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GEOLOGICAL SURVEY BULLETIN 1022

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

UNITED STATES GOVERNMENT PRINTING OFFICE, WASHINGTON : 1955

UNITED STATES DEPARTMENT OF THE INTERIOR

Douglas McKay, *Secretary*

GEOLOGICAL SURVEY

W. E. Wrather, *Director*

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[The letters in parentheses are those used to designate the chapters for separate publication]

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108–111, January–December 1942, Geological Survey Bulletin 939.
112–127, January 1943–December 1946, Bureau of Mines Information Circulars. [Mimeographed]
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140–143, January–December 1950, Geological Survey Bulletin 976.
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GEOLOGICAL SURVEY BULLETIN 1022-A

Geophysical Abstracts 156 January-March 1954

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

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GEOPHYSICAL ABSTRACTS 156, JANUARY–MARCH 1954

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

GENERAL INFORMATION

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

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

Beginning with this issue, patents will no longer be abstracted. Information on United States patents may be found in Geophysics, the publication of the Society of Exploration Geophysicists, which has included such abstracts for many years.

Beginning with this issue, also, a new system of numbering abstracts has been adopted to permit more ready location of individual abstracts. Numbers will be consecutive within each issue, and will be compound, consisting of the Geophysical Abstracts serial number and the individual abstract number. Abstracts in this issue are therefore numbered 156–1 to 156–187.

ABSTRACTORS

Geophysical Abstracts is prepared and compiled under the direction of Mary C. Rabbitt with the assistance of Dorothy B. Vitaliano and S. T. Vesselowsky. Other abstracts in this issue have been pre-

pared by James R. Balsley, Roland G. Henderson, Louis C. Pakiser, and Isidore Zietz.

LIST OF JOURNALS

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

Abbreviation	*Publication*
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.
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 Geol. Acad. Sci. Hungaricae	Acta Geologica Academiae Scientarum Hungaricae. Budapest.
Acta Geophy. Polonica	Acta Geophysica Polonica. Polskiej Akademii Nauk. Warszawa.
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.

Abbreviation	*Publication*
Akad. Nauk. Gruzinskoy SRR Soobshcheniya.	Akademii Nauk Gruzinskoy SSR Soobshcheniya. Tbilisi.
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 geologicheskaya, Seriya fizicheskaya. Moskva.
Akad. Nauk SSSR Ural'skiy filial Trudy Gorno-Geol. Inst.	Akademii Nauk SSSR Ural'skogo filiala Trudy, Seriya geologicheskikh nauk.
Alger Univ. Inst. Recherches Sahariennes Travaux.	Travaux de l'Institut de Recherches Sahariennes. Universite d'Alger.
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 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.
Annales des Mines	Annales des Mines. Paris.
Annales Géophysique	Annales de Géophysique. Centre Nationale de la Recherche Scientifique. Paris.
Annali Geofisica	Annali di Geofisica. Istituto Nazionale de Geofisica. Roma.
Ann. Rev. Nuclear Sci	Annual Review of Nuclear Science. Annual Reviews, Inc. in cooperation with National Research Council. Stanford, Calif.
Archives Sci. (Genève)	Archives des Sciences. Société de physique et d'histoire naturelle de Genève. Genève.
Archiv Meteorologie Geophysik u. Bioklimatologie.	Archiv für Meteorologié, Geophysik und Bioklimatologie. Wien.

Abbreviation	*Publication*
Arkiv Geofysik	Arkiv för Georysik. Kungliga svenska vetenskaps akademien. Stockholm.
Atmos. Terrest. Physics Jour	Journal of Atmospheric and Terrestrial Physics. Pergamon Press, Ltd., London.
Australian Bur. Min. Res. Geology and Geophysics, Bull.	Commonwealth of Australia. Bureau of Mineral Resources, Geology and Geophysics.
Australian Jour. Sci	Australian Journal of Science. Science House. Sydney.
Berg- u. Hüttenmänn. Monatsh	Berg- und Hüttenmännische Monatshefte. Wien.
Bohrtechnik-Brunnenbau	Bohrtechnik-Brunnenbau. Also published as Brunnenbau-Bohrtechnik and Brunnenbau-Tiefbohrtechnik. Berlin and Hannover.
Boll. Geodesia e Sci. aff	Bollettino di Geodesia e Scienze affini. Istituto Geografico Militare. Trieste, Italy.
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.
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.
Canadian Jour. Physics	Canadian Journal of Physics. Ottawa.
Canadian Min. Jour	Canadian Mining Journal. Gardenvale, Quebec.
Canadian Min. Metall. Bull	Canadian Mining and Metallurgical Bulletin. Montreal.
Chem. Metall. Min. Soc. South Africa Jour.	Journal of the Chemical Metallurgical and Mining Society of South Africa. Johannesburg.

Abbreviation	*Publication*
Chile Univ. Facultad Cienc. fis. y mat. Anales.	Anales de la Facultad de Ciencias fisicas y matemáticas. Universidad de Chile. Santiago de Chile.
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.
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.
Czechoslovakia, Státní. Geol. Ústav. Sbornik.	Sbornik Státního geologického ústavu Československé Republiky. Praha.
Czechoslovak Jour. Physics	Czechoslovak Journal of Physics. Centre of Research and Technical Development, Central Institute of Physics. Praha.
Deutsch. geol. Gesell. Zeitschr	Zeitschrift der Deutschen Geologischen Gesellschaft. Hannover, 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.
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.
Földtani Közlöny	Földtani Közlöny. Magyar Földtani Társulat [Hungarian Geological Society]. Budapest.
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.

Abbreviation	*Publication*
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 Mijnbouwkundig Genootschap. The Hague.
Geol. Rundschau	Geologische Rundschau. Stuttgart, Germany.
Geol. Soc. America Bull	Bulletin of the Geological Society of America. New York.
Geol. Soc. Japan Bull	Bulletin of Geological Society of Japan. Tokyo.
Geol. Soc. London Quart. Jour	Quarterly Journal of the Geological Society of London. London.
Geol. Soc. South Africa Trans. and Proc.	Transactions and Proceedings of the Geological Society of South Africa. Johannesburg.
Geol. Survey Japan Bull	Bulletin of the Japan Geological Survey. Tokyo.
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.

Abbreviation	*Publication*
Glasnik Prirod. Mus. Srpske Zemle	Glasnik Prirodnackog Museja Srpske Zemle. Beograd, Yugoslavia.
Glówny Inst. Naftowego Prace	Glówny Instytut Naftowego Prace. Katowice, Poland.
Glückauf	Glückauf-Bergmannische Zeitschrift. Essen, Germany.
Greece Inst. Geol. Ereunon Upedaphous Geol. Anag. Rept.	Institouton Geologias kai Ereunon, Upedaphous Geologikai Anagnoriseis. [Institute of Geology and Subsurface Research Geological Reconaissance Report]. Athinai.
Greece Uperesia Ereunon Upedaphous Ereunai oruktou ploutou tes Ellados.	Greece, Uperesia Ereunon Upedaphous [Subsurface Research Department] Ereunai oruktou ploutou tes Ellados [The mineral wealth of Greece]. Athinai.
Hokkaido Univ. Faculty Sci. Jour	Journal of the Faculty of Sciences. Hokkaido University. Sapporo, Japan.
Indian Jour. Meteorology and Geophysics.	Indian Journal of Meteorology and Geophysics. New Delhi.
Indonesia Madjalah Ilmu Alam Untuk	Madjalah Ilmu Alam Untuk Indonesia [Indonesian Journal for natural science]. Bandung, Java. Successor to Chronica Naturae.
Inst. Geog. y Catastral Mem	Memorias del Instituto Geografico y Catastral. Madrid.
Inst. geol. min. España notas y comunicaciones.	Instituto geologico y minero, notas y comunicaciones. Madrid.
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.
Istanbul Univ. Fakultesi Mecmuasi	Istanbul Universitesi fen Fakultesi Mecmuasi. Istanbul.
Ist. Veneto sci. lettere ed Arti Atti	Istituto Veneto di Scienze lettere ed Arti Atti. Venezia, Italy.
Japanese Jour. Astronomy	Japanese Journal of Astronomy. Science Council of Japan. Tokyo.

Abbreviation	*Publication*
Jour. Applied Physics	Journal of Applied Physics. American Institute of Physics. New York.
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.
K. Danske Vidensk. Selsk. Mat.-fys. Meddel.	Det Kongelige Danske Videnskabernes Selskab Matematisk-fysiske Meddelelser. København.
K. Nederland. Akad. Wetensch. Proc.	Proceedings Koninklijke Nederlandse Akademie van Wetenschappen. Amsterdam, Netherlands.
Kyōto Univ. Faculty Eng. Mem	Memoirs of the Faculty of Engineering. Kyōto University. Kyōto, Japan.
La Ricerca Sci	La Ricerca Scientifica. Roma.
Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények.	Magyar Állami Eötvös Loránd Geofizikai Intézet Geofizikai Közlemények. Budapest.
Marii Curie-Skłodowskiej Uniw., Rocz	Roczniki Uniwersitet Marii Curie-Skłodowskiej. Lublin, Poland.
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.
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.
Nafta (Yugoslavia)	Nafta. Institut za naftu. Zagreb, Yugoslavia.
Nat. Acad. Sci. Proc	Proceedings of the National Academy of Sciences. Washington, D. C.

Abbreviation	*Publication*
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.
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.
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 in Canada	Oil in Canada. National Geophysical Co. Calgary, Alberta.
Osservatorio Geofis. Trieste Pub	Osservatorio Geofisico Trieste Pubblicazione. (Reprints from scientific journals.)
Padova Univ. Ist. geod. e geofis. Pub	Istituto geodetico e geofisico Padova Universita Pubblicazione. (Reprints from scientific journals.)
Pakistan Jour. Sci	Pakistan Journal of Science. Pakistan Association for Advancement of Science. Lahore, Pakistan.
Państwowy Inst. Geol. Biul	Państwowy Instytut Geologiczny Biuletyn. Warszawa.
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.

Abbreviation	*Publication*
Physics today	Physics today. American Institute of Physics. New York.
Phys. Rev	Physical Review. American Institute of Physics. New York.
Phys. Soc. London Proc	Proceeding 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 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'Énseignement supérieur. Paris.
Rev. Geofísica	Rivista de Geofísica. Madrid.
Rev. géomorphologie dynamique	Revue de géomorphologie dynamique. Strasbourg, France.
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.
Savariensis Univ. Annales	Annales Universitatis Savariensis. Universite de la Sarre. Saarbrücken, Germany.

Abbreviation	*Publication*
Schweizer. mineralog. petrog. Mitt	Schweizerische mineralogische und petrographische Mitteilungen. Verlag Leeman. Zürich, Switzerland.
Schweizer. naturf. Gesell. Verh	Verhandlungen der schweizerischen naturforschenden Gesellschaft. Aarau, Switzerland.
Sci. Am	Scientific American. New York.
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 Bul	Bulletin of the Seismological Society of America. Berkeley, Calif.
Service carte géol. Algérie Bull	Service de la Carte géologique de l'Algérie-Tunisie Bulletin. Gouvernment général de l'Algérie.
Servizio geol. Italia Boll	Bollettino del Servizio geologico d'Italia. Roma.
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 physiques du Maroc. Institute scientifique Chérifien à Rabat. Rabat, Morocco.
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.

Abbreviation	*Publication*
Tellus	Tellus. Svenska Geofysiska Föreningen. Stockholm.
Tōhoku Univ. Sci. Repts	Tōhoku University Science Reports. Sendai, Japan.
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.
Umschau	Die Umschau. Frankfurt am Main, Germany.
U. S. Bur. Mines Inf. Cir.; Rept. Inv	United States Bureau of Mines Information Circular; Report of Investigations. 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. Natl. Research Council Highway Research Board Bull.	United States National Research Council, Highway Research Board Bulletin. Washington, D. C.
Vestnik Moskov. Univ	Vestnik Moskovskogo Universiteta. Moskva, U. S. S. R.
Volcano Letter	Volcano Letter. University of Hawaii. Honolulu.
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.
Zeitschr. Naturforschung	Zeitschrift für Naturforschung. Tübingen, Germany.
Zürich Inst. Geophysik Mitt	Erdgenössische Technische Hochschule Zürich Mitteilungen aus dem Institut für Geophysik.

GRAVITY

GENERAL AND THEORETICAL PAPERS, INCLUDING THOSE ON ISOSTASY

156–1. Castro, Honorato de. Gravedad y pesantez [Gravity and weight]: Petróleos Mexicanos, 2ª época, tomo 1, no. 12, p. 942–943, 1953.

The basic difference between the force of gravity and the weight of a body is explained by examples.—*S. T. V.*

METHODS OF ANALYSIS AND OBSERVATION

156–2. Trejo, Cesar A. A note on downward continuation of gravity: Geophysics, v. 19, no. 1, p. 71–75, 1954.

Comparing calculated and exact values in an ideal example, it is shown that Peters' proposed method of downward continuation of gravity is far less suitable than a combination of Peters' procedure for upward continuation and a finite differences method for downward continuation. It is shown also how Peters' method can be substantially improved by considering only the closest values in the downward step of a continuation process.—*Author's Abstract*

156–3. Baranov, V. Calcul du gradient vertical du champ de gravité ou du champ magnétique mésuré à la surface du sol [Calculation of the vertical gradient of the gravity field or the magnetic field measured at the surface of the ground]: Geophys. Prosp. v. 1, no. 3, p. 171–191, 1953.

The first vertical derivative of the gravitational and magnetic fields has the advantage of better defining anomalies which are not very prominent in the field map. It does not accentuate the anomalies as much as the second derivative but it has the advantage of being less sensitive to errors in the observed field.

The expression for the vertical gradient is derived by considering the formula for the field $g(0,0,Z)$ above the plane of observations:

$$g(0,0,Z)=\int_0^\infty \overline{g}\,(\rho)[Z\rho d\rho/(\rho^2+Z^2)^{3/2}]$$

where $\overline{g}\,(\rho)$ is the average value of the field on a circle of radius ρ in the observational plane. Since the integrand is discontinuous at the origin, it is not possible to differentiate under the integral sign. Consequently, the integration must be performed first. This results in a continuous function, permitting the calculation of first and second derivatives as well as the downward field extensions.

The numerical evaluation of the vertical derivative is effected by superimposing a grid on the field map and considering the grid intersections that lie on concentric circles of fixed radii. The average value of the field for each circle

is multiplied by fixed numerical coefficients to yield the derivative. Coefficients for 10 circles corresponding to an outermost radius of 10 units are given.

Using specific mathematical functions, theoretical evaluations are made for the first and second derivatives and the downward extension of the fields. Agreement between theoretical values and those calculated by using Baranov's formulas is splendid.—*I. Z.*

156–4. Haáz, István Béla. Kapcsolat a derékszögű hasáb tömegvonzásának potenciálja és e potenciál deriváltjai között [Relations between the potential of the attraction of the mass contained in a finite rectangular prism and its first and second derivatives] : Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 2, szám 7, p. 57–66, 1953.

The second derivatives of the potential of the attraction of the mass contained in a rectangular prism of finite dimensions may be expressed by simple well-known formulas. Formulas for the first derivatives are more complicated, containing hyperbolic functions. No formula expressing the potential itself is known. In the present study the first derivatives of the potential function, as well as this function itself, are expressed in terms of the second derivatives without integrating them. The starting point of computations is Euler's theorem for homogeneous functions. By applying the same procedure to the third derivatives, an equation similar to the Laplace equation is derived, of the form:

$$a\varphi_{xyz}+b\varphi_{xyz}+c\varphi_{xyz}=0$$

where a, b, c, are constant. The results may be extended to an inclined prism and to a prism of infinite dimensions.—*S. T. V.*

156–5. Kosbahn, B. Beitrag zur Interpretation von Schwerebildern mit Hilfe höherer Ableitungen [Contribution to the interpretation of gravity diagrams with the help of higher derivatives] : Geophys. Prosp., v. 1, no. 4, p. 250–258, 1953.

For the treatment of the problems involved in the interpretation of gravity pictures this paper gives a formula that holds generally for any potential function. It provides an extended applicability of the relation used by Elkins for the computation of the second derivative, and also yields an analogous relation to derivatives of higher order of the gravity field.

