; for the variation of temperature with depth. The great thermal inertia of the earth, due to very low heat conductivity, leads to conditions where the exterior surface is cooling, while near the center the temperature continues to rise. The computed quantities are presented in the form of rapidly converging series.—*S. T. V.*

14353. Rikitake, Tsuneji. Electrical conductivity and temperature in the earth: Tokyo Univ. Earthquake Research Inst. Bull., v. 30, pt. 1, p. 13–24, 1952.

Rikitake's previous work on determining the temperature distribution within the earth from the distribution of electrical conductivity and the theory of ionic crystals is revised for greater accuracy and to take into account changes in physical conditions above and below the so-called 20° discontinuity. Considering the pressure-effect of the conductivity it is found that the temperature is probably 1,000 K just below the crust and then increases almost proportionally to depth, the rate being estimated as 1.4 K per km. This distribution is roughly consistent with the density and bulk modulus distribution determined by Bullen.—*M. C. R.*

INSTRUMENTS AND METHODS OF MEASUREMENT

14354. Tavernier, Paul, and Prache, Pierre. Influence de la pression sur la resistivité d'une thermistance [Effect of pressure on the resistivity of a thermistor]: Jour. Physique et Radium, tome 13, no. 7–8–9, p. 423–426, 1952.

Experiments indicate the variation in resistance expressed as the fractional change $\Delta R/R_o$, of a thermistor subjected to pressures P up to 5,000 kg per cm^2 is given by $\Delta R/R_o = -4.6\times10^{-6} P$ and is independent of temperature in the range between 30 and 70 C. The correction to rough data is of the order of −0.01 degree for pressure of 100 kg per cm^2. Details of the experimental set up are given.—*M. C. R.*

OBSERVED TEMPERATURES IN THE CRUST AND HEAT FLOW

14355. Revelle, Roger, Maxwell, Arthur E., and Bullard, E. C. Heat flow through the floor of the eastern North Pacific Ocean: Nature, v. 170, no. 4318, p. 199, 1952.

The thermal gradient at 6 places in the eastern north Pacific ocean floor was found to be about 1.2×10^{-6} cal/cm^2/sec. This is the same order of magnitude as in continental areas. A possible explanation is that the heat is generated by radioactivity, the total amount beneath a unit area of continent or ocean being the same when summed to a depth of a few hundred kilometers.—*M. C. R.*

14356. Thomson, Andrew, and Bremner, P. C. Permafrost drilling and soil-temperature measurements at Resolute, Cornwallis Island, Canada: Nature, v. 170, no. 4330, pp. 705–706, 1952.

Temperatures have been measured in 2 drill holes, 307 and 453 feet deep. The average conductivity of core samples was determined by Misener as K=0.006 cgs units at 31.2 C. Short period fluctuations in the temperatures at the 8-inch level reflect fluctuations of air temperatures, but are damped out and become practically negligible at 60 inches. Seasonal temperature changes are perceptible to about 50 feet with a lag of about 6 months. Complete freezing of the active layer was observed to take place in about 3 weeks. Temperatures at 98, 300, and 450 feet are practically constant at —13.50, —11.59, and —9.54 C respectively. The layer between 50 and 98 feet is nearly isothermal.—*M. C. R.*

VOLCANOLOGY

14357. Werenskold, W. Faults and volcanoes: Am. Geophys. Union Trans., v. 34, no. 1, p. 110, 1953.

It is suggested that temperature and pressure in the earth's crust are so adjusted that no melting occurs except in special cases although the temperature is near the melting point. Movement along a vertical fault would disturb this balance; below the uplifted flank pressure would be lowered so that melting, and subsequent lava flows, might result.—*M. C. R.*

14358. Imbò, Giuseppe. Temperature d'irrigidimento di attuali lave etnee [The temperature of solidification of the present day lavas of Etna]: Accad. sci. fis. et mat Napoli Rend., ser. 4, v. 18, p. 18–21, 1951.

