Geophysical Abstracts 160 January–March 1955

GEOLOGICAL SURVEY BULLETIN 1033–A

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

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

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CONTENTS

GEOGRAPHICAL ABSTRACTS, 160, JANUARY–MARCH 1955

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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 journals such as the Bibliography of Seismology, Chemical Abstracts, Meteorological 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.

ABSTRACTORS

Abstracts have been prepared by J. R. Balsley, P. E. Byerly, Henry Faul, R. G. Henderson, G. V. Keller, D. R. Mabey, V. S. Neuschel, L. C. Pakiser, and Isidore Zietz as well as by the principal authors.

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*
Åbo Akad. Geol. Mineralog. Inst. Medd.	Meddelanden fran Åbo Akademis Geologisk-Mineralogiska Institut. Helsinki.
Acad. Aboensis Acta	Acta Academiae Aboensis. Åbo, Finland.
Acad. Colombiana Cienc. exactas fis. y nat. Rev.	Revista de la Academia Colombiana de Ciencias Exactas, Fisicas y Naturales. Bogotá.

Abbreviation	*Publication*
Acad. Japan Proc	Proceedings of the Japan Academy. Tokyo.
Acad. Malgache Bull	Bulletin de l'Académie Malgache. Tananarive, Madagascar.
Acad. Royale Belgique Bull., Cl. Sci	Bulletin de la Classe des Sciences de l'Académie Royale de Belgique. Bruxelles.
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. Naz. Lincei Atti Cl. sci. fis. mat. et nat. Rend.	Atti della Accademia Nazionale dei Lincei, Classe di scienze fisiche, matematiche, e naturali Rendiconti. Roma.
Accad. sci. fis. et mat. Napoli Rend	Rendiconti dell'Accademia delle scienze fisiche et matematiche. Societa nazionale di scienze, letteri ed arti in Napoli. Napoli, Italy.
Acta Cuyana de Ingenieria	Acta Cuyana de Ingenieria. Facultad de Ingenieria y Ciencias Exactas Fisicas y Naturales, Universidad Nacional de Cuyo. San Juan, Argentina.
Acta Geol. Acad. Sci. Hungaricae	Acta Geologica Academiae Scientarum Hungaricae. Budapest.
Acta Geophys. Polonica	Acta Geophysica Polonica. Polskiej Akademii Nauk. Warszawa.
Acta Phys. Acad. Sci. Hungaricae	Acta Physica Academiae Scientarum Hungaricae. Budapest.
Acta Phys. Polonica	Acta Physica Polonica. Polskiej Akademii Nauk. Warszawa.
Acta Tech. Acad. Sci. Hungaricae	Acta Technica Academiae Scientarum Hungaricae. Budapest.
Adv. Sci	Advancement of Science. British Association for the Advancement of Science. London.
Agricultura (Madrid)	Agricultura. Francisco Jiménez Cuende. Madrid.
Akad. Nauk. Gruzinskoy SSR Soobshcheniya.	Akademii Nauk Gruzinskoy SSR Soobshcheniya. Tbilisi, U. S. S. R.
Akad. Nauk SSSR Doklady	Akademii Nauk SSSR Doklady. Moskva.
Akad. Nauk SSSR Geofiz. Inst. Trudy.	Akademii Nauk SSSR Geofizicheskii Institut Trudy. Moskva.
Akad. Nauk SSSR Izv. Ser. geofiz., Ser. geol., and Ser. fiz.	Akademii Nauk SSSR Izvestiya Seriya, geofizicheskaya, Seriya geologischeskaya, Seriya fizicheskaya. Moskva.
Akad. Nauk SSSR Ural'sk. filiala Trudy Gorno-Geol. Inst.	Akademii Nauk SSSR Ural'skogo filiala Trudy, Seriya geologicheskikh nauk.
Akad. Nauk SSR Vestnik	Akademii Nauk SSSR Vestnik. Moskva.

Abbreviation	*Publication*
Alger Univ. Inst. Recherches Sahariennes Travaux.	Travaux de l'Institut de Recherches Sahariennes. Universite d'Alger. Algiers.
Am. Antiquity	American Antiquity. Society for American Archeology. Menasha, Wis.
Am. Assoc. Petroleum Geologists Bull.	Bulletin of the American Association of Petroleum Geologists. Tulsa, Okla.
Am. Geophys. Union Trans	Transactions of the American Geophysical Union. Washington, D. C.
Am. Inst. Min. Metall. Engineers 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. Mineralogist	American Mineralogist. Mineralogical Society of America. Menasha, Wis.
Am. Scientist	American Scientist. Society of the Sigma Xi. New Haven, Conn.
Am. Soc. Testing Materials Special Tech. Pub.	American Society for Testing Materials Special Technical Publication. Philadelphia, Pa.
Annales des Mines	Annales des Mines. Paris.
Annales Géophysique	Annales de Géophysique. Centre Nationale de la Recherche Scientifique. Paris.
Annales Guébhard-Séverine	Annales Guébhard - Séverine. Institut de géophysique et sciences diverses, Fondation Adrien Guébhard-Séverine. Neuchâtel, Switzerland.
Annali Geofisica	Annali di Geofisica. Istituto Nazionale de Geofisica. Roma.
Archives Sci. (Genève)	Archives des Sciences. Société de physique et d'histoire naturelle de Genève. Genève, Switzerland.
Archiv Meteorologie Geophysik u. Bioklimatologie.	Arkiv för Meteorologie, Geophysik und Bioklimatologie. Wien.
Arkiv Geofysik	Arkiv för Geofysik. Kungliga svenska vetenskaps akademien. Stockholm.
Australian Bur. Min. Resources Geology and Geophysics, Bull.	Commonwealth of Australia. Bureau of Mineral Resources, Geology and Geophysics.
Australian Jour. Sci	Australian Journal of Science. Science House. Sydney, Australia.
Bergakademie	Bergakademie. Zeitschrift für Bergbau, Hüttenwesen und verwandte Wissenschaften. Bergakademie, Freiberg, Germany.

Abbreviation	*Publication*
Berg- u. Hüttenmänn. Monatsh	Berg- und Hüttenmännische Monatshefte. Wien.
Bohrtechnik-Brunnenbau	Bohrtechnik - Brunnenbau. Also published as Brunnenbau-Bohrtechnik and Brunnenbau - Tiefbohrtechnik. Berlin and Hannover.
Bol. Radiactividad	Boletín de Radiactividad. Instituto Nacional de Geofisica. Madrid.
Boll. Geodesia e Sci. aff	Bolletino di Geodesia e Scienze affini. Istituto Geografico Militare. Trieste.
Brasil Univ., Escola de minas Rev	Revista da Escola de Minas. Universidad de Brasil. Ouro Preto, Brazil.
Braunkohle Wärme u. Energie	Braunkohle Wärme und Energie. Düsseldorf, Germany.
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. Napoli, Italy.
Butsuri-Tanko (Geophys. Explor.)	Butsuri - Tanko (Geophysical Exploration). Society of Exploration Geophysicists of Japan. Kawasaki, Japan.
Cahiers géol. Thoiry	Cahiers géologique de Thoiry. Imprimerie Artisanale de Moret. Thoiry, France.
California Univ. Geol. Sci. Pubs	University of California. Publications in Geological Sciences. Berkeley, Calif.
Cambridge Philos. Soc. Proc	Proceedings of the Cambridge Philosophical Society. London.
Canadian Inst. Min. Metallurgy Trans.	Transactions of the Canadian Institute of Mining and Metallurgy. Montreal, Quebec.
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, Quebec.
Chem. Metall. Min. Soc. South Africa Jour.	Journal of the Chemical Metallurgical and Mining Society of South Africa. Johannesburg.
Chile Univ. Facultad Cienc. fis. y mat. Anales.	Anales de la Facultad de Ciencias fisicas y matemáticas. Universidad de Chile. Santiago.
Ciel et Terre	Ciel et Terre. Société Belge d'Astronomie, de Météorologie et du Physique du Globe. Uccle, Belgium.
Ciencia (Mexico)	Ciencia. México, D. F.
Civil Eng	Civil Engineering and Public Works Review. Lomax Erskine and Co., London.

Abbreviation	*Publication*
Coimbra Univ. Mus. Mineralog. Geol. Mem. e Noticias.	Memorias e Noticias, Publicaos do Museu Mineralogico e Geologico. Universidade de Coimbra. Coimbra, Portugal.
Colorado School of Mines Quart_____	Colorado School of Mines Quarterly. Golden, Colo.
Compass _____	The Compass of Sigma Gamma Epsilon. Lincoln, Nebr.
Congreso Cientifico Mexicano Mem. Univ. Mexico.	Memoria del Congreso Cientifico Mexicano. Universidad Nacional Autonome de Mexico. México, D. F.
Czechoslovakia, Státní. Geol. Ústav. Sbornik.	Sbornik Státního geologického ústavu Československé Republiky. Praha.
Czechoslovak Jour. Physics_____	Czechoslovak Journal of Physics. Center of Research and Technical Development, Central Institute of Physics. Praha.
Deep-Sea Research_____	Deep-Sea Research. Pergamon Press, London.
Del. Geol. Survey Bull_____	Bulletin of the Geological Survey of Delaware. Wilmington, Del.
Deutsch. geol. Gesell. Zeitschr_____	Zeitschrift der Deutschen Geologischen Gesellschaft. Hannover, Germany.
Deutsche Geod. Komm. Veroffentl____	Veroffentlichungen der Deutsche Geodatische Kommission. Potsdam, Germany.
Deutschen Akad. Wiss. Berlin Sitzungsber. Kl. Math. Naturw.	Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin. Klasse für Mathematik und allgemeine Naturwissenschaften. Berlin.
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.
Earthquake Notes_____	Earthquake Notes. Eastern Section, Seismological Society of America. Washington, D. C.
Eclogae geol. Helvetiae_____	Eclogae geologicae Helvetiae. Societé géologique Suisse. Basel, Switzerland.
Econ. Geology_____	Economic Geology. Society of Economic Geologists. Urbana, Ill.
Electronics _____	Electronics. McGraw-Hill Publishing Co. New York.
Eng. Min. Jour_____	Engineering and Mining Journal. McGraw-Hill Publishing Co. New York.
Erdöl U. Kohle_____	Erdöl und Kohle. Berlin
Explosives Engineer_____	Explosives Engineer. Hercules Powder Co. Wilmington, Del.
Földtani Közlöny_____	Földtani Közlöny. Magyar Földtani Társulat [Hungarian Geological Society]. Budapest.

Abbreviation	*Publication*
Forschungen u. Fortschr	Forschungen und Fortschritte: Akademie Verlag G. M. B. H. Berlin.
France Bur. Recherches géol. et géophys. Pub.	Publications of the Bureau des Recherches géologiques et géophysiques. Paris.
Garcia de Orta	Garcia de Orta. Revista da Junta das Missões Geograficos e de Investigacões do Ultramor. Lisboa.
Geochim. et Cosmochim. Acta	Geochimica et Cosmochimica Acta. Pergamon Press, Ltd. London.
Geofisica Pura e Appl	Geofisica Pura e Applicata. Milano, Italy.
Geofys. Pub	Geofysiske Publikasjoner. Norske Videnskap Akademii. Oslo.
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.
Geol. Jahrb	Geologisches Jahrbuch. Geologisches Landesanstalten der Bundesrepublik Deutschland. Hannover, Germany.
Geol. Landesamt Baden-Wurttemberg Abh.	Abhandlungen des Geologisches Landesamt in Baden-Wurttemberg. Freiburg-im-Breisgau, Germany.
Geol. Mag	Geological Magazine. Stephen Austin and Sons. Hertford, England.
Geologie	Geologie. Staatlichen Deutschen Demokratischen Republik. Akademie Verlag. Berlin.
Geologie en Mijnbouw	Geologie en Mijnbouw. Koninklijk Nederlandsch Geologisch Mijnbouw-kundig Genootschap. The Hague.
Geol. Rundschau	Geologische Rundschau. Stuttgart, Germany.
Geol. Soc. America Bull	Bulletin of the Geological Society of America. New York.
Geol. Soc. Australia Jour	Journal of the Geological Society of Australia. Sydney, Australia.
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.
Geol. Vjesnik	Geoloski Vjesnik. Geoloska Istrazivanja N. R. Hrvatske, Zagreb, Yugoslavia.

Abbreviation	*Publication*
Geophysica	Geophysica. Geofysiikan Seura. Helsinki.
Geophysics	Geophysics. Society of Exploration Geophysicists. Tulsa, Okla.
Geophys. Mag	Geophysical Magazine. Central Meteorological Observatory. Tokyo.
Geophys. Prosp	Geophysical Prospecting. European Association of Exploration Geophysicists. The Hague.
Gerlands Beitr. Geophysik	Gerlands Beiträge zur Geophysik. Leipzig, Germany.
Glasnik Prirod. Mus. Srpske Zemlje	Glasnik Prirodnackog Museja Srpske Zemlje. Beograd, Yugoslavia.
Glowny Inst. Naftowego Prace	Głowny Instyut Naftowego Prace. Katowice, Poland.
Glückauf	Glückauf-Bergmannische Zeitschrift. Essen, Germany.
Great Britain Geol. Survey Bull	Bulletin of the Geological Survey of Great Britain. London.
Grenoble Univ. Lab. géologie Travaux	Travaux du Laboratoire de Géologie la Faculté des Sciences de l'Université de Grenoble. Grenoble, France.
Hallische Mon	Hallische Monographien. Max Niemeyer Verlag, Halle/Saale, Germany.
Hokkaido Univ. Faculty Sci. Jour	Journal of the Faculty of Sciences. Hokkaido University. Sapporo, Japan.
Illinois Geol. Survey Rept. Inv	Report of Investigations of the Illinois Geological Survey. Urbana, Ill.
Indian Jour. Meteorology and Geophysics.	Indian Journal of Meteorology and Geophysics. New Delhi.
Indonesia Jour. Sci. Research	Journal of Scientific Research in Indonesia. Published by the Organization for Scientific Research in Indonesia. Djakarta, Java.
Indonesia Madjalah Ilmu Alam Untuk.	Madjalah Ilmu Alam Untuk Indonesia [Indonesian Journal for natural science]. Bandung, Java. Successor to Chronica Naturae.
Indonesia Organization Sci. Research Verh.	Verhandelingen of the Organization for Scientific Research in Indonesia. Djakarta.
Industria Mineraria	L'Industria Mineraria. Associazione mineraria italiana. Roma.
Industria Mineraria	Industria Mineraria d'Italia e d'Oltremare. Roma.
Inst. geofis. de los Andes Colombianos Bol.	Boletin de l'instituto de los Andes Colombianos. Bogotá.
Inst. Geog. y Catastral Mem	Memorias del Instituto Geográfico y Catastral. Madrid.
Inst. geol. min. España notas y comunicaciones.	Instituto geológico y minero, notas y comunicaciones. Madrid.

Abbreviation	*Publication*
Inst. Physique du Globe Strasbourg Annales.	Annales de l'Institut de Physique du Globe. Université de Strasbourg. Strasbourg, France.
Inst. Royal Colonial Belge Bull.	Institut Royal Colonial Belge Bulletin des Séances. Bruxelles.
Inst. Royal Colonial Belge Mem.	Institut Royal Colonial Belge, Memoires. Bruxelles.
Inst. tech. bâtiment et travaux publics Annales.	Institut technique du bâtiment et des travaux publics, Annales. Paris.
Isostatic Inst. Pub.	Publications of the Isostatic Institute of the International Association of Geodesy. Helsinki.
Israel Research Council Bull.	Bulletin of the Research Council of Israel. Jerusalem.
Istanbul Tek. Univ. Bul.	Istanbul Teknik Universitesi Bulteni. Istanbul, Turkey.
Istanbul Univ. Fakultesi Mecmuasi.	Istanbul Universitesi fen Fakultesi Mecmuasi. Istanbul, Turkey.
Ist. Veneto sci. lettere ed arti Atti.	Instituto Veneto di scienze lettere ed arti Atti. Venezia, Italy.
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. Atmos. Terrest. Physics.	Journal of Atmospheric and Terrestrial Physics. Pergamon Press, Ltd., London.
Jour. Geography (Tokyo).	Journal of Geography. Tokyo Chigaku Kyohai. Tokyo.
Jour. Geology.	Journal of Geology. University of Chicago Press. Chicago, Ill.
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.
Kakioka Magnetic Observatory Mem.	Memoirs of the Kakioka Magnetic Observatory. Kakioka, Japan.
Kansas Geol. Survey Bull.	Bulletin of the Kansas Geological Survey. Wichita, Kans.
Karl Marx Univ. Leipzig wiss. Zeitschr. math-naturwiss. Reihe.	Zeitschrift der Karl Marx Universitet. Leipzig, Germany.
K. Danske Vidensk. Selsk. Mat.-fys. Meddel.	Det Kongelige Danske Videnskahernes Selskab Matemeatisk-fysiske Meddelelser. København.

Abbreviation	*Publication*
K. Nederland. Akad. Wetensch. Afd. Natuurkunde Verh.	Verhandelingen, Afdeeling Natuurkunde Koninklijke Nederlandse Akademie van Wetenschappen. Amsterdam, Netherlands.
K. Nederland. Akad. Wetensch. Proc.	Proceedings Koninklijke Nederlandse Akademie van Wetenschappen. Amsterdam, Netherlands.
Kyōto Univ. Coll. Sci. Mem.	Memoirs of the College of Science of Kyōto University. Kyōto, Japan.
Kyōto Univ. Disaster Prevention Research Inst. Bull.	Bulletin of the Disaster Prevention Research Institute, Kyōto University. Kyōto, Japan.
Kyōto Univ. Faculty Eng. Mem.	Memoirs of the Faculty of Engineering. Kyōto University. Kyōto, Japan.
La Ricerca Sci.	La Ricerca Scientifica. Roma.
Madagascar Bur. geol. Travaux.	Travaux du Bureau géologique. Direction des Mines et de la Géologie. Haut Commissariat de Madagascar et Dependances. Tananarive.
Maden Tetkik ve Arama Enstitüsü Mecmuasi.	Maden Tetkik ve Arama Enstitüsü Mecmuasi. Mining Research and Exploration Institute of Turkey.
Magyr Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlmények.	Magyar Állami Eötvos Loránd Geofizikai Intézet Geofizikai Közlemények. Budapest.
Marii Curie-Skłodowskiej Uniw., Rocz.	Roczniki Uniwersitet Marii Curie-Skłodowskiej. Lublin, Poland.
Meteoros	Meteoros. Revista de meteorologia y geofisica. Servicio Meteorologico Nacional. Buenos Aires.
Meyniana, Kiel Univ. Geol. Inst. Veroffentl.	Meyniana-Veroffentlichungen aus dem Geologischen Institut der Universitat Kiel. Kiel, Germany.
Michigan Acad. Sci. Papers.	Papers of the Michigan Academy of Science, Arts, and Letters. Ann Arbor, Mich.
Min. and Geol. Jour.	Mining and Geological Journal. Melbourne, Australia.
Minería	Minería. México, D. F.
Mineria y Metalurgia.	Mineria y Metalurgia. Servicio de Traducciones Tecnicas. Madrid.
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.
Nafta (Poland).	Nafta. Instytut Naftowy. Kraków, Poland.

Abbreviation	*Publication*
Nafta (Yugoslavia)	Nafta. Institut za naftu, Zagreb, Yugoslavia.
Natl. Acad. Sci. Proc	Proceedings of the National Academy of Sciences. Washington, D. C.
Nature	Nature. Macmillan and Co. London.
Naturh. Ver. Rheinlande u. Westfalens Verh.	Verhandlungen des Naturhistorisches Vereins der Rheinlande und Westfalens. Bonn, Germany.
Naturwiss. Ver. Steiermark Mitt	Mitteilungen des Naturwissenschaftlichen Vereines für Steiermark. Graz, Austria.
Neues Jahrb. Geologie u. Paläontologie Abh., Montash.	Neues Jahrbuch für Geologie und Paläontologie Abhandlungen and Monatshefte. Stuttgart, Germany.
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 Dept. Sci. Indus. Research, Seismol. Observatory Bull.	Bulletin of the Seismological Observatory, Department of Scientific and Industrial Research. Wellington.
New Zealand Jour. Sci. Technology	New Zealand Journal of Science Technology. Department of Scientific and Industrial Research. Wellington.
Norsk Geol. Tidsskr	Norsk Geologisk Tidsskrift. Norsk Geologisk Forening. Oslo.
Notes Marocaines	Notes Marocaines. Société de géographie du Maroc. Rabat.
Nucleonics	Nucleonics. McGraw-Hill Publishing Co. New York.
Observatorio di fisica cosmica de San Miguel Mem.	Observatorio di fisica cosmica de San Miguel Memorias. Argentina.
Oil and Gas Jour	Oil and Gas Journal. Petroleum Publishing Co. Tulsa, Okla.
Oil Forum	Oil Forum. Oil Forum, Inc. Ft. Worth, Tex. and New York.
Oil in Canada	Oil in Canada. National Geophysical Co. Calgary, Alberta.
Okayama Univ. Balneological Lab. Repts.	Reports of the Balneological Laboratory, Okayama University. Misasa Hot Springs, Tottori-ken, Japan.
Osservatorio Geofis. Trieste Pub	Osservatorio Geofisico Trieste Publicazione. (Reprints from scientific journals.) Trieste.
Österreich. Akad. Wiss. Kl. math.-naturw., Erdbeben-Komm. Mitt.	Mitteilungen der Erdbeben-Kommission, Österreichische Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse. Wien.

Abbreviation	*Publication*
Padova Univ. Ist. geod. e geofis. Pub__	Istituto geodetico e geofisico Padova Universita Pubblicazione. (Reprints from scientific journals.)
Pakistan Jour. Sci_____	Pakistan Journal of Science. Pakistan Association for Advancement of Science. Lahore, Pakistan.
Państwowy Inst. Geol. Biul_____	Państwowy Instytut Geologiczny Biuletyn. Warszawa.
Pennsylvania State Univ. Min. Industries Expt. Sta. Bull.	Bulletin of the Mineral Industries Experiment Station. Pennsylvania State University. State College, Pa.
Peru Inst. Geol. Bol_____	Instituto Geologico del Perú Boletin. Ministerio de Fomento. Direccion de Minas y Petroleo. Lima.
Petroleos Mexicanos_____	Petroleos Mexicanos. Servicio de Informacion. México, D. F.
Petroleum Engineer_____	Petroleum Engineer Publishing Co. Dallas, Tex.
Philos. Mag_____	Philosophical Magazine. Taylor and Francis. London.
Physica _____	Physica. Physica Foundation. Utrecht, Netherlands.
Physics today_____	Physics today. American Institute of Physics. New York.
Phys. Rev_____	Physical Review. American Institute of Physics. New York.
Phys. Soc. London Proc_____	Proceedings of the Physical Society. London.
Phys. Verhandlungen_____	Physikalische Verhandlungen. Physik-Verlag. Mosbach im Baden, Germany.
Potsdam geod. Inst. Veroffentl_____	Potsdam geodätisches Institut.. Veroffentlichen. Berlin Akademie Verlag. Berlin.
Precambrian _____	Precambrian. Winnipeg, Manitoba.
Priroda_____	Priroda. Akademiya Nauk SSSR. Moskva.
Producers Monthly_____	Producers Monthly. Bradford District Pennsylvania Oil Producers Association. Bradford, Pa.
R. Acad. Cien. y Artes de Barcelona Mem.	Memorias de la Real Academia de Ciencias y Artes de Barcelona.
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, Spain.
Rev. Cienc. Apl_____	Revista de Ciencia Aplicada. Madrid.
Rev. gén. sciences pures et appl_____	Revue générale des sciences pures et appliquées. Societé d'edition d'Enseignement supérieur. Paris.