This relation has not been utilized to determine in details the course of the derivatives of higher order in a plane, but is merely applied to points of comparatively extreme curvature of the isogams where the differential values present a ratio favourable to the "noise level". By this method the values of the derivatives of higher order will not be determined themselves but only the ratios responsible for the depth of divergence in comparison with the course of an anomaly of masses replaced by points.

It is shown by examples of intercalated masses that the divergence points are important and by law related to the form and position of the density contrasts themselves.

An analysis of the total gravity picture is made possible by progressing from elements close to the surface to deeper ones. In this way the fundamental fea-

tures of the earth's crust will be obtained. The application of the analysis process to a gravity anomaly actually measured in Northwest Germany is given.—*Author's Abstract*

156–6. Facsinay, László. A graviméter mérések korszerü értelmezésének módszerei [Methods of modern interpretation of gravimeter measurements]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 2, szám 11, p. 95–120, 1953.

The interpretation of magnetic surveys was recently made easier by the introduction of the third partial differential coefficient of the potential function. The similarity of magnetic and gravitational fields suggests that the same procedure be used when interpreting gravitational surveys made both by gravimeters and by torsion balances. Facsinay shows how this method can be advantageously employed, using numerous published data of American surveys. The same procedure is applied to some recent surveys in Hungary in areas previously geologically investigated by drill holes.—*S. T. V.*

156–7. Olczak, Tadeusz. On gravitational attraction of a rectangular parallelepiped: Acta Geophys. Polonica, v. 1, no. 1, p. 65–72, 1953.

Formulas for calculating the gravity effect of a rectangular slab, as found in papers and textbooks, contain a fault which limits their applicability. Olczak here derives the formula for vertical gradient in a more accurate form.—*D. B. V.*

156–8. Martin, Rodolfo. Gravity maxima corresponding with sedimentary basins: Geophysics, v. 19, no. 1, p. 89–94, 1954.

Gravity maxima have been found over the deepest part of two sedimentary basins in Argentina, the Río Salado and San Jorge basins. A possible explanation is offered: that before the sediments were laid down, isostatic compensation had taken place between the elevated blocks on the sides and the depressed blocks in the center which formed the basin, and that when sediments filled the basin no further isostatic adjustment took place because of insufficient time or because of increased rigidity of the crust. Wuenschel, in the following discussion, questions the interpretation and suggests that in the Río Salado basin the calculated anomally on this hypothesis is not the equivalent of the observed anomaly.—*M. C. R.*

156–9. Grant, Fraser S. A theory for the regional correction of potential field data: Geophysics, v. 19, no. 1, p. 23–45, 1954.

An analytical method based on the theory of statistical probability is developed for separating regional from local potential field effects. Weighted observed values are integrated to obtain "expected" values describing a smoothed field. The appropriate standard deviation used in the calculations is determined with the aid of theoretical regional and local fields which are representative of the data. Applied to an artificial composite field the method accurately separated the residual anomaly from the regional field. As shown by an application to a practical gravity survey (previously studied in terms of residuals by Griffin, 1949) the results are quite independent of the size of the diagram used in the computations and suggest that the residual map has physical significance.—*R. G. H.*

156–10. Nettleton, L. L. Regionals, residuals, and structures: Geophysics, v. 19, no. 1, p. 1–22, 1954.

A critical review of the various methods for determining regional effects indicates that neither the graphical systems nor the various numerical and mathematical systems provide a philosophically sound basis for separating a potential field into regional and residual components. The former depend on the judgment of the operator and the latter on assumptions or empirical steps in the mathematical derivation of the numerical factors or coefficients used in the calculations. Each system has its advantages and disadvantages and a proper appreciation of these is necessary for the successful application of either or both systems to a given problem.

The various published mathematical systems are compared by reducing their numerical factors to a common basis and listing them in tabular form. This comparison shows the gross variation in numerical coefficients and weighting factors derived by different mathematical approaches. Comparisons of the graphical system and certain of the grid systems, made by carrying them out over a gravity map of the same area, show the effect of these variations on second derivative maps. Other examples of applications are listed from maps in the geophysical literature.

It is concluded that the lack of an objective criterion for the isolation of anomalies is due to the inherent ambiguity in the sources of potential fields, but that in spite of the empirical nature of any regional method, the proper application of a system appropriate to the particular problem encountered can give very useful results.—*Author's Abstract*

156–11. Swartz, Charles A. Some geometrical properties of residual maps: Geophysics, v. 19, no. 1, p. 46–70, 1954.

From well known mathematical theory it can be demonstrated that most contour maps may be considered to be built up by the superposition of a double infinity of elementary undulating surfaces, each of which has the form of a horizontal sinusoidally corrugated sheet, infinite in extent. These elementary surfaces may have all possible wave lengths, orientations, amplitudes, and phases. Several examples are given of simple mosaic-type composite maps built up by combining only two such elementary surfaces in different ways. These resemble geophysical contour maps in many significant respects.

Residual maps are often prepared by using a template procedure for computing the residual value at any point as a linear combination of several neighborhood values interpolated from the original map. An expression is derived for the Fourier transform of any residual map prepared in this way. This transform gives the amplitude spectrum of the residual map in terms of the amplitude spectrum of the original map and the geometry of the template pattern. It is applied to the special case of an original map of the two-component mosaic variety mentioned above. The results are presented quantitatively in the form of attenuation, or filter, curves which show the amplitudes of the residual anomalies for various sizes and shapes of original anomalies, and for several different residual templates.

The geometrical significance of "second derivative" maps is discussed, and it is shown that they may be prepared by a process which is a limiting case of applying a residual template pattern of very simple type.

Attenuation curves are presented for several kinds of residual templates when applied to an idealized original contour map consisting of a single anomaly of various shapes. These filter curves are very similar to those for original maps of the simple mosaic type. It is concluded that, since most geophysical maps may be considered to be of a kind intermediate between these two extreme types, the attenuation curves given here may be useful for designing residual templates which will have desired selective characteristics.—*Author's Abstract*

156–12. Buchheim, W., and Lauterbach, R. Isoanomalien-Richtungsstatistik als Hilfsmittel tektonischer Analyse [Statistical treatment of isoanomaly trends as an aid in tectonic analysis] : Gerlands Beitr. Geophysik, Band 63, Heft 2, p. 88–98, 1953.

This paper presents a statistical method of determining dominant trends of isoanomaly lines when such trends are obscured by intricate contour patterns. The suggested procedure involves constructing tangents to the contour lines at intervals of a stated number of degrees, measuring the length of arc between them, and adding up those having equal azimuth. When the results are plotted as radii of a semicircle, dominant trends, if any, become apparent.—*D. B. V.*

156–13. Morelli, Carlo. Variazione diurna della gravità in Europa [Diurnal variations of gravity in Europe] : Annali Geofisica, v. 6, no. 2, p. 295–307, 1953.

This is the continuation of the previous study [see Geophys. Abs. 14609]. A theoretical proof is presented that the curves of diurnal variation of gravity, calculated for northern Italy with $\varphi_0=45°$ and $\lambda_0=12°$ E. from Greenwich, are also applicable for every other longitude, if times are corrected accordingly.

It can be seen, that difference $\Delta\varphi$ in latitude produces effects not exceeding 0.01 mgal for $\Delta\varphi<2°$, where $\Delta\varphi=\varphi-\varphi_0$, and can be compensated up to the limit of $\Delta\varphi\lessgtr13°$ by a correction factor applied to amplitudes computed with the derived formulas.

In order to make possible the utilization of computed graphs for $\varphi<32°$ or $\varphi>57°$ curves can be readily constructed making easy interpolation possible. As an example such curves are computed for the second half of the year 1953 for $\varphi=30°$ and $\varphi=60°$.—*S. T. V.*

156–14. Facsinay, László, and Haázné, Rózsás Hajnal. Kőzetsürüségmeghatározás a felszin alatt különböző mélységekben végzett graviméter-mérések alapján [Density determinations of rocks based on subsurface gravimeter measurements at different depths] : Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 2, szám 4, p. 1–9, 1953.

Gravity measurements were made on different levels of a mine, the difference between extreme stations being 325.7 m. The densities of intermediate formations were computed from the measurements and were found to be in good agreement with the known geologic section, but higher than the densities found in laboratory measurements. It is therefore suggested that corresponding corrections be applied to densities when computing Bouguer anomalies. The accuracy of gravimetric measurements when these corrections are indicated is about 0.1 mgal.—*S. T. V.*

156–15. Kaufman, S. Analog computer solves geophysical problems: Electronics, v. 26, no. 6, p. 174–177, 1953.

The analog computer described in this article was specially devised to perform rapidly the arithmetical operations required to interpret potential-field data. The need for rapid computation of geophysical data arises from the large number of calculations required to interpret the results of magnetometric or gravimetric measurements. The analog computer saves time, as it can be adjusted for about five operations per second and also diminishes the occurrence of errors. A description of the electronic computer is given, as well as some indications as to its use.—*S. T. V.*

OBSERVATIONS OF GRAVITY AND GRAVITY SURVEYS

156–16. Ewing, Maurice, and Worzel, J. Lamar. Gravity anomalies and structure of the West Indies: Geol. Soc. America Bull., v. 65, no. 2, p. 165–174, 1954.

Seismic-refraction results and gravity data have been used to deduce the crustal structure from the ocean basin north of the Puerto Rico trench to the Caribbean Sea. It is concluded that the Mohorovičić discontinuity (characterized by compressional-wave velocities of about 8 km/sec) lies at 9 km below sea level under the ocean basin, 12 km under the Caribbean Sea, at about 16 km under the trench, at slightly shallower depth under Puerto Rico. The large negative gravity anomaly is attributed to a great thickness of sediments in the trench rather than to a "sialic root" due to a down-buckle of the crust under the trench, as formerly thought.

Turbidity currents are assigned an important role in the accumulation of the sediments. It is suggested that a trench formed in an unspecified way quickly collects sediments, largely by turbidity currents. When granitized and uplifted the sediments form an island arc like the West Indies. Contamination of basaltic lavas by the sediments can account for andesitic lavas, and the accompanying water, rather than being juvenile, is derived from sea water. The trenches at or near the continental margins confine continental debris to the continental margins and collect oceanic debris. The basaltic crust and this debris are first formed into an island arc and later into a continental addition.—*Authors' Abstract*

156–17. Worzel, J. Lamar, and Ewing, Maurice. Gravity anomalies and structure of the West Indies, Part II: Geol. Soc. America Bull., v. 65, no. 2, p. 195–200, 1954.

In relation to the gravity and seismic work described in the preceding abstract, measurements were made at 44 new gravity stations on a profile extending from about 200 miles due north to 200 miles due south of San Juan, Puerto Rico. This paper presents the gravity profile and structure sections along that line, together with a map showing the location of gravity and seismic stations.—*D. B. V.*

156–18. Uhley, Robert P., and Scharon, [H.] LeRoy. Gravity surveys for residual barite in Missouri: Mining Engineering, v. 6, no. 1, p. 52–56, 1954.

Large blocks of residual barite and gravel barite, buried in a mantle of dark-red clay overlying the Potosi dolomite, have been successfully located by precise, detailed gravity surveys in Washington County, Mo. Barite tonnages have been

estimated from the gravity data within 35 percent. In addition to small gravity anomalies caused by barite bodies, anomalies may also be caused by irregularities in the bedrock surface and concentrations of quartz and dolomite in the residuum.—*L. C. P.*

156–19. Pohly, Richard A. Gravity case history: Dawn No. 156 pool, Ontario: Geophysics, v. 19, no. 1, p. 95–103, 1954.

The Dawn No. 156 pool in southwestern Ontario was discovered in January 1952 on a gravity maximum. The gravity survey had been made with a Worden meter on 1,000-foot spacing along the main roads. Because of the salt beds that occur in relatively long trends, and because the reefs have shown a consistently circular shape, only those gravity maxima that showed little elongation were considered as evidence of reefs. By April 1953, seven wells had been drilled on gravity anomalies, and reefs were found in five.—*M. C. R.*

156–20. Oldham, C. H. G. The correlation between pre-Cambrian rock densities and Bouguer gravity anomalies near Parry Sound, Ontario: Geophysics, v. 19, no. 1, p. 76–88, 1954.

A gravity survey and a survey of rock densities have been carried out over an area of two thousand square miles near Parry Sound. A closed positive Bouguer gravity anomaly of thirty milligals was delineated, and a considerable variation was found to exist in the densities of pre-Cambrian gneisses. In most previous interpretations of gravity over the Canadian Shield the gneisses have been assumed to possess a unform density and anomalies have been attributed to changes in the thickness of horizontal crustal layers. In this paper it is shown that the Parry Sound anomaly can be explained in terms of structures within the crust taking the form of projections downward of the density variations found at the surface. The postulated structure is a nearly circular basin of dense gneisses. The shape is reasonable and agrees with such geological evidence as is available.—*Author's Abstract*

156–21. Cook, Alan Hugh, and Thirlaway, Henry Ivison Shipley. A gravimeter survey in the Bristol and Somerset coalfields: Geol. Soc. London Quart. Jour., v. 107, pt. 3, p. 255–286, 1951 (1952).

The variations of gravity in the Bristol and Somerset coalfields are shown to correspond in a general way to the geologic structure, but discrepancies in detail indicate that the anomalies are partly due to structures underlying the coalfields that may have controlled the development of sedimentation and deformation in the region. Detailed studies were made in certain areas to assist the planning of a program of exploratory boring.—*D. B. V.*

156–22. Selem, A. M., and Monnet, C. Application of vertical gradients and comparison of different geophysical methods in a difficult area: Geophys. Prosp. v. 1, no. 3, p. 208–219, 1953.

Seismic-reflection, telluric, and gravity maps are presented for the uplifted area of Ferrara in northern Italy. There is good agreement between the gravity anomalies and the shallow seismic anomalies. For parts of the area where seismic results are poor, the first vertical derivative map of gravity compares favorably with that based on telluric data. Profiles of residual anomalies, vertical gravity gradients, telluric currents, and seismic reflections are given

for a line northwest of Ferrara and compared to the stratigraphic data from two adjacent wells, Diamantina B. and Vincenza Nuova. From this comparison Selem and Monnet postulate the existence of a fault between the two wells.—*I. Z.*

156–23. Fabiani, Ramiro. Sulle interpretazioni geologiche delle anomalie negative della gravità regionale in Sicilia [On the geological interpretation of the negative regional gravity anomalies in Sicily]: Accad. Naz. Lincei Atti, Cl. sci. fis. mat. e nat. Rend., v. 14, fasc. 3, p. 365–373, 1953.

This is an abridged version of a paper published in La Ricerca Scientifica (Geophys. Abs. 14615).—*D. B. V.*

156–24. Norinelli, Armando. Collegamento gravimetrico pendolare fra Padova e Trieste [Gravimetric tying by pendulum method of Padova and Trieste]: Ist. Veneto sci. lettere ed arti Atti., Cl. sci. mat. e nat., tomo 110, p. 41–64, 1952.

During the summer of 1951 a gravimetric tie was made between the Osservatorio Astronomico of Padova (45°24.0′ N. lat., 11°52.3′ E. long.) and the Osservatorio Geofisico of Trieste (45°38′ N., lat., 13°45.1′ E. long.).

Mioni's bipendular apparatus, provided with vacuum chambers and six interchangeable pendulums, was used. Time measurements were made with two Nardini chronometers tied by radio signals with the stations of Rugby, Great Britain and Pontoise, France. Forty-eight measurements were made, and the results obtained were treated by the methods of the calculus of observations. The difference Δg between Padova and Trieste was found to be $\pm$ 0.0008 gal., which is in good agreement with the difference previously obtained by C. Morelli (see Geophys. Abs. 12315).—*S. T. V.*

156–25. Pícha, Jan. Report on gravimetric measurements carried out at points of the basic gravimetric network during 1948 and 1949 on the territory of Czechoslovakia: Czechoslovak Jour. Physics, v. 1, no. 1, p. 24–26, 1952.

An outline is presented of gravimetric work in Czechoslovakia during 1948–49 in the first and second order of the networks. Stations were selected on the basis of their accessibility and freedom from industrial disturbances. From the known geographic coordinates of the stations, normal gravity was computed using Cassinis' formula. The altitude was determined by barometric measurements.