During the eruption of Etna of November 25, 1950, the temperature of ejected lava was measured, and the temperature of solidification was found to be 635 C, some 30° lower than in some recent eruptions. As in some previous studies, the temperature of solidification was found to be related to the whole process of eruption, its total duration, and to the presence or absence of explosive phenomena preceding and accompanying the eruption.—*S. T. V.*

TECTONOPHYSICS

FORCES IN THE EARTH AND OROGENESIS

14359. Scheidegger, Adrian E. Examination of the physics of theories of orogenesis: Geol. Soc. America Bull., v. 64, no. 2, p. 127–150, 1953.

This is a review of the theories of orogenesis from the viewpoint of the physicist. The principal conclusion is that all theories of orogenesis must remain purely speculative until more factual data about the earth are known.—*M. C. R.*

14360. Bullen, K. E. On strain energy and strength in the earth's upper mantle: Am. Geophys. Union Trans., v. 34, no. 1, p. 107–109, 1953.

Considerations of strain energy suggest that either the Gutenberg-Richter magnitude formula gives the energy of large earthquakes too great by a factor rather greater than ten, or that the fracture resisting strength of the material in the focal region of the greatest deep earthquakes is at least of order 500 kg/cm^2. It is suggested further that $SR^{1/2}$, where S denotes the breaking

strength and R the volume of the strained material just prior to an earthquake, has for the greatest deep earthquakes a value at least half that for the greatest shallow earthquakes.—*Author's Abstract*

14361. Chevallier, J. M. Analyse harmonique du relief terrestre [Harmonic analysis of terrestrial relief] : Rev. géomorphologie dynamique, 3° année, no. 5, p. 219–246, 1952.

The earth's surface is represented by the means of a Fourier series. This harmonic analysis supplies an objective criterion for evaluation of the symmetries or asymmetries of the globe. The results can be formulated as follows: the average altitude along each parallel circle is strikingly antisymmetric with respect to the equator; relatively few harmonics are of importance—practically the first four, and their frequencies are low; the position of these harmonics suggests a certain meridianal symmetry, altered by a conspicuous torsion from southeast to northwest, akin to equational antisymmetry.

A cosmogonic interpretation of these results is attempted and the hypothesis is advanced that tides slowed down the earth's spin and in pre-Cambrian times caused deformation of the terrestrial ellipsoid with ensuing fractures of the crust.

An important geophysical aftereffect of the asymmetry of the earth is the complicated movement of the terrestrial axis of rotation.—*S. T. V.*

14362. Hattori, Tadahiko. On the periodic components of latitude variation: Japanese Jour. Astronomy, v. 1, no. 1, p. 87–97, 1952.

Variation of latitude consists of two periodic components, one with a period of a year, the other, the so-called Chandlerian term, a period of fourteeen months. The former is thought to be caused by changes of mass distribution in the earth's atmosphere, the latter by the elastic yielding of the earth.

The tidal disturbance of the moon and the sun on the coordinates of the pole, was calculated taking into consideration the effect of the elastic yielding of the earth. Comparison of the results with observational data on latitude variations reveals noticeable discrepancies. As calculated by de Sitter, these discrepancies cannot be attributed to local redistribution of atmospheric masses on the earth's surface. Brown has suggested movements of matter within the crust as their probable cause. This latter hypothesis finds confirmation in the correlation that was established between the Chandlerian periodic motion of the pole and the periodicity of stronger earthquakes in the region of western Java.—*S. T. V.*

14363. Young, Andrew. The contribution of the seasonal movements of air masses to the variation of latitude: Acad. Royale Belgique Bull., Cl. sci., 5 ° ser., tome 38, p. 824–837, 1952.

Variations in the moments of inertia of the earth are calculated from atmospheric pressure variations as recorded for each month of the years 1925 to 1930 at some 340 meteorological stations distributed over the earth. The rigidity of the earth body was assumed. With these data, the variation of latitude was computed, taking damping and possible resonance into account. Comparing the calculated variations of latitude, with or without damping, with the observed motion of the pole it is possible to distinguish random disturbances superimposed over regular periodic variations. These disturbances are produced by some as yet unknown causes.—*S. T. V.*

14364. Ledersteger, K. Neue analyse des Chandler-Bewegung [New analysis of the Chandlerian motion]: Bull. géodésique, no. 23, p. 67–72, 1952.