Abbreviation	*Publication*
Rev. Geofísica	Revista de Geofísica. Madrid.
Rev. géomorphologie dynamique	Revue de géomorphologie dynamique. Strasbourg, France.
Rev. Inst. Français du Pétrole	Revue de l'Institut Français du Pétrole et Annales des combustibles liquides. Paris.
Rev. Sci	Revue Scientifique. Paris.
Rev. Sci. Instruments	Review of Scientific Instruments. American Institute of Physics. New York.
Riv. Geofisica Appl	Rivista da Geofisica Applicata. Milano, Italy.
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.
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, Australia.
St. Louis Acad. Sci. Trans	Transactions of the St. Louis Academy of Science. St. Louis, Mo.
Savariensis Univ. Annales	Annales Universitatis Savariensis. Universite de la Sarre. Saarbrücken, Germany.
Schweizer. mineralog. petrog. Mitt	Schweizerische mineralogische und petrographische Mitteilungen. Verlag Leeman. Zürich, Switzerland.
Schweizer, naturf. Gesell. Verh	Verhandlungen der schweizerischen naturforschenden Gesellschaft. Aarau, Switzerland.
Science	Science. American Association for the Advancement of Science. Washington, D. C.
Science Progress	Science Progress. Edward Arnold and Co. London.
Sci. Monthly	Scientific Monthly. American Association for the Advancement of Science. Washington, D. C.
Seismol. Soc. America Bull	Bulletin of the Seismological Society of America. Berkeley, Calif.
Service carte géol. Algérie Bull	Service de la Carte géologique de l'Algérie-Tunisie Bulletin. Gouvernement général de l'Algérie.
Servizio geol. Italia Boll	Bollettino del Servizio geologico d'Italia. Roma.

Abbreviation	*Publication*
Sindicato Nac. Engenheiros Geógrafos Pubs.	Sindicato Nacional dos Engenheiros Geógrafos, Publicaçoes, Coimbra, Portugal.
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.
Soc géol. France Compte Rendus	Comptes Rendus de la Société géologique de France. Paris.
Soc italiana scienze nat. Atti	Atti della Societa Italiana di Scienze Naturali e del Museo Civico di Storia Naturale in Milano. Milano, Italy.
Soc. physique et histoire nat. Genève Mem.	Société de Physique et d'Histoire Naturelle de Genève Memoires. Genève, Switzerland.
Soc. sci. nat. phys. Maroc Bull	Bulletin de la société des sciences naturelles et physique du Maroc. Institute scientifique Chérifien à Rabat. Rabat.
South African Inst. Civil Engineers Trans.	Transactions of the South African Institute of Civil Engineers. Johannesburg.
South African Jour. Sci	South African Journal of Science. South African Association for the Advancement of Science. Johannesburg.
Southwestern Jour. Anthropology	Southwestern Journal of Anthropology. University of New Mexico. Albuquerque, N. Mex.
Srbija Zavod. geol. i geofiz. istraživanja Vesnik.	Vesnik Zavoda za geološka i geofizička istraživanja. Beograd.
Tellus	Tellus. Svenska Geofysiska Föreningen. Stockholm.
Texas Jour. Sci	Texas Journal of Science, Texas Academy of Science. Houston, Tex.
Tōhoku Univ. Research Inst. Sci. Repts.	Tōhoku University Research Institute Science Reports. Sendai, Japan.
Tōhoku Univ. Sci. Repts	Tōhoku University Science Reports. Sendai, Japan.
Tokyo Natl. Sci. Mus. Bull	Bulletin of the National Science Museum. Tokyo.
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.
Uganda Protectorate Geol. Survey Dept. Records.	Records of the Uganda Protectorate Geological Survey Department. Entebbe.
Umschau	Die Umschau. Frankfort am Main, Germany.

Abbreviation	*Publication*
U. S. Bur. Mines Inf. Circ.; Rept. Inv.	United States Bureau of Mines Information Circular; Report of Investigations. Washington, D. C.
U. S. Bur. Reclamation Eng. Mon.	United States Bureau of Reclamation Engineering Monographs. Washington, D. C.
U. S. Bur. Reclamation Geology Rept.	United States Bureau of Reclamation Geology Report. Washington, D. C.
U. S. Civil Aeronautics Adm. Tech. Devel. Rept.	United States Civil Aeronautics Administration, Technical Development Report. Washington, D. C.
U. S. Coast and Geod. Survey Serial; Special Pub.	United States Coast and Geodetic Survey Serial; Special Publication. Washington, D. C.
U. S. Geol. Survey Bull.; Circ.; Prof. Paper.	United States Geological Survey Bulletin; Circular; Professional Paper. Washington, D. C.
U. S. Geol. Survey Geophys. Inv.	United States Geological Survey, Geophysical Investigations. Washington, D. C.
U. S. Natl. Bur. Standards Jour. Research.	United States National Bureau of Standards Journal of Research. Washington, D. C.
U. S. Natl. Research Council Highway Research Board Bull.	United States National Research Council, Highway Research Board Bulletin. Washington, D. C.
Ver. Schweizer. Petroleum Geologen u. Ingenieure Bull.	Vereinigung der Schweizerischer Petroleum-Geologen- und Ingenieure Bulletin. A. Schudel Co. Basel, Switzerland.
Vestnik Moskov. Univ.	Vestnik Moskovskogo Universiteta. Moskva.
Vísindafélag Íslendinga.	Vísindafélag Íslendinga. Societas scientarum Islandica. Reykjavik.
Volcano Letter.	Volcano Letter. University of Hawaii. Honolulu.
Vses. nauchno-issled. inst. razved, geofiz. Trudy.	Vsesoyuznyy nauchno-issledovatel'skiy institut razvedochnoy geofiziki, Trudy [Transactions of the All-Soviet Scientific Research Institute for Geophysical Exploration]. Moskva.
Western Australia Geol. Survey Bull.	Western Australia Geological Survey Bulletin. Perth, Australia.
World Oil.	World Oil. Gulf Publishing Co. Houston, Tex.
World Petroleum.	World Petroleum. New York.
Zeitschr. angew. Mathematik u. Physik.	Zeitschrift für angewandte Mathematik und Physik. Basel, Switzerland.
Zeitschr. Erzbergbau u. Metallhüttenwesen.	Zeitschrift für Erzbergbau und Metallhüttenwesen. Dr. Reiderer Verlag. Stuttgart, Germany.

Abbreviation	*Publication*
Zeitschr. Geophysik	Zeitschrift für Geophysik. Friedr. Vieweg Sohn. Braunschweig, Germany.
Zeitschr. Naturforschung	Zeitschrift für Naturforschung. Tübingen, Germany.
Zisin	Zisin. Seismological Society of Japan. Tokyo.
Zürich Inst. Geophysik Mitt.	Erdgenössische Technische Hochschule Zürich Mitteilungen aus dem Institut für Geophysik.

GENERAL PAPERS

160–1. Toperczer, Max. **Geophysik [Geophysics] : 237 p., Wien, Johann L. Bondi & Sohn, 1951.**

This is a popularly written introduction to geophysics. It includes discussion of the shape and size of the earth, gravity, geotectonic phenomena, volcanism, seismology, geomagnetism, and the application of geophysical methods in prospecting for minerals.—*S. T. V.*

160–2. Krumbein, W. C. Experimental design in the earth sciences: Am. Geophys. Union Trans., v. 36, no. 1, p. 1–11, 1955.

Many Earth phenomena involve simultaneous change of several variables, usually not directly under man's control. Isolation of certain phenomena permits controlled laboratory experimentation, but there is also need for study of simultaneous natural variation in several factors, which in this context supplements rather than competes with laboratory experimentation. Statistical design provides a technique adapted to both laboratory experimentation and the observation of the effects of natural variations.

The present paper reviews the application of some statistical methods to the Earth sciences, with special reference to the design of experiments for analysis of variance. Consideration is given to the nature of distributions encountered in Earth-science data, to sampling problems, and to some principles of experimental design. Geological examples are used, but parallels are drawn from other Earth-science fields. The use of probabilistic models in developing Earth-process theories is touched upon briefly.—*Author's abstract.*

160–3. Groshevoy, G. V. K voprosu o proyektirovanii i raschete magnitnykh sistem dlya geofizicheskikh priborov [On the problem of designing and computing magnetic systems for geophysical instruments] : Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 20(147), p. 88–94, 1953.

A method is suggested for the improvement of the design of magnetic systems of some instruments such as galvanometers, oscillographs, and others, usable only when the magnetic flux within a similar instrument is known, by making magnetic field measurements. As a preliminary step, correlation must be established between the magnetic leakage of the system and the intensity of magnetization in the gap. In order to decrease the leakage a new magnet is designed with variable cross section and proper length so that a maximum of magnetic energy is concentrated near the vicinity of the rotating element.—*S. T. V., I. Z.*

160–4. Poisson, Charles. La physique du globe à Madagascar [Geophysics in Madagascar] : Acad. Malgache Bull., 50th anniversary special no., p. 117–134, 1954.

This is a historical summary of geophysical investigations in Madagascar. Meteorology, terrestrial magnetism, gravimetry, and seismology are discussed.—*M. C. R.*

GRAVITY

GENERAL AND THEORETICAL STUDIES

160–5. Berroth, A[lfred]. Die regelmässigen Teile des Schwerefelds mit einer Anwendung auf Mitteleuropa [The regular parts of the gravity field, with an application to Central Europe]: Geofisica Pura e Appl., v. 28, p. 1–35, 1954.

The regular parts of the gravity field are the continental and regional terms; the local part is the remainder. The regional term always refers to a large area and cannot be defined by a datum. These component terms—the continental, the regional, and the local—can be determined by two methods. The first consists of computing point by point the numerical value of a theoretical function. In the second method the derivation is computed area by area with an adjustment in terms of adjoining boundary values.

The second method is applied to the data of several surveys in Germany and France, and the corresponding expressions for the continental, regional, and local anomalies are derived. Appropriate maps are included.—*S. T. V.*

160–6. Kalashnikov, A. G. Modelirovaniye anomaliy magnitnogo i gravitatsionnogo poley [The modeling of the anomalies in magnetic and gravitational fields]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 546–553, 1954.

This is a description of the special field meter used for measurement of field intensity in model experiments (see Geophys. Abs. 7020 and 11024 for discussion of experimental conditions). The main element of this instrument is a very small rotating coil which can be placed at any point without disturbing the field pattern in the vicinity. Such a coil has been constructed using a wire of 25μ diameter, with the exterior diameter of the coil being only 0.8 mm. The field patterns produced by disturbing bodies of different forms and physical properties have been measured with such a field meter. The results are shown.—*S. T. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

160–7. Heiskanen, W. A. New era of geodesy: Science, v. 121, no. 3133, p. 48–50, 1955.

This is an account of the symposium, The New Era in Geodesy, at Ohio State University in November 1954. New geodetic measuring instruments, the development of gravimeters, the progress of recent gravity measurements on continents and at sea, and their significance for geodetic and geophysical purposes were discussed.—*M. C. R.*

160–8. Heiskanen, W. A. Relative significance of the different methods of modern geodesy: Am. Geophys. Union Trans., v. 35, no. 6, p. 883–886, 1954.

The possibilities, limitations, and relative significance of such methods as classic, flare, and rocket-star triangulation; arc measuring; Shoran and Hiran; the solar eclipse; occultation; and moon photographing are discussed briefly. The gravimetric method, either alone or with already-existing measured arcs and additional astronomical observations, can be used to check the dimensions of the reference ellipsoid and the international gravity formula, to determine the absolute deflections of the vertical at the initial points of geodetic systems

and convert existing systems to a world system, to obtain control points in areas where maps on scales of 1:100,000 or smaller are sufficient, and to determine the undulation of the geoid and the deflection of the vertical at any needed point.—*M. C. R.*

160–9. Woollard, G. P., Harding, N. C., and Rose, J. C. The problem of calibrating high-range geodetic-type gravimeters: Am. Geophys. Union Trans., v. 36, no. 1, p. 12–24, 1955.

Gravimeters may be calibrated by measurement of the vertical gradient in tall buildings, reoccupation of sites for which there are pendulum gravity measurements, statistical average of results of ties, and measurements on tilt tables. Comparative data are given for different types of gravimeters calibrated by the same method and for the same type of gravimeter calibrated by different methods. Accuracy of the various methods cannot be evaluated because there is no universally accepted standard against which results can be compared. Lack of such a standard causes confusion in the use of gravimetric data and possible erroneous results in studies incorporating these data.—*M. C. R.*

160–10. Cook, A. H. Magnetic perturbations of invar pendulums used for relative gravity measurements: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 7, no. 1, p. 1–21, 1954.

Certain discrepancies in recent relative gravity measurements made with the Cambridge pendulum apparatus may be due to magnetic forces on the invar pendulums. In addition to effects which have been described previously, it is shown that disturbances may arise from a magnetic screen surrounding the pendulums and from the magnetic interaction of two pendulums swinging together. Theoretical estimates of these effects are compared with experiments. The behaviour of the pendulum is qualitatively as predicted, but the numerical results are in poor agreement. This may be due in part to the difficulty of making calculations for pendulums with dimensions comparable to their distances from the magnetic screen and each other. The application of the results to gravity measurements is considered.—*Author's abstract*

160–11. Györgyi, G. Die theorie der Schwingungen der auf einen Torsionsdraht aufgehängten Waage nach Eotvos-Selényi [The theory of the oscillations of a wire-suspension Eötvös-Selényi torsion balance]: Acta Phys. Acad. Sci. Hungaricae, tomus 4, fasc. 1, p. 79–86, 1954.

A rotating earth produces a Coriolis force which sometimes affects the readings on a torsion balance. This effect had been investigated theoretically by Selényi. As a result of Györgyi's study, the instrumental design necessary to reduce this effect to a negligible amount has been determined.—*S. T. V., I. Z.*

160–12. Harrison, J. C. A laboratory investigation of the second order corrections to gravity measured at sea: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 7, no. 1, p. 22–31, 1954.

A Vening Meinesz pendulum apparatus was subjected to simple harmonic accelerations, and the changes in the periods of the pendulums caused by the motion were measured. The second-order corrections were investigated for vertical accelerations with periods between 5.9 and 12.8 seconds and for horizontal accelerations with periods between 3.30 and 6.85 seconds. These corrections were always found to be consistent with Browne's expressions. The long-period pendulums,

added to the main apparatus in 1938 in order to record its horizontal accelerations, were found to give satisfactory results.—*Author's abstract*

METHODS OF ANALYSIS AND INTERPRETATION

160–13. Metzger, J. Marée de l'écorce: l'effet du déphasage dans l'analyse des observations [Earth tides: effect of phase displacement in the analysis of the observations]: Geofisica Pura e Appl., v. 29, p. 71–83, 1954.

The relative amplitude A of the earth tide is deduced from the ratio of the theoretical to the observed variations of gravity. The direct comparison of their hourly values allows the determination of this ratio, but this method neglects the eventual phase displacement of the earth tide over the generating forces. The resulting (negative) error on the usual values of A is about 11 percent (supposing a phase displacement of 1 hour), if only extreme amplitudes are compared; it reaches 14 percent if the totality of the hourly values is taken into account.

If the effect of the phase displacement is slight at the hours when the tide has a great value, it is conceivable that it introduces a noticeable relative error on the hourly readings corresponding to a low value. The computation shows nevertheless that the total result is little improved by systematic elimination of the latter.—*Author's summary, S. T. V.*

160–14. Neumann, R. Role joué par la correction luni-solaire en prospection gravimétrique [Effect of the luni-solar correction in grametric exploration]: Geophys. Prosp., v. 2, no. 4, p. 290–305, 1954.

As a practical matter, the application of tidal corrections to all stations is pointless as long as the field operations do not substantially exceed 2 hours. Use of tidal corrections, however, permits distinguishng three kinds of instrumental drift; a good knowledge of the operational drift is valuable in determining the quality of a set of observations and sometimes makes it possible to detect small errors close to the limit of precision.—*M. C. R.*

160–15. Ackerman, H. A., and Dix, C. H. The first derivative of gravity: Geophysics, v. 20, no. 1, p. 148–154, 1955.

The first vertical derivative of gravity can be calculated from the second vertical derivative of gravity. The method involves obtaining average values of the second vertical derivative on circles about the point where $\delta g/\delta z$ is to be computed and integrating the resulting function over the plane. The process is reputed to be more convenient and more rapidly convergent than one given earlier by Evjen employing observed values of gravity. Applied to the anomaly of a slab, the formula gave satisfactory results.—*R. G. H.*

160–16. Balavadze, B. K. K metodike opredeleniya vertikal'nogo gradienta sily tyazhesti [On the methods of determining the vertical gradient of gravity]: Akad, Nauk SSSR Izv. Ser. geofiz., no. 1, p. 45–56, 1955.

Having analyzed the problem of the experimental determination under field conditions of the vertical gradient of the gravity force, that is of the expression

$$\delta u^2/\delta z^2 = \delta g/\delta z$$

using a Nørgaard quartz gravimeter, the author arrived at following results: the measurement can be made with an accuracy of $\pm 15 \times 10^{-9}$ cgs if towers of about 45 meters height are available; the value of the vertical gradient is very

much affected by the topography of the area; precise values can be obtained only if the surveyed area is sufficiently smooth; and the anomalies of the vertical gradient vary over a wide range, being determined by the shape, size, and depth of the disturbing bodies, especially if these are near the surface of the earth. This makes the vertical gradient an important indicator in surveying geologic structures; to obtain detailed values of the anomalies of the vertical gradient it is necessary to have very detailed map of Δg values. If only approximate values of Δg are available (accuracy ± 4 milligals), then the computed values can be assumed to correspond to the regional component of the anomalies $(\Delta \delta g/\delta h)$. Such values of anomalies can be useful in reducing the gravity force to any chosen level.—*Author's summary, S. T. V.*

160–17. Baranov, V. and Tassencourt, J. Some remarks on the errors in the calculation of the vertical gradient of gravity: Geophys. Prosp., v. 2, no. 4, p. 285–289, 1954.

Possible errors in the method of computing the vertical gradient of gravity given by Baranov (Geophys. Abs. 156–3) are of two kinds; errors of plotting due to necessary interpolation in the reading of each canonical value, and errors in the calculation of the coefficients. The effect of such errors is shown to be small.—*M. C. R.*

OBSERVATIONS OF GRAVITY AND GRAVITY SURVEYS

160–18. Anderson, Richard C. A gravity survey of the Rio Grande trough near Socorro, N. Mex.: Am Geophys. Union Trans., v. 36, no. 1, p. 144–148, 1955.

A gravity survey involving 61 stations was made across the Rio Grande trough near Socorro, N. Mex. The anomaly observed was such that a two-dimensional type of analysis could be used to determine the form of the trough in this area. Separate analyses of the data were made for each of two assumptions: that the Tertiary fill was composed principally of unconsolidated sediments, and that the Tertiary fill was made up primarily of consolidated sediments and volcanics. The analyses yielded limiting values of 2,100 and 5,800 ft, respectively, for the greatest thickness of Tertiary fill.—*Author's abstract*

160–19. Logue, Lester L. Gravity anomalies of Texas, Oklahoma, and the United States: Oil and Gas Jour., v. 52, no. 50, p. 132–135, 1954.

Regional gravity surveys reveal information on the cumulative effects of igneous and sedimentary rocks and of tectonic activity. The surveys can, therefore, be of assistance to research geologists and stratigraphers in making regional correlations and regional structural studies, particularly in establishing tectonic axes and the development of orogenic history. A special 28 by 35 inch multicolor insert map, showing the gravity anomalies of Texas, Oklahoma, and the entire United States, and the major structural axes, is included in this paper.—*L. C. P.*

160–20. Einarsson, Trausti. A survey of gravity in Iceland: Vísindefelag Íslendinga, v. 30, 2 p. and 15 maps, 1954.

This survey of gravity in Iceland comprises about 900 stations distributed over most main parts of the country, especially the southern and western parts. The work was done in the years 1950–54, most of it with a Worden gravimeter of high precision.

Ten maps of gravity anomalies have been prepared, five for Bouguer anomalies and five for isostatic anomalies—one of each type for the country as a whole, showing contour lines at 10 milligal intervals, and four of each type for the southern and western lowlands with contour lines at 1 or 2 milligal intervals.

The general map of the Bouguer anomalies represents a bowl of depth about 75 milligals, essentially an expression of compensation of the elevated central parts of the country.

By isostatic reductions (after Airy-Heiskanen), it is shown that the bowl may be explained on the basis of a thin sialic crust (Heiskanen scheme), T=20 km. The geology of Iceland indicates that the present high average elevation of the country is the result of an uplift that occurred relatively recently (latest Tertiary or earliest Quaternary) and that, therefore, the thickening of the sial that compensates for the elevated mass occurred so late, after formation of the majority of the Icelandic rocks. It is believed that this development, accompanied by block faulting, was the result of the action of a strong horizontal, biaxial stress field.

The isostatic reduction that explains the Bouguer bowl leads to an essentially constant level of isostatic anomalies for the whole country, about +45 milligals. In spite of this considerable positive anomaly, it is concluded that there is no overweight. The main reason for this conclusion is that the depressed country rose to equilibrium position after disappearance of the Quaternary ice load.

Details of the gravity field indicate a density contrast at a depth of the order of 5 km so that below this depth a thick layer of low density (something like 2.2–2.4) is inferred. This might be sediments forming the basement of the Tertiary plateau basalts.

The gravity anomalies further indicate the existence of rather thick layers of light volcanic products at depth in the Recent volcanic zones. These zones (not to be confused wih the volcanic zone, as usually presented) seem to have been active for a long time in such a way that at times they formed basins that were filled with light volcanic material, and at times were uplifted to form mountain ranges.—*Author's summary*

160–21. Damm, B., and Baumann, A. Dichteuntersuchungen an Gesteinen des Westharzes [Density studies on rocks of the western Harz]: Geol. Jahrb., Band 68, p. 161–168, 1954.

An average density is calculated for major geologic units of the western Harz on the basis of extensive new determinations of density. For the entire Harz the new average value of 2.7 is obtained. An attempt is made to explain the origin of density variations in graywackes by variations in the contents of clay, quartz, potash feldspar, and other constituents.—*H. F.*

160–22. Gretener, Peter. Scheweremessungen nordweslich von Zürich und ihre geologische Interpretation [Gravity measurements northwest of Zürich and their geologic interpretation]: Eclogae geol. Helvetiae, v. 47, no. 1, p. 173–222, 1954. Reprinted as Zürich Inst. Geophysik Mitt., no. 25, 1954.