A Nørgaard gravimeter was used and differences in gravity at each station were measured eight times, with an average accuracy estimated to be 0.15 mgal. The established basic gravimetric network was tied to several pendulum stations that had been previously tied to Potsdam geodetic system.—*S. T. V.*

156–26. Filjak, R., and Galovic, S. Rezultati geoloskih i geofizickih ispitivanja istocnog dijela Banije [Results of geologic and geophysical exploration of the eastern part of Banija]: Nafta (Yugoslavia), godina 4, broj 7, p. 205–212, 1953.

During 1952 gravimetric measurements were made in the area south of the Sava river in the Banija region, Croatia, in exploration for geologic struc-

tures favorable for the accumulation of oil. The results of the survey are presented as an isogam map. A strong anomaly with a maximum of +28 mgal was found. It is probable that this anomaly is caused by the greater density of Eocene and other older deposits extending in the direction of the great syncline along the Sava. Several less important gravity maxima of as much as 23 mgal were also found. The possible geologic cross sections producing these maxima are suggested.—*S. T. V.*

156–27. Janković, S. Mogućnost istrazhivańa khromita pomoću gravimetra u oblasti Ljubotenskog masiva [The effectiveness of gravimeter measurements in prospecting for chromite in the region of Ljuboten massif]: Glasnik Prirod. Mus. Srpske Zemle, Ser. A., knńiga 4, p. 183–195, 1951.

The massif of Ljuboten is composed of dunite, harzburgite, and other rocks of the peridotite group. The average density of the upper formations ranges from 2.34 to 2.94. The density of the chromite-bearing rock is only 0.3 mgal greater, but owing to its shallow depth it has been possible to locate the chromite bodies. A Nørgaard gravimeter was employed in this study because the torsion balance would not give sufficient accuracy, on account of unfavorable topographic conditions. The gravity profiles are shown and their interpretation discussed in the paper.—*S. T. V.*

156–28. Societé Cherifienne des Petroles, and Aynard, C. An attempt to interpret the gravimetric map of the northern part of the Moroccan Basin of Gharb. Maps of residual anomaly and first derivative: Geophys. Prosp., v. 1, no. 4, p. 279–290, 1953.

The main features of the gravimetric map of the Gharb [Rharb] correlate well with the configuration of the basement as indicated by other geophysical and geologic information. The Cretaceous and Miocene layers in the basin have a total maximum thickness of 13,000 feet. To interpret local features in the northern part of the basin, residual and first derivative anomalies were constructed from the Bouguer anomaly map. On the derived maps the geologically ill-defined boundary between the "Hills Basin" and "Plains Basin" was successfully delineated. The derivative and residual maps also agree well with local seismic and electrical data. Most of the local features are attributed to Cretaceous Preriffan tectonics. The authors are thoroughly convinced of the complete objectivity of the first derivative method.—*R. G. H.*

156–29. Thyer, R. R., and Vale, K. R. Geophysical surveys, Oaklands-Coorabin coal field, New South Wales: Australian Bur. Min. Resources Geology and Geophysics Bull. 19, p. 7–35, 1952.

During 1948-1950, extensive gravity surveys were made over an area of about 1,450 square miles around the Oaklands-Coorabin coal field in the Riverina division of New South Wales to map the boundaries of the Coal Measures. Seismic surveys were made in addition to try to obtain thickness of sediments at several critical places and to provide a control for separating effect of sediments from the regional effect. The residual gravity map suggests the presence of a Permian basin approximately 600 square miles in area with a possible extension in northwesterly direction.—*S. T. V.*

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156–30. Dooley, J. C. Gravity and magnetic reconnaissance Roma District, Queensland: Australian Bur. Min. Resources Geology and Geophysics, Bull. 18, 24 p. 1950.

Gravimetric and magnetic surveys were made during 1947 and 1948 in the Roma district of Queensland, Australia, in search for oil. Altogether 750 stations were occupied. A Western gravimeter with a Watts vertical variometer were used. The results of the investigation are presented as gravity and magnetic contour maps of the areas.—*S. T. V.*

MAGNETISM

MAGNETIC FIELD OF THE EARTH

156–31. Takeuchi, Hitoshi, and Shimazu, Yasuo. On a self-exciting process in magneto-hydrodynamics: Jour. Geophys. Research, v. 58, no. 4, p. 497–518, 1953.

Bullard (1949) proposed that the earth's main field may be produced and maintained by a self-exciting dynamo driven by convection currents in the core. Maxwell's equations of electrodynamics are examined for solutions supporting Bullard's model. The expressions for magnetohydrodynamic coupling lead to differential equations which with the boundary conditions constitute an eigenvalue problem. Approximate solutions are obtained for chains of coupling of magnetic fields involving harmonics up to the fourth degree. It is concluded that the self-exciting dynamo is possible by a variety of fluid motions; that the maximum radial velocity of the fluid in the core of the order 10^{-2} cm per sec and that the dynamo model is driven by comparatively low harmonics.—*R. G. H.*

156–32. Fanselau, G[erhard], and Lucke, O. Zur Frage der Erklärung des erdmagnetischen Kernfeldes [On the question of the explanation of the geomagnetic field of the core]: Forschungen u. Fortschr., Jahrg. 27, Heft 3, p. 73–75, 1953.

Fanselau and Lucke take issue with H. Haalck concerning his theory of the genesis of the magnetism of the earth's core (see Geophys. Abs. 13307 and 14785). They affirm that Haalck's derivation is based on the statistical theory of Boltzmann, applicable to the kinetic theory of gas, whereas the statistical computations of electron movements must be based on the Fermi-Dirac theory. Therefore Haalck's conclusions cannot be applied to the problem discussed.—*S. T. V.*

156–33. Stoyko, Nicolas. Sur la variation de la rotation de la Terre et l'inversion de la polarité du champ magnétique terrestre [On the variation of the rotation of the earth and the inversion of the polarity of the geomagnetic field]: Acad. Sci. Paris Comptes Rendus, tome 236, no. 16, p. 1591–1593, 1953.

Studies of the variation of the rotation of the earth about its axis have shown that for each variation of the length of rotation there is a corresponding variation in the magnetic field of the earth. The magnetic field at the pole is about 0.66 gauss. For an inverse field of the same intensity, the total field at the pole must be decreased by about 1.32 gauss. According to Hospers the polarity lasts for a period of about 500,000 years and the time necessary to change the po-

larity is about $1/10$ that. Thus to explain the inversion of the polarity the length of the day must increase during a period of about 550,000 years. The rotation of the earth is slowed by the friction of the tides, and this slowing down, if long enough, should reverse the polarity of the field. If the present rate of 0.00164 sec per century has persisted for 550,000 years, the day has increased by about 9 seconds, and this is sufficient to explain the reversal. As in the past the field has been reversed several times it is necessary to postulate a cause of periodic acceleration in the rotation of the earth. This cause could be the coincidence between the period of rotation of the earth and the free period of resonance of the atmosphere.—*M. C. R.*

156–34. Gaibar-Puertas, C. Caractéristiques de la variation séculaire du signe et de l'intensité de l'aimantation moyenne du globe [Characteristics of the secular variation of sign and intensity of the mean magnetization of the globe]: Ciel et Terre, 69° année, fasc. 11–12, p. 297–301, 1953.

Gaibar-Puertas has made a global analysis of the mean annual values of total intensity F for the last 5 years and has calculated the mean annual variation registered by all observatories for 5-year periods from 1880 to 1950. These mean values have been analyzed according to sign of the variation, with the northern and southern hemispheres considered separately as well as together. The average absolute values were also calculated for each hemisphere and for the whole globe.

The resulting curves show that, in general, the remagnetization observed between epochs 1930–1935 and 1940–1945, as well as the demagnetization which began more recently, are general in character, affecting the hemispheres inpendently of the sign of secular variation.—*D. B. V.*

156–35. Kalinowska, Zofia. Some remarks on the secular variations of the earth's magnetic field in Poland: Acta Geophys. Polonica, v. 1, no. 3–4, p. 208–217, 1953.

This is an analysis of observations made at the Świder observatory since 1921. The annual mean and secular changes are presented in a table, and graphs compare the variation of the various magnetic elements (ΔD, ΔI, ΔH, and ΔZ) at Świder, Niemegk, Lovö, Rude Skov, and Sluck.—*D. B. V.*

156–36. Dermul, Am. Une détermination de la declinaison magnétique à Anvers, au debut du XVIII^e siécle [A determination of the magnetic declination at Antwerp at the beginning of the 18th century]: Ciel et Terre, 69° année, fasc. 11–12, p. 317–319, 1953.

The monk Bouvart recorded measurements of magnetic declination made at Antwerp on June 11, 12, and 13, 1710. His manuscript also records 12 earlier determinations, beginning in 1571, giving time and place of each. Plotted graphically, these early values fall into an appreciably regular curve.—*D. B. V.*

156–37. Wijk, A. M. van, and Viljoen, J. D. Magnetic observations at the secular variation stations in Southern Rhodesia: South African Jour. Sci., v. 50, no. 4, p. 94–97, 1953.

Reoccupation of magnetic field stations in Rhodesia has yielded accurate data on secular variation for that territory. Tables give the absolute values of the magnetic elements and the secular variations of D, H, Z, and I for 1948–1953

(per annum) at 6 field stations (Salisbury, Umtali, Fort Victoria, Bulawayo, Livingstone, and Chirundu). Diurnal variations at Salisbury and Bulawayo are compared with corresponding curves for Hermanus and Elisabethville.—*D. B. V.*

156–38. Oriol Cardús, J. Nota relativa a la actividad solar y geomagnetica [Note on solar and geomagnetic activity]: Rev. Geofísica, año 12, no. 46, p. 140–148, 1953.

From analysis of geomagnetic and solar observations made at the Ebro observatory, Spain, during the first three months of 1953, Oriol Cardús finds a noticeable decrease of sunspots during this period, confirming the 11-year periodicity of sunspot activity. On the other hand, no decrease in geomagnetic or electrotelluric disturbances was noted.—*S. T. V.*

156–39. Hulburt, Edward O. Magnetic storms, aurorae, ionosphere and zodiacal light: Sci. Monthly, v. 78, no. 2, p. 100–109, 1954.

After a fairly detailed explanation of his ultraviolet-flare theory and of the neutral-stream theory of magnetic storms of Chapman and Ferraro, Hulburt concludes that at present the most reasonable hypothesis is the former, in which the sun emits a flare of ultraviolet light together with a spray of ions and electrons. The ultraviolet light causes changes in the ionosphere which give rise to the magnetic storm, and the ions proceed as a magnetically self-focused stream to high latitudes to cause aurorae and magnetic disturbances.

The paper continues with a short discussion of two theories explaining zodiacal light and gegenschein, the planet-dust theory, and the atmospheric-ion theory. In conclusion, Hulburt draws attention to the possible effects produced in the upper atmosphere by sweep up by the earth of interplanetary material, and of electric charge brought to the earth by cosmic rays, either of which may possibly produce greater effects than the magnetic storm theories outlined above.—*D. B. V.*

156–40. Meek, J. H. Correlation of magnetic, auroral, and ionospheric variations at Saskatoon: Jour. Geophys. Research, v. 58, no. 4, p. 445–456, 1953.

An analysis has been made for the five-month period from December 1951 to April 1952 of the variations at Saskatoon of the horizontal component (H) of the earth's magnetic field, the position in the sky and intensity of auroral light, and of critical frequencies and heights of the ionospheric reflecting regions.

There is a relationship between the maximum elevation above the northern horizon of auroral light and the maximum amplitude of variation of H. Some types of sporadic E reflecting layers appear more frequently during disturbances.

Detailed analysis of magnetically disturbed nights shows that magnetic bays and certain other phenomena are correlated. An increase in the intensity of aurora is related to the rate of decrease of H in the bay. Radio-wave absorption or weak reflections at levels below 100 km correspond to the periods when H is of the order of 500 gammas or more from its normal value.—*Author's Abstract*

MAGNETIC PROPERTIES OF ROCKS AND MINERALS

156–41. Nagata, Takes[h]i. Rock magnetism: 236 p., Tokyo, Maruzen Co., 1953.

This is a review of present knowledge of the magnetism of rocks. The topics covered are: magnetic properties of rock-forming ferromagnetic minerals and of rocks, instruments and methods of measuring the magnetic properties of rocks,

the remanent magnetization of igneous and sedimentary rocks, and such "geophysical problems" as paleomagnetism, inverse remanent magnetization, and the relation of rock magnetism to magnetic anomalies and local variations in the geomagnetic field.—*M. C. R.*

156–42. Bates, L. F., and Martin, D. H. Domains of reverse magnetization: Phys. Soc. London Proc., ser. A, v. 66, pt. 2, p. 162–166, 1953.

An experimental study by the powder deposit technique has been made of interesting domains of reverse magnetization which arise when an initially saturated crystal of silicon-iron is demagnetized. Two cases have been studied with the crystal (a) as perfect as possible, and (b) with an artificial defect made at the end to provide controlled demagnetization effects. They show that imperfections in the surface are very important in determining the observed demagnetization phenomena. The surfaces of the crystals may themselves act as imperfections.—*Authors' Abstract.*

156–43. Néel, Louis. Sur le ferromagnétisme des ferrites ou ferrimagnétisme [On the ferromagnetism or ferrimagnetism of ferrites]: Physica, v. 16, no. 3, p. 350–351, 1950.

A formula is derived that gives the variation of the spontaneous magnetization of $Fe_2O_3 \cdot FeO$ with temperature, making possible the determination of the temperature at which the substance loses its magnetism even below the Curie point. Good agreement was found between the temperatures determined by the formula and the experimental results.—*S. T. V.*

156–44. Alexopoulous, K., and Theodossion, A. On the nature of ferromagnetism in pyrrhotite: Phys. Soc. London Proc. ser. B, v. 66, pt. 1, p. 753–759, 1953.

The g-value of 0.63 for pyrrhotite indicates that there is a large contribution to the magnetization from orbital moment. The electron density distribution will therefore depend on the direction of magnetization, and the intensity of X-ray reflections from a suitable plane might be expected to show a detectable dependence on this direction. Inglis showed in 1934 that the g-value was consistent with the carrier being a d-- electron with $m_1=+2$, $m_0=-\frac{1}{2}$. On this assumption calculations have been made of the electronic and atomic form factors (for one effective d— electron per atom) and of the structure factors for reflection on the (110) plane for magnetization normal and parallel to this plane. Although the electronic form factor in the first case is nearly twice as great as in the second, the final calculated difference in intensity is only about 0.83 percent. A long series of careful intensity measurements has been made, using ionization chamber methods and the experimental result for the difference is $0.30 \pm 0.15\%$. It is thus shown experimentally that either there is no change in charge distribution with direction of magnetization in pyrrhotite, or the change is much smaller than that indicated by theoretical calculations for the simplest type of model consistent with the experimental g-value.—*Authors' Abstract.*

156–45. Nagata, Takes[h]i. Self-reversal of thermo-remanent magnetization of igneous rocks: Nature, v. 172, no. 4384, p. 850–852, 1953.

Of the many rocks examined only one, a dacitic pitchstone from Mount Aso, (Aso-zan) Japan, exhibits self reversal of thermoremanent magnetism in the

laboratory. This rock contains ferromagnetic mineral grains, 0.1 to 0.5 mm in diameter, of three types: *A*, with a Curie point between 500° and 530° C., *B*, with a Curie point between 200° and 250° C., and *AB*, with both *A* and *B* in varying proportions. By grinding *AB* grains to 3–5 microns the two components can be separated. *A* is found to be cubic titanomagnetite with 58.7 percent Fe_2O_3, 34.2 percent FeO, and 7.0 percent TiO_2. *B* is rhombohedral, with a composition of 43.5 percent Fe_2O_3, 24.2 percent FeO, and 32.3 percent TiO_2, between ilmenite and hematite. As *A* and *B* have normal thermoremanent magnetization and the *AB* grains, reverse thermoremanent magnetization, it seems likely that the phenomena can be best explained by Néel's two-phase theory (see Geophys. Abs. 13319). —*J. R. B.*

INSTRUMENTS AND METHODS OF OBSERVATION

156–46. Wickerham, W. E. The Gulf airborne magnetic gradiometer: Geophysics, v. 19, no. 1, p. 116–123, 1954.