The Chandler movement is essentially an oscillation having an assumed period of the order of time of a double revolution of the moon's nodes. The variation in its period is only apparent and relies upon a sudden change of phase which occurred at the beginning of 1928. If attention is paid to the residuals, a secondary oscillation with an 11-year period can be detected. This explains the Witting perturbations, and is possibly connected with the sunspot cycle.—*Author's summary.*

14365. Dungen, F. H. Van den, Cox, J. F., and Mieghem, J. Van. Sur la redistribution des masses d'air audessus des oceans [On the redistribution of air masses over oceans]: Acad. Royale Belgique Bull., Cl. sci., tome 38, no. 1–2, p. 102–105, 1953.

Exceptions are taken to the procedure of calculating the seasonal displacements of air and vapor masses from hemisphere to hemisphere using simple considerations of hydrostatics. Skin friction and generation of surficial ocean currents, producing horizontal pressure gradients over the oceans, would probably increase the unexplained terms of the trajectory of the pole.—*S. T. V.*

14366. Sekiguchi, Naosuke. Theory of the rotation of the earth having three unequal principal moments of inertia: Japanese Jour. Astronomy, v. 1, no. 1, p. 99–122, 1952.

A detailed analysis, based on principles of classic mechanics, is presented of the theory of the rotation of the earth, assuming it to be a triaxial, perfectly rigid ellipsoid with density distribution symmetrical with respect to the plane passing through the equator. The disturbing lunisolar effect on the procession, nutation, and the hour angle of the vernal equinox is considered. Under these assumptions the effect on the latitude variation and on rotation velocity of the earth is computed. The deviations of observed data from computed values are attributed to geophysical causes such as periodic displacements of atmospheric masses and to probable movements of the earth's core.—*S. T. V.*

14367. Holmberg, E. R. R. A suggested explanation of the present value of the velocity of rotation of the Earth: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 6, p. 325–330, 1952.

The coincidence of the period of rotation of the earth and a natural period of vibration of the atmosphere may be not fortuitous but due to the earth's being driven at a constant rate in synchronism with the vibration. The atmosphere, behaving as a heat engine, transfers solar heat into mechanical energy at one of the natural periods of the atmospheric mass and this produces an accelerating couple acting in opposition to the retarding couple produced by oceanic tides. If the oceanic couple, averaged over a time long enough to permit an appreciable change of the earth's angular velocity, is less than indicated at present, there may exist an equilibrium between these effects. The retarding effect of oceanic tides is strongest in shallow basins, and fluctuations of the ocean bottom may be responsible for a relatively large value of the retarding couple at present.

The astronomical evidence supporting the current opinion that the rotation is being steadily retarded is reviewed and found to contain contradictions, and it is claimed that the high value of the angular momentum of the earth-moon orbit supports the hypothesis of equilibrium.—*P. E. B.*

14368. Munk, Walter [H.], and Revelle, Roger. On the geophysical interpretation of irregularities in the rotation of the earth: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 6, p. 331–347, 1952.

Astronomical measurements for the past 300 years have revealed fluctuations of the annual average of the angular velocity of the earth. Variations of several milliseconds in the length of the day have occurred over periods of a few decades. It was formerly thought that these changes occurred abruptly, and accordingly past investigations have searched for catastrophic causes. This limitation has been removed by the recent work of Brouwer, who has shown that the observed changes in the length of day can be fitted to cumulative random series.

Munk and Revelle investigate possible causes involving changes in the moment of inertia due to redistributions of matter and variable motion relative to the earth's crust. Variations in the distribution of air mass are completely inadequate to account for the observed fluctuation of the length of day and variations in oceanic circulation have a negligible effect, but random fluctuations in the elevation of continental blocks of the crust, if sufficiently large to cause observed changes in the length of day, would bring about displacements in the pole of rotation far greater than those observed from 1890 to 1950. A symmetrical oscillation of the crust, with movements in opposite directions in the high and low latitudes, and its implications seem difficult to explain as regards a source mechanism. Tide-gage data are inadequate to preclude this possibility. Electromagnetic coupling of the mantle to a turbulent core could account for the observed fluctuations, provided the conductivity of the mantle is about 10^{-9} emu. Vestine's calculation of the westward drift of the magnetic field between 1890 and 1950 shows the proper relationship, qualitatively and quantitatively, to Brouwer's calculations of the length of day over the same period.