A detailed gravity survey was made in the summer of 1952 with 780 stations established in an area of 250 square miles northwest of Zürich. The gravity data indicate that the Laegern anticline continues in a northeasterly direction and joins the Irchel anticline; there is a considerable thickness of Quaternary deposits in the Limmat, Glatt, and Furt valleys increasing toward the south; the thickness of Tertiary sediments near Zürich is ⅔ to 1 mile; and a regional gradient of 1.9 milligals in a N. 30° W. direction results from the mass deficiency

under the Alps, the rising surface of the Grundgebirge toward the Black Forest, and the rising surface of the Mesozoic rocks towards the north-northwest.—*M. C. R.*

160–23. Pacella, Giovan Battista. Prime operazioni con i gravimetri Worden dell' Istituto Geografico Militare [First operations of the Istituto Geografico Militare with the Worden gravimeter]: Boll. Geodesia e Sci. aff., anno 13, no. 3, p. 209–218, 1954.

Two Worden gravimeters were used for measurements along the levelling lines from Firenze to Bologna and Firenze to Pisa to Montepescolo to Arezzo to Firenze. Results are tabulated.—*M. C. R.*

160–24. Bulanzhe, Yu. D. Uskoreniye sily tyazhesti v iskhodnykh punktakh Moskvy: Geofian—I, Geofian II i Moskva-Iskhodnaya [The acceleration of gravity at the base stations of Moscow: Geofian I, Geofian II, and Moscow-Initial]: Akad. Nauk SSSR Geofiz. Inst. Trudy no. 20(147), p. 3–19, 1953.

High-precision determinations of gravity were made at three stations near Moscow, as a basis for future detailed gravitational surveys and for the study of the variation of gravity with time. These stations, together with the central gravimetric station of Gaish in the main building of the astronomical observatory, were tied together by these measurements. The instruments used were Nørgaard gravimeters. The following values of g were obtained: Gaish, 981559.1 milligals; Geofian II, 981547 $\pm$0.11 milligals; Geofian II, 981561 $\pm$0.09 milligals; Moscow-Initial, 981531 $\pm$0.13 milligals. The data are expressed in the Russian gravitational system, which differs from the Potsdam system by approximately $\pm$0.76 to 0.79 milligals.—*S. T. V., I. Z.*

160–25. Tsuboi, Chuji; Jitsukawa, Akira; and Tajima, Hirokazu. Gravity measurements along the lines of precise levels over whole Japan by means of a Worden gravimeter. VII. Kyushu district: Acad. Japan Proc., v. 30, no. 7, p. 594–598, 1954.

Gravity measurements were made at 538 places on the island of Kyushu, and the results are shown as a Bouguer anomaly map contoured at a 5-milligal interval. On the whole the Bouguer anomaly increases systemically toward the northern and western coasts, suggesting that denser subcrustal material lies nearer the surface under the Yellow Sea than in a normal "continental" area. A gravity high extends across the island in an east-west direction and is connected with the positive anomaly on the west coast of Shikoku. A gravity low south of the ridge with a minimum of —56 milligals suggests a notable depression in the crust. Strong earthquakes frequently occur in this area.—*M. C. R.*

160–26. Sassa, Kenzo, and Iida, Kumizi. Gravity measurements in Kansai districts [In Japanese with English abstract]: Zisin, v. 5, no. 4, p. 17–21, 1952.

Gravity measurements were made at 100 stations, data for which are tabulated, in a study of ground subsidence, variations of gravity with time, and the relation of such variations to seismic activity. A maximum change of 0.5 milligals in one year was observed.—*M. C. R.*

160–27. Hayakawa, Masami; Katani, Yoshitaka; and Ichinohe, Tokio. Interpretation of gravity measurements in Kansai districts [In Japanese with English abstract]: Zisin, v. 5, no. 4, p. 22–31, 1952.

Bouguer anomalies in the city of Osaka and the changes in gravity in Kansai districts from December 1950 to January 1952 in units of 0.1 milligal are shown on maps. The Bouguer values for Osaka are also tabulated.—*M. C. R.*

MAGNETISM

MAGNETIC FIELD OF THE EARTH

160–28. Bullard, E. C., and Gellman, H. Homogeneous dynamos and terrestrial magnetism: Royal Soc. London Philos. Trans., ser. A, v. 247, no. 928, p. 213–278, 1954.

The main object of the paper is to discuss the possibility of a body of homogeneous fluid acting as a self-exciting dynamo. The discussion is for the most part confined to the solution of Maxwell's equations for a sphere of electrically conducting fluid in which there are specified velocities. Solutions are obtained by expanding the velocity and the fields in spherical harmonics to give a set of simultaneous linear differential equations which are solved by numerical methods. Solutions exist when harmonics up to degree four are included. The convergence of the solutions when more harmonics are included is discussed, but convergence has not been proved. The simultaneous solution of Maxwell's equations and the hydrodynamic equations has not been attempted, but a velocity system has been chosen that seems reasonable from a dynamical point of view. A parameter in the velocity system has been adjusted to satisfy the conservation of angular momentum in a rough way. Orders of magnitude are derived for a number of quantities connected with the dynamo theory of terrestrial magnetism. It is concluded that the dynamo theory does provide a self-consistent account of the origin of the earth's magnetic field and raises no insuperable difficulties in other directions.—*Authors' abstract*

160–29. Scholte, J. G., and Veldkamp, J. Geomagnetic and geoelectric variations: Jour. Atmos. Terrest. Physics, v. 6, no. 1, p. 33–45, 1955.

The geomagnetic variations and their relation to earth-currents have been investigated, especially the pulsations with periods of 10 to 10^2 seconds. A worldwide survey of a few examples of pulsations (selected from the IATME Bulletins and the quarterly De Bilt reports) indicates that the source of the phenomenon may be the ionospheric vibrations caused by a disturbance of the ionization equilibrium. The connection with the electric field induced in the earth was studied by measuring the ratio of amplitudes of the north-south component H_y of the magnetic field and the east-west component E_x of the electric field; the phase-difference between these quantities has been determined for a great number of pulsations. As it was doubted if the theory of plane waves reflected by a plane earth was valid in this case, the earth's radius being small compared with the wavelength of these vibrations, the reflection by a sphere has been investigated theoretically. The results are very similar to those of the plane-earth theory, with the exception of the ratio between horizontal and vertical magnetic components. The values of E/H and of the phase-difference between electric and magnetic variations depend on the structure

of the earth; it is therefore possible to derive some knowledge of the upper layers from the measurements. In this way some information with respect to the distribution of the conductivity in the ground at the observatory Witteveen has been obtained.—*Authors' abstract*

160–30. Vening Meinesz, F. A. Correlation between geomagnetic field and tectonic movements?: K. Nederland. Akad. Wetensch. Proc., ser. B, v. 57, no. 3, p. 395–399, 1954.

Attention is called to a correlation between geomagnetic secular changes as shown by Vestine and tectonic deformation of the crust, both with respect to the general westward movement and the direction of movement in California and in Japan, China, and Indonesia. A direct relation between the two movements is unlikely because of the very different order of magnitude. The relation may be similar to that between irregularities in the movements of the areas of geomagnetic change and of the nondipole part of the field and the irregularities in the earth's rotation (see Geophys. Abs. 14415 and 14622), wherein the angular momentum from changes in currents in the core is neutralized by an angular momentum of the mantle and crust. The coupling forces between the core and the mantle, which bring about the conservation of angular momentum, cause a movement of the mantle as a rigid whole if they are relatively shortlived, as those connected with the irregularities in secular geomagnetic terms, but cause a viscous flow in the mantle if they operate over long periods. Normally this flow would have about opposite velocity at the surface of the mantle to that at the lower boundary where it is caused by the currents in the core, and would be extremely slow. Evidence for the tectonic effects of core currents is admittedly not strong, but the possibility is worth consideration.—*M. C. R.*

160–31. Cullington, A. L. The geomagnetic field in New Zealand at epoch 1950.5: New Zealand Dept. Sci. Indus. Research, Geophys. Mem. 2, 32 p., 1954.

The values of the magnetic elements, reduced to epoch 1950.5, are given for 230 stations at which observations were made in New Zealand from 1941 to 1951. These data have been analysed and isomagnetic charts for all elements, at epoch 1950.5, are appended. Vertical earth-air electric currents were evaluated and Chapman's criteria used to test the mutual consistency of the D and H charts.

The values of the magnetic elements, reduced to epoch 1950.5, are also given for stations on The Snares, Auckland, Campbell, and Chatham Islands.—*Author's summary*

160–32. Slaucitajs. L. Über die zeitlichen Störungen der magnetischen Deklination im Gebiete Nordeurasiens und Grönlands [Secular disturbances of magnetic declination in northern Eurasia and Greenland]: Geofisica Pura e Appl., v. 28, p. 37–46, 1954.

Disturbances of magnetic declination long observed in polar regions, especially in the zones of aurora borealis, were studied on the records of the Tromsö magnetic observatory and the records for the second Polar Year from seven high-latitude stations. Diurnal, annual, and 11-year periods were noted. The asymmetry of western and eastern deviations is a characteristic of the disturbance; in certain places a strong local magnetic disturbance is also noticeable.—*S. T. V.*

160–33. Nagata, T[akesi]. An intuitive description of the Chapman-Ferraro theory of the initial phase of a magnetic storm: Jour. Geophys. Research, v. 59, no. 4, p. 467–470, 1954.

The Chapman-Ferraro theory of the initial phase of a magnetic storm is reviewed in a simple intuitive form, by considering the macroscopic dynamical character of a moving ionized stream in a magnetic field. Fundamental equations thus obtained are (a) $H_s^2=nm+(w-w_o)^2$, (b) $H_s=2H_p$, and (c) $H_p=H_o/Z^3$. The second can be replaced by (b)'. $H_s=(3/2)H_p$, in the case of Ferraro's model of one-dimensional distribution of a permanent magnetic field. These results are in exact agreement with the final results obtained by Chapman and Ferraro, and recently by Ferraro.—*Author's abstract*

MAGNETIC PROPERTIES OF ROCKS AND MINERALS

160–34. Roquet, J. Sur les rémanences magnétiques des oxydes de fer et leur intérêt en géomagnetisme [On the remanent magnetization of iron oxides and its significance in geomagnetism] (Part I): Annales Géophysique, tome 10, no. 3, p. 226–247, 1954.

Results are presented of measurements of thermoremanent and isothermal remanent magnetization of a variety of samples including chemically prepared pure αFe_2O_3; pure artificial magnetite; the same magnetite with small additions of Fe_2O_3, manganese, calcium, and titanium respectively; baked clays of Arvor kaolin containing the above magnetites; Noron clays prepared for E. Thellier; Auvergne basalt; and bricks dating from Gallo-Roman time to 1933. Curves of the thermoremanent magnetization, $\sigma(\theta, H, T_o)$, versus H are presented for fields as great as 8,850 oersteds. The specific susceptibility, χ, and the ratio $\sigma(\theta,H,20^\circ)/\chi H$ are also presented. The isothermal remanent magnetization (at room temperature) is given as of function of H for fields as great as 30,000 oersteds. Data for weak fields are given for all the experiments.

No inverse remanent magnetization was noted in any of the experiments. At the same field, the isothermal remanent magnetization was much less than the thermoremanent magnetization. The ratio $\sigma(\theta, H,20^\circ)/\chi H$ was very large for samples of pure αFe_2O_3. The thermoremanent magnetization in fields of several oersteds was already large compared to the maximum achieved at 8,850 oersteds. Saturation for isothermal remanent magnetization of two samples of pure αFe_2O_3 and one sample of Noron clay was not achieved even in fields of 30,000 oersteds.—*P. E. B.*

160–35. Roquet, J. Sur les rémanences magnétiques des oxydes de fer et leur intérêt en géomagnétisme [On the remanent magnetization of iron oxides and its significance in geomagnetism] (Part II): Annales Géophysique, tome 10, no. 4, p. 282–325, 1954.

The effects of opposing fields, heating, and time on the stability of thermoremanent and isothermal remanent magnetizations of αFe_2O_3, magnetite, and certain other substances described in the previous paper are considered. Curves of remanent magnetization versus demagnetizing field for samples with thermoremanent magnetization are presented, as well as hysteresis curves for isothermal remanent magnetization (measurements made after removal of the applied field). A series of curves showing the effects of reheating samples with remanent magnetization demonstrates the great stability of thermoremanent magnetization acquired in a weak field. Thellier's laws of partial thermoremanent magnetization seem to be verified for αFe_2O_3 and magnetite for fields of the order of the

earth's field. Attempts to verify Néel's theory of the magnetization of baked clays and volcanic rocks met with some success. Rocks with fine-grained ferromagnetic constituents are best for determining fossil magnetizations, as the thermoremanent magnetization is stronger and more stable, and the isothermal remanent magnetization is relatively weak for fields of the order of the earth's field. Baked clays, in general, should be very good for this purpose. The magnetic properties of rocks vary considerably with the percentage of phenocrysts and microcrystalline constituents. This explains in part why there is no simple relation among susceptibility, natural remanent magnetization, and magnetite content. The dimensions and shape of the grains must also be considered.—*P. E. B.*

160–36. Kawai, Naoto; Kume, Shoichi: and Sasajima, Sadao. Magnetism of rocks and solid phase transformation in ferromagnetic materials: Acad. Japan Proc., v. 30, p. 588–593, 1954.

The work of E. Pouillard which demonstrated that the Curie point of a ferromagnetic material decreases linearly with increasing molecular percentage of ilmenite in solid solution in magnetite has been verified by using synthetic crystals of titanomagnetite and the results have been extended to a crystal with 80 mol percent of ilmenite and a Curie point of −45° C. The magnetization versus temperature curves of virgin specimens characteristically showed discontinuities indicative of different phases with different Curie points. Specimens heated above the Curie point and quenched showed no such discontinuities when remeasured immediately, but if they were held at room temperature after quenching, they showed discontinuities which changed with the length of time the specimen was held at room temperature. This leads to the conclusion that the quenched phase is homogeneous and unstable and over a period of time gradually transforms into several metastable phases which eventually reduce to two main parts having Curie points at 550° C and 90° C. X-ray investigations of the various materials tend to confirm these conclusions, as does the fact that the Curie points of 84 natural specimens of titanomagnetite are grouped around 90° C and 550° C. A hypothetical solid-phase equilibrium diagram is presented for the ilmenite-magnetite series with one solid phase above about 750° C and one or two solid phases below depending upon the composition.—*J. R. B.*

160–37. Nagata, T[akesi], and Uyeda, S[eiya]. Interaction of two constituents in ferromagnetic materials showing reverse thermo-remanent magnetism: Nature, v. 175, no. 4444, p. 35–36, 1955.

The reversed thermoremanent magnetism of the Haruna dacitic rocks has been attributed to the effect of close interaction between the *A* and *B* ferromagnetic constituents during their cooling in a magnetic field. Electron-microscope photographs of etched surfaces of Haruna rock show clearly that constituent *A* intergrows in echelon into constituent *B*. The width of the strips of constituent *A* is approximately 0.2μ, and the length ranges from 1μ to 5μ. Each strip is probably a single domain or several domains. In the Towada rocks the interaction of *A* and *B* is weak, and the thermoremanent magnetization is perfectly normal.—*R. G. H.*

160–38. Curnow, C. E., and Parry, L. G. Oxidation changes in natural ilmenite: Nature, v. 174, no. 4441, p. 1101, 1954.

An impure ilmenite concentrate obtained as a byproduct in the winning of rutile from beach sands has been refined to produce a "magnetic ilmenite."

The Curie point of the latter is between 100° and 200° C; the temperature dependence is otherwise consistent with that for Nagata's *B*-component of the Haruna and Asio rocks.—*R. G. H.*

160–39. Hospers, J. Rock magnetism and polar wandering: Jour. Geology, v. 63, no. 1, p. 59–73, 1955.

Lava flows and other igneous rocks become magnetized in the direction of the local geomagnetic field when they cool down after their formation. Similarly, sediments acquire a weak magnetic polarization on deposition. The mean direction of magnetization of series of recent lava flows and sediments has been determined; it is found that these mean directions agree closely with the theoretical dipole field. This field is the field due to a geocentric axial magnetic dipole. The conclusion is therefore drawn that the mean position of the magnetic poles (taken over a period of several thousand years) coincides with the geographic poles.

Assuming that the same is true for the geological past, the position of the geographic poles can be defined within fairly narrow limits by using the mean direction of magnetization of older rocks. Measurements on igneous rocks, of Tertiary and Quaternary age and from Europe only, are available. It is concluded that the large amount of polar wandering suggested by Kreichgauer, Koppen and Wegener, and Milankovitch cannot be reconciled with the new data. If polar wandering has taken place at all, it has not exceeded 5°–10° since Eocene times.—*Author's abstract*

160–40. Hospers, J., and Charlesworth, H. A. K. The natural permanent magnetization of the Lower Basalts of Northern Ireland: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 7, no. 1, p. 32–43, 1954.

Lava flows of the so-called Lower Basalts of Ireland, which are probably of Eocene age, possess inverse remanent magnetization with mean declination and inclination of N. 194° E., −60.2°, where declination and inclination of the present field are N. 13° W., +70°, respectively.

The mean direction of magnetization of geologically recent lava flows in Iceland, covering a period of several thousands of years, agrees closely with the direction of the geocentric axial dipole field. It is thus concluded that over a period of several thousands of years, the magnetic poles center on the geographic poles. In the Tertiary Northern Ireland lava flows the opposite of the mean direction of magnetization (regardless of what produced the inverse nature) is slightly different from the direction of the present dipole field. It is radically different from the direction of the dipole field calculated for the position of the geographic north pole in Eocene times proposed by advocates of the polar-wandering hypothesis. If the age of the Lower Basalts is Eocene, any consequent shift of the geographic north pole must have been less than suggested in the polar-wandering hypothesis; this would not be so if the lava flows are considerably younger.—*P. E. B.*

160–41. Kato, Yoshio; Takagi, Akio; and Kato, Iwao. Reverse natural remanent magnetism of dyke of basaltic andesite, found near Sendai, Japan: Tōhoku Univ. Sci. Repts., 5th ser., v. 6, no. 1, p. 62–69, 1954.

Reverse remanent magnetism has been observed in a group of roughly parallel dikes of basaltic andesite intruded into a green tuff near Sendai. The direction of magnetization in the tuff is the same as that of the present earth's field except where it is in contact with the dike. Samples of both rocks were heated

to more than 900° C and cooled in the present field, and the magnetization was then the same as the present field. It is concluded that the reverse remanent magnetization of the dike is the result of thermal remanent magnetization, and that the direction is coincident with the direction of the geomagnetic field at the time they were intruded (Miocene).—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

160–42. Schonstedt, E. O., and Irons, H. R. NOL vector airborne magnetometer type 2A: Am. Geophys. Union Trans., v. 36, no. 1, p. 25–41, 1955.

The NOL vector airborne magnetometer type 2*A* (*VAM–2A*) measures the direction and intensity of the Earth's magnetic field from aircraft. Like the earlier type 1*A*, it continuously records the total intensity of the field and the magnitudes of a number of angles which specify its direction, but the 2*A* can be used in all latitudes and requires fewer steps in the reduction of results. Electronic circuits are used to average continuously the always-varying angular magnitudes over predetermined intervals of time, so as to minimize errors arising from the deflection of the pendulously suspended magnetometer mechanism by accelerations of the aircraft. The total-field measuring system of the magnetometer has a temperature coefficient of about 0.5γ/°C. Drift due to causes other than temperature change is about 1 gamma in 12 hours. Magnetic compensation virtually eliminates the necessity for correcting the data for the field of the aircraft. In a region where the angle of dip is about 60°, *F*, *H*, *Z*, *I*, and *D* are measured under average conditions with estimated probable errors of 15, 40, and 30 gammas and 3 and 5 minutes of arc, respectively.—*Authors' abstract*

160–43. Oil and Gas Journal. Hydrogen atom put to work in photo-magnetometer survey: Oil and Gas Jour., v. 53, no. 45, p. 88, 1955.

An airborne magnetometer based on nuclear physics has been developed. Changes in the rate of spin of oriented hydrogen atoms in a water sample are used to determine the absolute magnetic field.—*L. C. P.*

160–44. Kumagai, Naoiti and Kawai, Naoto. A resonance type magnetometer: Kyōto Univ. Coll. Sci. Mem., Ser. B, v. 20, no. 4, p. 307–309, 1953.

A sensitive astatic magnetometer has been designed to measure the natural remanent magnetic polarization of rocks and that of small single grains of rock-forming ferromagnetic material. Magnets are fixed in opposite magnetic direction on both ends of a hollow aluminum cylinder 25 cm long and 0.2 cm in diameter. The specimen is placed in front of the lower magnet and rotated around a vertical axis with an angular velocity whose period is equal to that of the free oscillation of the magnetometer until it acquires a resonance oscillation. In the resonance state, the phase angle of the magnetometer oscillation is retarded $\pi/2$ from that of the rotation of the magnetic dipole of the specimen, and it is thus possible to find the direction of the horizontal projection of the dipole vector with respect to the coordinate axes fixed to the specimen. The magnitude of the polarization can be obtained by comparison of the observed amplitude of the resonance oscillation of the magnetometer with the amplitude caused by a standard sample of known polarization. Polarizations as small as 10^{-8} cgs per cc can be determined with a 5 cm cube placed 10 cm from the lower magnet. The smallest grain of natural magnetite measurable is 300μ in diameter.—*M. C. R.*

160–45. Lauterbach, Robert. Mikromagnetik—ein Hilfsmittel geologischer Erkundung [Micromagnetics—an aid to geological investigation]: Karl Marx Univ. Leipzig wiss. Zeitschr. math.-naturwiss. Reihe, Jahrg. 3, Heft 3, p. 224–238, 1953–54.

"Micromagnetics," as the term is used here, is a geophysical method based on the detailed mapping of small magnetic anomalies (less than 10^4 gammas in amplitude and less than 10 meters in extent). The principles and techniques, diagnostic criteria, and geological and mineralogical applications are discussed. The method is applied to selected test areas in a given region, and can be used not only on direct outcrops, but also for surfaces underlying younger layers or weathered zones a few meters thick. Microanomalies are influenced by rock structure and composition; analyzed statistically they can indicate, for instance, contacts between different formations, direction of flow structure in porphyry, or direction of sedimentation in young sediments. In a broad sense, the shapes of micromagnetic anomalies are "geological documents" which can lead to petrographic and geologic conclusions not obtainable by direct observation.—*D. B. V.*

160–46. Lauterbach, Robert. Quartärgeologie und Mikromagnetik [Quaternary geology and micromagnetics]: Karl Marx Univ. Leipzig wiss. Zeitschr. math.-naturwiss. Reihe, Jahrg. 3, Heft 3, p. 281–289, 1953–54.

The sorting of sediments by flowing water or wind, with resulting uneven distribution of magnetite content, makes it possible to apply the micromagnetic method to problems of Quaternary geology. This paper presents a number of examples of its application to such deposits, including beaches, moraines, valley trains, tidal flats, sand dunes, and river sand bars.—*D. B. V.*

MAGNETIC OBSERVATIONS AND SURVEYS

160–47. Toperczer, M[ax]. Der verlauf der erdmagnetischen Elemente in Wien, 1851 bis 1950 [The course of the geomagnetic elements in Wien, 1851 to 1950]: Archiv Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 5, Heft 2, p. 231–249, 1952.