The Gulf airborne gradiometer is an attachment used in conjunction with a standard Gulf airborne magnetometer. As the magnetometer has sufficiently fast response to follow faithfully rapid changes in intensity, it is possible to take the time derivative of the recorded intensity as a measure of the time rate of change of the magnetic variations traversed. The time-derivative record may be converted to a gradient record by converting time into distance, as the aircraft travels in a substantially straight line at a known ground speed. Experiments with laboratory-simulated anomalies have demonstrated the success of the gradiometer. A partial block diagram of the circuit is included. —*M. C. R.*

156–47. Bruckshaw, J. M. The initial adjustments of vertical variometers: Geophys. Prosp., v. 1, no. 4, p. 259–271, 1953.

The mean of two readings taken in azimuths 180° apart only eliminates the error of misorientation and of inclination of the knife edge if these factors are sufficiently small. The necessary accuracy in the 180° rotation and in the readjustment of the levels is investigated and a practical test for initial adjustments is developed. To permit rapid carrying out of this orientation test, a new tripod head has been designed, in which the whole of the head has been mounted on a ball-and-socket joint so the axis of the system can be moved within a cone of about 15° semivertical angle.—*M. C. R.*

156–48. Bebestyén, Károly. Egyszerű berendezés kőzetek mágneses szuszceptibilitásának meghatározására [Simple apparatus for the determination of the magnetic susceptibility of rocks]: Magyar Állami Eötvös Loránd Goefiz. Intézet Geofiz. Közlemények, kötet 2, szám 2, p. 21–24, 1953.

A simple apparatus, constructed in the laboratories of the Hungarian geophysical institute, by which the magnetic susceptibility of rock samples can be accurately determined even under field conditions, consists of an oscillating circuit containing an induction coil. The natural frequency of the circuit is determined with the coil alone and with the coil containing a core of the rock being tested. From the difference of the inductances of the coil, the magnetic susceptibility of the sample can be computed. The dimensions of the apparatus

could be decreased by using a flashing quartz oscillator as the frequency standard. A wiring diagram and photograph of the apparatus are given.—*S. T. V.*

156–49. Zietz, Isidore, and Henderson, R. G. Total-intensity magnetic anomalies of three-dimensional distributions by means of experimentally derived double layer model fields: Science, v. 119, no. 3088, p. 329–330, 1954.

A series of experimental measurements of the total magnetic intensity in the direction of the inducing field has recently been completed for a series of models as part of a program to devise rapid methods for the interpretation of total-intensity aeromagnetic maps. Experiments were conducted in a building of nonferrous material in which a Helmholtz coil is used to simulate the field of the earth, and models composed of uniform mixtures of 1 part magnetite and 2 parts plaster of paris and of several different dimensions were studied. Experimentally derived field maps will be made available in a form independent of the susceptibility of the model and the strength of the inducing field and dependent only on the geometry of the model so that complicated bodies may be built up by proper combination of blocks and the total normalized field computed arithmetically.—*M. C. R.*

MAGNETIC OBSERVATIONS AND SURVEYS

156–50. Barta, György, and Dér, Miklós. Mágneses mérések a békebarlang új bejáratának kitüzésére [Magnetic measurements as the aid in determination of the entrance of the cavern named "Peace"]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 2, szám 8, p. 67–72, 1953.

Magnetic measurements to find the entrance to a newly discovered cavern covered with a thick layer of sediments in Aggtelek, Hungary, are described. An electromagnet with a vertical axis which could be energized by a commutating current was placed at a suitable point over the long axis of the cavern, and the magnetic field produced by the electromagnet in the ground was measured at numerous stations with a Schmidt magnetometer. By this procedure it was possible to determine the depth to the cavern and to find the place where an entrance could be most easily dug. This method had the advantage of being independent of local magnetic anomalies and disturbances of the geomagnetic field.—*S. T. V.*

156–51. Kutscher, Fritz. Zur Erdmagnetik der Eifel-Senke [On the geomagnetism of the Eifel depression]: Deutsch. Geol. Gesell. Zeitschr., Band 103, p. 216–218, 1951 (1952).

Positive anomalies to the east and west of the negative middle Devonian Kalkmulden zone are ascribed to Variscan plutons. The north-south structural trend of the whole Eifel region fits into a Rhenish tectonic pattern.—*D. B. V.*

156–52. U. S. Geological Survey. Total intensity aeromagnetic maps of Minnesota: Geophys. Inv. Maps GP 98, 99, 100, and 102, 1953.

The following maps show by contour lines the total magnetic intensity at approximately 1,000 feet above the earth's surface and the geology of the area, as prepared by G. M. Schwartz of the Minnesota Geological Survey: East-central Itasca County (GP 98), southeastern Itasca County (GP 99), northern Aitkin County (GP 100) and parts of Kanabec, Mille Lacs, and Pine Counties (GP 102).

Profiles accompany each map. All are on a scale of 1 inch=1 mile, and the contour interval is 50 gammas in GP 102, 50 and 250 gammas in GP 99 and GP 100, and 50, 250, 500, 1,000, and 5,000 gammas in GP 98.—*M. C. R.*

156–53. Canada Geological Survey. Aeromagnetic maps of Newfoundland: Dept. of Mines and Tech. Surveys, Geophysics Papers 176–180, 1954.

The following quadrangles in Newfoundland have been published as blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level: G. P. 176, Badger; G. P. 177, Buchans; G. P. 178, Mount Peyton; G. P. 179, Gander, G. P. 180, Grand Falls.—*D. B. V.*

156–54. Canada Geological Survey. Aeromagnetic maps of Province of New Brunswick: Dept. of Mines and Tech. Surveys, Geophysics Papers 121–123, 125, 129–145, 147, 1953; and 154, 155, 166, 66 (revised ed.), 1954.

This is a continuation of the series listed in Geophys. Abs. 13005, 13211, and 13451. The following quadrangles in the Province of New Brunswick have been published as blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 500 feet above ground level: G. P. 121, Big Bald Mountain, in Northumberland County; G. P. 122, Serpentine Lake, in Northumberland and Victoria Counties; G. P. 123, McKendrick Lake, in Northumberland County; G. P. 125, Grand Falls, in Victoria and Madawaska Counties; G. P. 129, Tobique, in Victoria County; G. P. 130, Florenceville, in Carleton County; G. P. 131, Plaster Rock, in Victoria County; G. P. 132, Andover, in Victoria and Carleton Counties; G. P. 133, Doaktown, in Northumberland and York Counties; G. P. 134, Aroostook, in Victoria County; G. P. 135, Napadogan, in York County; G. P. 136, McAdam, in York and Charlotte Counties; G. P. 137, Forest City, in York County; G. P. 138, Haynesville, in York, Northumberland, Carleton, and Victoria Counties; G. P. 139, Fosterville, in York and Carleton Counties; G. P. 140, Woodstock, in Carleton County; G. P. 141, Burtts Corner, in York County; G. P. 142, Juniper, in Carleton, Victoria, and York Counties; G. P. 143, Coldstream, in Carleton and York Counties; G. P. 144, Tuadook Lake, in Victoria, Northumberland, York, and Carleton Counties; G. P. 145, Canterbury, in York and Carleton Counties; G. P. 147, Millville, in York and Carleton Counties; G. P. 154, Charlo, in Restigouche County; G. P. 155, Campbelltown, in Restigouche County; G. P. 166, Upsalquitch Forks, in Restigouche County; and 66 (revised), California Lake, in Northumberland, Gloucester, and Restigouche Counties.—*D. B. V.*

156–55. Canada Geological Survey. Aeromagnetic maps of Province of Ontario: Dept. of Mines and Tech. Surveys, Geophysics Papers 109, 110, 113, 118, 124, 126, 127, 128, 146, 148, 1953.

This is a continuation of the series listed in Geophys. Abs. 13000, 13931, and 14247. The following quadrangles in the Province of Ontario have been published as blue-line aeromagnetic maps, which show by contour lines the total magnetic intensity at about 1,000 feet above ground level: G. P. 109, Barrys Bay, in Hastings and Renfrew Counties and Nipissing District; G. P. 110, Wilberforce, in Haliburton and Hastings Counties; G. P. 113, Orilla, in Simcoe, Ontario, and Victoria Counties; G. P. 118, Gravenhurst, in Victoria, Simcoe, and Ontario Counties and Muskoka District; G. P. 124, Orr Lake, in Simcoe County; G. P. 126, Lake Joseph, in Muskoka and Parry Sound Districts; G. P. 127, Seguin

Falls, in Parry Sound and Muskoka Districts; G. P. 128, Penetanguishene, in Simcoe County and Muskoka District; G. P. 146, Gooderham, in Peterborough, Haliburton, and Hastings Counties; G. P. 148, Bracebridge, in Muskoka District.—*D. B. V.*

156–56. Canada Geological Survey. Aeromagnetic maps of the Province of Quebec: Dept. of Mines and Tech. Surveys, Geophysics Papers 120, 149–153, 156–160, 1954.

This in a continuation of the series listed in Geophys. Abs. 13004, 13006, 13454, 13706, 13930, 14100, 14248. The following quadrangles in the Province of Quebec have been published as blue-line aeromagnetic maps, which show by contour lines the total magnetic intensity at about 500 feet above ground level: G. P. 120, Armstrong, in Beauce and Frontenac Counties; G. P. 149, St. Malachie, in Bellechasse, Dorchester, and Levis Counties; G. P. 150, St. Joseph, in Dorchester and Beauce Counties; G. P. 151, Beauceville, in Beauce, Dorchester, and Frontenac Counties; G. P. 152, Megantic, in Frontenac County, G. P. 153, St. Evariste, in Frontenac and Beauce Counties; G. P. 156, Disraeli, in Wolfe, Frontenac and Megantic Counties; G. P. 157, Scotstown, in Frontenac, Compton, and Wolfe Counties; G. P. 158, Lyster, in Lotbiniere, Megantic, Nicolet, and Arthabaska Counties; G. P. 159, Thetford, in Megantic, Beauce, Frontenac, and Wolfe Counties; G. P. 160, St. Sylvestre, in Lotbiniere, Megantic, Beauce, and Dorchester Counties.—*D. B. V.*

ELECTRICITY

GENERAL AND THEORETICAL STUDIES

156–57. Huber, A. Die Randwertaufgabe der Geoelektrik für Kugel und Zylinder [The boundary value problem of geoelectrical exploration for a sphere and a cylinder]: Zeitschr. angew. Mathematik u. Mechanik, Band 33, Heft 10–11, p. 382–393, 1953.

The electrical-resistivity methods are theoretically based upon the potential of the field that is generated by a point source in a nonhomogeneous medium. The potential, vanishing at infinite distance, is determined by the strength of the source and by two homogeneous boundary conditions at the contact of two media of different electric constants. Physical quantities measured on the surface and those on the plane boundary surface separating two geologic formations with different electric properties can be correlated. In the present study the theory is extended for the case when this boundary surface is a sphere or a cylinder of revolution. The potential is constructed for surfaces of cylindrical and spherical symmetry, and is discussed in detail for the special case of a mine gallery, with circular cross-section as an example.—*S. T. V.*

156–58. Lipskaya, N. V. Anomal'noye pole local'noy neodnorodnosti s konechnym znacheniyem elektroprovodnosti [Anomaly field produced by a local heterogeneity of finite electro-conductivity]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, p. 514–522, 1953.

Continuing her studies on the electrical anomalies produced by a buried mass, Lipskaya analyzes the case of a body of finite conductivity (see Geophys. Abs. 11833). The ground is homogeneous and isotropic with a known electric con-

ductivity σ_2. It is also assumed that $\sigma_2 < \sigma_1$, but is of the same order of magnitude, which precludes the assumption that the surface of the disturbing body is an equipotential surface. The electrical field is produced by a point source at the surface.

Using the method of images and representing the field intensity with the aid of spherical functions, a general theoretical analysis of the problem is presented and the intensity of the field is given in the form of converging series. No numerical examples are given.—*S. T. V.*

156–59. Chanturishvili, L. S. Ob iskazhenii odnorodnogo elektricheskogo polya nerovnost'yu dnevnoy poverkhnosti v vide chetyrekhgrannoy prizmy [On the disturbance of a homogeneous electric field produced by an irregularity having a prismatic cross section] : Akad. Nauk Gruzinskoy SSR Soobscheniya, tom 12, no. 10, p. 597–603, 1951.

Placing the zero point of the coordinates on the undisturbed plane of the earth and choosing for the x-axis the direction of the current, for the Oy-axis downward vertically, Chanturishvili denotes the intensity of the field at any point of lower semispace as $z=x=iy$, where x and y are its coordinates. The Christoffel-Schwarz theorem is applied for conformal mapping, and in the formula obtained for the transformed plane, the function under the integral sign is developed into a series that is broken up after two terms. This gives an approximate expression adaptable for numerical computations.

Having derived the formula for the general case, Chanturishvili then discusses certain special cases and gives the results in the form of graphs constructed for different shapes of the cross section of the trough. As a corollary to the analysis presented, the conclusion can be drawn that an embankment disturbs the pattern of electric field more than a trough of the same shape.—*S. T. V.*

ELECTRICAL PROPERTIES OF ROCKS AND MINERALS

156–60. Mansfield, R., and Salam, S. A. Electrical properties of molybdenite: Phys. Soc. London Proc., Ser. B, v. 66, pt. 5, p. 377–385, 1953.

The following electrical properties of natural crystals of MoS_2 have been measured: conductivity, Hall coefficient and thermoelectric power over the temperature range —183° C. to 500° C., and the room temperature change of conductivity in a magnetic field. It was found that the majority of the specimens were p-type semiconductors. The variation of the mobility of the charge carriers with temperature has been derived and indicates that the scattering of the charge carriers is mainly due to thermal vibrations of the lattice except at low temperatures when impurity scattering becomes important. Reasonable agreement is obtained between the values of the mobility calculated from the change in conductivity in a magnetic field, and from Hall coefficient and conductivity measurements. The results of the thermoelectric power measurements, and the variation of the concentration of charge carriers derived from the Hall coefficient are discussed and compared with theory.—*Authors' Abstract*

156–61. Wyllie, M. R. J., and Southwick, P. F. An experimental investigation of the S. P. and resistivity phenomena in dirty sands: Jour. Petroleum Technology, v. 6, no. 2, p. 44–57, 1954.

The importance of the so-called "dirty sand" or "conductive solids" problem in electric log interpretation was first stressed in a paper in 1949. Since that

time the problem has been generally recognized as a most serious one. Several research papers bearing on the theory of the effects of clay contaminants on reservoir rock resistivities have appeared. These papers, while contributing to the theory of the problem, have not offered any practical solution.

In the present paper an experimental investigation has been made of the effects of ion-exchange materials on the electrical properties of natural and synthetic porous media. The method used to make synthetic dirty sands is entirely novel and has proved a valuable guide to a better understanding of the properties of dirty sands generally. The effects of the ion-exchange materials on both the resistivity and self potential (S. P.) logs have been examined. From the data obtained it has been possible to formulate a simple, practical method whereby electrical logs of dirty sands can be qualitatively interpreted. The method is in all essentials identical to that presently in use for interpreting clean sands. New light has also been thrown on the significance of the term "formation factor" when it is applied to dirty sands.—*Authors' Abstract*

INSTRUMENTS AND METHODS OF OBSERVATION

156–62. Ciuk, Edward. Geoskop [in Polish with English summary] : Pánstwowy Inst. Geol. Prace, tom 7, p. 65–93, 1951.

A description of the Geoskop is given, and several subsurface investigations with the aid of this instrument, chiefly by R. Börner, are described. In his evaluation of the Geoskop, Ciuk is in agreement with Börner (see Geophys. Abs. 13951) and is enthusiastic about the possible uses of this new instrument; this judgment is in sharp contrast to the opinions of other geophysicists (see Geophys. Abs. 13952, 13953).—*S. T. V.*

156–63. Sebestyén, Károly. Természetes potenciál mérésére szolgáló kompenzátor [Compensator for measurement of self potential] : Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 2, szám 10, p. 91–94, 1953.

A description is given of a compensator specially adapted for measurements of self potentials in geophysical surveys. A wiring diagram and photograph of the instrument are given.—*S. T. V.*

156–64. Krylov, M. K. Geofizicheskaya razvedka polyami vysokikh chastot (Interferentsionnoye zondirovaniye) [Geophysical exploration using fields of high frequencies (Profiling by the interference method)] : Vestnik Moskov. Univ., no. 3, p. 161–179, 1953.