An organized vertical crustal movement, even if a priori unlikely, cannot be altogether ruled out as a possible cause for the fluctuations in the length of day, especially if most of the motion is ascribed to the Antarctic, where tide-gage data are lacking. There is positive evidence for ascribing the fluctuations to variable motion in the earth's core, which also has "the advantage of being even less accessible than the Antarctic."

Tabulated values for certain mean sea-level fluctuations and some pertinent areal integrals are included.—*P. E. B.*

14369. Munk, Walter [H.], and Revelle, Roger. Sea level and the rotation of the earth: Am. Jour. Sci., v. 250, no. 11, p. 829–883, 1952.

From ancient beach lines, Daly has proposed an eustatic lowering of sea level by about five meters during the last few thousand years. This would decrease the length of day by 30 milliseconds if the lowering is due to "rapid" growth of ice caps, and by 90 milliseconds if, as suggested by Daly, the lowering is due to isostatic after flow in the earth's mantle following a rapid meeting of ice caps. The corresponding value derived from ancient observations of eclipses, 27 ± 18 milliseconds, indicates rapid growth of ice caps. For the last hundred years, tide-gauge records and the retreat of glaciers indicate a rise in the sea level by 10 cm. This rise would displace the north pole of rotation by something like 10 feet towards the North Atlantic, the precise value and direction depending on the source of melted water. Such a displacement is not inconsistent with astronomic evidence.—*Authors' Abstract.*

14370. Cailleux, André. Récentes variations du niveau des mers et des terres [Recent variations of land and sea level]: Soc. géol. France Bull., 6e ser., tome 2, fasc. 1–3, p. 135–144, 1952.

Measurements of average sea level from 1885 to 1951 disclose a eustatic rise with a speed of 1,300 mm per thousand years, probably due in part to the recent great melting of glaciers. This is added to regional deformation. Isostatic adjustments to the deglaciation aside, sinking (from 0 to 4,100 mm) predominates in areas of strong sedimentation, and elevations (from 0 to 3,770 mm) on the uninvaded rocky coasts. Speeds are of the same order as those of past transgressions, epeirogenies and orogenies.—*Author's Abstract, M. C. R.*

14371. Polli, Silvio. Misura dei lenti movimento verticali della superficie terrestre [Measurements of slow vertical movements of the earth's surface]: Annali Geofisica, v. 5, no. 3, p. 433–439, 1952.

A procedure is demonstrated that permits the calculation of slow vertical movements of the earth's surface by means of tide-gauge determinations of mean ocean levels. This procedure is valid for large zones as well as for those more restricted. Results obtained from the coastal regions can be applied to the inland regions by means of a precise correlation. This method is based on the determination of the difference between the velocity of the mean vertical movement of all the seas and that of a designated station. Such a difference gives the absolute vertical displacement of the coast in the region considered. From the data of all the marine stations of the Earth, grouped in ten-year intervals, and further by coastal region, the mean ten-yearly variation of some coastal regions from the mean of all the oceans for the period 1871–1940 has been calculated.

In this period of time the mean increase of the level of the sea has been 1.1 cm per 10 years. The method permits the measurement of vertical displacements of the coastal level with a precision that is on the order of a few tenths of a millimeter for a ten-year interval.—*Author's Summary*

ELASTIC CONSTANTS AND STRENGTH OF ROCKS

14372. Maxwell, John C., and Verrall, Peter. Expansion and increase in permeability of carbonate rocks on heating: Am. Geophys. Union Trans., v. 34, no. 1, p. 101–106, 1953.