A series of geomagnetic data for Wien is based on observations at three different observatories for the periods 1851–98 and 1928–50. Geomagnetic elements for 1898–1928 are interpolated from observations at Stara Dala, Pola, Praha, and Potsdam. A homogeneous series of horizontal-intensity values for 1851–1900 at Praha is also given.—*M. C. R.*

160–48. Lauterbach, Robert. Beiträge zur tektonischen Deutung der geomagnetischen Übersichtkarte der Deutschen Demokratischen Republik [Contribution to the structural interpretation of the geomagnetic survey map of the German Democratic Republic]: Karl Marx Univ. Leipzig wiss. Zeitschr. math.-naturwiss. Reihe, Jahrg. 3, Heft 3, p. 271–279, 1953–54.

The vertical-component magnetic survey map of East Germany, based on data of the Geophysical Survey of the Reich and on further measurements, is reproduced on reduced scale together with a magnetic structure map. The predominant feature shown, besides the already-known Mecklenburg anomaly, is a Rhenish-trending high extending from the Pritzwalker massif to the eastern border of the Harz. It appears likely that this can be correlated with other

Rhenish structures south of the anomalies of the Central German swell (Mitteldeutschen Schwelle); the Ilmenauer axis, in particular, is the exact north-northeast prolongation of Carle's Hegau-Heldburg lineament.

The great arc of anomalies running from Kyffhaüser through Wettin, Dessau, and Baruth to Guben is related to the Elbe line (Elbelinie). Whether it represents transverse displacement, as postulated by von Siemens from the gravity map, cannot be determined until further measurements reveal its exact course in the Elbe valley region.—*Author's summary, D. B. V.*

160–49. Godard, L[ouis]. Étude géomagnétique dans les Ardennes [A magnetic study of the Ardennes]: Annales Géophysique, tome 10, no. 3, p. 254–257, 1954.

A series of positive vertical magnetic anomalies in the Ardennes are presumably due to intrusions at depth.—*P. E. B.*

160–50. Krulc, Zvonimir. Geomagnetiska istrazivanja na otoku Visu [Geomagnetic investigations on the island of Vis]: Geol. Vjesnik, sv. 5–7, god 1951–53, p. 225–228, 1954.

In prospecting for water on the island of Vis, surveys were made to locate magnetic eruptive rocks. Two anomalies of +1200 and +965 gammas were discovered. The shapes of the distubing bodies were determined by the method suggested by Baturic.—*S. T. V.*

ELECTRICITY

GENERAL AND THEORETICAL STUDIES

169–51. Kunetz, G[esa]. Enregistrements des courants telluriques à l'occasion de l'éclipse de soleil du 25 février 1952 [Recordings of telluric currents at the time of the solar eclipse of February 25, 1952]: Annales Géophysique, tome 10, no. 3, p. 262–270, 1954.

Variations of potential differences between nonpolarizable electrodes 1,000 meters apart were observed at seven different places. Single lines were oriented approximately north-south and double lines approximately east-west. Six parties of the Compagnie Générale de Géophysique, in France, Italy (2 parties), the Sahara, French Equatorial Africa, and Venezuela, and one party of the Schlumberger Well Surveying Corp. in the United States participated. The results are summarized as follows: the correlation of rapid fluctuations in detail is very poor between the eastern and western hemispheres; many groups or "pulses" of rapid variations occurred simultaneously at all stations; the mean level of intensity of these variations averaged over 30-minute intervals is approximately the same at all stations; this mean level of activity shows a gradual shift depending upon local time, with the maximum during the day and the minimum during the night; and no effect of the eclipse on intensities or frequencies of telluric currents was detected.—*P. E. B.*

ELECTRICAL PROPERTIES OF ROCKS AND MINERALS

160–52. Ovchinnikov, I. K., and Kilyukova, G. G. Effektivnaya elektroprovodnost' sredy s vklyucheniyami [Effective electric conductivity of a medium with heterogeneous inclusions]: Akad. Nauk SSSR Izv. Ser. geofiz, no. 1, p. 57–59, 1955.

Theoretical computations of electrical conductivity in a medium with inclusions in the form of ellipsoids resulted in formulas in which conductivities are expressed as elliptic integrals of the first and second kind. (See Geophys. Abs. 158–87.) The formulas have been experimentally verified using a medium consisting of clay with intermixed metallic clippings of various shapes and thicknesses. Comparison of the theoretical values with measurements gave very satisfactory agreement, except where the metallic clippings were very thin. The relatively great discrepancy under these conditions is probably the effect of an oxide film on the metal.—*S. T. V.*

160–53. Volaravich, M. P., and Parkhomenko, Ye. I. P'yezoelektricheskiy effekt gornykh porod [Piezoelectric phenomena in rocks]: Akad. Nauk SSSR Doklady, tom 99, no. 2, p. 239–242, 1954.

Rock specimens were tested for the existence of piezoelectric effect by measuring with a cathode-ray oscillograph the electromotive force produced when mechanical impulses were received from a special seismometer which worked in reverse sense, being fed by electrical impulses and transforming them into mechanical ones (see Geophys, Abs. 14479). As a rule, an electromotive force was generated in rocks containing grains of crystalline quartz, such as granite, gneiss, sandstone, and quartzite, but piezoelectric properties were not discovered in jasper, syenite, gabbro, marble, dolomite, and limestone.—*S. T. V.*

INSTRUMENTS AND METHODS OF OBSERVATION

160–54. Wait, James R. Theory of electromagnetic surface waves over geological conductors: Geofisica Pura e Appl., v. 28, p. 47–55, 1954.

A wave radiated from a vertical antenna over a horizontally stratified ground is studied with respect to the attenuation and wave tilt of the surface wave and the height-gain function. These properties, and consequently the stratification in the half space, can be accounted for in terms of a complex factor Q which is the ratio of the normal ground-surface impedance to the intrinsic impedance of the upper layer. When Q is unity, the propagation is determined entirely by the electrical properties of the upper layer. A geophysical exploration method is suggested in which the form of the height-gain function obtained by measurements with an airborne receiver would be compared with theoretical curves to gain information concerning the substrata.—*R. G. H.*

160–55. Belluigi, Arnaldo. Su un problema fondamentale Geomatrans [On a fundamental problem in Geomatrans]: Geofisica Pura e Appl., v. 28, p. 57–65, 1954.

The solution is given of the problem of the magnetic transient (Matrans). A rectilinear transmitter of finite length, excited by an alternating current of low frequency, is stretched over the horizontal surface of the ground. The ground is everywhere homogeneous and isotropic except that at a given depth in which there is a thin widespread conductive layer parallel to the ground surface.

A step function of the current excites the bipole at a given instant. The transient electromagnetic field (geoeltrans) is determined with this. Of this field the magnetic field (matrans) is particularly examined. A new method of electromagnetic prospecting (especially for locating bodies of good electric conductivity) is deduced, analogous to the investigations of the electromagnetic

field, associated above all with the names of Levi-Civita and Sundberg.—*Author's abstract, M. C. R.*

160–56. Bellairs, G. ff. Instrumentation for a new electromagnetic geophysical field technique, as applied in South Africa: Geophysics, v. 20, no. 1, p. 155–162, 1955.

The technique described consists of passing an alternating current through the ground between a pair of electrodes and measuring the resulting vertical magnetic field at various points on the surface of the ground. A vacuum-tube oscillator with an output of 160 watts is used to energize the ground. The pickup unit consists of a portable coil and amplifier, capable of measuring field strengths as low as 1 microgauss.—*G. V. K.*

160–57. Fritsch, Volker. Einige Probleme der geolektrischer Bodenverfestigung [Some problems in the geoelectric method in reinforcing the ground]: Geofisica Pura e Appl., v. 28, p. 149–158, 1954.

In soil consolidation by the geoelectric method, the electric energy sent into the electrodes produces the greatest effect in the immediate vicinity of the electrode, causing a rapid rise of the resistivity of the ground. There exists a critical time limit beyond which this method of consolidation becomes too expensive. Therefore, electrodes must be in a form to produce a long critical time or that can easily be displaced after the critical time has been reached. Rollers equipped with electric connections can be advantageously used if only a thin layer covering the ground is to be consolidated. In general, the best results can be obtained only if the voltage and the current are adapted to the physical characteristics of the ground. Water can be removed only if its content is higher than a certain minimum determined by the structure of the soil. Many experimental graphs and data are included.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

160–58. Maeda, Katsuro. Apparent resistivity for dipping beds: Geophysics, v. 20, no. 1, p. 123–139, 1955.

The problem of the potential field about a current electrode on the surface of the earth over a dipping bed is considered. A general solution is obtained in the form of a harmonic series of modified Bessel's functions of the second kind, manipulated to satisfy Laplace's equations in cylindrical coordinates and the usual boundary conditions of continuity of potential and potential gradient. An analysis of the general solution shows that the same results can be obtained by using the image theory only in special cases. These special cases occur when the reflection coefficient is $+1$ and the dip angle is π/m, or when the reflection coefficient is -1 and the dip is $\pi/2m$, m being an integer. A table of values for the potential field is presented for three dip angles: 30°, 45°, and 60°. In addition, several families of curves of apparent resistivity as a function of electrode spacing are presented.—*G. V. K.*

160–59. Van Nostrand, Robert G., and Cook, Kenneth L. Apparent resistivity for dipping beds—a discussion: Geophysics, v. 20, no. 1, p. 140–147, 1955.

A review of the literature pertaining to the calculation of resistivity from potential measurements in the vicinity of a dipping bed is presented. These papers are grouped in two categories, depending on whether the theoretical analysis is

by the method of images or by harmonic analysis. Until recently, most of the theoretical work has been carried out using the image theory. However, continued work along this line has shown that in most cases such an approach can give only an approximate solution to the problem, and that an exact solution can be obtained only in two special cases. More recently, harmonic analysis has been used to obtain an exact solution to the problem, as shown by Maeda. However, the evaluation of this exact solution is not always easy, and it is possible that approximate solutions obtained using the image theory may be sufficiently accurate for field use.—*G. V. K.*

160–60. Deppermann, K. Die Abhängigkeit des scheinbaren Widerstandes vom Sondenabstand bei der Verpunkt-Methode [The dependence of the apparent resistivity on the electrode spacing in the four point method]: Geophys. Prosp., v. 2, no. 4, p. 262–273, 1954.

The dependence of the apparent resistivity on the distance between the potential electrodes is examined and a numerical method is described permitting quantitative calculations. Such a numerical relation is also established for the transformation of Wenner graphs into Schlumberger graphs. In addition it is shown in which manner the jumps in observed Schlumberger curves that result from changing the probe spacing must be smoothed out.—*Author's abstract*

ELECTRICAL SURVEYS

160–61. Merriam, D. F. Electrical resistivity studies in the Kansas River Valley: Kansas Geol. Survey Bull. 109, pt. 7, p. 97–112, 1954.

To investigate the application of restivity methods to ground water studies in eastern Kansas, electrical resistivity depth profiles were made in the Kansas River valley at places where geologic conditions were known. The Wenner electrode arrangement was used. Results of this survey show that the depth to water table can be determined with an accuracy of not less than 15 percent, whereas the error in interpretation of bedrock depth is only 9 percent. To a less certain degree, interpretations can also be made about lithology and the type of water contained in the alluvial sediments.—*S. T. V.*

160–62. Jacobson, Rollyn P. Geophysical case history of a commercial gravel deposit: Mining Engineering, v. 7, no. 2, p. 158–161, 1955.

A resistivity survey resulted in delineating a commercial gravel deposit in Jefferson County, Missouri. Empirical methods of interpreting the resistivity were used to prepare an isopach map of the overburden. This isopach map compares favorably with the information obtained from drilling.—*L. C. P.*

160–63. Zagorac, Željko. Istrazivanje vode u krsu i upotreba primjenjene geofizike [Prospecting for water in karst and the use of applied geophysics]: Geol. Vjesnik, sv. 5–7, god 1951–53, p. 201–216, 1954.

The physical principles of prospecting for water by electric resistivity methods are briefly reviewed with special reference to hydrologic problems occurring in karst regions, such as the determination of the volume of caverns and fissures filled with water. Many examples of work in Yugoslavia are cited. Special problems in the geophysical exploration of Brioni and Vis islands resulted from the mixing of underground streams of sweet and salt water which caused problems in making the measurements.—*S. T. V.*

160–64. Sedlar, Jošica. Geoelektricna ispitivanja za nalaz vode u krsu na otocima [Geoelectric exploration for water in karst on islands]: Geol. Vjesnik, sv. 5–7, god 1951–1953, p. 217–224, 1954.

Electric surveys for water were made on the island of Vis in 1952 in a region of pronounced karst structure. The subsurface was investigated to depths of 90 meters or more. The most important hydrological feature is the greater height of the water table in the middle part of the island than near the shore; because of the different densities of the water, that along the shores is almost pure sea water. The pressure of subterranean streams bringing fresh water toward the shore where it mixes with salt water is also an important hydrologic characteristic. In places the fresh water is separated almost at sea level by accidental underground fissure-free "dams." The structure along the shore is very important in determining the salinity of the water.—*S. T. V.*

160–65. Jensen, K. D. Geo-electrical investigations of manganese ore bodies in India: Geofisica Pura e Appl., v. 28, p. 91–108, 1954.

The manganese ores occur in metamorphic rocks of Archaean age and generally lie along the strike in parallel groups of long bands or series of lenticular layers. Both equipotential-lines and resistivity methods and the two in combination have been successfully used in determining the ore bodies. Four examples are described in detail.—*M. C. R.*

160–66. Suyama, Junji, and Kobayashi, Hajime. Electrical prospecting at Kasuga gold mine, Kagoshima prefecture [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 4, no. 12, p. 35–46, 1953.

Gold deposits in the Kasuga mine are massive in form and are the result of hydrothermal replacement in tuff and tuff-breccia. Resistivity surveys provided information on the forms of the deposit and the clay alteration zone.—*M. C. R.*

160–67. Suyama, Junji. Electrical prospecting at the Oguchi gold mine, Kagoshima prefecture [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 4, no. 11, p. 35–40, 1953.

Electrical resistivity and self-potential surveys for gold-bearing quartz veins.—*M. C. R.*

160–68. Shibatō, Kihei. Geophysical prospecting at Noda-Tamagawa Mine, Iwate prefecture [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 4, no. 12, p. 17–34, 1953.

Electrical surveys were made in the vicinity of the manganese deposits in the Noda-Tamagawa mine and in two unknown areas. On the basis of the electrical survey results in an unknown area, further exploration was recommended. Results of the magnetic surveys were not promising.—*M. C. R.*

160–69. Shibatō, Kihei. Electrical prospectings on sulphur deposit at the Matsuo-Hachimantai district, Iwate prefecture [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 5, no. 1, p. 41–48, 1954.

Electrical surveys were made in two areas at the Kuragata mine and two areas at the Appi mine. In the areas where pyrite and sulfur are found in the

"argillitized" zone, weak and irregular negative anomalies and low resistivity were found. In the silicified zone, a negative anomaly of -2000 mV or more and high resistivity were found. In the second area, drilling shows the silicified zone is at least 50 meters deep.—*M. C. R.*

160–70. Kaneko, Jun, and Honma, Ichiro. Electrical prospecting of water supply for industrial purposes at Seiban district, Hyogo prefecture [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 5, no. 1, p. 13–22, 1954.

Electrical surveys were made to delineate subsurface structure and suggest locations of aquifers.—*M. C. R.*

SEISMOLOGY

ELASTIC WAVES

160–71. Keylis-Borok, V. I. K voprosa a rasprostranenii statsionarnykh kolebaniy v sloe, lezhashchem mezhdu dvumya poluprostranstvami [On the propagation of steady oscillations in a layer between two semispaces]: Akad. Nauk SSR Geofiz. Inst. Trudy, no. 20 (147), p. 20–35, 1953.

Steady sinusoidal oscillations in a perfectly elastic plane-parallel layer in contact with two semispaces are investigated. The média are assumed to be homogeneous, isotropic, and perfectly elastic. Oscillations are obtained by applying a concentrated force varying sinusoidally with time at right angles to the layer.

Formulas are derived for the oscillatory displacements at points within the layer and the surrounding media. The natural frequencies of the displacements are also determined. The natural frequencies near the point of application of the force have sharp resonances. With increasing distance from the applied force, the amplitudes of the oscillations rapidly attenuate. The derived formulas can probably be used for determining the thickness of the layer, if the velocity of wave propagation is known.—*S. T. V., I. Z.*

160–72. Pinney, Edmund. Surface motion due to a point source in a semi-infinite elastic medium: Seismol. Soc. America Bull. v. 44, no. 4, p. 571–596, 1954.

The theory of the motion of the surface of a semi-infinite elastic solid due to an impulsive internal point source is developed, both for *P*-wave and *S*-wave point sources. Solutions are presented for a *P*-wave point source and for *S*-wave point sources oriented perpendicular and parallel to the surface of the solid. The motion for the first and third cases was computed by numerical-integration methods for $\lambda = \mu$, and is illustrated by graphs and tables.—*P. E. B.*

160–73. Honda, Hirokichi, and Nakamura, Kohei. On the reflection and refraction of the explosive sounds at the ocean bottom. II: Tōhoku Univ. Sci. Repts., 5th ser., v. 6, no. 1, p. 70–84, 1954.

The propagation of sound from a point source in an ocean of uniform depth overlying a semi-infinite elastic solid is investigated theoretically. The branch-line integrals in the integral formulas are evaluated by various methods, and

the expressions for waves reflected at the surface and bottom of the sea and the refracted waves propagating in the lower medium with the velocity of dilatational and distortional waves along the bottom surface are obtained. Paths of some waves and displacements in some pulses are shown as examples.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

160–74. Gamburtsev, G. A. Glubinnoe seysmicheskoye zondironvaniye zemnoy kory [Deep seismic sounding of the crust of the earth]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 123–133, 1954.

In seismological investigations using large explosions in 1949–50 in northern Tien Shan, in central Asia, it was possible to determine the geologic structure to a depth of about 40 km by distributing geophones over a distance of about 300 km. Seismographs with lower frequency (about 10 cycles per second), and higher amplification than usual were installed in groups to check extraneous noises. The best results were obtained by placing explosives on the bottom of the lake Issyk-Kul or Kara-Kul, at depths of about 25 meters. Two seismic waves were established, one with the velocity of the propagation of 8.0 kmps, the other 6.5 kmps.—*S. T. V.*

160–75. Karus, Ye. V., and Pasechnik, I. P. Izucheniye uprugikh i pogloshchayushchikh svoystv gornykh porod v ikh yestestvennom zaleganii metodami seysmoakustiki [The investigation of elastic and absorbing properties of rocks in place by seismoacoustic methods]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 514–526, 1954.

A method is described for measuring in place the elastic and absorptive properties of various rocks. Energy is introduced into the ground through electromagnetic or piezoelectric vibrators producing steady mechanical vibrations in the ground and detected by standard seismic equipment. The frequency of induced vibration ranges from 50 to 4,000 cycles per second, and the energy consumption is only about 50 watts. By examining the seismic profiles it is possible to determine the phase velocities of the seismic waves as well as the coefficient of damping in different formations.—*S. T. V., I. Z.*

160–76. Olson, Robert W. High resolution reflection seismograph: Oil and Gas Jour., v. 53, no. 36, p. 84–86, 1954.

A high-resolution reflection seismograph system has recently been developed and tested by the Houston Technical Laboratories. Originally designed to record shallow reflections in the depth range of 50 to about 2,500 feet, the "HR" system has surprisingly recorded high-frequency reflections from depths as great as 10,000 feet. At intermediate depths, reflections that are barely workable on conventional seismograms are clearly resolved at frequencies above 90 cycles per second.

The system combines high-frequency amplifiers, fast automatic gain control, high-speed recording, high-frequency galvanometers, and simultaneous mixed and unmixed recording of 12 traces. It can be used to solve a variety of problems, including mapping small features, detailed (or general) coverage of larger features at medium depth, and geologic engineering work, such as investigation of dam foundations.—*L. C. P.*

160–77. Tomodá, Yosibumi, and Aki, Keiiti. Magnetic recording seismometer by means of moving magnet [In Japanese with English abstract]: Zisin, v. 5, no. 4, p. 13–16, 1952.

A description of a seismograph in which the displacement of the seismometer is recorded on magnetic tape by a small magnet attached to the seismometer arm.—*M. C. R.*

160–78. Suzuki, Ziro. On the frequency response of the seismometer with air damper [In Japanese with English abstract]: Zisin, v. 5, no. 4, p. 46–51, 1952.

Frequency-response curves have been calculated for a seismometer with air damping. Numerical results are given for the Ishimoto instrument.—*M. C. R.*

160–79. Mori, Kiyoshi, and Nagumo, Shozaburo. Some experiments on the "A. G. C." using amplifier for seismic prospecting [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 4, no. 11, p. 21–34, 1953.

Experiments on the transient characteristics of the automatic gain control amplifier and their influence on the detection of reflections are described.—*M. C. R.*

METHODS OF ANALYSIS AND INTERPRETATION

160–80. Koefoed, O. Some observations on seismic weathering corrections: Geophys. Prosp., v. 2, no. 4, p. 274–280, 1954.

A series of short (10 meters or less) refraction profiles disclosed that the velocity in the weathered layer varied between 300 and 700 meters per second in a horizontal direction, and that the traveltime curves did not pass through the origin. The velocity variations cause an uncertainty of about 10 percent in the weathered-layer corrections. The failure of the traveltime curves to pass through the origin results from extremely low velocities near the surface. The latter observation agrees qualitatively with the theory of Gassman, who derived the velocity distribution for a hexagonal packing of spherical solid bodies. This means in practice that poor geophone planting could cause appreciable errors in the weathered-layer correction.—*L. C. P.*

160–81. Krey, T[heodor]. A remark concerning the problem of how to place the reference plane (datum level) in reflection seismic prospecting: Geophys. Prosp., v. 2, no. 4, p. 281–284, 1954.

The seismic velocity in rock depends upon the depth. The datum plane should be so placed that fluctuations in planes of equal velocity caused by topography do not introduce errors in the depth computations. Faust has shown that the seismic velocity in rocks of the same age and lithologic type varies with the $\frac{1}{6}$ power of the depth. The problem of placement of the datum plane is solved analytically. The exact equation used depends upon the type of sedimentation (uniform, continuously increasing, or decreasing), tectonic movements, and surface erosion. Abrupt variations in surface elevation will cause a departure from the theory presented.—*L. C. P.*

160–82. Rice, R. B. Additional notes on the resolved-time computing methods: Geophysics, v. 20, no. 1, p. 104–122, 1955.