When electromagnetic waves propagating through the ground from a transmitter on the surface of the earth meet a surface separating two layers of different electromagnetic properties, they are partly reflected back to the surface of the earth, producing interference with the initial waves. By observing on a separate receiver the returning combined wave, it is possible on the basis of known equations of electromagnetic field to compute the depth of the reflecting surface. The computations are based not on the relations controlling radio waves, but on those established for electric transmission lines with distributed electromagnetic constants, considering the ground as a wave guide. Established relations were used in several surveys made by the students of Moscow University, but have not yet been tested in practical field work.—*S. T. V.*

156–65. Belluigi, Arnaldo. Teoria dei carotaggi elettromagnetici transitori [Theory of electromagnetic transient logging]: Riv. Geofisica Appl., v. 14, no. 1, p. 19–29, 1953

This paper is part of a study of logging of electromagnetic transients. The theory of the Matranslog is reviewed, a solution is given for measure of the voltage fall in the elementary Eltranslog, and some solution is given for the problem of mutual reception in the Matranslog. A new technique, the lateral electromagnetic transient log, is proposed.—*S. T. V.*

156–66. Militzer, H. Die elektrische Eigenpotentialmethode in Erzbergbau [The self-potential method in mining industry]: Geologie, Jahrg. 2, no. 24, p. 291–292, 1953.

Successful application of the self-potential method can be expected only in regions showing a certain degree of electrolytic heterogeneity of the ground, resulting from the presence of massive bodies or lenses of pyrite, pyrrhotite, magnetite, cobalt ores, and some other minerals. Ground water containing O_2, CO, and different salts acts intensively on sulfide and oxidized ore bodies. It acts differently on the portions not containing oxygen, thus producing chemical asymmetry, with the resulting generation of electromotive forces.

The instrumentation is very simple, consisting only of a potentiometer, two nonpolarizing electrodes, and single core cables. Militzer recommends constructing a vertical self-potential profile, in using this method, and comparing the profile with the corresponding geologic cross section. This makes possible the determination of the carriers of self-potential currents. The greatest depth of penetration will be 60–80 meters.—*S. T. V.*

156–67. Herbold, W. Erfahrungen mit neuzeitlichen Bohrgeräten und verfahren in Braunkohlenbergbau [Experiences with modern drilling tools and methods in brown coal mining]: Braunkohle Wärme u. Energie, Band 5, Heft 19/20, p. 430–440, 1953.

Among recent improvements in exploration for coal are electrical and gamma-ray logging of drill holes. Several parallel profiles obtained by these methods and later checked by drilling are shown.—*S. T. V.*

156–68. Metzger, Adolf A. T. Über elektromagnetische Vertikalsondierungen nach Haalck nebst einer Weiterentwicklung der Darstellung der Messergebnisse [Vertical sounding according to Haalck together with further development of the treatment of the data obtained in measurements]: Åbo Akad. Geol. Mineralog. Inst. Medd., no. 34, p. 53–65, 1952.

Haalck, in 1932, suggested a method of electromagnetic vertical profiling based on the comparison of the horizontal magnetic field produced by the current flowing in the ground from and to electrodes and of the field generated by feeding cables. Developing this idea, Metzger introduces the ratios of the field produced by cables and two other fields, that produced in a homogeneous isotropic ground and in the ground under investigation, neither perfectly homogeneous nor isotropic. Dividing the last ratio by that of the ideal case, he obtains what he calls "coefficient of the field". Changing the distance between the electrodes, he obtains the curve of the field coefficient with peaks characteristic for the area under investigation and corresponding to places of better electric conductivity. Using this curve, it was possible to investigate electromagnetically

several sites. Subsequent drilling confirmed the results of electromagnetic surveying. In most of the investigated areas Quaternary sedimentary deposits or marshy layers covered the bedrock thus making impossible the application of resistivity methods. The method was also successfully applied to logging of drill holes.—*S. T. V.*

156–69. Deppermann, K. Erdölsuche durch Funk [Prospecting for oil with radio waves]: Erdöl u. Kohle, Jahrg 6, Heft 11, p. 729, 1953.

Deppermann reports briefly on the experiments of W. M. Barret in trying to establish by the reflection of radio waves, the boundary surface between formations impregnated with oil and those filled with salt water.—*S. T. V.*

METHODS OF ANALYSIS AND INTERPRETATION

156–70. Barnes, H. E. Soil investigations employing a new method of layer-value determination for earth resistivity interpretation: U. S. Natl. Research Council Highway Research Board Bull. 65, p. 26–36, 1952.

Since 1950 the Michigan State Highway Department has applied geophysical methods to the exploration of the ground when planning new highways. The Gish-Rooney resistivity method with Wenner's arrangement of electrodes was selected. As a result of much field work and calculation of electrical measurements, a method of interpreting field data has been developed, based on the premise that Wenner's formula is a truly fundamental expression for determining the average apparent resistivity of any thickness of an earth mass. It is recognized that the value of E/I in Wenner's formula (E=potential differential across the inner two electrodes, I=current carried through the mass) may give an approximate value of resistance, but it nevertheless serves as a comparative value with which different types of soil may be differentiated from each other.—*S. T. V.*

ELECTRICAL SURVEYS AND WELL LOGGING

156–71. Mainguy, M., and Grépin, A. Some practical examples of interpretation of telluric methods in Languedoc (southeastern France): Geophys. Prosp., v. 1, no. 4, p. 233–240, 1953.

Telluric surveys have been made in four areas in southeastern France. In the Alès-Maruejols basin, the results lead to the location of the discovery well. In two areas the telluric method provided data generally more detailed than gravity data and, in one, more detailed than seismic data. In the Tertiary basin south of Lunel the results seem to be related to very shallow layers and of no practical use for prospecting.—*M. C. R.*

156–72. Hallenbach, F. Geo-electrical problems of the hydrology of West German areas: Geophys. Prosp., v. 1, no. 4, p. 241–249, 1953.

The supply of drinking water and water for general use in the towns and communities of Western Germany is in many cases insufficient. In order to eliminate the difficulties in the supply of water, geophysical methods have been applied to a large extent since the end of the war.

The most important hydrological problems, which were solved successfully by geo-electrical measurements, are as follows: (1) Search for, and delimita-

tion of, areas with salty ground water. (2) Investigation of the geological situation in catchment areas for large waterworks, and the finding of suitable places for the establishment of new plants, and in particular: (3) Search for and determination of the thickness and nature of water-bearing sands and gravels and of the relief of the underlying impervious strata.

Some typical examples are presented herewith.—*Author's Abstract*

SEISMOLOGY

ELASTIC WAVES

156–73. Vaněk, Jeři. A contribution to the theory of elastic waves produced by shock: Czechoslovak Jour. Physics, v. 3, p. 97–119, 1953.

Elastic waves produced by a spherical source in an infinite, homogeneous, isotropic, and perfectly elastic medium are investigated with the assumption that the stress, evenly distributed over the surface of the source exciting stress, is an arbitrary function of time and is produced by an explosion. The azimuthal component of the strain is neglected, which makes the problem a two-dimensional one of the radial propagation of dilatational and shear waves from the sphere.

By applying Laplace transformation, the solution of the problem is reduced to the evaluation of Bromwich-Wagner integrals in the complex plane.

The exciting function is generally aperiodic, but the resulting displacement of the points of the medium is periodic and oscillatory.

In particular, the intensity of the corresponding amplitude A, varying with the distance r from the source, was analyzed and A was found to vary as A_0/r^K, where A_0 is the initial amplitude and K is a variable parameter.—*S. T. V.*

156–74. Homma, S. Love waves in a surface layer of varying thickness: Geophys. Mag., v. 24, no. 1, p. 9–14, 1952.

Previous investigations have shown that Love waves in a strict sense cannot be transmitted in a layer of varying thickness. The propagation of Love-type waves in an approximate sense is investigated for a wedgelike surface layer. Asymptotic solutions are obtained in neighborhoods were the distance, R, from the apex is much greater than the wavelength. In the region where Love-type waves are propagated without much deformation, the velocity and wave form are the same as for a layer of uniform thickness equal to the mean thickness in that region. The distance x in which the wave can be transmitted without losing its general character is of the order of the square root of R, where x and R are in units of wavelength.—*R. G. H.*

156–75. Homma, S., and Nishizawa, Y. Observation of Rayleigh waves propagated over a stratified surface: Geophys. Mag., v. 23, no. 3, p. 191–202, 1952.

The theory of Rayleigh waves propagated over the surface of the ground with a single surface layer has been developed by Sezawa and Kanai who found there are in general two dispersion curves, one a modification of Rayleigh waves in a nonstratified medium, the other quite different. The latter had a finite upper limit of wavelength, a minimum group velocity at a finite wavelength and two maximum group velocities, one at a finite, the other at an infinitesimal wave-

length; in the dispersion curve of the former, one of the maximum group velocities occurs at an infinite wavelength. Sezawa named the former M_1, the latter M_2. From examination of the characteristic equation derived by Sezawa it was found that there are an infinite number of dispersion curves other than M and M_2; these are a kind of overtones of higher order of M and have the upper limit of wavelength as in M_2. The phase and group velocities of the waves at an infinitesimal wavelength coincide with the velocity of the transverse wave in the upper layer. The minimum group velocity of the wave of lowest order but M_2 (here called M_3) has been calculated using the same numerical assumptions as Kanai. The maximum group velocity was not obtained because of the difficulty in exact numerical calculation. The periods of individual waves are in simple relation M_2' (maximum group velocity of M_2) : M_2 : M_3=6 : 3 : 2. The phase velocity of M_2' is greatest, that of M_2 least; group velocities are arranged in order M_2', M_2, and M_3. Motion of the particle in M_3 is in an elliptic orbit, retrograde, but with horizontal amplitude smaller than vertical. All three phases, M_2', M_2 and M_3, have been identified on the record of shocks in the Kantō district.—*M. C. R.*

INSTRUMENTS AND METHODS OF OBSERVATION

156–76. Grenet, Gaston. Les caractéristiques des séismographes électromagnétiques [The characteristics of electromagnetic seismographs]: Annales Géophysique, tome 8, no. 3, p. 328–332, 1952.

It is shown how it is possible, using only two families of curves, to determine all the constants of a seismograph having a pendulum and a galvanometer, or, conversely, to construct a seismograph having specified properties. After presenting the necessary equations, Grenet generalizes the results partially in order to examine the case where several galvanometers are used, with two recorders mounted in cascade, only the last being used for registration.—*D. B. V.*

156–77. Stegena, Lajos. Alacsonyfrekvenciás torziólapos szeizmométer [Low-frequency electrodynamic seismometer with torsion-blade suspension]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 2, szám 5, p. 34–44, 1953.

A description is given of a low-frequency electrodynamic seismometer constructed in the Hungarian geophysical institute. The oscillating system of this instrument is suspended on a torsionally strained tape. This construction notably decreases the frictional resistance of the seismometer.—*S. T. V.*

156–78. Nash, Harry C., and Carome, Edward F. The seismolog: A photoelectric earthquake indicator for a seismograph: Seismol. Soc. America Bull., v. 43, no. 3, p. 283–290, 1953.

This is a description of apparatus in use since September 1948 at John Carroll University, Cleveland, to provide immediate indication that an earthquake has occurred. The deflection of an auxiliary light beam reflected from one of the seismograph galvanometers is detected by a phototube, the electrical impulse is then amplified and carried to a control unit where the signal voltage is again amplified and shaped to operate a relay circuit which in turn actuates a recorder (a modification of the Chronolog) printing the time of the impulse on a paper tape.—*M. C. R.*

156–79. Loper, G. B., and Pittman, R. R. Seismic recording on magnetic tape: Geophysics, v. 19, no. 1, p. 104–115, 1954.

A system of recording and reproducing exploration seismograms on magnetic tape is described. Geophones and amplifiers with broadband response, approximately 4–300 cps, are used to channel the seismic signals to a 13-tract tape recorder. The magnetic tape is 1 inch wide. One of the tracks is used to record a time reference signal. Each broad-band recording is formed into an endless loop and played back in repeating fashion. The signals are fed through a flexible system of filtering and mixing, then examined on the screen of a 12-trace cathode-ray oscilloscope. The sweep of the oscilloscope is synchronized with the loop and, by varying the sweep speed, the entire record, or an expanded portion thereof, is held stationary on the screen. Conventional paper records of the modified record as reproduced on the screen are finally made with a regular seismic camera. Played-back records with variations of filtering and mixing are shown in order to illustrate the potential usefulness of the technique.—*Author's Abstract.*

156–80. Jones, Owen A. The new University of Queensland seismological station: Seismol. Soc. America Bull., v. 43, no. 3, p. 247–254, 1953.

A new station, in operation since May 1951, was set up on the new University campus at St. Lucia (27° 30′ 02″ S. lat., 153° 00′ 53″ E. long) in a circular underground vault. Two Milne-Shaw instruments, three Benioff seismographs, a Sprengnether and three Sprengnether microseismographs form the station equipment. The Benioffs were transferred to Rabaul, New Britain in March 1953 and replaced by two Wood-Anderson seismographs and an oil-damped vertical seismograph. A Benioff variable-reluctance seismometer is on order. Research work underway is described.—*M. C. R.*

156–81. Martin, Hans. Beitrag zur Theorie der Einschwingvorgänge mit besonderer Berücksichtigung des ballistischen Galvanometers [Contribution to the theory of transient vibrations with special attention to the ballistic galvanometer]: Gerlands Beitr. Geophysik, Band 62, Heft 4, p. 275–287, 1952.

The differential equation for vibrations resulting from nonperiodic sources is analyzed with special reference to the relation between the deflection of a ballistic galvanometer and the disturbing impulse. Theoretical solutions are illustrated on the basis of several examples with different initial and boundary conditions.—*S. T. V.*

156–82. García Siñeriz, José. Estudio comparativo de los métodos sismicos de prospección [Comparative study of seismic methods of prospecting]: Rev. Geofísica, año 10, no. 40, p. 263–280, 1951.

The basic relations of two seismic methods, reflection and refraction, are derived, and formulas are given for the depth of reflecting layer, for the velocity of seismic waves, and the time of arrival at different geophones.

The advantages and drawbacks of both methods in particular cases are discussed. The treatment covers not only parallel horizontal layers but also inclined strata.—*S. T. V.*

156–83. Szénás, György, and Ádám, Oszkár, Szeizmogeológiai viszonyok délnyúgat-magyarországon [Seismological conditions in southwest Hungary]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények kötet 2, szám 9, p. 73–89, 1953.

Great difficulties are always met with in seismic-reflection surveying in areas where karst basement is overlain by lenticular sediments. In an investigation designed to improve the technique of geophysical surveys of such areas and to find the limits of applicability of seismic-reflection method in similar cases, numerous seismic profiles were made and the velocity of seismic waves determined in many points in southwest Hungary. Szénás and Ádám conclude that, if the explosion of the charge is produced at some height over the ground, better results can be obtained, because of the more favorable frequency spectrum of the seismic waves.—*S. T. V.*

156–84. Gough, D. I. The investigation of foundations by the seismic method: South African Inst. Civil Engineers Trans., v. 3, no. 2, p. 61–70, 1953.

Seismic prospecting uses explosive charges to investigate geologic formations to a depth of about 10,000 feet, as in prospecting for oil. In studying sites for engineering structures the layer to be investigated is at a depth of only 100–200 feet; this allows the use of hammer blows instead of explosives, as the source of seismic energy. On the other hand, owing to the short distances between the source of energy and the point of observation the time intervals are very short, sometimes only 100–200 microseconds, and must be measured very accurately.

In his investigations Gough employed just one seismometer with cathode-ray tube replacing the galvanometer, the seismometer being connected through an amplifier to the vertical deflector plate. At short ranges the new instrument has notable advantages if the ground is brought to vibrations exceeding the seismic noise level. An account is given of the results obtained in investigations of several sites; the travel-time curves are reproduced and interpreted. In his studies Gough regularly discovered layers of very low seismic velocity, such as 0.26–0.40 km per sec. The results obtained were found to be in good agreement with subsequent drilling.—*S. T. V.*

156–85. Roberts, E. B., and Ulrich, F. P. Seismological activities of the U. S. Coast and Geodetic Survey in 1951: Seismol. Soc. America Bull., v. 43, no. 3, p. 255–268, 1953.