Experimental observations of the effects of heating of marbles, limestones, and travertine at one atmosphere, and at 5,000 and 10,000 pounds per square inch confining pressures are described. Results indicate that calcite-bearing rocks expand permanently when heated 100 to 200 C or more above normal temperature irrespective of pressure. The permeability is markedly increased as the rock expands with higher temperatures, though lowered somewhat by confining pressure. The permanent expansion of carbonate rocks on heating may be of importance in the formation of replacement deposits in such rocks.—*M. C. R.*

INTERNAL CONSTITUTION OF THE EARTH

14373. Mintrop, Lüdger. Der Untergrund der Kontinente and Ozeane nach geophysikalischen Untersuchungen [The crustal structure of continents and oceans from geophysical investigations]: Annali Geofisica, v. 5, no. 2, p. 163–200, 1952.

Analysis of the different theories of the formation of oceans and continents leads Mintrop to conclude that: The Airy hypothesis is not in accordance with

seismic observations, as the Sierra Nevada and the Alps have no roots and there are even indications of the existence of anti-roots under the mountains; the buckling hypothesis of Vening-Meinesz cannot be maintained and is not necessary for the explanation of negative gravity anomalies in the Indian Archipelago (Malay Archipelago); the convection theory of Griggs and others cannot be maintained in view of the stratification of the earth's crust as revealed by seismic observations; the uplift of continents may be caused by geothermal processes, changing the volume of deeply seated formations; the crystalline crust is thicker under the oceans; and the thickness of the plastic layers of the crust can be determined by seismic observations of blasts.—*S. T. V.*

14374. Valle, Paolo Emilio. Una relazione diretta fra la velocità delle onde elastiche e la densità nell'interno della terra [A direct relation between the velocity of elastic waves and the density in the interior of the earth]: Annali Geofisica, v. 5, no. 3, p. 417–431, 1952.

A direct relation between the velocity of elastic waves and the density of a homogeneous isotropic solid has been found by theoretical treatment of the problem. The solid is supposed monoatomic and the theory applies to temperatures greater than the Debye temperature.

The theory is based on the solid state equation and on the hypothesis that the modulus of elasticity, which determines the velocities of the waves of thermal motion, depend only on the mean distance between the particles of the solid.

The applicability of this relation to the interior of the Earth is discussed and a comparison made between the velocity of seismic waves given by Jeffreys and the density of Bullen. The agreement between the theory and geophysical data is satisfactory, either for the mantle of the Earth, or for the core, to which the theory can be extended.—*Author's summary*

14375. Bullen, K. E. On density and compressibility at pressure up to thirty million atmospheres: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 6, no. 6, p. 383–401, 1952.

A critical examination is made of curves presented by W. M. Elsasser on the density and compressibility of materials at zero temperatures and pressures up to 30 million atmospheres, and of Elsasser's inference that the Earth's core consists of iron or nickel iron. An argument leading Elsasser to suggest that the writer's Earth models A and B may require adjustments because of discrepancies with Elsasser's results is shown to be invalid.

New tables are presented which fit the date used by Elsasser at 30 million atmospheres and are also consistent with geophysical data. The calculations leading to these tables imply that the atomic number to be associated with the material of the outer central core should be at least 6 units less than the value derived using simple extrapolations from quantum-mechanical calculations for high pressures. If the reduction in the atomic number is no more than 6 units, the most probable composition of the material in question would still be nickel iron, and to this extent Elsasser's main conclusion is supported. But there are other aspects of the new calculations which suggest that the needed reduction may be greater than 6 units; these aspects raise the probability that the outer central core consists of a modification of ultrabasic rock. A caution is issued against forming too definite conclusions on either of the 2 opposing theories on the whole evidence so far available.

Some support is found for the view that the Earth's present inner core is more likely to consist of an accumulation of iron and denser materials than of ultrabasic rock that has undergone a second pressure transformation. Support is also found for the view that the density gradients of model B require a progressive change of composition with increase of depth in the inner core. The hypothesis that the inner core is solid is strengthened. Strong support is given to Elsasser's argument against the presence of large amounts of compressed hydrogen in the central core.—*P. E. B.*

14376. Bullen, K. E. Cores of terrestrial planets: Nature, v. 170, no. 4322, p. 363–364, 1952.

Earth models with an iron core as postulated by Urey, with a core due to pressure modifications as proposed by Ramsey, and a core partly of nickel iron and partly of modified ultrabasic rock as suggested by Bullen are compared, using data on Venus, Mars, and Mercury.—*M. C. R.*