In the resolved-time method of computing, both the horizontal and vertical coordinates are plotted in time units on a cross section. The vertical times are ordinary reflection times with standard corrections. The horizontal times represent the shot-point spacing according to a variable horizontal velocity which depends upon the velocity-time or velocity-depth function. "Migrated" depth-point positions in the resolved-time section are determined by swinging arcs about the shot points or midpoints and constructing the reflecting horizon by straight-line tangents to these arcs. If elevation correction times are large and the dips are steep, the arcs should be swung from a point midway between the bottom of the weathered layer and the shot elevations instead of from the datum. A "depth" section can then be prepared by using the appropriate average vertical velocity and the true shot-point locations in distance.

Cross-spread computations can be handled by an extension of the resolved-time method to three dimensions. A circular slide rule has been constructed for this purpose.

By using a reliable horizontal-velocity function, good agreement with curved-path methods of computation can be obtained.—*L. C. P.*

160–83. Yepinat'yeva, A. M. Nekotorye voprosy povysheniya tochnosti interpretatsii pri sovmestnom ispol'zovanii dannykh metodov otrazhennykh i prelomlennykh voln [Certain questions of the more precise interpretation of data obtained from simultaneous use of reflected and refracted waves]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 4, p. 331–348, 1954.

It is usual in analyzing traveltime curves to replace the actual structure by an assumed structure. Thus the real medium of a composite structure can be replaced either by a homogeneous medium with an intermediate velocity or propagation, a stratified medium with constant velocity in each layer, or a heterogenous medium with velocity continuously varying with depth. Similarly for refracted waves the real medium is replaced either by a homogeneous medium with a constant velocity or by a stratified medium with the velocity constant in each layer, but changing from layer to layer. The best assumption will be the one that gives the traveltime curve most nearly approaching the real one. The determination of different seismic velocities and the position of intermediate layers are given for different velocity ratios of velocities and various geometric conditions, including that of a thin layer of high velocity within a homogeneous medium. Similar problems are also discussed for the combined data when the waves are reflected and refracted.—*S. T. V.*

160–84. Dix, C. Hewitt. Seismic velocities from surface measurements: Geophysics, v. 20, no. 1, p. 68–86, 1955.

The purpose of this paper is to discuss field and interpretative techniques which permit, in favorable cases, the quite accurate determination of seismic interval velocities prior to drilling. A simple but accurate formula is developed for the quick calculation of interval velocities from "average velocities" determined by the known x^2-T^2 technique. To secure accuracy a careful study of multiple reflections is necessary and this is discussed.

Although the principal objective in determining velocities is to allow an accurate structural interpretation to be made from seismic reflection data, an important secondary objective is to get some lithological information. This is ob-

tained through a correlation of velocities with rock type and depth.—*Author's abstract*

160–85. Hershberger, John. Recent developments in strong-motion analysis: Seismol. Soc. America Bull., v. 45, no. 1, p. 11–21, 1955.

The integration of acceleration records by the U. S. Coast and Geodetic Survey to produce velocity and displacement curves has nearly always required the use of arbitrary adjustments, in addition to the three legitimate adjustments involved in fixing the two constants of integration and the acceleration axis. These adjustments were necessary because not all parts of the velocity curves were horizontal for a given choice of axis of acceleration. Consequently the second integration frequently led to unreasonable displacements. Even with the use of an accelerometer which eliminated the possibility of zero shifts, acceptable integration results have been obtainable only for short periods of ground motion.

The Carder displacement meter has thoroughly proved its superiority over integration as a means for obtaining displacement information of general engineering significance, and is being increasingly used for this purpose.—*P. E. B.*

160–86. Savarenskiy, Ye. F., and Nenilina, V. S. Ob uchete geologicheskikh neodnorodnostey pri opredelenii polozheniya ochaga zemletryaseniya [How geologic heterogeneities can be accounted for when locating the focus of an earthquake]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 17–30, 1955.

To eliminate the effect of geologic heterogeneities near the surface, the focus is first found by the Wadati method, and the seismic ray is approximately traced from the focus to the station. In most places the seismic velocities and the geologic structure through which the ray comes are known. The boundaries between formations are assumed to be horizontal so that the angle is changed, but not the time of the arrival of the ray. The observed-time data may then be reduced to a plane sufficiently deep to avoid local structural irregularities. For the area to the east of Caspian Sea this depth is assumed to be 7–10 km. The displacement of the ray caused by the refraction to this plane of reduction may be found by a simple geometric construction. A more precise position of the focus is then found by repeating the Wadati construction taking as the points of observation these new positions of the rays. Several examples are given.—*S. T. V.*

OBSERVATIONS OF SEISMIC WAVES

160–87. Levin, F. K., and Hibbard, H. C. Three-dimensional seismic model studies: Geophysics, v. 20, no. 1, p. 19–32, 1955.

Elastic-wave propagation in a two-layer model, consisting of a 3-inch thick slab of Sauereisen No. 31 cement over a 1-inch thick slab of marble, has been studied at the Carter Oil Co. Laboratory. The dilatational wave velocities in the cement and marble are 7,300 fps and 18,400 fps respectively. Shots and geophones were represented by piezoelectric transducers placed in a variety of source and detector combinations. Numerous refracted and reflected dilatational and shear waves were identified. The shear waves were surprisingly prominent. The region of maximum energy shifts toward later times with increasing separation of source and detector. The amplitude of the ground roll falls off approximately as the square root of the distance. Model studies are valuable in investigating not only fundamental problems but also such practical field problems as multiple geophone patterns.—*L. C. P.*

160–88. Suzuki, Ziro, and Sima, Hiromu. On forms of seismic waves generated by explosion, 1: Tohoku Univ. Sci. Repts., 5th ser., v. 6, no. 1, p. 85–94, 1954.

Seismographic observations were made on the grounds of the Geological Survey of Japan at Kawasaki at intervals of 25 cm from 11.25 to 25.25 meters. The source was a detonating cap fired at a depth of 74 cm. The ground motion generated consisted of some simple and regular wave groups and an irregular motion that is the apparent result of the superposition of wave groups. The period of the waves was constant within the range of observation. The amplitude ratio to the standard amplitude in a wave group varies linearly with distance. The "growing rate" of waves varies regularly in the order of their appearance in the group, the head of the group decaying with distance while the tail increases. Thus the initial motion of later phases is sometimes misread.—*M. C. R.*

160–89. Howell, B. F., Jr., and Budenstein, D. Energy distribution in explosion-generated seismic pulses: Geophysics, v. 20, no. 1, p. 33–52, 1955.

Three orthogonal components of ground velocity were recorded at distances ranging from 10 to 1172 feet from a small explosion. On the basis of transmission velocities and particle motion, the seismic waves were divided into three groups, corresponding to the direct arrival of body waves, an early-arriving surface wave believed to be the coupled wave, and Rayleigh surface waves. The relative energy content of each of these wave groups was determined graphically by squaring the amplitude of each of the pulses and taking the sum over the time interval during which a particular group arrived. At distances less than 400 feet from the shot, the direct arrivals had the most energy, but at greater distances, the Rayleigh waves contained most of the energy. A rate of attenuation of 0.019 nepers per foot was determined for the direct wave, of 0.011 nepers per foot for the second wave group, ad of 0.0053 nepers per foot for the third wave group.—*G. V. K.*

160–90. Dix, C. Hewitt. The mechanism of generation of long waves from explosions: Geophysics, v. 20, no. 1, p. 87–103, 1955.

To explain the differentiation of the energy from an underground explosion into high-frequency pulses and low-frequency surface waves, it is postulated that low-frequency waves are formed by energy returning to the vicinity of the shot after being reflected from a free surface or a similar reflecting horizon. In an attempt to justify this phenomenon mathematically, the vertical displacement due to a point source in a semi-infinite medium is calculated for points along a vertical line through the source. It is found that the reflected and direct traveling energies combine to produce a long-period displacement.—*G. V. K.*

160–91. Riggs, Emmet D. Seismic wave types in a borehole: Geophysics, v. 20, no. 1, p. 53–67, 1955.

Experiments with multiple seismometer arrays within a borehole revealed a well-developed secondary wave following the compressional wave. The wave was generated under controlled conditions and was identified as a tube wave traveling through the fluid column. The measured tube-wave velocity agrees closely with the velocity calculated from Lamb's formula for a thick-walled tube. Although the amplitude of the tube wave is higher than that of the formation compressional wave, the accuracy of formation-velocity data can be assured by using proper techniques of measurement.—*L. C. P.*

160–92. Krey, Th[eodor], and Teudesmann, G. Einige Geschwindigkeitsmessungen in Schussbohrungen Norddeutschlands [Some velocity measurements in drill holes in northern Germany]: Erdöl u. Kohle, Jahrg. 7, Heft 9, p. 548–550, 1954.

Measurements of seismic velocities in drill holes showed that when the charge is placed on the ground over the hole and the geophone suspended on a cable in the bore hole, the wave propagating through the cable causes interference. It is necessary to place the charge at a certain lateral distance from the hole and make necessary corrections for the refracted waves. The velocity in the ground above the water table was very low, in some places only 200 meters per second. Below the water table, the velocity immediately increased to 1,600–2,000 meters per second. Data are given on several graphs.—*S. T. V.*

160–93. Tatel, Howard E., and Tuve, Merle A. Note on the nature of a seismogram—I: Jour. Geophys. Research, v. 59, no. 2, p. 287–288, 1954.

Coherent patterns obtained from multiple seismograms have indicated that there could be strong conversion of compressional waves to surface waves at the Earth's uneven surface. In addition, ground-motion studies have shown the presence of Rayleigh waves after the *P* arrival and before the *S* arrival. This conversion could account for much of the ground motion in a typical seismogram.—*Authors' abstract*

160–94. Tatel, Howard E. Note on the nature of a seismogram—II: Jour. Geophys. Research, v. 59, no. 2, p. 289–294, 1954.

Model experiments have experimentally verified Lamb's calculation of the ground motion from a distant point disturbance. Surface irregularities alter the simple wave patterns, making them conform to field seismograms. This is in agreement with a hypothesis previously deduced from field experience. The *P* wave makes *R* waves at a surface scattering center. Reciprocity holds for the models used. Scattering centers at a surface cause conversion of *P* to *R* and *R* to *P* waves respectively. Thus, the complex nature of a seismogram can be attributed in part to the interaction of seismic waves with surface irregularities and the resultant generation of surface waves. Just what fraction is due to surface and volume scatterings remains for future investigation to determine.—*P. E. B.*

160–95. Knopoff, L. Seismic wave velocities in Westerly granite: Am. Geophys. Union Trans., v. 35, no. 6, p. 969–973, 1953.

A laboratory method for determining the velocity of elastic waves in rocks, using essentially the same procedure as in field seismology, consists in the excitation of specimens from a ¼-inch cube stack-of-six lithium sulfate monohydrate crystals placed in direct contact with a polished surface excited by a square voltage pulse of 2.5 microseconds duration, detection of the surface motion by another crystal element, and observation of the amplified signal on an oscilloscope. Observations were made at receiver stations 0.5 cm apart, 1.0 to 12.5 cm from the source. Velocities of 5.76, 3.23, and 2.98 kmps for *P*, *S*, and *R* were obtained for a specimen of Westerly granite. Velocities and elastic constants computed from them are higher than earlier laboratory measurements but in excellent agreement with the value for Poisson's ratio by Adams and Coker and field measurements by Leet and Ewing and by Leet for similar granites.—*M. C. R.*

160–96. Berg, Hellmut. Kritische Bemerkungen zu den P_b-Angaben bei Nahheben [Critical notes on the P_b-data in near earthquakes] : Geofisica Pura e Appl., v. 28, p. 66–74, 1954.

Notations of earthquake phases in station bulletins are not expected to be as reliable as those in monographic studies, but should be useful in statistical studies. Investigations of the P_b–P_n differences at several European stations, however, suggested that P_b had often been mistaken for P_g and vice versa. Detailed studies are therefore necessary to check P_b data in bulletins.—*M. C. R.*

160–97. Press, Frank, and Ewing, Maurice. Waves with P_n and S_n velocity at great distances: Natl. Acad. Sci. Proc., v. 41, no. 1, p. 24–27, 1955.

Phases related to P_n have been observed at the Lamont Observatory at epicentral distances of 69°–79° and to S_n at distances of 52°–125°. These must result from wave-guide action in which compressional waves and shear waves are trapped beneath the Mohorovičić discontinuity. "Whispering gallery" propagation in the mantle by multiple-grazing reflection from the Mohorovičić discontinuity is proposed.—*M. C. R.*

160–98. Nuttli, Otto W. The *P* wave and the earth's core: Am. Geophys. Union Trans., v. 35, no. 6, p. 962–968, 1954.

A study of the traveltimes of the *P* wave for recent large-magnitude earthquakes indicates that the *P* curve is branched, the point of bifurcation occurring at an arcual distance of approximately 90°. From the slope of the earlier portion of the *P* curve, the depth to the core of the Earth is found to be 2,901 km. It is suggested that the later *P* wave may be one which has traveled to a depth of only 2,700 km.—*Author's abstract*

160–99. Shurbet, D. H. Bermuda *T* phases with large continental paths: Seismol. Soc. America Bull., v. 45, no. 1, p. 23–25, 1955.

The paths of propagation involved in this study consist of land paths up to 51° preceding 14° of water path. The energy travels as *P* before entering the water. A *T* phase will be generated by the arrival of a *P* phase at a steep submarine slope if the *P* phase contains energy within the characteristic frequency range of the *T* phase, and this *T* phase can be detected at distant stations if there are no obstacles in the intervening path. A deep-focus earthquake is apparently a better generator of the *T* phase. Background noises in the sofar channel occasionally arise from earthquakes as much as several thousand miles inland.—*P. E. B.*

EARTHQUAKE OCCURRENCES AND EFFECTS

160–100. Ritsema, A. R. A statistical study of the seismicity of the earth: Indonesia Organization Sci. Research Verh. no. 46, 36 p., 1954.

From studies based primarily on the data available in Gutenberg and Richter's Seismicity of the Earth, Ritsema suggests that the tangential stresses causing earthquakes, at least at shallow depths, are distributed homogeneously and that all earthquakes are therefore expressions of one force (for example, the force caused by a homogeneous contraction of the earth). Earthquakes in the upper part of the mantle take place at preferred depths which seem to be closely associated with discontinuities. Curves of strain-release versus time suggest that the same physical conditions exist at depths between 40 and 310 km, and between 310 and 720 km, and that the boundary of the shallow and intermediate

earthquake zones could better be placed at a depth of 30–40 km rather than 70–80 km. The zones of shallow, intermediate, and deep earthquakes may be subject to the same strain-generating stresses, but the reactions in the three zones seem to be independent of each other. The regularity of the curves suggests that earthquakes all over the world within each zone are connected with each other.—*M. C. R.*

160–101. Ritsema, A. R. The seismicity of the Sunda arc in space and time: Indonesia Madjalah Ilmu Alam Untuk, v. 110, no. 1–3, p. 41–49, 1954.

Seismicity maps of the Sunda arc, based on Benioff's $E^{\frac{1}{2}}$ factor, indicate relative maximums in displacement for shallow, intermediate, and deep earthquakes are distributed fairly regularly at mean distances of 650 to 700 km. The most pronounced maximums in the shallow zone are in the central Sumatra salient and in the intermediate zone in the south Banda Sea. There is an exceptional minimum in displacement in the shallow zone near the island of Sumbawa. Curves of displacement factor versus depth are symmetrical, with the part below 400 km being a nearly perfect reflected image of the part between 80 and 400 km except for absolute value. This symmetry may be used as an argument for the existence of a convection current in the mantle with center of rotation at about 400 km. There is some evidence that maximums, minimums, and steeper gradients in the upper part of the curve are related to discontinuities, and that most earthquake foci in depth are associated with the discontinuities. Curves of strain-release versus time indicate a rather constant displacement with a sudden greater displacement in the shallow zone in 1936, with an increase in the intermediate zone in 1938, and faint evidence of increasing displacement in the deep zone in 1943. The cycle of activity marked by greater frequency of major shocks apparently starts in the crust and is propagated slowly to deeper levels where most of the strains will be adjusted by plastic flow. Diagrams of strain-release versus time for different parts of the arc suggest that the cycle is propagated from west to east. Nearly all the earthquake displacements take place within a triangular zone of the crust from about 100 km outside the oceanic trough to a depth of about 200 km about 100 km inside the inner nonvolcanic arc.—*M. C. R.*

160–102. Rothé, J. P., and Dechevoy, N. La seismicité de la France de 1940 à 1950 [The seismicity of France from 1940 to 1950]: Inst. Physique du Globe Strasbourg Annales, tome 7, 3e pt., p. 24–62, 1954.

A catalog of earthquakes with epicenters in France. Maps of equal earthquake intensity are given for the principal 38 earthquakes of the period 1940–50.—*H. F.*

160–103. Grandjean, A. Séismes d'Algerie de 1940 à 1950 inclus [Algerian earthquakes from 1940 to 1950 inclusive]: Inst. Physique du Globe Strasbourg Annales, tome 7, 3e pt., p. 63–85, 1954.

A catalog of earthquakes with epicenters in Algeria. Maps of equal earthquake intensity are given for the principal earthquakes in the coastal regions during the period 1940–50.—*H. F.*

160–104. Sorskiy, A. A. O seysmichnosti rayona Shemakhi v Zakavkaz'e [Seismicity of the Shemakha region in Transcaucasia]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 35–44, 1955.

The Shemakha region is known as the most seismically active zone of the Caucasus; it is grade 8–9 on the seismicity map of the U. S. S. R. From study of

detailed descriptions of all earthquakes in the area since 1872 and of the city itself and the surrounding villages, Sorskiy concludes that the great destruction resulted from the poor quality of the buildings and from landslides seriously damaging the buildings, rather than the force of the earthquakes. Therefore, the seismicity of the region should not be considered as more than 8.—*S. T. V.*

160–105. Wood, Harry O. The 1857 earthquake in California: Seismol. Soc. America Bull., v. 45, no. 1, p. 47–67, 1955.

From newly discovered contemporary accounts and old reports long overlooked it is concluded that the earthquake in 1857 in California has been the strongest shock in the Coast Range region of south-central and southern California since the coming of white men.—*P. E. B.*

160–106. Ramirez, J. E. El terremoto de Arboledas, Cucutilla y Salazar de las Palmas, 8 de julio, 1950 [The earthquake of Arboledas, Cucutilla, and Salazar de las Palmas, July 8, 1950]: Inst. geofis. de los Andes Colombianos Bol., no. 10, p. 1–92, 1953.

On July 8 and 9, 1950 several earthquakes occurred in the Departamento de Santander del Norte, Colombia, centered near Arboledas, Cucutilla, and Salazar de las Palmas. The total duration of these shocks was about half a minute, and the intensity was 10 on the modified Mercalli scale. The epicenter of the earthquake was lat 7°38′ N., long 72°47′ W.; the depth of focus 15.4 km. The cause of the earthquake was clearly tectonic. The seismic history of the region since 1610, and a detailed description of the destruction produced by the present shock are included.—*S. T. V.*

160–107. Bonelli, J. Nota acerca del sismo de foco profundo de 29 de marzo de 1954 [Note on the deep focus earthquake of March 29, 1954]: Rev. Geofísica, año 13, no. 49, p. 113–116, 1954.

The earthquake of March 29, 1954, at $6^h\ 18^m\ 28^s$ (G. M. T.) whose epicenter was $\varphi = 36°$ N. lat, $\lambda = 4.5°$ W. long, had a depth of focus of 630–650 km. If other earthquakes occur at such a great depth, it will be necessary to modify theories of the deep geology of the Mediterranean.—*S. T. V.*

160–108. Debrach, J. Le tremblement de terre de profondeur anormale de la Sierra Nevada (Mars 1954) [The earthquake of abnormal depth in the Sierra Nevada March 1954]: Notes Marocaines, no. 4, p. 21–22, 1954.

A brief note on the earthquake of March 29, 1954 in southern Spain, believed to have been at a depth of 650 km, and a request for macroseismic observations to aid in the study of the shock.—*M. C. R.*

160–109. Bullen, K. E. On the size of the strained region prior to an extreme earthquake: Seismol. Soc. America Bull., v. 45, no. 1, p. 43–46, 1955.

A previous formula of the author's has been adapted to give the volume V of the region in which the material is near breaking-point, just prior to an extreme earthquake, in terms of the released energy and breaking-strength near the focus. In the light of recent earthquake energy-magnitude data of Gutenberg, Richter, and Benioff, it is inferred that V is at least of the order of the volume of a sphere of radius 25 km. Comparison with other estimates of the size of

strained regions in earthquakes suggests V may possibly reach the order of the volume of a sphere of radius 50 km. It is suggested that a factor in the occurrence of extreme earthquakes is the existence, in the zone of strain, of strength rather greater than in the majority of major earthquakes of magnitude one unit or more less than the extreme value.—*Author's abstract*

160–110. Kosenko, S. I. K voprosu o vychislenii energii zemletriyaseniy [On the computation of the energy of earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 21 (148), p. 3–15, 1953.

Formulas for the determination of the energy developed during an earthquake by calculations based on the resulting seismic disturbances in the earth are discussed. The theory is applied in a particular area to determine whether a huge landslide or an earthquake was the primary cause of tremors which had developed in the ground. The low energy calculated indicated that the landslide was the source of disturbance.—*S. T. V., I. Z.*

160–111. Trapp, E. Ableitung der Magnitudengleichung für die Erdbebenstationen Wien and Graz und allgemeine Bemerkungen zur Magnitudenberechnung [The derivation of the magnitude equation for the seismological stations at Wien and Graz and some general remarks on the calculation of magnitude]: Archiv Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 6, Heft 3–4, p. 440–450, 1954.

Magnitude equations for the Wien and Graz stations were derived from the data of 158 and 121 teleseisms of normal depth of focus and magnitude of 7 or greater. The station constant is the same for both stations, $C=+0.15$. One problem in determining the magnitude is the calculation of the maximum horizontal amplitude, especially when only one component is available. The D term in the magnitude equation is weighted in its present form and should be based on the regional and individual characteristics of the earthquake.—*M. C. R.*

160–112. Vvedenskaya, A. V. Metodika i resul'taty obobshcheniya nabliudeniy seti statsionarnykh seysmicheskikh stantsiy Sredney Azii za 1950–1953 gg [The methods and results of the generalization of the observations by seismic stations of Central Asia during 1950–53]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 497–514, 1954.

Within the area bounded by latitudes 35° N. and 46° N. and meridians 65° E. and 85° E., there are 25 permanent seismic stations equipped with sensitive Kharin and Kirnos instruments. This is one of the most seismically active regions in Soviet Russia. During 1950–53, 23 strong earthquakes (intensity greater than 6) and more than 3,000 less-violent ones were registered by the stations of this network.

The epicenters and depths of foci were determined for all stronger earthquakes. Conclusions about the relations of the foci to the tectonics of the region differ from those of Rozova.—*S. T. V., I. Z.*

160–113. Malinovskaya, L. N. Dinamicheskaya kharakteristika ochagov yugo-zapadnoy Turkmenii [The dynamic characteristics of the foci in southwestern Turkmen S. S. R.]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 1, p. 31–34, 1955.