The network of 28 stations continued. New Benioff vertical seismographs were installed at Nelson, Nev., and at Pierce Ferry, Ariz. During the year 15,800 messages about 6,500 earthquakes were received in the Washington office and 1,242 reports from 148 earthquakes were received as part of the questionnaire program in western United States. Data are given for the principal shocks in the United States and territories. Strong-motion, vibration, and tiltmeter programs were continued. Instrumental development and cooperative activities of the agency are also described.—*M. C. R.*

METHODS OF ANALYSIS OF EARTHQUAKE OBSERVATIONS

156–86. Northwood, T. D., and Anderson, D. V. Model seismology: Seismol. Soc. America Bull., v. 43, no. 3, p. 239–246, 1953.

Model experiments on two seismological problems are described, the so-called Lamb problem and the problem of reflection from a spherical surface such as

the earth. In the first, the Rayleigh wave behaved as predicted, progressing without change in form or duration. The *P* phase began sharply and gradually developed into an elongated wave train; the *S* phase was poorly marked. Attenuation was somewhat greater than predicted by Lamb. When a source acting tangential to the surface was produced, the movement was similar when the movement of the source was longitudinal, but only a clearly defined *S* wave resulted when the movement was transverse. In the study of reflections it was found that in minimum-path reflections a tail or "coda" is added to the pulse, and in maximum-path reflections a prelude is added, as suggested by Jeffreys.—*M. C. R.*

156–87. Gutenberg, B[eno]. Wave velocities at depths between 50 and 600 kilometers: Seismol. Soc. America Bull., v. 43, no. 3, p. 223–232, 1953.

A new method is described for finding the velocities of longitudinal and transverse waves in the upper 600 km of the earth's mantle. It is based on the apparent velocity ($d\Delta/dt$) at the point of inflection of the travel-time curve as a function of the focal depth of earthquakes. The resulting velocities below the Mohorovičić discontinuity show a clear decrease with depth with a minimum at a depth of roughly 100 km for longitudinal waves and 150 km for transverse waves. Poisson's ratio increases from about 0.26 at a depth of 50 km to 0.29 at 250 km and does not change noticeably in the deeper part of the earth's mantle. Small local differences in rate of the velocity decrease result in noticeable local differences in amplitudes and perhaps even in travel times at epicentral distances between about 5° and 20°. There is no evidence of a discontinuity in the mantle between the low-velocity layer and a depth of about 900 km, nor of noticeable differences in velocity at any given depth between the various regions for which data are available.—*Author's Summary*

156–89. Rühmkorf, Hans Albert. Laufzeitanomalien im Bereich einer Storung Takahasi [Proof of the theorem of Ryutaro Takahasi]: Rev. Geofísica, año 12, no. 45, p. 1–3, 1953.

A method of graphical determination of the epicenters of earthquakes is suggested, based on recorded time differences in the arrival of transverse and longitudinal waves at three or more seismological stations, as suggested by Takahasi. Carrasco points out that the same procedure can be applied to the problem of determining the thickness of a formation whose lower boundary surfaces reflect seismic waves.—*S. T. V.*

METHODS OF ANALYSIS OF SEISMIC SURVEY DATA

156–89. Rühmkorf, Hans Albert. Laufzeitanomalien im Bereich einer Storung [Travel-time anomalies in the vicinity of a disturbance]: Geophys. Prosp., v. 1, no. 4, p. 272–278, 1953.

The measurement of well velocity data in the well of Scheibenhardt I have shown that it is possible to observe a noticeable measurable increase of the travel time of seismic waves when approaching a disturbance. The tectonic event of the disturbance is combined in this case with a disorder (shattering) of the layers without subsequent cementation.

The significance of these anomalies for reflection seismics is discussed. When existing they will then overlap the diffraction, treated by Th. Krey.—*Author's Abstract.*

156–90. Kunz, Bruno. Strahlenkrümmung und Wellengeschwindigkeit [The ray curvature and cake velocity]: Geofisica Pura e Appl., 1. 26, p. 10–15, 1953.

According to Fermat's principle, the wave is propagated in a medium in such a way that the ray travels between two points in the shortest interval of time. It follows that in nonhomogeneous media, as in seismic prospecting, the ray paths are curved lines. Using variational calculus, Kunz shows that when the seismic velocity increases with depth, ray paths are circles of radius $r=1/aC_1$, where C_1 is a constant and a is the rate of increase of velocity with depth. Similarly Kunz proves that if the velocity increases linearly with the distance from the center of waves, the ray paths are spirals. Some other cases of the variation of velocity of propagation, of interest to astronomers, are also discussed.—*S. T. V.*

156–91. Castro, Honorato de. Curvas de tiempos iguales [Curves of equal travel times]: Ciencia (Mexico), v. 13, no. 4–6, p. 105–108, 1953.

It is known that if the seismic velocity remains constant down to a reflecting boundary, the curves of equal travel time are elliptical. In this article the equation for equal travel time curves is derived for velocity increasing with depth, using the methods of analytic geometry. This facilitates the determination of the depth of the reflecting boundary and the velocity of the seismic waves.—*S. T. V.*

156–92. Dooley, J. C. Calculation of depth and dip of several layers by refraction seismic method: Australian Bur. Min. Resources Geology and Geophysics, Bull. 19, app., 9 p. and 4 figs., 1952.

A graphic calculation of the depth and dip of several layers from seismic refraction data is described. The following assumptions are made: all interfaces are continuous plane surfaces; the seismic velocity does not vary in each layer; each layer has a higher velocity than the layers above it; all layers have enough thickness and velocity contrast to be recorded; the traverse lies approximately in the direction of maximum dip of all interfaces.—*S. T. V.*

156–93. Kilczer, Gyula. Antiklinális adatainak kiszámítása a refrakciós terjedési idő-görbéből [Computation of anticlinical data from refraction travel-time curves]: Magyar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 2, szám 3, p. 25–32, 1953.

This study gives a graphoanalytical method of analyzing results obtained from seismic-refraction exploration of anticlinal structures in search for oil or coal deposits. By this procedure the depth of the refracting layer, angles of the inclination of the flanks, and the velocity of propagation of the seismic waves may be determined with sufficient accuracy. Both symmetrical and asymmetrical anticlines are considered. The suggested procedure may be extended to more than two layers, as, for example, a salt dome covered by two layers.—*S. T. V.*

156–94. Haáz, István Béla. Mesterséges rengéshullámokat visszaverő síkfelület térbeli helyzetének és a rengések terjedéssebességének együttes meghatározása [Determination of the reflecting plane and the wave velocity in the seismic reflection prospecting]: Maygar Állami Eötvös Loránd Geofiz. Intézet Geofiz. Közlemények, kötet 2, szám 6, p. 53–56, 1953.

This is the continuation of the study of the determination of the position of the reflection plane (see Geophys. Abs. 14501). In the present paper the problem

is treated for the case when the velocity of the seismic wave is unknown and formulas are derived from which the position of reflecting plane can be determined independently of the seismic velocity.—*S. T. V.*

156–95. Contini, Camillo. L'influenza dell'inclinazione delle superfici isotache nel calcolo delle superfici riflettenti dei rilievi sismici a riflessione [Effect of the inclination of equal-velocity surfaces in the calculation of reflecting surfaces in seismic reflection surveys]: Riv. Geofisica Appl., v. 14, no, 1, p. 1–17, 1953.

In calculating reflecting surfaces from seismic-reflection survey data, it is usually assumed that the equal-velocity surfaces are plane and horizontal, whereas in reality they are complex and variable because of different tectonic conditions. In this paper Contini attempts to determine the errors resulting from this assumption and to devise a method to reduce these errors. Three configurations of the equal velocity and reflecting surfaces are considered: one in which the layers are plane and horizontal and then dip at a constant angle, and two in which layers of the previous case dip at increasing angles. Formulas are developed to take into account the effect of the tilted equal-velocity surfaces; correction charts, based on the structure of the middle Po plain are given.—*S. T. V.*

156–96. Contini, Camillo. La diffrazione nei rilievi sismici a riflessione [Diffraction phenomena in seismic reflection]: Annali Geofisica, v. 6, no. 1, p. 73–112, 1953.

Following the methods used in theoretical optics, Contini applies the principles of Huygens-Fresnel and Kirchhoff to the study of the path of seismic waves meeting a reflecting surface in their propagation through the ground. The results vary from the familiar ones obtained in geometric optics, because of the great length of seismic waves. Thus discontinuities of the reflecting plane do not produce abrupt variations in the shape of the wave fronts reaching the surface, as predicted by the principles of geometric optics, but the shape is changed gradually, both in amplitude and phase angle. These results are important in the interpretation of seismograms.

Several examples of correlations between the details of subsurface structure and the seismograms are analyzed—*S. T. V.*

156–97. Lorenz, H. Verfahren zur Konstruktion durchlaufender Reflexionshorizonte an steilen Flanken unter Berücksichtigung des gebrochenen Strahlenganges [Method for the construction of continuous reflecting horizons on steep flanks taking into account the refraction effect]: Gerlands Beitr. Geophysik, Band 63, Heft 2, p. 99–107, 1953.

This paper presents a method of correcting seismic reflection data, obtained on the steep flanks of salt domes, for the effect of refraction. It is shown that the true coordinates of a reflecting point L_n can be obtained by interpolating between those of L_n*, the point obtained by the tangent method (that is, neglecting the refraction effect), and those of L_n^0, obtained by the method of path differences. Formulas and diagrams are given for the calculations by each method, and a practical example for 3 layers is worked out.—*D. B. V.*

OBSERVATIONS OF SEISMIC WAVES

156–98. Lehmann, I. On the shadow of the earth's core: Seismol. Soc. America Bull., v. 43, no. 3, p. 291–306, 1953.

The existence of a shadow having its edge at about 105° was investigated in a study of 34 earthquakes well-recorded at Copenhagen at distances of between 90° and 130° and with a good series of *P* observed at European stations of high reliability. Both time of arrival and amplitude were considered. In general there is no indication of a deviation of the slope of the time curve from the Jeffreys-Bullen 1940 curve prolonged, and there is, with but one exception, no sudden drop in amplitude. On the assumption that the first *P* beyond 105° is direct rather than diffracted, a trial time curve for distances to 130° has been constructed. The slope at the end is 4.37 sec per degree in comparison to the Jeffreys-Bullen slope of 4.4 sec per degree.—*M. C. R.*

156–99. Burke-Gaffney, T. N. A search for the phase *PKJKP*: Seismol. Soc. America Bull., v. 43, no. 4, p. 331–334, 1953.

Riverview records for 48 shocks at distances greater than 125° were examined for *PKJKP*. The results were inconclusive. It is suggested that search for *PKJKP* is most likely to be successful at stations that have short-period high-magnification instruments and at which P′ is observed with an amplitude of 20μ or greater.—*M. C. R.*

156–100. Evernden, Jack Foord. Direction of approach of Rayleigh waves and related problems: Seismol. Soc. America Bull., v. 43, no. 4, p. 335–374, 1953.

Part I of this paper is devoted primarily to the presentation of the basic data of this investigation. As the data were obtained by the tripartite technique, a detailed discussion of the net used is included. From the data presented, it is readily apparent that: (a) Free vibration in a "natural period" of the earth's crust in the vicinity of a recording station does not occur as a result of an earthquake at distance. (b) Extensive wandering of the plane of polarization of seismic surface waves is due to variations in the azimuth of arrival of the surface waves. (c) Surface waves arriving at Berkeley from a given earthquake do not have the nature of a continuous train of waves, but rather are characterized by the arrival of groups or packets composed of only a few periods. Thus the coda is not entirely a dispersion phenomenon but also has a scattered or refracted component. And (d) transverse motion does not exist in observed Rayleigh waves; apparent transverse motion is due simply to arrivals from other than the station-to-epicenter azimuth.

The detailed discussion of the basic data will be presented in Part II of this paper.—*Author's Abstract*

156–101. Nagamune, T. On the travel time and the dispersion of surface waves (I): Geophys. Mag., v. 24, no. 1, p. 15–22, 1952.

The travel times of Rayleigh and Love waves from earthquakes in three geographic regions were investigated on the basis of distant-earthquake data obtained at the Matsushiro seismological observatory. For the Eurasian continent the velocities were much greater than those obtained by Gutenberg and Richter. Similarities in the character of propagation imply that the region between Formosa and the observatory has almost the same crustal structure as

the continent. In the northwest coastal region of the Pacific, the average velocity of Love waves was almost equal to that for the continent while the average velocity of Rayleigh waves was smaller. For the Pacific Ocean, the data agree with those of other investigators.—*R. G. H.*

156–102. Molard, P[ierre]. Remarques au sujet des ondes "T" [Remarks on the subject of "T" waves]: Annales Géophysique, tome 8, no. 3, p. 335–336, 1952.

Ewing has observed short period waves in the sofar channel whose arrival time and maximum velocity coincide with those of *T* waves (see Geophys. Abs. 13333). Molard does not accept Ewing's hypothesis of *T*-wave propagation in the form of compressive waves in the water; the waves in question can also be reasonably explained on the one hand as Love waves, and on the other as modified Rayleigh waves. The fact that they coincide with *T* waves should not be taken as evidence that they are the same.—*D. B. V.*

EARTHQUAKE OCCURRENCES AND EFFECTS

156–103. Gutenberg, Beno. Earthquakes. Istanbul Tek. Univ. Bul., v. 4, no. 1, p. 66–70, 1951 (1952).

This is the text of a lecture delivered at the University of Istanbul. Causes of earthquakes, their geographic distribution, and their effects are reviewed.—*S. T. V.*

156–104. Due Rojo, Antonio. Notas sismologicas de 1952 [Seismologic notes for 1952]: Rev. Geofísica, año 12, no. 45, p. 49–52, 1953.

The two most violent earthquakes recorded in 1952 were those of Hokkaido (March 4) and Kamchatka Peninsula (Nov. 4), both of magnitude 8¼. Tsunami caused by these earthquakes were observed on marigraphic stations as far away as New Zealand. During the year, 24 earthquakes had a magnitude of 7–8; one of these, of magnitude 7.7, in Kern County, Calif., caused considerable damage.

A table of stronger earthquakes, classified according to focal depth, is given. Of these earthquakes, 75 occurred at less than 100 km; 24 at 150–250 km; 9 at 300–500 km; and 19 at 550–700 km. A world map indicating distribution of earthquakes occurring during 1952 is also given.—*S. T. V.*

156–105. Williams, J. Stewart, and Tapper, Mary L. Earthquake history of Utah, 1850–1949: Seismol. Soc. America Bull., v. 143, no. 3, p. 191–218, 1953.

Records of Utah earthquakes from the time of publication of the first newspaper in Utah to the end of 1949 have been assembled, and the essential data are presented in chronological order. An effort has been made to assign each earthquake to a fault. A fault map of Utah accompanies the report.—*M. C. R.*

156–106. Ramirez, J. E. Progresos de la sismologia en Centro-America, Mexico y las islas del Caribe durante los años 1950 y 1951 [Progress in seismology during the years 1950 and 1951 in Central America, Mexico, and on the Caribbean islands]: Rev. Geofísica, v. 12, no. 45, p. 53–69, 1953.

Ramirez gives a brief review of the development of seismological studies in the countries indicated in the title, emphasizing the important role played by

the United States, particularly by the U. S. Coast and Geodetic Survey. A table of the 21 seismological stations of these regions lists the geographic position, altitude, instrumental equipment, and geological foundation of each.

Also included is a list of about 125 earthquakes which occurred during 1950 and 1951 in these countries.—*S. T. V.*

156–107. Cornelius, Carl-Detlef. Wie breiten sich Erdbebenwellen im Boden aus? [How are earthquake waves propagated in the earth?]: Umschau, Jahrg. 54, Heft 2, p. 48–50, 1954.

The earthquake of February 22, 1953, in the Werra region of Germany was one of the relatively rare "collapse" type of earthquakes. It was rather strong for one of this type, with a maximum intensity of 8 and a felt area of 30-mile radius. The shock originated from movement in the Zechstein and Buntsandstein at Widdershausen between Knüllgebirge and the Thüringer Wald.

The effect of various conditions of fractures, cleavage, and displacements in the strata on earthquake wave propagation is discussed at some length.—*D. B. V.*

156–108. Pinar, Nuriye. Preliminary note on the earthquake of Yenice-Gönen, Turkey, March 18, 1953: Seismol. Soc. America Bull., v. 43, no. 3, p. 307–310, 1953.