GENERAL GEOPHYSICAL EXPLORATION

14377. Lahee, Frederick H. Field geology (5th ed.), 883 p., New York, McGraw Hill Book Company, 1952.

Gravity, magnetic, seismic, and electrical methods of exploration are outlined in chapter 23 (69 pages).—*M. C. R.*

14378. Joesting, H. R. Geophysics—Annual review 1952: Mining Engineering, v. 5, no. 2, p. 151–155, 1953.

The outstanding discoveries, advances and trends in geophysics during 1952, with emphasis on mining and engineering geophysics, are outlined. Information was obtained from about 75 correspondents in all parts of the world except the U.S.S.R. satellite countries.—*M. C. R.*

14379. Garcia Rojas, Antonio. Exploration work in Mexico: Geophysics, v. 18, no. 1, p. 188–200, 1953.

Oil exploration in Mexico has been intensified since 1940 so that, at present, the number of crews per million barrels of oil produced is approaching that of the United States. There are now 20 geologic parties, 20 seismic parties, 4 gravity-meter parties and 1 electrical party operating in Mexico. The number of wildcats per million barrels of oil produced, however, is far below that of the United States, although there has been a sharp increase since 1945. Most of the work has been done in the Gulf Coast area. Geophysical methods are credited with finding a very large percentage of new oil fields. Pemex employs gravity measurements locate regional trends and some local anomalies, followed by detailed seismic work. Electrical methods are used successfully to locate shallow fracture zones.—*L. C. P.*

14380. Pot, R. Well logging and testing techniques applied to reservoir analysis: Canadian Min. Metal Bull., v. 45, no. 480, p. 208–212, 1952.

This paper reviews the principal testing methods which are available to the petroleum engineer to aid in the prediction of the potential productivity of an oil well. The methods mentioned are coring, formation testing, electrical well logging, radiation well logging, bottom-hole pressure measurements, and sam-

pling of reservoir fluids, with particular emphasis being placed on formation testing. A method of formation testing is described in which the pressure opposite the formation being tested is suddenly reduced, and the pressure surge resulting from the fluid being released from the formation is measured. The size of the pressure surge is controlled by both the porosity and permeability around the borehole.—*G. V. K.*

MISCELLANEOUS PATENTS

14381. MacLagan, A R. Inclination indicator, U. S. patent 2,624,952 granted January 13, 1953. 22 claims. Assigned to Eastman Oil Well Survey Co.

An instrument for indicating the inclination of a borehole by use of plumb bob.

14382. Goble, R. W. Method of and apparatus for the measurement of distance or time interval by the use of compressional waves in the so-called supersonic range, U. S. patent 2,631,270, granted March 10, 1953. 5 claims. Assigned to Eastman Oil Well Survey Co.

An apparatus for determining the cross-sectional area of a well boring.

14383. Boucher, F. G. Oil well orientation device, U. S. patent 2,632,959, granted March 31, 1953. 1 claim. Assigned to Standard Oil Development Co.

A device for remote readings of magnetic compass orientations in a well.

14384. Patnode, H. W. Electrical dip meter for logging boreholes, U. S. patent 2,633,485, granted March 31, 1953. 8 claims. Assigned to Gulf Research and Development Co.

14385. Hasbrook, A. F. Apparatus for recording time intervals, U. S. patent 2,626,004, granted January 20, 1953. 5 claims. Assigned to Olive S. Petty.

14386. Sellers, C. F. Geophysical prospecting device, U. S. patent 2,627,727, granted February 10, 1953. 2 claims. Assigned to Robert H. Ray, Inc.

A submersible bell for making under-water geophysical measurements.

14387. Muskat, M. Electrical calculator for solving phase-equilibrium problems, U. S. patent 2,630,968, granted March 10, 1953. 9 claims. Assigned to Gulf Research and Development Co.

14388. Staff, W. S. Pencil galvanometer, U. S. patent 2,633,480, granted March 31, 1953. 11 claims. Assigned to Socony-Vacuum Oil Co.

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