The dynamic characteristics of 27 earthquakes recorded by the seismic expeditions of the Academy of Sciences were determined and all initial seismic shocks were found to be equivalent to a dipole plus a moment. Geologically

this corresponds to a fault with consequent relative displacement of the two sides along the plane of the fault. Results are shown on the map of the region.—*S. T. V.*

160–114. Hodgson, John H. Fault-plane solution for the Tango, Japan, earthquake of March 7, 1927: Seismol. Soc. America Bull., v. 45, no. 1, p. 37–41, 1955.

In an attempt to obtain confirmation of the fault-plane methods in use by the Dominion Observatory by comparison with an observed fault, a solution has been attempted for the Tango, Japan, earthquake of March 7, 1927. The direction of first motion was read from seismograms, accumulated for an earlier study by E. A. Hodgson and filed at Ottawa.

The data derived from the records are not sufficient to allow an independent solution that is very closely defined, but it is shown that they do satisfy the known strike, dip, and relative displacement very well.—*Author's abstract*

160–115. Vvedenskaya, A. V. K voprosu a dinamicheskoy kharakteristike ochagov udalennykh zemletryaseniy [On the dynamic characteristics of the foci of distant earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 20 (147), p. 37–46, 1953.

The dynamic characteristics of an earthquake can be determined from the data at distant seismological stations only if the effect of the heterogeneity of crustal layers on the longitudinal and transverse waves is eliminated. For this reason the ratio of the initial displacements of *P* and *S*, the ratio of the two components of the displacement at the arrival of *S*, and the direction of the displacement at the arrival of *P*, are chosen.

Seismograms at each station are characterized by an angle with reference to the epicenter, and the angle of emergence to which corresponds a ray leaving the focus at a certain angle. By using the results of Keylis-Borok (see Geophys. Abs. 14035, 12935, 13330) and Vvedenskaya (Geophys. Abs. 13847) and the equations of nodal lines resulting from the deformation of the ground by the propagating waves, a system of equations can be derived relating the coordinates of the station, the path of the waves, and the dynamic characteristics of the impulse in the focus. Three assumptions are made of the kind of shock at the focus: that the dynamic action is produced by one force, by two forces not forming a moment, or by a double force with a moment.

The results are applied to the earthquakes of Nov. 4, 1946, Nov. 6, 1946, and Dec. 5, 1948 in Turkestan. Agreement is found between the computations and the tectonics of the region for the first shock but not for the other two. Further seismologic and geologic studies are needed.—*S. T. V.*

160–116. Savarenskiy, Ye F. Seysmishnost' SSSR, itogi i perspektivy eye izucheniya [Seismicity of the U. S. S. R., results and future outlook of investigations]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 5–24, 1954.

The seismicity of a region is characterized by the intensity, frequency, and location of earthquakes in the area. Progress in studies of seismicity can be achieved only after correlations are established between the dynamic conditions at the focus and geologic and geophysical features of the crust; the correlations will establish a genetic relation between slow tectonic processes and the occurrence of earthquakes. One of the important problems is the determination of the correlation between weak and violent earthquakes. Weak

earthquakes are often not forerunners, but aftershocks, of earthquakes and their frequency spectra are very different. However, it may be important to find the characteristics of strong earthquakes from the weak ones. To study earthquakes in general, and especially weak ones, it will be necessary to increase the number of seismic stations, making the average distance between stations not more than 100 km; to equip the stations with better, more precise instruments; and to extend the scope of tectonic investigations of seismic zones.

Tectonic studies of the seismic regions of the Carpathian Mountains, the Crimea, central Asia, the Lake Baikal region, the Far East, including Kamchatka, are reviewed.—*S. T. V.*

160–117. Belousov, V. V., and Gzovskiy, M. V. Tektonicheskiye usloviya i mekhanism vozniknoveniya zemletryaseniy [Tectonic conditions and the genesis of earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 25–35, 1954.

The distribution of earthquakes on the surface of the earth is related to slow universal vertical movements of the crust, especially noticeable along the borders between oceans and continents. The seismicity is greatest in areas where there is differential movement of the surface on the two sides of the border. Within the U. S. S. R., there are several areas characterized by such differential vertical movements: the foreland of the Pamirs, the Crimean Peninsula, and the Pacific coast of Siberia. Seismic phenomena of a region are closely related to changes along tectonic lines. If the movement is slow, it causes plastic deformation without earthquakes, but if these movements are rapid, they are accompanied by sudden shocks. Results of several experiments on specimens of such subjects as wax, paraffin, and ozocerite are cited for evidence.—*S. T. V.*

160–118. Gubin, I. Ye. O nekotorykh voprosakh seysmicheskogo rayonirovaniya [On certain questions of seismic zoning]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 36–73, 1954.

Gubin again notes that a map of seismicity determined exclusively on the basis of statistical data is incomplete and must be completed by studies of the tectonic phenomena causing earthquakes. Numerous examples from the seismic history of Central Asia are cited in illustrations.—*S. T. V.*

160–119. Dumitrashko, N. V., and Lilienberg, D. A. Primeneniye geomorfologicheskikh metodov v seysmotektonicheskikh issledovaniyakh [The application of geomorphologic methods to seismotectonic investigations]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 74–86, 1954.

As seismic phenomena are related to tectonic movements of the crust, studies of tectonic forms and their recent modifications can form a basis for prediction of future earthquakes. Seismic zones are associated with mountainous regions, especially the foothills, in areas of recent differential movement.

Several examples from various seismic areas of the U. S. S. R. are discussed; moderation must be exercised in using the method as only the place of occurrence can be predicted with any degree of certainty.—*S. T. V.*

160–120. Kharin, D. A., and Masarskiy, S. I. Issledovaniye epitsentral' nykh oblastey pri pomoshchi regional'nykh seysmicheskikh stantsiy [The investigation of epicentral areas with the aid of the observations col-

lected by regional seismic stations]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 97–112, 1954.

In studying the causes of an earthquake it is necessary to have detailed precise data on the phenomena at the focus, including records of even relatively weak preliminary shocks. It is necessary to have a sufficiently dense network of stations, the greatest distances between the stations being no more than 150 or preferably only 100 km. Time measurements must be very accurate, and high-speed recording seismographs must be used. Many examples, from the stations of central Asia and Caucasus, are cited.—*S. T. V.*

160–121. Keylis-Borok, V. I., and Vvedenskaya, A. V. Issledovaniye napryazheniy v ochagakh Khaitskoy epitsentral' noy zony [Investigation of stresses at foci in the Khait epicentral zone]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 113–123, 1954.

The dynamic conditions at the foci of 41 earthquakes in Central Asia were studied using Wolf's stereographic projection. The records of 5 earthquakes were incomplete, but in other 36 the motion indicated was a double force with a moment added. Two principal directions of faulting, related to geologic conditions, were found.—*S. T. V.*

160–122. Bonchkovskiy, V. F. Naklony zemnoy poverkhnosti kak odin iz vozmozhnykh predvestnikov zemletryaseniy [The inclination of the earth's surface as one of the possible forerunners of earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 134–153, 1954.

Study of the variations of the inclinometer readings accompanying seismic activity for a period of several years in different parts of central Asia indicated that in the absence of seismic activity readings of inclinometers remained constant, but disturbances could be observed as soon as the seismic activity began, even on inclinometers great distances apart. Several types of disturbances were regularly observed, but no relation to accompanying seismic activity could be established. A program of continuous observations with inclinometers at several seismic stations is suggested.—*S. T. V.*

160–123. Gamburtsev, G. A. O novykh metodakh i apparature dlya registratsii seysmicheskikh yavleniy [The new methods and apparatus for recording seismic phenomena]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 154–156, 1954.

Experiments have suggested that the rupturing of formations leading to earthquakes is preceded first by destruction of elemental portions connecting the formations. The destruction of elemental portions produces weak shocks of much higher frequency than observed during ordinary seismic shocks that can be observed and recorded if the seismographs are adjusted to a frequency of 10–30 cycles per second. Slow vibrations, which must also be considered, can be studied with seismogravimeters and electric inclinometers, which can measure inclinations and their changes and also register the vertical movements of the ground with periods of many minutes or hours. The new correlation method can also be successfully used for investigation of earthquakes and the deep geology of a region.—*S. T. V.*

160–124. Antsyferov, M. S. O primenenii geoakusticheskikh metodov k resheniyu problemy prognosa zemletryaseniy [The use of geoacoustic

methods in the solution of the problem of predicting earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 157–161, 1954.

An earthquake is the manifestation of the destruction of mechanical ties between two parts of formations that takes place when the stresses become greater than strength of the ties. This is preceded by an often very long series of local elemental destructions of the formation at the points where the stress is higher than in others, and these elemental destructions produce little seismic shocks, of higher frequencies than the main shock. To record the foreshocks, it is necessary to make seismographs sensitive to weak seismic shocks. The newest seismographs used for the study of these weak shocks is capable of registering impulses of 10–12 cycles per second. The geoacoustic phenomena, as Antsyferov calls these partial destructions, are of local character only because they are characterized by high frequency and as such are rapidly damped.—*S. T. V.*

160–125. Kalashnikov, A. G. Vozmozhnosti magnitometricheskikh metodov v reshenii voprosa o predvestnikakh zemletryaseniy [The potentialities of magnetometric methods in the finding of the forerunners of earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 162–180, 1954.

Relationships between seismic phenomena and geomagnetic disturbances including the appearance of intensive disturbances in the records of geomagnetic observatories coinciding with destructive earthquakes at great distance, are reviewed. A simple installation to be used for measurements of such magnetic disturbances in the Garma geophysical observatory is described, and the difficulties in these measurements and their interpretation because of ionospheric activity are emphasized. Kalashnikov appeals to geophysicists to develop seismologic theories in accordance with the basic principles of dialectic materialism.—*S. T. V.*

160–126. Tikhonov, A. N., Ivanov, A. G., Troitskaya, V. A., and D'yakonov, B. P. K voprosu o svyazi zemnykh tokov i zemletryaseniy [On the relation between telluric currents and earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 25 (152), p. 181–191, 1954.

The existence of a causal relationship between seismic phenomena and changes in the pattern of telluric currents is discussed, and several coincidences of the two are cited. Existing observational data indicate that sometimes these phenomena coincide and seem to be related, but that seismic shocks do not always follow telluric-current disturbances. The evidence is not sufficient to draw definite conclusions.—*S. T. V.*

160–127. Hudson, D. E., Alford, J. L., and Housner, G. W. Measured response of a structure to an explosive-generated ground shock: Seismol. Soc. America Bull., v. 44, no. 3, p. 513-527, 1954.

Measurements were made of ground accelerations and the resulting building accelerations at a point very near a large quarry blast. In the case of simple buildings, the building acceleration may be calculated with satisfactory accuracy from a knowledge of the ground acceleration. The response of the test building to the ground acceleration of a typical strong-motion earthquake was computed, and it was found that the resulting accelerations were in excess of those usually provided for in earthquake-resistant design. It is concluded that the satisfactory performance of well-designed structures during strong earth-

quakes may have two explanations. First, that vibration energy is dissipated by stresses in excess of the elastic limit, with the result that hidden damage may occur; and second, that ordinary buildings may have sources of strength which are not taken into account in their design.—*Authors' abstract*

160–128. Merritt, R. G., and Housner, G. W. Effect of foundation compliance on earthquake stresses in multistory buildings: Seismol. Soc. America Bull., v. 44, no. 4, p. 551–569, 1954.

This paper shows the quantitative effect that foundation compliance has on the maximum base shear force and the fundamental period of vibration in typical tall buildings subjected to strong-motion earthquakes. A study was made of five-, ten-, and fifteen-story building models on the Electric Analog Computer, subjecting them to the ground accelerations of actual earthquakes. The base shear forces were measured, the foundation compliance of the models being changed through a very wide range.

The properties specified for the building models are shown to be similar to the properties found in real buildings. The experimental results imply that the maximum base shear forces in typical buildings of five stories and higher during strong-motion earthquakes will be essentially unaffected by any degree of foundation compliance that can be expected in normal building practice. The fundamental period buildings will be increased by about 10 percent if the foundation compliance is the maximum that can be expected in standard building practice.—*Authors' abstract*

160–129. Kobayashi, Hiroyoshi. Damage of buildings in southern Hokkaido by earthquake of March 4, 1952 [In Japanese with English abstract]: Zisin, v. 5, no. 4, p. 32–38, 1952.

A study of the damage to buildings in Tokachi and Hidaka in relation to the type of construction. Many photographs.—*M. C. R.*

SEISMIC SURVEYS

160–130. Kornfeld, Joseph A. Seismic problems in Williston Basin: Oil and Gas Jour., v. 52, no. 50, p. 196–200, 1954.

In the Williston Basin, the thick Tertiary cover and Quaternary glacial drift introduce serious problems in making near-surface corrections of seismic data. Difficult drilling conditions are made worse by the badlands topography, and the mobility of the equipment is lessened.

Record quality is generally good in the Cedar Creek anticline, Nesson anticline, Plains provinces, and eastern limb areas. It may be improved by the use of multiple geophones. Variations in near-surface velocities are the principal problem at Cedar Creek anticline. Near-surface corrections are usually uphole times checked by extended refraction spreads. Shot holes as deep as 500 feet are required in some areas. Severe winters curtail production to about 80 percent of the summer rate; the spring thaw may cut production by as much as 40 percent.—*L. C. P.*

160–131. Johnson, R. B. Use of the refraction seismic method for differentiating Pleistocene deposits in the Arcola and Tuscola quadrangles, Illinois: Illinois Geol. Survey Rept. Inv., no. 176, 60 p., 1954.

The purpose of this study is to illustrate the usefulness of the refraction seismic method in distinguishing stratigraphic units within unconsolidated sedi-

ments of Pleistocene age. The physical properties of glacial drift are such that compaction can produce considerable changes in seismic velocity. The result of the compaction of drift by successive ice sheets in an area should be a velocity stratification which would correspond to stratigraphic units of different ages.

In the area selected for study the refraction seismograph successfully recorded the various drift sheets and has permitted the accurate mapping of the contact between drifts of Wisconsin and Illinoian ages and further subdivision of Wisconsin drift into Shelbyville and Cerro Gordo age sediments deposited during the Tazewell substage. In the Arcola-Tuscola area, glacial drifts of different ages transmit energy at characteristic average velocities. Reliable subsurface control is essential to successful seismic interpretation of Pleistocene results.—*Author's abstract*

160–132. Ewing, Maurice, Worzel, J. L., Ericson, D. B., and Heezen, Bruce C. Geophysical and geological investigations in the Gulf of Mexico, Part 1: Geophysics, v. 20, no. 1, p. 1–18, 1955.

In 1953 the research vessels *Vema* and *Atlantis* spent about three weeks in the Gulf of Mexico. Coring, seismic refraction, and topographic studies were undertaken. The topography in the various physiographic provinces is illustrated by reproductions of precision depth records from the continental shelf, continental slope, continental rise, and abyssal plain areas.

Many sediment cores longer than 30 feet were taken in the Gulf. An abrupt change separates approximately 3 feet of Recent sediments from Wisconsin in all cores taken in depths greater than 1,700 fathoms. This change is very similar to one found in many Atlantic and Caribbean cores indicating an abrupt termination of the Wisconsin glacial epoch. Abundant evidence of turbidity current deposition was found in all cores from the abyssal plain and the continental rise. Deposition of sediments in the unusually rough and broad continental slope area is apparently very rapid in the depressions and very slow on the elevations.

The seismic results point to the southern half of the Gulf of Mexico as a typical oceanic area, modified by an increased load of sediments. A profound change near the continental slope is required for connecting this structure to typical continental structures.—*Authors' abstract*

160–133. Joset, Alain, and Holtzscherer, Jean-Jacques. Détermination des épaisseurs de l'Inlandsis du Groenland [Determination of thicknesses of the Greenland ice cap]: Annales Géophysique, tome 10, no. 4, p. 351–381, 1954.

Thicknesses of the Greenland ice cap were determined from reflection shooting by the Expéditions Polaires Françaises. In the few areas where there was no cover of névé, surface waves were so well developed that mixing did not help in clarifying reflections, and geophone spreads were moved far enough from the shot that reflections were bracketed in time by the direct *P* and *S* waves. In areas with névé (generally about 100 meters thick), reflections were easy to pick. Two reflections were obtained, occasionally a third, and rarely a multiple of the first. The geologic section is a variable thickness of névé and ice, a thickness of 200–300 meters of probable morainal debris welded into a highly elastic mass by ice, and finally the bedrock.

All traverses were south of latitude 74° N. The maximum thickness of ice determined was 3,410 meters near the "dôme central." A west-east profile

across Greenland from approximately latitude 69° N. to 72° N. indicates there are mountain ranges on both the east and west coasts with the intervening area near sea level. Relief of the mountains on the east is 1,000–1,800 meters and of the range on the west 600–700 meters. A north-south profile indicates that the bedrock surface is approximately at sea level from 67° N. to 74° N. latitude. South of about 65° N. latitude, bedrock elevations are approximately 1,000 meters above sea level. The mean ice thickness on this profile is 2,420 meters.

Maps of the network of reflection lines, selected cross sections showing ice thickness and bedrock topography, representative seismic records, and tables giving station locations, ice thickness, and bedrock elevations are presented.—*P. E. B.*

160–134. Muraoka, Hideki; Magumo, Syozaburo; and Kawashima, Takeshi. Seismic prospecting at Nopporo, Ebetsu-machi, Sapporo-gun, Hokkaido [In Japanese with English résumé]: Geol. Survey Japan Bull., v. 4, no. 11, p. 15–20, 1953.

Seismic surveys have in general confirmed the anticlinal structure at Nopporo inferred from gravity surveys. Three layers are recognized at depths of 800, 1,200, and 1,700 meters at the crest of the anticline. The western slopes are more gentle than the eastern.—*M. C. R.*

MICROSEISMS

160–135. Saxer, L. Über die Entstehung und Ausbreitung quasiperiodischer Luftdruckschwankungen [On the generation and propagation of quasi-periodic barometric variations]: Archiv Meteorologie, Geophysik u. Bioklimatologie, Ser. A, Band 6, Heft 3–4, p. 461–463, 1954.

Records of small oscillations of the atmospheric pressure having a period of several seconds and an amplitude of about 10^{-4} to 10^{-3} mm Hg were examined, and a relation to the height of the ocean waves in the Atlantic and to microseisms has been found. The diurnal and annual variation of the pressure-amplitudes can be explained by the wind-currents and temperature changes in the layer of air 50 km up, where the oscillations generated by the ocean waves are reflected.—*Author's abstract*

160–136. Bernard, Pierre. Sur un nouveau procédé d'enregistrement de l'agitation microséismique [On a new method of recording microseisms]: Acad. Sci. Paris Comptes Rendus, tome 238, no. 14, p. 1528–1530, 1954.

An arrangement is described of a device, developed by F. Carbenay, in conjunction with a vertical seismograph, whereby in the microseism range the maximum current can be considered proportional to the amplitude of the displacement. A sample record for a 24-hour period is shown.—*M. C. R.*

160–137. Mosetti, F[erruccio]. A proposito di una questione sulle onde microbariche caratteristiche dei fronti [On one question of the microbaric waves characteristic of fronts]: Annali Geofisica, v. 7, no. 3, p. 463–468, 1954.

Minute barometric oscillations associated with the passage of a front were studied with a special microbarograph system. There is an evident correlation between these long-observed long-period microbaric waves and the appearance

of microseisms. The frequency of the observed atmospheric waves was very low, so that the period of the waves can be measured in minutes.—*S. T. V.*

160–138. Blaik, Maurice, and Donn, William L. Microseism ground motion at Palisades and Weston: Seismol. Soc. America Bull., v. 44, no. 4, p. 597–612, 1954.

An analysis of microseism ground motion at Palisades and Weston is made on the basis of both statistical and individual wave studies. Data from three-component seismographs are utilized for the study of six microseism storms. The results of both methods of ground-motion analysis show that the microseisms studied for Palisades and Weston are either pure Rayleigh waves or combinations of Rayleigh waves approaching from different directions. The study also tends to support earlier findings of Lee that a relationship seems to exist between certain microseism parameters and local geology. The use of the data to determine wave-approach directions on the assumption of Rayleigh waves supports earlier reports of refraction at the continental borders, and gives further evidence for the existence of a microseism discontinuity at the margin of the continent in the vicinity of Long Island.—*Authors' abstract*

ISOTOPE STUDIES AND AGE DETERMINATIONS

160–139. Cameron, A. E., and Lippert, E. L., Jr. Isotopic composition of bromine in nature: Science, v. 121, no. 3135, p. 136–137, 1955.

The average of many determinations on samples of Michigan brines, Searles Lake bromine, Pacific Ocean bromine, West Virginia brines, and Gulf water is $Br^{81}/B^{81}=1.0217\pm0.0002$, in excellent agreement with the ratio determined by Williams and Yuster.—*M. C. R.*

160–140. Craig, Harmon. Geochemical implications of the isotopic composition of carbon in ancient rocks: Geochim. et Cosmochim. Acta, v. 6, no. 4, p. 186–196, 1954.

The identification of the origin of carbon in carbonaceous deposits as derived from organic material or from limestone by the isotopic composition, as proposed by Rankama and Wickman, is based on the assumptions that graphite can be formed from limestone, that in the process of making graphite from these two sources isotopic fractionation or exchange processes cannot cause carbon from either source to cross over the isotopic dividing line which delimits the biogenic range, and that the isotopic composition represented by this dividing line has remained constant. Thermodynamic data on the dissociation of carbon dioxide show that graphite has rarely, if ever, been produced from limestone. The assumption that isotopic fractionation or exchange cannot produce a significant change in isotopic composition during graphitization is not justified. There is no independent evidence that the exchange reservoir composition and the isotopic dividing line have been constant during geologic time. The isotopic identification of ancient carbon samples does not seem to be valid.—*M. C. R.*

160–141. Dole, Malcolm, Lane, G. A., Rudd, D. P., and Zaukelies, D. A. Isotopic composition of atmospheric oxygen and nitrogen: Geochim. et Cosmochim. Acta, v. 6, no. 2/3, p. 65–78, 1954.

High altitude air samples collected in glass bulbs during balloon flights up to heights of 87,000 feet were found to contain oxygen with a normal isotope ratio, deviations less than ±0.05 percent. Air samples collected in Aerobee rockets up

to altitudes of 51.6 km contained nitrogen having a normal isotope ratio, deviations less than ±0.15 percent. The oxygen of the rocket samples contained a higher percentage of O^{18} than normal, but when an estimated correction was applied for the preferential loss of O^{16} by clean-up of oxygen by the steel collecting tanks, the O^{18} percentage of the oxygen in air at 51.6 km was normal to ±0.3 percent.

Air collected at ground level in a number of locations all over the world contained oxygen having a normal isotope ratio to ±0.025 percent. Air pumped out of the ocean water at different depths in the Pacific Ocean contained oxygen having a higher O^{18} percentage than normal; the less the percentage of oxygen in the sample, the greater was the O^{18} percentage. The oxygen-isotope fractionation factor for the process consuming dissolved oxygen was 0.991. The nitrogen-isotope ratio in dissolved ocean air was normal.

The oxygen-isotope fractionation factor for the clean-up or chemisorption of oxygen by steel was 1.026, while the factor was 1.061 for the clean-up of oxygen by copper.—*Authors' abstract.*

160–142. Allenby, R. J. Determination of the isotopic ratios of silicon in rocks: Geochem. et Cosmochim Acta, v. 5, no. 1, p. 40–48, 1954.