The earthquake, which was of magnitude 7¾, was felt over an area of 30,000 sq km, damaged several thousand buildings, and resulted in the deaths of 250 persons, originated along the Yenice–Gönen seismic line. Secondary shocks on the Çan and Ezine-Lâpseki seismic lines also caused major damage. The Yenice-Gönen fault is more than 80 km long. Both vertical and horizontal displacements occurred along the fault. The epicenter is believed to have been at Yenice.—*M. C. R.*

156–109. Ritsema, A. R. Some new data about earthquake movements at great depth in the Indonesian Archipelago: Indonesia Madjalah Ilmu Alam Untuk, v. 109, no. 1–3, p. 34–40, 1953.

Analysis of earthquakes in Indonesia between 1904 and 1945 as included in the Gutenberg-Richter catalog shows the foci of most were at depths ranging from 60 to 300 km; foci at depths ranging from 500 to 700 km were relatively numerous, but very few were between 300 to 500 km. Three deep focus earthquakes, Java Sea, August 11, 1937; Flores Sea, June 29, 1934; and the Mindanao earthquake, September 22, 1940, were studied and the foci found to be at depths of 610 km, 720 km, and 660 km respectively. The shear planes of all these earthquakes had the same dip of 55° NW or 35° SE. In all three the same distribution of compression and dilatation was found at the surface of the earth.—*S. T. V.*

156–110. Peterschmitt, É[lie]. Étude de la magnitude des séismes [Study of magnitude of earthquakes]: Inst. Physique du Globe (Strasbourg), Annales, tome 6, 3e pt., p. 51–58, 1950.

In Gutenberg's fundamental formula for magnitude, $M=\log A-\log B+C+D$ (where M=magnitude, A=horizontal movement, B is a function of distance from epicenter, C the station coefficient, and D a coefficient characteristic of the earthquake) $\log B$ can be represented generally by the equation $-\log B=1.818=1.656 \log \Delta$ for the distance interval of 15–130 degrees. Peter-

schmitt analyzes data of 267 earthquakes recorded at Strasbourg and obtains good agreement with this value. He then calculates the value of C for Strasbourg as 0.13, and from these values derives the value of D for each of the 267 earthquakes.

He concludes that the values of D obtained show divergence from those expected on the basis of Gutenberg's formula which seem to be dependent on geography rather than on magnitude; earthquakes of different types may present equal horizontal amplitudes at a given station. Probably all ground movements should be taken into account in the calculations of magnitude.

However, the divergence between Gutenberg's formula and that which led to the regional study presented here is not an argument against the notion of magnitude. This notion permits classification of the regions of the globe not only according to absolute magnitude of their earthquakes, but also according to departure from the mean. The former gives information on the general tectonics of the globe, the latter will doubtless, when the method is refined, permit adding to our knowledge of the deep regional geology of the earth.—*D. B. V.*

156–111. Munk, Walter H. Small tsunami waves reaching California from the Japanese earthquake of March 4, 1952: Seismol. Soc. America Bull., v. 43, no. 3, p. 219–222, 1953.

Tsunami waves from the earthquake of March 4, 1952, were recorded at La Jolla and Oceanside, Calif. The period was somewhat longer than 30 minutes, unusually long for tsunamis, and the amplitude was 1.5 inches at Oceanside, about 1 inch at La Jolla. A tsunami of about the same period was recorded at Honolulu with an amplitude of about 6 inches. One possible explanation of the great difference in amplitude is reflection from the continental shelf off California.—*M. C. R.*

SEISMIC SURVEYS

156–112. Walker, J. Ryan. Exploration history (prior to the Cotton Valley discovery) of the Ruston field, Lincoln Parish, La.: Geophysics, v. 19, no. 1, p. 124–138, 1954.

The discovery well was drilled after a reconnaissance surface survey, two reflection seismograph surveys, and an unsuccessful test. The surface survey in 1930 indicated a surface structure. A reflection survey in 1934 indicated a single closure north of the surface structure. The initial test brought in gas but also a considerable amount of salt water and was therefore not a commercial well and was eventually abandoned. A seismograph survey was made in 1936, and interpretations were made in two horizons. Later development showed fair agreement with subsurface control in the northern part of area, but considerable disagreement in the southern half. The discovery well was drilled in 1943. Later seismograph surveys mapped the Cotton Valley formation.—*M. C. R.*

156–113. Hill, M. N. Seismic refraction shooting in the deep sea: Adv. Sci., v. 10, no. 37, p. 12–16, 1953.

Seismic-refraction measurements by the Department of Geodesy and Geophysics of Cambridge University in the Atlantic Ocean west of the English Channel, where the depth ranges from less than 100 fathoms to 2,600 fathoms show that the Mohorovičić discontinuity apparently lies between 9 and 12 km

below sea level. The velocity of 7.8–7.9 kmps measured in the layer below the discontinuity was consistently less than the accepted value of 8.1 kmps for the same layer below the continents. Above the Mohorovičić discontinuity there was apparently a layer in which the velocity ranged from 6.3 to 7.1 kmps, which is excessive for the granitic layer and corresponds with the supposedly basaltic layer. From the results obtained it seems, also, that the bottom of the ocean is not a smooth layer but is folded and faulted into structures similar to those found on the continents.—*S. T. V.*

156–114. Hill, Maurice Neville, and King, William Bernard Robinson. Seismic prospecting in the English Channel and its geological interpretation: Geol. Soc. London Quart. Jour., v. 109, pt. 1, p. 1–18, 1953.

A deep-sea seismic-refraction survey was made along a line extending about 50 miles southwards from Plymouth, and results correlated with geological information obtained by core sampling and dredging.

The maximum range between shot point and receiver was 8 miles. Because two ships were not available, sonoradio buoys were constructed which transmitted the signals, received on hydrophones hanging about 60 feet below them, to the ship from which the charges were fired. Hydrophones were used because the difficulties of lowering and maintaining electrical connection with geophones on the sea bed in deep water were prohibitive. The use of hydrophones prevented anchoring the buoys, even in shallower water, as the tidal stream past them otherwise produced excessive disturbance; hence this method is not recommended for inshore areas where there is danger of the buoys going aground. As many as 3 buoys were used simultaneously at different distances in line from the ship, and each transmitter operated on a separate radio channel. Adequate information concerning structure could be obtained with 5 shots. The accuracy of the results is estimated to be within 1 percent. The lines were all shot along the general strikes in the neighboring land masses, thus avoiding complexities in observations because of the dip component along the shot line.

Results are presented in detail, together with their analysis and interpretation. The evidence points to the existence of a trough filled with 3,000 feet of New Red Sandstone deposits, extending from within a few miles of the English coastline to a point south of the middle of the channel. A line of reefs of metamorphic rocks, extending from Bolt Tail to west of the Eddystone Rocks, projects through the New Red Sandstone formations. Southwards from the Eddystone Rocks, Permian and Triassic breccias and sandstones are followed by Keuper Marl and a thin layer of Lower Jurassic. These in turn are covered unconformably by a few hundred feet of Chalk.—*D. B. V.*

156–115. Weber, Hans. Erdölgeologische Aufschlussergebnisse in Westholstein [The results of prospecting for oil in western Holstein]: Erdöl u. Kohle, Jahrg. 6, Heft 12, p. 765–770, 1953.

This is a report of the results of exploration by the seismic reflection method and by well-logging during 1949-1953 in western Holstein, Germany. General geologic and petrographic investigations of the region were undertaken at the same time. The results are presented as well logs and corresponding geologic profiles. Several salt domes were delineated and oil deposits discovered.—*S. T. V*

MICROSEISMS

156–116. Due Rojo, Antonio. El problema de los microsismos [The problem of microseisms]: Rev. Geofísica, v. 10, no. 40, p. 320–331, 1951.

This is another report on the international conference held at Vatican City in November 1951 on the nature of microseisms. See also Geophys. Abs. 13875.—*S. T. V.*

156–117. Imbert, Bertrand. Sur l'agitation microséismique à Port-Martin (Terre Adélie) [On microseisms at Port Martin, Adelie Coast]: Acad. Sci. Paris Comptes Rendus, tome 236, no. 25, p. 2420-2423, 1953.

Microseisms were recorded at Port Martin between July and September 1950 and from March 1, 1951, to January 22, 1952. The observations indicate that the microseisms are largely due, not to waves along the coast, but to swell which generally follows the barometric lows. The principal zone of excitation of the microseisms is not the center of the low but is related to the cold front which follows the low. The coast of Antarctica is, of course, protected during most of the year by ice.—*M. C. R.*

156–118. Donn, William L., and Blaik, Maurice. A study and evaluation of the tripartite seismic method of locating hurricanes: Seismol. Soc. America Bull., v. 43, no. 4, p. 311–330, 1953.

Tripartite records from the U. S. Navy stations at Bermuda, Cherry Point, and Miami were studied in detail for the 1950 hurricane season in an evaluation of the tripartite methods of determining storm position. The error between computed and observed storm azimuths exceeds the theoretical error by a considerable amount. This difference may be the result of the procedure, lack of wave coherence at the three elements of the tripartite net, and refraction and multiple wave paths. To explain the discrepancies, a study of individual waves was undertaken. Differences in period and amplitude indicate that the waves and group measured are incoherent. The period differences are of the same order as arrival time differences, thus precluding any accuracy in computational results depending on such time differences.

Individual and average wave velocities for the three stations were studied, and a wide range was observed. The lowest velocity observed at a station seems to approach most nearly the velocities of the component waves forming microseisms.

It is considered at present that the operational value of tripartite stations in locating and tracking storms is small and that almost as much can be determined from a qualitative appraisal of records as from time-consuming measurements and computations.—*M. C. R.*

156–119. Donn, William L. The relationship between microseism period and storm position: Science, v. 119, no. 3080, p. 55–57, 1954.

A study of the distribution of microseism periods in the Gulf of Mexico, the Caribbean Sea, and the western north Atlantic Ocean recorded at 15 stations from 16 hurricanes shows that a definite relationship exists between microseism period and storm position. The only obvious correlation appears to be with depth of water or water and sediment. The short periods characteristic of the Gulf of Mexico and the continental shelf are thought to negate ocean waves or swells as a generating mechanism.—*M. C. R.*

ISOTOPE STUDIES AND AGE DETERMINATIONS

156–120. Korff, Serge A. Effects of the cosmic radiation on terrestrial isotope distribution: Am. Geophys. Union Trans., v. 35, no. 1, p. 103–106, 1954.

Primary cosmic radiation when incident upon atoms in the atmosphere produces a secondary radiation. The neutrons produced in the process are the main agents active in building up new isotopes and altering the isotope distribution. The best-known process is the formation of radiocarbon by the absorption of a neutron in the nitrogen nucleus, but as this is followed by beta decay to nitrogen, the distribution is not altered permanently. Another important process is the production of tritium by the interaction of neutrons with nitrogen and the subsequent decay to helium three. Other isotope building processes (O^{17}, N^{15}, Si, Na, Li, and Al) do not contribute in an important way to the existing isotope distribution.—*M. C. R.*

156–121. Goguel, Jean. A propos du calcul de Holmes sur l'âge de la Terre [On Holmes' calculation of the age of the earth]: Soc. géol. France Comptes Rendus, no. 13, p. 248–250, 1953.

Goguel presents a graphical solution of the age of the earth, based on the same samples as those used by Holmes in his mathematical calculation, and points out the advantages of the former method.—*D. B. V.*

156–122. Collins, C. B., Farquhar, R. M., and Russell, R. D. Isotopic constitution of radiogenic leads and the measurement of geological time: Geol. Soc. America Bull., v. 65, no. 1, p. 1–22, 1954.

This paper reports the isotopic abundances for lead extracted from 1 galena and 96 uranium minerals, the latter mostly from the Athabasca province of the Canadian shield. Ages were calculated from the Pb^{207}/Pb^{206} ratio for the 73 samples having sufficiently low common lead contamination, and from the Pb^{207}/U^{238} ratio for 9 chemically analyzed samples. On this basis it is established that the last mountain building in the Athabasca province took place from 1,860 to 1,630 million years ago; the many younger ages determined for pitchblende deposits are correct, and indicate solution and redeposition at a later time. The method of extracting and preparing small quantities of lead as lead tetramethyl for mass spectrometer analysis is described.—*D. B. V.*

156–123. Patterson, Claire C., Goldberg, Edward D., and Inghram, Mark G. Isotopic compositions of Quaternary leads from the Pacific Ocean: Geol. Soc. America Bull., v. 64, no. 12, p. 1387–1388, 1953.

The concentration of lead in a red clay, a manganese nodule, and a lower Pleistocene marl, all from the Pacific Ocean, has been determined spectrophotometrically, using Pb^{210} for yield corrections, and by the isotope dilution method. The isotopic compositions of the isolated leads were determined in a mass spectrometer by using surface ionization methods. Concentrations of iron and manganese were also determined spectrophotometrically. The values obtained are listed in a table.

Similarity of Pb/Mn ratios and dissimilarity of Pb/Fe ratios in the manganese nodule and the red clay may indicate that a major amount of the lead in oceanic waters may be absorbed on manganese hydrosols. The composition of the leads in the nodule and clay are similar, and differ from that obtained from

the acid-soluble fraction of the marl; this may indicate that lead of the deeper ocean deposits (nodule and clay) is more nearly representative of a mean oceanic lead than that of the near-off-shore deposits (marl). If so, the isotopic composition of a number of marine leads will have an unknown variation from an assumed direct correlation.—*D. B. V.*

156–124. Stieff, L. R., Stern, T. W., and Milkey, R. G. A preliminary determination of the age of some uranium ores of the Colorado Plateaus by the lead-uranium method: U. S. Geol. Survey Circ. 271, 19 p., 1953.

A study of the Pb^{206}/U and Pb^{207}/U^{235} ages and the Pb^{207}/Pb^{206} ratios of the uranium ores of the Colorado Plateaus was undertaken by the Geological Survey on behalf of the U. S. Atomic Energy Commission because of its direct bearing on the origin of these ores. A preliminary treatment of the data for 41 ore samples containing more than 0.1 percent uranium gives an average Pb^{206}/U age of approximately 71 million years, an average Pb^{207}/U^{235} age of about 82 million years, and an average Pb^{207}/Pb^{206} ratio equivalent to an age of 425 million years. At least part of the large discrepancy between the mean lead-uranium ages and the much less reliable Pb^{207}/Pb^{206} ages is due to small systematic mass spectrometric errors. The extreme sensitivity of the Pb^{207}/Pb^{206} ratio to small mass spectrometric errors invalidates not only the Pb^{207}/Pb^{206} ages but also the corrections for the presence of old radiogenic lead and the selective loss of radon which must be based in part on precise determinations of the Pb^{207}/Pb^{206} ratio.

Errors in the chemical analyses for lead and uranium introduce uncertainties in the mean Pb^{206}/U age of approximately ± 3 million years. The small systematic mass spectrometric errors should not increase the mean Pb^{206}/U age by more than 3 million years. Better corrections for common lead and additional corrections for selective loss of uranium and the presence of old radiogenic lead should lower the mean Pb^{206}/U age by approximately 10 million years. If the entire Pb^{207}/Pb^{206} ratio anomaly is assumed to be due to the selective loss of radon, an improbable assumption, the mean Pb^{206}/U age would increase approximately 10 million years.

The data suggest that the calculated ages are close to the true age of the ores. From these calculated ages it is reasonable to assume that the uranium was introduced into the sediments not later than the late Cretaceous or early Tertiary (55 to 80 million years ago). This assumption differs markedly from the assumption that the present uranium deposits were formed in the Late Triassic and Late Jurassic sediments of the Colorado Plateaus (152 and 127 million years ago), during or soon after deposition of the sediments. Careful study is continuing in order to reduce the uncertainties in interpretation of both field and laboratory data so that a satisfactory hypothesis of origin of these ores may be definitely established. To place this laboratory study on a firmer basis, ages are being determined by the lead-uranium methods on many additional carefully selected samples of uraninite and other primary ore minerals.—*Authors' Abstract*

156–125. Cooke, H. B. S. Some recent geological developments in South Africa: South African Jour. Sci., v. 50, no. 5, p. 123–133, 1953.