Mass spectrometer measurements of silicon from silicate rocks indicate a maximum variation in the Si^{28}/Si^{30} ratio of 1.3 percent. The light isotope, Si^{28}, shows a preference for the basic rocks, while the heavy isotope tends to concentrate in acidic and sedimentary silicates. Precious opal and sinter contain an unusually high percentage of the Si^{28} isotope. These variations are believed to be the results of isotopic exchange reactions which have occurred during the geochemical and geological history of the earth.—*Author's abstract*

160–143. White, F. A., Collins, T. L., Jr., and Rourke, F. M. New naturally occurring isotope of tantalum: Phys. Rev., v. 97, no. 2, p. 566–567, 1955.

Examination of the mass spectrum in the region of Ta^{181} indicates that Ta^{180} exists as a naturally occurring isotope of low abundance. New isotopic values are: Ta^{180}, abundance 0.0123 ±0.0003 percent; Ta^{181}, 99.998 percent; $Ta^{177, 178, 179}$, <0.0003 percent; and $Ta^{182, 183}$, <0.0002 percent.—*M. C. R.*

160–144. Patterson, C[laire C.], Tilton, G., and Inghram, M[ark G.]. Age of the earth: Science, v. 121, no. 3134, p. 69–75, 1955.

Determinations based on lead ores indicate an age of 3.5×10^9 years for the crust. Estimates by the meteorite method (calculating Pb^{207}/Pb^{206} age from observed differences between the isotopic composition of recent lead from the surface of the earth and lead isolated from iron meteorites) are 4.5×10^9 years for the age of the earth. However, there is no compelling evidence that when the earth was formed it contained lead with the same isotopic composition as that in iron meteorites. Further, suitable samples for comparison with meteoritic lead should be derived from a closed chemical system of uranium and lead that has existed since the earth was formed, and should be representative of all the lead in the system. There is insufficient knowledge of the lead samples used to be sure they fulfill these requirements.—*M. C. R.*

160–145. Wasserstein, B. Ages of uraninites by a new method: Nature, v. 174, no. 4439, p. 1004–1005, 1954.

Wasserstein has previously suggested that the generation of tetravalent lead within the crystal lattice of uraninites causes a shrinkage in the unit cell pro-

portional to time. Further study has led to classification of uraninites as α type if they agree with this thesis, and γ or β type, according as oxidation or reduction is required to yield cube edges corresponding to an α-type analogue. X-ray examinations indicate that each type forms its own age series showing shrinkage with time. Thorianites belong to the γ-type, and the existence of a yet-unknown oxide is suggested.—*R. G. H.*

160–146. Begemann, F., Buttlar, H. V., Houtermans, F. G., Isaac, N., and Picciotto, E. [E.]. Application de la methode du DaDà a la mesure de l'age "chimique" d'un mineral d'uranium [Application of the RaD method to the determination of the chemical age of an uranium mineral]: Geochim. et. Cosmochim. Acta, v. 4, no. 1/2, p. 21–35, 1953.

The RaD method suggested by Houtermans for the determination of the chemical age of uranium minerals consists of the measurement of Pb/U from the ratio Ra/Pb. This ratio can be determined on any quantity of lead from the mineral, even extremely small quantities, and quantitative analyses of uranium and lead are not necessary. Pb/U ratios determined for two samples of Shinkolobwe pitchblende by chemical analysis and by the RaD method were in agreement within the limit of experimental errors.—*M. C. R.*

160–147. Wilson, J. T[uzo], Farquhar, R. M., Gretener, P., Russell, R. D., and Shillibeer, H. A. Estimates of age for some African minerals: Nature, v. 174, no. 4439, p. 1006–1007, 1954.

New and earlier age determinations have led to new interpretations of the structure of the Canadian Shield. To test the conclusions for other continents, 45 minerals from Africa and a few from other continents were analyzed. The ages agree well with those given by other investigators for uranium, thorium, and lead minerals from Africa. The following conclusions are suggested: the ages for uranium minerals are most reliable when concordant ages are obtained by both chemical and isotopic analyses; the ages of old lead ores obtained by isotopic analyses agree with those determined for contemporaneous uranium and thorium minerals; vein minerals, including galena, give only minimum ages; minerals more than 2×10^9 years old come from areas underlain by rocks of Keewatin and Timiskaming types and by granites cutting them; Archean-type rocks younger than 2×10^9 years from belts each of which is marked by pegmatites formed during a limited range in time, are gneissic, and do not contain a high proportion of lavas; and the sialic blocks of the continents have been built entirely in geologic time.—*R. G. H.*

160–148. Campana, Bruno. Absolute age of the uraniferous granite and pre-Cambrian tillite in the Crockers Well area (Olary District, South Australia): Australian Jour. Sci., v. 16, no. 6, p. 240–241, 1954.

Age determinations based on the lead-uranium ratio indicate that the uranium-bearing granite of the Plumbago-Crockers Well area is 580±30 million years old, and therefore pre-Cambrian. From the field relationships, it is deduced that the Adelaide system of ancient glacial sediments must be of late Proterozoic age, approximately 500 to 600 million years old.—*D. B. V.*

160–149. Louw, J. D. Geological ages of Witwatersrand uraninites: Nature, v. 175, no. 4451, p. 349–350, 1955.

Geological age determinations were made to decide between the placer hypothesis and the hydrothermal theory for the origin of uranium in the conglomer-

ates of the Witwatersrand system. The results, though not strictly accurate, seem to justify the conclusion that the uraninites have a true age considerably greater than the sedimentary system, and that the mineral was introduced into the Witwatersrand sedimentary beds as a detritus.—*R. G. H.*

160–150. Parwel, A., and Wickman, F. E. Några preliminära resultat av åldersbestämningar på svenska pegmatitmineral [Some preliminary results of age determinations on Swedish pegmatite minerals]: Geol. Fören. Stockholm Förh., Band 76, Häfte 3, p. 353–354, 1954.

This brief note lists the ages of eight pegmatite minerals from seven places in southern and central Sweden, as determined from lead-isotope analyses. The ages range from 675 million years (euxenite from Gräne) to 1,810 million years (hjelmite from Nya Kårarvet). A more detailed paper is forthcoming.—*D. B. V.*

160–151. Wasserburg, G. J., and Hayden, R. J. Age of meteorites by the A^{40}—K^{40} method: Phys. Rev., v. 97, no. 1, p. 86–87, 1955.

The ages of two stony meteorites were determined by measuring the A^{40}/K^{40} ratio using an isotopic dilution technique. With a branching ratio $\lambda_e/\lambda\beta=0.085$ and a decay constant $\lambda=0.55\times10^{-9}$ yr^{-1}, the ages obtained were $(4.82\pm0.20)\times10^9$ and $(4.58\pm0.20)\times10^9$ years.—*Authors' abstract*

160–152. Shillibeer, H. A., and Russell, R. D. The potassium-argon method of geological age determination: Canadian Jour. Physics, v. 32, no. 11, p. 681–693, 1954.

The method described involves determination of potassium by the flame photometer, extraction and purification of radiogenic argon, measurement by the McLeod gage, and determination of its isotopic composition by the mass spectrometer. For calculating ages, the decay equation is used in the form

$$t=\frac{1}{(1+R)\lambda_\beta}\log_e\left(1+\frac{(1+R)A^{40}}{RK^{40}}\right)$$

where t is age; A^{40} and K^{40} are the masses of argon-40 and potassium-40 present per gram of mineral; λ, the decay constant for β-emission, is $0.503\pm.046\times10^{-9}$ per year; and R is the branching ratio, taken as 0.089. Six age determinations are given for samples from Canada, Finland, and Rhodesia. Ages of four compared with ages of minerals from nearby places determined by lead methods are in excellent agreement.—*M. C. R.*

160–153. Shillibeer, H. A., and Watson, K. Some potassium-argon ages for Ontario: Science, v. 121, no. 3132, p. 33–34, 1955.

Ages have been determined by the method described in the preceding abstract for several samples of mica and perthite from Ontario. Tests on associated minerals from the same pegmatites, to determine whether consistent results would be obtained for minerals of different lattice structure, gave results that agree within the limits of experimental error. Lead-lead and lead-uranium ages for associated uraninites are also in good agreement. The age limits of 800 to 1,100 million years for the Grenville orogeny seem reasonable.—*M. C. R.*

160–154. Gentner, W., Präg, R., and Smits, F. Argonbestimmungen an Kalium-Mineralien. II. Das Alter eines Kalilagers im Unteren Oligozan [Determination of argon in potassium minerals. II The age of a potash deposit in the lower Oligocene]: Geochim. et Cosmoshim. Acta, v. 4, no. 1/2, p. 11–20, 1953.

New measurements of the argon content in potassium salts indicate a relationship between the argon content and the size of crystals. A diffusion constant of $(1.5\pm1)\times10^{-19}$ cm^2 per second for argon in potassium chloride is found. These measurements indicate an age of 21±3 million years for a lower Oligocene sample.—*M. C. R.*

160–155. Focken, C. M. The radiocarbon dating method: Australian Jour. Sci., v. 17, no. 1, p. 10–11, 1954.

This is a brief report on a study tour of laboratories using radiocarbon-dating techniques, in the United States and Europe, undertaken in preparation for the establishment of a radiocarbon-dating laboratory in Melbourne. Early work toward this end will be done at the Chemistry Department of Melbourne University; after a reliable technique has been developed and tested, it is expected that the apparatus will be installed at the Applied Science Museum of Victoria.

Focken observes that the acetylene method, being perfected both by the U. S. Geological Survey and the Royal Institution in England, is inherently more efficient than the solid-carbon method. The scintillation method, it is agreed, seems to show greatest promise. Its range has already been extended back to 44,000 years, and with a sufficiently large sample, could feasibly be elaborated to extend back to 100,000 years.—*D. B. V.*

160–156. Ballario, C., Beneventano, M., Marco, A. de, Magistrelli, F., Cortesi, C., and Mantovani, T. Apparatus for carbon–14 dating: Science, v. 121, no. 3143, p. 409–412, 1955.

The method used at the carbon–14 laboratory established at the University of Rome is fundamentally the same as that developed by Libby, but with modifications in the techniques of preparing radiochemically pure carbon and in the development of a four-element counter to permit simultaneous measurement of four samples of different specific activity. Control measurements have been made on two samples, one from a piece of wood from the Roman ships at Lake Nemi attributed to the Emperor Caligula, and the second from charcoal found in an Etruscan tomb.—*M. C. R.*

160–157. Brannon, H. R., Taggart, M. S., Jr., and Williams, M. Proportional counting of carbon dioxide for radioactive dating: Rev. Sci. Instruments, v. 26, no. 3, p. 269–273, 1955.

Determinations of naturally occurring radiocarbon have been made with proportional counters filled with carbon dioxide at pressures up to 10 atmospheres. After chemical and radiochemical purification, the sample is converted into carbon dioxide for the counter filling. Extreme purity is required of the counter-filling gas to prevent electron attachment by impurities. Procedures are described for producing carbon dioxide of sufficient purity to provide consistent and reproducible results. A counting efficiency of 100 percent is obtained for carbon–14 betas contained in the active volume of the counter, giving a sample counting rate for the counters used of 45 cpm for contemporary material at filling gas pressure of 10 atmospheres. With the present background of 13.5 cpm and a counting time limit of two days, dating may be extended to a maximum age limit of 42,000 years.—*Authors' abstract*

160–158. de Vries, Hl. and Barendsen, G. W. Measurements of age by the carbon–14 technique: Nature, v. 174, no. 4442, p. 1138–1141, 1954.

Carbon–14 age determinations were made with a proportional counter filled with carbon dioxide prepared from the sample. Samples consisting of shells

from different parts of the Gulf of Paria (South America) gave reasonable calculated rates of sedimentation at various depths. Measurements on peat and shell samples in Holland gave some indication of the lowering of the Dutch coast relative to sea level. Bones of domestic animals found beneath lava in southwest Syria had an age of 4,075±160 years. Ages found for numerous archeological samples were in agreement with expected ages.—*R. G. H.*

160–159. Ralph, Elizabeth K. University of Pennsylvania radiocarbon dates 1: Science, v. 121, no. 3136, p. 149–151, 1955.

Samples dated consisted of charcoals from many levels in Belt and Hotu caves in Iran.—*M. C. R.*

160–160. Zumberge, J. H., and Potzger, J. E. Pollen profiles, radiocarbon dating, and geologic chronology of the Lake Michigan basin: Science, v. 121, no. 3139, p. 309–311, 1955.

Age determinations from the University of Michigan Radiocarbon Laboratory on a peat layer uncovered by high water of Lake Michigan in 1952 provide a basis for absolute chronology of the Lake Michigan basin. The time lapse between the Algonquin and Nipissing stages was 4,000 years with Lake Algonquin ending about 8,000 years ago. Lake Chippewa intervened between these stages about 5,000 years ago, coincident with the oak and pine period in southern Michigan. The xerothermic period reached a maximum some time after 4,000 years ago and is coincident in time with the Nipissing stage.—*M. C. R.*

RADIOACTIVITY

INSTRUMENTS AND METHODS OF OBSERVATION

160–161. Bate, G[eorge] L., Volchok, H. L., and Kulp, J. L. A low-level radon counting system: Rev. Sci. Instruments, v. 25, no. 2, p. 153–157, 1954.

A stable, convenient system for low-level counting of radon is described. The system permits a precision of 8±1 percent with an efficiency of about 80 percent. The lower limit of measurement is the amount of radon in equilibrium with about 10^{-14} gram of radium. A vibrating reed electrometer is used to amplify slow pulses obtained from an ionization chamber operated at 300 volts. The cumulative pulse count is recorded by a mechanical register following amplification of the output of the electrometer. Special care in construction and selection of the ion chamber materials permits an alpha background as low as 15 cph for a 4-liter volume. Chemical pretreatment of the gases is unnecessary for most samples.—*Authors' abstract*

160–162. Rosenthal, Donald J., and Auger, Hal O. Liquid scintillation counting of tritium and C^{14} labeled compounds: Rev. Sci. Instruments, v. 25, no. 7, p. 670–674, 1954.

A liquid scintillation counter suitable for H^3 and C^{14} activities is described. A photomultiplier tube with a high sensitivity and signal-to-noise ratio is used, and is cooled to −10° C to further reduce the tube noise background. The phototube is mounted in a chassis containing its preamplifier, and the pulses are then led to a high-stability amplifier scaler. The radioactive materials are dissolved in aliquots of a xylene solution containing p-terphenyl (1.9 g/liter) and the diphenylhexatriene (0.020 g/liter). Substances which quench the scintillations or color the scintillator solution cannot be counted by this method. A minimum

of 4.3×10^{-10} curie of H^3, or 1.8×10^{-11} curie of C^{14} may be measured by the counter.—*Authors' abstract*

160–163. Cowper, G. Aerial prospecting with scintillation counters: Nucleonics, v. 12, no. 3, p. 29–32, 1954.

Aerial prospecting for radioactive minerals is practicable when a sufficient fraction of the mineral deposit is exposed at the surface, the gamma-radiation detector is sufficiently sensitive to record unambiguously a significant change in the ground radioactivity from an altitude governed by aircraft safety, and the total weight of the detecting equipment is small enough to permit use of a small aircraft, making the method economically sound. To meet the second and third conditions a practical airborne detector using scintillation counters was developed at Chalk River (Atomic Energy of Canada Ltd.) in 1950. Two counters are used, with the crystal units in each containing two thallium-activated sodium iodide crystals 2 inches in diameter and 2 inches long placed end to end. A lucite cap on the cylinder containing the crystals fits over the end of the photomultiplier tube. A conventional counting-rate meter with a modified integrating circuit and an additional circuit to cancel the contribution from large cosmic-ray pulses is used and its output recorded continuously on a recording milliammeter. The sensitivity was demonstrated by the detection of an 88-millicurie radium source in the center of a frozen lake at altitudes of several hundred feet. The most difficult problem is one of interpretation, distinguishing between localized outcrops of high-grade ore and large areas of slightly abnormal radioactivity.—*M. C. R.*

160–164. Flagg, A. H., Myers, J. P., Campbell, J. L. P., Terry, J. M., and Mardock, E. S. Radioactive tracers in oil production problems: Jour. Petroleum Technology, v. 7, no. 1, p. 1–6, 1955.

The use of radioactive tracers to solve petroleum-engineering problems is discussed. Injection rates for water are best determined using a radioactive tracer consisting of particles large enough to be filtered out as the water floods permeable sands. Tracers of ionic size tend to be adsorbed by shales or travel too far into the permeable zones to be detected. For gas injection profiles, an oil-soluble gas carrying radioactive iodine is used. This gas is partially adsorbed by oil in the permeable formations near the borehole wall, thus having the same advantages as suspended particles in the waterborne tracers. Such tracers have been used not only to determine injectivity profiles, but also to establish the location of many well-treatment processes, such as hydrafrac, acidizing, plugging, and cementing.—*G. V. K.*

160–165. Lundberg, Hans. Many factors involved in finding oil by airborne scintillometers: Oil Forum, v. 9, no. 1, p. 23–24, 28, 1955.

This theoretical study of the alpha star populations in loaded emulsions was blocking of upward-moving water by the cap rock over the oil accumulation. The high sometimes found as a halo around the low may result from the escape of water around the edges of the cap and the transportation of radium salts toward the surface in its upward movement. Use of scintillometer surveys for oil exploration requires geological knowledge, experience, good mapping and flying techniques, and a method of correctly interpreting recorded patterns without being lead astray by the many unrelated sources.—*M. C. R.*

160–166. Senftle, F. E., Farley, T. A., and Stieff, L. R. A theoretical study of alpha star populations in loaded nuclear emulsions: Geochim. et Cosmochin. Acta, v. 6, no. 4, p. 197–207, 1954.

This theoretical study of the alpha star populations in loaded emulsions was undertaken in an effort to find a quantitative method for the analysis of less than microgram amounts of thorium in the presence of larger amounts of uranium. Analytical expressions for each type of star from each of the significantly contributing members of the uranium and thorium series as well as summation formulas for the whole series have been computed. The analysis for thorium may be made by determining the abundance of five-branched stars in a loaded nuclear emulsion and comparing of observed and predicted star populations. The comparison may also be used to check the half lives of several members of the uranium and thorium series.—*Authors' abstract.*

160–167. Lauterbach, Robert. Zur Frage tektonischer Untersuchungen mit Hilfe emanometrischer Messungen [On the question of structural investigations by means of emanometric measurements]: Karl Marx Univ. Leipzig wiss. Zeitschr. math.-naturwiss. Reihe, Jahrg. 3, Heft 3, p. 291–292, 1953–54.

Microradiological soil-gas surveys, analogous to Lauterbach's micromagnetic technique (see Geophys. Abs. 160–45) can be used to obtain structural information such as the trend of a vein or fault. As the radioactive anomalies are often of the order of only a few meters in size, a network of stations 2 or 3 meters apart, in selected test areas, is desirable. Graphs obtained by plotting these anomalies statistically show good agreement with those based on magnetic and geoelectric measurements.—*D. B. V.*

RADIOACTIVITY OF ROCKS, WATERS, AND AIR

160–168. Hée, A[rlette], Derville, R. P., and Jarovoy, M[ichel]. Determination of the radioactivity of the Quincy granite by the photographic method: Am. Jour. Sci., v. 252, no. 12, p. 736–744, 1954.

Approximate uranium and thorium contents of powdered Quincy (Mass.) granite have been determined with nuclear photographic emulsions. Compared with previous results, obtained by different methods, the new values have a wide range, because the radioactive elements are concentrated in distinct centers scattered haphazardly through the rock. The radioactive centers have been localized in thin sections by the emulsion techniques; they are found chiefly in sphene and ilmenite associated with riebeckite. The nuclear emulsion technique, which delineates the distribution of radioactive atoms in various accessory minerals, may be useful in the study of the problem of geologic age of rocks.—*Authors' abstract*

160–169. Hayase, Ichikazu. The radioactivity of rocks and minerals studied with nuclear emulsion 1. The minute radioactive minerals of the Tanakamiyama and Mikumo granites, Siga prefecture, Japan: Kyōto Univ. Coll. Sci. Mem., Ser. B, v. 20, no. 4, p. 247–260, 1953.

Radioactivity was found to be greater in the contact facies than in the interior of both granites, and greater in the Tanakamiyama granite, which is a stock type, than the Mikumo granite, which is a batholithic granite. The radioactive elements seem to be concentrated in minute minerals, especially the zircons. The indicated radioactivities (in 10^{-12} g per g Ra) are: Tanakami-

yama granite, 2–3 in the contact facies, 1.5–2 in the central part, and 1–1.5 in leucocratic facies; Mikumo, 1.2 in the contact facies, less than 0.7 in main part, and perhaps more than 1.5 in the schistosed hornfels granite.—*M. C. R.*

160–170. Westerveld, J. Radioactivity and chemistry of some Indonesian eruptive rocks: K. Nederland. Akad. Wetensch. Afd. Natuurkunde Verh., eerste reeks, deel 20, no. 4, 52 p., 1954.

The total radioactive radiation and beta-emission intensities were measured for both individual samples and average powder mixtures of 137 samples of Indonesian eruptive rocks, representing 10 groups. In addition, chemical bulk analyses and total radiation of average samples and the radium contents of average powder mixtures were determined. Appreciable variations of the mutual proportions between total radiation (measured with a double ionization chamber) and beta-emission intensities (measured by a Geiger-Müller counter) indicate the existence of relatively strong alpha radiators as well as beta radiators. The fluctuations are probably due to variations in the proportions of thorium- and uranium-bearing accessories.

The so-called tin granites show the greatest total radiations, beta emissions, and Ra content (about 3×10^{-12} g Ra per g), followed next in order by the granites of the Soela and Banggai Islands (about 2.7×10^{-12} g Ra per g). The southwest Borneo intrusive rocks show relatively high total radiations and beta emissions but a moderate Ra content (about 1.3×10^{-12} g Ra per g) owing possibly to high Th:U proportions. Rather low radiations characterize the granodiorites of central and western Borneo (about 1.2×10^{-12} g Ra per g), the lavas of the Quaternary andesite volcanoes (about 1.3×10^{-12} g Ra per g), and the Miocene granodiorites and diorites of the Soenda orogen; the Mesozoic granites of Sumatra comprise a few stronger radiators, and the peridotites of the Moluccan orogen exclusively very low ones.

Total radioactive radiations and Ra contents of average powder mixtures representing separate rock clans increase roughly with SiO_2 and K_2O weight percentages.—*M. C. R.*

160–171. Judson, Sheldon, and Osmond, J. K. Radioactivity in ground and surface water: Am. Jour. Sci., v. 253, no. 2, p. 104–116, 1955.

Values for the uranium content and total radioactivity of some underground and surface waters are presented for samples from 77 localities, largely in the United States. The uranium content for these samples ranges between 0.02 ppb and 46 ppb. The uranium content and total radioactivity of water from carnotite-bearing beds in the Grand Junction, Colorado area are spectacularly high when contrasted with values for water from nonmineralized beds.

Uranium content and total radioactivity was determined from residues obtained by evaporation of water samples. The total radioactivity of these residues is shown to change through time.—*Author's abstract*

160–172. Espino Flores, A. L. Aguas radioactivas de la Republica Mexicana y determinacion de los elementos a que se debe su radioactividad [Radioactive waters of the Mexican Republic and determination of the elements to which they owe their radioactivity]: Congreso Cientifico Mexicano Mem. Univ. Mexico, v. 2, p. 46–81, 1953.

Data are given for 17 springs. Radioactivity in 10^{-12} curie per liter ranges from 11.0 to 1874.6. Helium (trace or 0.002 or 0.00042 percent by volume) is reported for 7 springs.—*M. C. R.*

160–173. Hatuda, Zin'itiro. Radon content and its change in soil air near the ground surface: Kyōto Univ. Coll. Sci. Mem., Ser. B, v. 20, no. 4, p. 285–307, 1953.

The concentration of radon in soil air was determined daily for two periods, from October 1944 to October 1945, and from August 1946 to September 1947. In the first series, soil air from depths of 0.6, 1, and 2 meters was sucked into tubes and the radon content was determined by the Schmidt type fontactoscope; in the second, soil air from a depth of 1 meter was drawn directly into an ionization chamber through a drying tube which had been evacuated in advance. The averages of the radon contents in the first series were 5.41, 11.7, and 19.2 Eman (1 Eman=10^{-10} curie per liter) for soil air at 0.6, 1, and 2 meters respectively. Changes in content are gradual, especially when meteorological changes are not conspicuous. Concentration of radon in soil air at depths varies with the rising or lowering of atmospheric pressure, as the level of the "equi-concentration surface" is raised as an atmospheric low approaches, and the reverse with the approach of a high. Precipitation usually has the effect of increasing the radon concentration, especially at the shallowest depth, but whether increase or decrease, the change is hyperbolic with depth. A seasonal variation was observed, in general, with an increase during the rainy season and a decrease during the dry season. The effect of temperature was practically negligible. Felt earthquakes were followed by an increase in the concentration of radon and in one instance were preceded.—*M. C. R.*

160–174. Tomkins, R. V. Potash in Saskatchewan: Canadian Min. Metall. Bull., v. 48, no. 514, p. 70–73, 1955.

This is a description of potash deposits in Saskatchewan. A qualitative correlation of potash beds can be obtained from gamma-ray logs, and some estimate of the grade of potash can be made.—*L. C. P.*

HEAT

160–175. Carte, A. E. Heat flow in the Transvaal and Orange Free State: Phys. Soc. London Proc., Section B, v. 67, pt. 9, p. 664–672, 1954.

The thermal conductivity of 46 rock samples and the temperature at a number of points along the lengths of three boreholes were measured. The heat flow from the earth is derived from these and other measurements of temperature and conductivity. Values of the heat flow lie in the region $(1.1\pm0.3)\times10^{-6}$ cal cm^{-2} sec^{-1}.—*Author's abstract*

160–176. Blum, Eugen. Zur Interpretation von Bohrloch-Temperatur-diagrammen [On the interpretation of drill-hole temperature records]: Erdöl u. Kohle, Jahrg 7, Heft 5, p. 272–275, 1954.

The temperature of the walls of a drill hole delivering a fluid, such as water, oil, or gas, or into which such a fluid is injected, is determined by the previous history of this operation. The temperature at any depth is different from the corresponding temperature of the surrounding ground not yet pierced by the drill. As soon as the pumping is discontinued, thermal equilibrium begins to be reinstated. Two temperature graphs representing extreme cases are shown. Reestablishment of equilibrium is a slow process which permits conclusions to be drawn on the thermal state of the drill hole before the pumping was stopped.—*S. T. V.*

VOLCANOLOGY

160–177. Ewing, Maurice, and Press, Frank. Tide-gage disturbances from the great eruption of Krakatoa: Am. Geophys. Union Trans., v. 36, no. 1, p. 53–60, 1955.

The aerial disturbance from Krakatoa was recorded at many stations on at least three passages around the Earth. A wave on the ocean was recorded at tide stations in almost all parts of the world. Only at nearby stations did the arrival times uniformly agree with that expected for gravity waves in the ocean; many distant arrivals were attributed to coincidental local earthquakes. It is shown that the tide-gage disturbances at distant stations correlate in time with the first aerial wave arriving at the station in the direction from ocean to continent, a result which would be expected from coupling between the barometric disturbance and the ocean surface wave. These observations have led to theoretical and experimental investigations of several types of air-coupled surface waves.—*Authors' abstract*

160–178. Volcano Letter. Activity of Ngauruhoe Volcano, New Zealand: Volcano Letter, no. 525, p. 4, 1954.

Ngauruhoe Volcano on North Island, New Zealand erupted violently on June 4, 1954. The explosive phase lasted for several days, and the volcano was still active in September. There were several flows on the flanks in June, July, and August.—*V. S. N.*

160–179. Richards, A[drian] F. Volcanic eruptions of 1953 and 1948 on Isabela Island, Galapagos Islands, Ecuador: Volcano Letter, no. 525, p. 1–3, 1954.

An eruption along a lateral fissure on the northern flank of Sierra Negra (Volcan Grande) on southern Isabela (Albemarle) Island was reported on August 27, 1953, by captains of several tuna clippers. The violent phase of the eruption ceased between October 7, 1953, and the end of January 1954.

An eruption, from a new peripheral vent near the east summit of Volcan Wolf on northern Isabela Island, occurred on January 24, 1948, according to Joseph Madruga, master of the *Paramount* at that time. The violent phase lasted four or five days although the date of the end of eruption is not known.—*V. S. N.*

160–180. Murauchi, Sadanori. Explosive activities of Myojin Reef, 1952 [In Japanese with English abstract]: Zisin, v. 5, no. 4, p. 39–45, 1952.

An account of the formation and initial observations of the new volcano in September 1952.—*M. C. R.*

TECTONOPHYSICS

160–181. Gzovskiy, M. V. Modelirovaniye tektonicheskikh poley napryazeniy i razryvov [Modeling of the tectonic fields of stresses and ruptures]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 527–545, 1954.

The conditions of similarity between different model stress patterns are discussed, including the more complicated cases where inertia forces, as in seismic wave phenomena, are to be taken into consideration. Experimental techniques and analytical conclusions that have been used in photoelastic investigations

are applied to the problem discussed. This is a continuation of Gzovskiy's earlier paper (Geophys. Abs. 159–207).—*S. T. V.*

160–182. Lynch, S. A. Resume of thought concerning origin of Gulf of Mexico: Texas Jour. Sci., v. 6, no. 2, p. 134–141, 1954.

A review of ideas on the origin of the Gulf from Suess (1885) to the present.—*M. C. R.*

160–183. Raphael, Jerome M. Crustal disturbances in the Lake Mead area: U. S. Bur. Reclamation Eng. Mon. No. 21, 14 p., 1954.

The designers of Hoover Dam, recognizing that 41½ thousand million tons of water to be impounded in Lake Mead might be sufficient to cause local deformation of the earth's crust, made theoretical studies to compute the amount and extent of this deformation. Following completion of construction, three series of precise levels were run over a period of 15 years to measure the actual movement of the crust.

The weight of Lake Mead has caused settlement of the general area, which by 1950 had reached a maximum of 7 inches. This settlement is still continuing, but at a decreasing rate; the total may eventually reach 10 inches. The settlement is apparently of the same order of magnitude as that predicated by assuming the earth's crust to be strained elastically, and only about one-third of that computed by assuming that an 18-mile thick crust floats on a liquid base and bends under load. Anomalous settlements have been ascribed to depletion of ground water. No direct connection could be found between earthquake incidence and lake loading. This, together with a regional warping leads to the conclusion that the Lake Mead settlement, and the anomalous troughs, are superposed on regional deformations which are the surface manifestations of a long-time geotectonic disturbance.—*Author's introduction*

160–184. Vening Meinesz, F. A. Earth-crust movements in the Netherlands resulting from Fennoscandian postglacial isostatic readjustments and Alpine foreland rising: K. Nederland. Akad. Wetensch. Proc., Ser. B, v. 57, no. 1, p. 142–155, 1954.

Crustal movements in the Netherlands are affected by the postglacial rising of Fennoscandia which may be expected to bring about a sinking in the surrounding area and the rising of the Alpine foreland which has caused a recent upward movement in the Rhineland, the Ardennes, and Limburg. From Niskanen's theoretical treatment of the postglacial uplift, it can be shown that the depression from the ice flattens out, getting shallower and broader, until after infinite time the surface will be flat. The breadth of the present area of rising roughly coincides with that of the original depression. The amount of depression by the ice and the rate of uplift as given by Nansen in 1927 agree reasonably with the figures derived from Niskanen's theoretical treatment. The Niskanen formula with appropriate assumptions indicates that the maximum depression in the Netherlands will occur in A. D. 6800 and will be 100.7 meters, 3.8 meters more than at present. The rising of the Alpine foreland may result from melting of the deeper crustal root of the Alps and its spreading northward below the crust in the shape of currents with a frontal edge of finite thickness. Such currents would cause a belt of moderate positive gravity anomalies, which may correspond to the east-west belt of positive anomalies through the middle of the Netherlands. The edge would then be marked by the depression through which

the Rhine and the Waal take their western course. Another lobe may be the cause of the rising in the direction of Thourout in Belgium.—*M. C. R.*

160–185. Klompé, Th. H. F. The structural importance of the Sula Spur (Indonesia): Indonesia Madjalah Ilmu Alam Untuk, v. 110, no. 1, 2, 3, p. 21–40, 1954.

Stratigraphic, structural, geophysical, and bathymetric studies indicate that the Sula Spur (an area including the Banggai, Sula, Obi, and Misool islands north of Ceram and Buru) is different from areas north and south where there has been strong Tertiary diastrophism. Sediments are weakly folded or unfolded; positive gravity anomalies indicate a mass surplus that could be caused by a strong upward force in the crust and uplift of the heavier substratum; the area is nearly aseismic in contrast to areas north and south; and bathymetric surveys show the existence of precipitous slopes that have been interpreted as fault scarps. Island arcs are strongly curved in opposite directions. The Sula Spur must be considered as a consolidated remnant of an older, possibly Variscian, orogenic period that has formed an important obstacle in the Tertiary diastrophism and is consequently responsible for the extraordinary trend of the arcs in this part of the archipelago.—*M. C. R.*

160–186. Pariyskiy, N. N. O vliyanii svobodnoy nutatsii zemli na uglovuyu skorost eye vrashcheniya [The effect of the free nutation of the earth on the angular velocity of its rotation]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 19 (146), p. 123–127, 1953.

Analysis of the changes of the angular velocity of the rotating earth under the influence of the free nutation due to the triaxiality of the globe that is assumed to be perfectly rigid shows that the amplitude of the variation in the duration of the sidereal day will be about 9×10^{-16} seconds and can be neglected.—*S. T. V.*

160–187. Bernasconi, Carlo. Moto di un vortice sulla terra e sua influenza sulla polodia [Movement of a vortex on the earth and its influence on the movement of the pole]: Geofisica Pura e Appl., v. 28, p. 190–198, 1954.

The earth is assumed surrounded by a veil of incompressible perfect fluid rotationally moved by a point-shaped double vortex, and the total kinetic energy of the system is calculated. The influence of such a vortex on the rate of rotation of the earth is found to be negligible.—*M. C. R.*

160–188. Pariyskiy, N. N., and Berlyand, O. S. Vliyaniye sezonnykh izmeneniy atmosfernykh tsirkulyatsiy na skorost' vrashcheniya zemli [The effect of seasonal changes in atmospheric circulation on the rotational velocity of the earth]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 19 (146), p. 103–122, 1953.

Observations have shown that the angular momentum of the rotating earth including the atmosphere does not remain constant during the year. The effect of atmospheric circulation is determined by computing the air masses participating in wind motions from data on barometric pressure and temperature for the entire surface of the earth and for sufficiently great altitudes as given on Shaw's maps, and finding the angular momentum for the atmosphere for 12 different assumptions. The results show that seasonal variations of atmos-

pheric circulation are important factors in the annual changes of the rotation velocity. Best results were obtained for the assumptions of complete absence of or very small frictional resistance.—*S. T. V.*

160–189. Scheidegger, Adrian E. Directional permeability of porous media to homogeneous fluids: Geofisica Pura e Appl., v. 28, p. 75–90, 1954.

Investigations have shown that in groundwater- and oil-bearing strata there are preferential directions of flow that are often maintained over wide areas. Johnson and Hughes analyzed a series of oil well cores by cutting them into small horizontal plugs, and they obtained directional permeabilities which they plotted in the form of polar graphs. They were not able to give a physical explanation of this phenomenon. On the other hand, there exists a theory of permeability in which the latter is represented as a symmetric tensor. This theory has been developed by Ferrandon, but no experimental substantiation of it seems ever to have been attempted.

In the present paper, the author undertakes to compare the two sets of findings. From Ferrandon's theory, the directional permeabilities (denoted by k) corresponding to the experiments of Johnson and Hughes are calculated, and it is shown that $k^{-1/2}$ if plotted as a polar graph, should form an ellipse. The data of Johnson and Hughes are then drawn. In this manner, a substantiation of the tensor theory of Ferrandon is obtained.—*Author's abstract*

160–190. Farrington, William B. Analysis of stress conditions in the upper Spraberry in western Texas: Am. Geophys. Union Trans., v. 36, no. 1, p. 139–143, 1955.

Upper Spraberry cores were studied to learn whether fractures were open in the formation or only incipient. Release of fluid pressures in a pressure vessel into which core samples had been placed produced longitudinal axial fractures in previously unfractured cores, showing that some of the fractures must be incipient. A statistical study showed that the core diameters across fractures were slightly less than along fractures. The difference in core diameters may have been the result of a small difference in the magnitude of the two principal horizontal stresses, which difference was computed from a knowledge of Young's modulus under formation conditions. The Mohr diagram was used to analyze the stresses in three dimensions, while the Mohr envelope indicating rupture conditions was constructed with data obtained from tension and compression tests on core samples. The tensile stress required to cause fracture under formation conditions as determined with the Mohr diagram compares favorably with the Hydrafrac pressure required for the "formation break." The average horizontal stress appears to be about half the vertical stress due to overburden, and this may be due in part to the low Poisson ratio of the rock.—*Author's abstract*

INTERNAL CONSTITUTION OF THE EARTH

160–191. Gutenberg, B[eno]. Effects of low-velocity layers: Geofisica Pura e Appl., v. 29, p. 1–10, 1954.

Effects of low velocity channels in the atmosphere, the ocean, and the solid earth are discussed. There are two major low-velocity channels in the atmosphere, one with its axis at the tropopause, and another at a height of about 80 km. They produce "zones of silence" and permit the transmission of waves involving the whole atmosphere. Low-velocity layers in the ocean result from

the combined effects of temperature, pressure, and salinity. In the earth, the sudden decrease of velocity at the boundary of the core produces a low-velocity channel for elastic waves. In the earth's crust there are two major low-velocity channels, one below the Mohorvičić discontinuity, the other at a depth of about 15 km. Misinterpretation of their effects have caused incorrect conclusions concerning the structure of the outer portion of the earth's mantle.—*Author's summary*

160–192. Molodenskiy, M. S. Uprugiye prilivy, svobodnaya nutatsiya i nekotoryye voprosy stroyenya zemli [Elastic tides, free nutation, and some questions about the structure of the earth]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 19 (146), p. 3–52, 1953.

Deformations and stresses are computed which are produced in the rigid mass of the earth by the action of tidal forces. The results are obtained by numerical integration of differential equations governing the position of elastic equilibrium of the terrestrial body. The analysis includes the effects of lunisolar tides, those of the displacement of the terrestrial pole, and of the variations of rotational velocity of the earth. In all computations the terrestrial mantle was assumed to be perfectly elastic, compressible, and gravitative. The density of the earth and its elastic characteristics were assumed to vary with depth. The velocities of seismic waves introduced into the computations are those observed in the mantle. Sixteen different assumptions were made for the variation of density with depth. The most plausible results of the computations were later compared with observed values of the tidal effect on the vertical, on the force of gravity, and on the period of free nutation. The available evidence is not sufficient for checking all the results computed; only the effects on the period of free nutation can be reliably compared. The variation of this quantity makes possible the estimation of the average value of the shear modulus in the earth's core.—*S. T. V.*

160–193. Shor, George G., Jr. Deep reflections from southern California blasts: Am Geophys. Union Trans., v. 36, no. 1, p. 122–138, 1955.

Two records showing reflections from the Mohorivičić discontinuity at normal incidence have been obtained from large quarry blasts in southern California. Each record shows a strong reflection with corrected traveltime near 10.6 seconds. An earlier reflection appears near 9.0 seconds. Strong reflections were also obtained at distances slightly beyond critical. Computations of the thickness of the crust near the quarries have been made using velocity data obtained from blast and earthquake refraction studies. The results using any crustal model that fits the refraction data or by assuming a single-layer crust agree closely. In this area the Mohorovičić discontinuity is 32 km below sea level, and the mean velocity in the crust is 6.2 kmps. The data give additional evidence for the existence of a zone in which velocity decreases with depth.—*Author's abstract*

160–194. Knopoff, L. and Uffen, R. J. Densities of compounds at high pressures and the state of the earth's interior: Jour. Geophys. Research, v. 59, no. 4, p. 471–484, 1954.

A quantum statistical method, already well developed for pure elements, has been extended to the prediction of the equation of state of compounds at extremely high pressures at absolute zero. Application of a finite-strain condition to possible constituents of the earth, found by Birch to be valid for many

materials, leads to satisfactory interpolation between the existing laboratory data and the quantum predictions for these materials. The quantum calculations begin to hold at pressures of the order of 10^{14} dynes per cm^2, pressures greatly exceeding those obtainable within the earth. The finite-strain interpolative procedure is assumed to predict the pressure-density relationships at pressures corresponding to those prevailing within the earth. From Bullen's pressure-density values for the earth, it is found that, assuming the absence of phase transitions, the base of the mantle has the same density as an olivine possessing 63 percent Mg_2SiO_4. By a similar procedure, the earth's outer core cannot be pure iron, but has the same density as a mixture of 90 percent iron and 10 percent olivine. For the temperatures prevailing within the earth, the quantum calculations at absolute zero are not significantly altered; a latitude in the interpolative procedure is indicated at these temperatures, leading to a composition of olivine at the base of the mantle ranging between 47 and 63 percent Mg_2SiO_4.—*Authors' abstract*

160–195. Dietz, R. S. Marine geology of northwestern Pacific: Description of Japanese Bathymetric Chart 6901: Geol. Soc. America Bull., v. 65, p. 1199–1224, 1954.

The region covered by Japanese Hydrographic Chart 6901 (plate 1 of this report) can be divided into the Pacific basin proper, the Philippine Sea basin, and the submerged portion of the Asia continental block. The dominant structures of the Pacific basin are large-scale undulations of low relief, but the most striking features are five groups of seamounts considered to be volcanic. The Pacific basin is considered a stable area and the sinking of the guyots a local isostatic adjustment. The Philippine Sea basin is bounded on the west by the Asia continental block, on the east by great geanticlinal ridges and is bisected by the Kyushu-Palau geanticlinal ridge. Trenches lie seaward of the ridges. The ridges are active belts surmounted by volcanoes and islands. The basin has normal Pacific crustal structure deformed by the compressional forces that affected the margin of Asia. The continental slope marks the boundary of the Asia sialic block and extends from Kamchatka along the Kurile Islands, Japan, and the Ruykyu Islands to Formosa and probably along the east side of the Philippine Islands. Featureless shelves with shelf-breaks at normal depth fringe China and Siberia. Continental slopes are canyoned and irregular in detail. The Kurile basin, Japan Sea basin, and the Ryukyu basin are abyssal basins within the continental block, possibly caused by group drifting of the island arcs that opened up simatic pools within the continental block.—*V. S. N.*

160–196. Fisher, Robert L. On the sounding of trenches: Deep-Sea Research, v. 2, no. 1, p. 48–58, 1954.

The greatest minimum traveltime recorded during bathymetric investigations by the Scripps Institution of Oceanography in the Tonga Trench in 1952–53 corresponded to a depth of $5{,}814 \pm 15$ fathoms ($10{,}633 \pm 27$ meters), corrected, which if accurate is the greatest depth yet recorded for the Southern Hemisphere. The principal sources of error in the explosion-oscillograph method, used in these soundings, are evaluated. It is concluded that errors in interpretation are probably many times as great as errors in measurement, and that this sounding is not a valid maximum but merely a minimum interpreted value for the reflection traveltime at one shot position. A better estimate is obtained by analysis of the echo trains of all shots along the profile. From this it is evident that the deepest point is probably at least 5,900 fathoms.

Soundings in the Japan Trench, recorded with a high frequency echosounder, indicate a maximum depth of about 5,250 fathoms (9,600 meters), corrected, in the Ramapo Deep.—*D. B. V.*

GEOPHYSICAL EXPLORATION

160–197. Hammond, Rolt. Civil engineering and geophysical prospecting, Part 1: Civil Eng., v. 50, no. 584, p. 191–193, 1955.

This is a brief review of the magnetic, gravitational, and seismic methods. It is said that a "torsion balance type" instrument is used in gravity surveys, and a Worden gravimeter is described. The first application of the seismic method in determining depth to bedrock is said to have been in Sweden in 1941. The seismic refraction method is described as that used by the Southwestern Industrial Electronics Co.—*M. C. R.*

160–198. Boyd, James. Geophysics in an expanding economy: Mines Mag., v. 45, no. 1, p. 8–10, 34, 1955.

A discussion of the role of geophysics in locating the raw materials required in our expanding economy.—*L. C. P.*

160–199. Peacock, H. B. $2,000,000,000 worth of seismic records: Oil and Gas Jour., v. 53, no. 45, p. 180–182, 1955.

There is 2 billion dollars invested in seismic records stored in the United States. Review and reinterpretation of the records, better coordination of geology and geophysics, and trading of seismic data can increase the value of this investment.—*L. C. P.*

160–200. Kliewer, Don. U. S. geophysical activity: World Oil, v. 140, no. 3, p. 100, 1955.

The number of geophysical crews in the United States declined 6.8 percent during 1954, leaving 700 crews active.—*D. R. M.*

160–201. Closs, Hans. Practica de la reflexión sismica en Alemania [The seismic reflection method in Germany]: Rev. Geofísica, año 13, no. 49, p. 77–103, 1954.

A review of the development of the geophysical methods of exploration, primarily of the seismic reflection method, in Germany since the last World War.—*S. T. V.*

160–202. Ferrell, G. D. Muskeg doesn't bother these vehicles: Oil and Gas Jour., v. 53, no. 20, p. 392–395, 1954.

This is a description of the Bombardier muskeg tractor used in seismic operations in Alberta, Canada.—*L. C. P.*

160–203. Prescott, Harold R. How Continental trains its geophysicists: Oil and Gas Jour., v. 53, no. 38, p. 91, 1955.

A description of the program used by the Continental Oil Co. in training geophysicists.—*D. R. M.*

INDEX