This paper sums up progress in geological knowledge in the Union of South Africa since 1939. It includes a résumé of absolute age determinations, which seem to fall into 3 groups, 1,900 million, 2,100 million, and 2,450–2,950 million years respectively. These age determinations are particularly important in Africa because the continent as a whole has few fossiliferous rocks.

It is also mentioned that in the Orange Free State, geophysical techniques have proved invaluable in the exploration and development of important gold deposits.—*D. B. V.*

156–126. Libby, W. F. Chicago radiocarbon dates, IV: Science, v. 119, no. 3083, p. 135–140, 1954.

Radiocarbon dates obtained at the University of Chicago laboratory during the period September 1, 1952, to September 1, 1953, are listed. Samples included human hair and skin from the Predynastic period of Egypt, a charcoal beam from Iraq used to date the Hammurabian calendar, grasshopers from Grasshopper Glacier, lotus seeds from Japan, as well as many charcoals from various archeological sites in North and Central America, Asia, and Africa.—*M. C. R.*

156–127. Craig, Harmon. Carbon–13 variations in sequoia rings and the atmosphere: Science, v. 119, no. 3083, p. 141–143, 1954.

Isotopic analyses of wood from the radial growth of a single *Sequoia gigantea* show significant but small variations that have no systematic trend with time. The data indicate that the isotopic composition of atmospheric carbon has been constant to at least one per mil during the 2,500 year interval from 900 B. C. to 1600 A. D. Variations probably represent the effect of varying external conditions on the assimilation and respiratory processes of the tree rather than to atmospheric changes.—*M. C. R.*

156–128. Arnold, James R. Scintillation counting of natural radiocarbon: I. The counting method: Science, v. 119, no. 3083, p. 155–157, 1954.

In a scintillation counter for C^{14} measurements, as developed at the University of Chicago laboratory, tubes and a sample cell of 100-ml volume are enclosed in a mercury shield inside a freezer held at —20° C. Preamplifiers are attached to the shield. The gain of the preamplifiers is 30, and that of the main amplifiers about 2,500, effectively eliminating the "light dark current." Phototubes are DuMont type K1192. The speed of the amplifier is of the order of 1 μsec, and this effectively controls the time constants of the rest of the circuits. Pulse-height analyzers are designed for wide-gate operation. The liquid phosphor used is basically a solution of 0.4 percent diphenylaxazole in toluene with 20 ppm of dyphenylhexatriene. The method permits measurement of natural C^{14} to a precision of 0.46 percent in 48 hours, and six half lives are within the range of possible measurement.—*M. C. R.*

156–129. Iversen, Joh[anne]s. Radiocarbon dating of the Alleröd period: Science a. 118, no. 3053, p. 9–11, 1953.

Radiocarbon analyses of material from an exposed Alleröd section at Ruds Vedby in Zealand (Sjælland) in the classical Danish region show ages of 10,800 to 12,000 years. Material from supposed Alleröd localities in Germany and the British Isles has been shown to be of the same age. The Two Creeks forest bed of the United States is about 11,400 years old and is thus of the same age as the Alleröd oscillation.—*M. C. R.*

RADIOACTIVITY

INSTRUMENTS AND METHODS OF OBSERVATION

156–130. Moscicki, W. On the use of CO_2+CS_2 filled G.M. counters for age determinations: Acta Phys. Polonica, v. 17, fasc. 3–4, p. 238–240, 1953.

In experimenting with Geiger-Müller counters with gas mixtures of different chemical composition, Moscicki found that by using CO_2 with a small addition of CS_2 (2 to 10mm Hg), it is possible to use the counter in geochronometric measurements, counting separately the background through an anticoincidence channel, the pulses from the counter without the channel, and the pulses from an a. c. field. Comparative determinations made on several geologic specimens of known age from the geologic museum of Warszawa gave satisfactory agreement.—*S. T. V.*

156–131. Berbezier, J., Chaminade, R[obert], and Lallemant, C. Description de l'equipement d'un vehicle de radiosondage gamma [Description of the equipment of a vehicle for gamma-ray surveying]: Annales Géophysique, tome 8, fasc. 2, p. 260–263, 1952.

This is a detailed description of the type of equipment with which over 10,000 m of boreholes were surveyed during a period of 18 months by the French commission on atomic energy. Photographs and a schematic diagram are included.—*D. B. V.*

156–132. Berbezier, J., and Lallemant, C. Description du materiel simplifié de radiosondage gamma employé sur les exploitations minières [Description of simplified materials for radioactive prospecting used in mine workings]: Annales Géophysique, tome 8, fasc. 3, p. 314–315, 1952.

Berbezier and Lallemant describe two adaptations of their apparatus for radioactive prospecting in mines. The adapted apparatus can be used to explore vertical drill holes 150 m deep, and horizontal drill holes more than 70 m long. Photographs and schematic diagram are included.—*D. B. V.*

156–133. Jurfliewicz, I., Miesowicz, M., and Mikucki, A. A G.-M-counter apparatus for gamma-ray well-logging: Acta Geophys. Polonica, v. 1, no. 3–4, p. 187–196, 1953.

This is an English version of a work previously published in Polish in the Głowny Instytut Naftowego Prace (Geophys. Abs. 14933).—*D. B. V.*

156–134. Hée, A[rlette], Wack, Monique, and Jarovoy, Michel. Étude du rayonnement β des roches [Study of the beta-radiation of rocks]: Annales Géophysique, tome 8, no. 3, p. 323–327, 1952.

This study was undertaken in order to determine whether the beta radiation of rocks could be used as a quantitative indication of the radioactive content. The procedure is similar to that proposed for gamma radiation (Geophys. Abs. 14705), but the amount of rock necessary is relatively small, of the order of 10 grams compared to the 2 tons required for gamma-ray measurement, and measurements can be made in the laboratory and serve as a control for field measurements. Two Geiger-Müller counters were used, one with glass walls, the other of the type 10 B1, on samples of potassium chloride, Quincy granite, Rosskopf rhyolite, Brifosse granite, and Brifosse granite enriched with potassium chloride. The results are summarized in curves.

The effect of potassium in the rock, as determined experimentally was found always to be weaker than that calculated according to the potassium chloride curve, suggesting that beta radiation is absorbed more rapidly in rock than in KCl. The effect of uranium was calculated by introducing a known quantity of uranium into the rock and measuring the effect of the addition. Thorium was treated similarly. For the Quincy granite and Rosskopf rhyolite, the amounts of potassium, uranium, and thorium were calculated from the total beta-radiation effect, with an error of about 5 counts per minute.

It is concluded that the beta-radiation method should be applied along with other radiation studies; its imperfections, like those of the other methods, are inherent in the minuteness of the quantities involved in all radioactivity studies.—*D. B. V.*

156–135. Patten, Andy. Radioactivity in the mineral industries: Compass, v. 31, no. 2, p. 88–96, 1954.

This is a summary of the application of radioactivity in the mineral industries. The main geologic uses are in determining the age of rock bodies, explaining geologic theory, and prospecting for petroleum or uranium minerals. In the petroleum industry, radioactivity is particularly useful, not only in geophysical exploration and exploitation of wells, but in the refining process as well. In metallurgy radioactivity is used mainly as a tracer in solving problems of mineral dressing and physical metallurgy. Mining of radioactive substances (principally uranium, which formerly was possible only from high-grade ores) is now carried on mainly in many small operations producing low-grade carnotite.—*D. B. V.*

RADIOACTIVITY OF ROCKS, WATERS, AIR

156–136. George, E. P., MacAnuff, J. W., and Sturgess, J. W. Observations of extensive cosmic-ray showers below ground: Phys. Soc. London Proc., v. 60, ser. A., pt. 4, no. 400 A, p. 346–356, 1953.

The decoherence curve of extensive showers has been studied at a depth of 60 m water equivalent below ground out to a distance of 320 m. The relative frequencies of coincidences in various combinations of counter sets are found to be consistent with the assumption that the frequency of showers containing N particles is proportional to $N^{-\gamma}$ with $\gamma=3.2\pm0.2$. By comparison with observations at other depths it is concluded that the particles in extensive showers are absorbed less rapidly in the earth than the normal particles of the vertical component. The observed showers can be readily understood in terms of the small fraction of penetrating particles (presumed μ -mesons) that is known to exist in extensive showers observed at sea level. At counter separations less than 3 m the observed coincidences are much too frequent to be attributed to extensive showers, indicating a significant contribution from locally produced penetrating particles. The origin of these secondary particles is discussed.—*Authors' Abstract.*

156–137. Kuroda, P. K., Damon, P. E., and Hyde, H. I. Radioactivity of the spring waters of Hot Springs National Park and vicinity in Arkansas: Am. Jour. Sci., v. 252, no. 2, p. 76–86, 1954.

The radon content of the waters of Hot Springs National Park has been redetermined, using an I–M type fontactoscope. Thoron was detected in these waters for the first time with the aid of a scintillation tube.

The radon content of the hot waters is extremely variable (0.1 to 30 millimicrocuries per liter; average, 0.8), possibly because each spring has its own radium-bearing tufa as source of radon. The radon content of the cold waters is also extremely variable (0.1 to 7.3 millimicrocuries per liter) and averages about the same as the hot springs. Radon in spring waters issuing directly from the border of the uranium-vanadium-niobium prospect at Potash Sulphur Springs averages about 15 millimicrocuries per liter and the radon content is more uniform (6 to 40 millimicrocuries per liter).

Besides having purely scientific interest, such information can be applied to the search for fissionable materials.—*D. B. V.*

156–138. Trembaczowski, Emanuel. Promieniotwórczość wód na Sławinku pod Lublinem [Radioactivity of the waters in Sławinek near Lublin]: Marii Curie Skłodowska Uniw. Rocz., Dział AA, v. 6, no. 2, p. 15–24, 1951 (1953).

The radioactivity of water from Sławinek sources near the city of Lublin, Poland, was measured with an emanometer, consisting of a gold leaf electrometer and an ionization chamber. The sensitivity of the electrometer was 1.34 volt per scale division. The procedure for the measurements and their theory is discussed and the formula for radioactive intensity is derived. The radioactivity of the water in the well of the source was found to be 1.63 Mache units, similar to that found in several other European sources.—*S. T. V.*

156–139. Trembaczowski, Emanuel. Promieniotwórczość wód Lubelszczyzny [Radioactivity of waters in Lublin province]: Acta Geophys. Polonica, v, 1, no. 2, p. 126–142, 1953 (with German summary).

In 1952, radioactivity measurements were made on 57 different waters from 24 places in the province of Lublin. An emanometer was used, consisting essentially of a gold leaf electrometer and an ionization chamber. The results are presented in a table. In most places the activity did not exceed 1 Mache unit, but one spring showed 5.4 Mache units.—*D. B. V.*

156–140. Simpson, D. J. Correlation of the sediments of the Witwatersrand system in the West Witwatersrand, Klerksdorp and Orange Free State areas by radioactivity borehole logging: Geol. Soc. South Africa Trans. and Proc., v. 55, p. 133–152, 1953

Comparison of the distribution of radioactive material in the West Witwatersrand area with that of similar sediments in the Klerksdorp and Orange Free State areas indicates that the succession is the same in all three areas and that the great majority of the radioactivity cycles, although showing some variation, preserve their position and characteristics remarkably well over the whole area.

From the logs illustrated it is considered that the Monarch, Vaal and Basal reefs occupy the same position within their cycles, whereas the Monarch Upper Leaders can be correlated with the Vaal Reef Leaders and Leader Reefs of the Orange Free State.

Logging has shown that areas where the Vaal and Basal reefs are auriferous from an economic point of view give radioactivity curves differing from those obtained over barren areas. A suggested explanation is that the gold content of the economic horizons in the R3C subcycle is intimately related to the presence of an intermittent disconformity within that cycle. Where the disconformity is found below the reefs, important gold values can be expected, but where it is

absent, the chances of obtaining exploitable gold values are negligible. Reworking and resorting of distributed gold seem to have taken place at this disconformity.

The apparently abnormal distribution of activity in the normally barren Van den Heevers Rust area may be due to contamination of barren incoming material from contemporaneous erosion of local active material.—*D. B. V.*

HEAT

INSTRUMENTS AND METHODS OF OBSERVATION

156–141. Czyzowski, Jerzy. Maksymalno-minimalny termometr głębinowy [Maximum- and minimum-thermometer for use at great depth]: Nafta (Poland), rok 9, no. 5, p. 119–121, 1953.

Correlation of formations in an oil field can be often made more easily by establishing temperatures corresponding to different oil-bearing strata penetrated by the drill hole. The determination of corresponding temperatures is facilitated by the thermometer designed and constructed at the Polish institute of oil research. The construction of this simple instrument is described and the rules for its use given.—*S. T. V.*

156–142. Correns, C. W. Flussigskeitseinschlüsse mit Gasblasen als geologische Thermometer [Liquid inclusions with gas bubbles as a geologic thermometer]: Geol. Rundschau, Band 42, Heft 1, p. 19–34, 1953.

Correns, in a critical examination of new and old work on liquid inclusions in crystals, points out that the disappearance of gas bubbles on heating does not give a sure indication of the temperature at which a crystal formed unless the nature of the liquid and the pressure under which it developed are known, and it is certain that no primary gas bubbles were included. Criteria for settling these questions are listed, but the author points out that they are most uncertain, so that use of this technique, especially the decrepitation method, is often rash.—*English summary by J. Sutton.*

156–143. Skinner, B. J. Some considerations regarding liquid inclusions as geologic thermometers: Econ. Geology, v. 48, no. 7, p. 541–550, 1953.

Experiments on stability of liquid inclusions in a Brazilian quartz crystal suggest that the amount and composition of liquid in vacuoles depend on ambient pressure and temperature, and thus may vary during geologic time. Considerable care must be taken, therefore, in using and interpreting temperature of formation from liquid inclusions. When such evidence is at variance with other lines of evidence, as is often the case, it would be pertinent to consider the possibility that the vacuoles indicate later and different conditions from those operative at the time of formation.—*D. B. V.*

156–144. Kullerud, Gunnar. The FeS-ZnS system—a geological thermometer: Norsk Geol. Tidsskr., bind 32, heft 2–4, p. 61–147, 1953.

This extremely detailed study leads to the conclusion that the degree of solubility of FeS in the ZnS lattice is a reliable index of temperature of formation, which can be used to shed light on a number of problems of geological significance. Some of the more important applications, such as determining the temperature of formation of ore bodies, of skarn, and of pegmatites and distin-

guishing different generations of ore, are illustrated with examples. The application to the study of granitization merits treatment in a separate paper (Geophys. Abs. 156–145).—*D. B. V.*

156–145. Kullerud, Gunnar, and Neumann, Henrich. The temperature of granitization in the Rendalsvik area, northern Norway: Norsk Geol. Tidsskr., bind 32, heft 2–4, p. 148–155, 1953.

Applying the FeS-ZnS geological thermometer to sulfides in graphitic schist closely associated with granitized sediments in the Rendalsvik area, the temperature of granitization is calculated to be 440±25° C, at estimated average pressure of 2,000±1,000 atmospheres. In view of experimental evidence that no granitic magma can exist below 670° C, it is concluded that the granite is nonigneous. This is in full harmony with the field evidence.—*D. B. V.*

156–146. Lettau, Heinz. Improved models of thermal diffusion in the soil: Am. Geophys. Union Trans., v. 35, no. 1, p. 121–132, 1954.

It is shown that the non-homogeneous case of soil-heat conduction, that is, when soil-heat conductivity and capacity are functions of depth, can be treated rigorously. An exact formula is derived which gives the thermal diffusivity of the soil as a function of depth, on the basis of Fourier coefficients of diurnal courses of soil temperature at a variety of depths. By employment of the new model of soil-heat diffusion one avoids misleading results which are obtained when the classical model of heat diffusion in a solid conductor is applied to natural soil indiscriminately.

The case of depth-time varying thermal diffusivity can only be solved in approximate form. The practical application of the classical and the two new models is discussed with the aid of soil-temperature data obtained by the Johns Hopkins Laboratory of Climatology, Seabrook, N. J.—*Author's Abstract*

OBSERVED TEMPERATURES IN THE CRUST AND HEAT FLOW

156–147. Bouwer, R. F. Measurement of borehole temperatures and the effect of geological structure in the Klerksdorp and Orange Free State areas: Geol. Soc. South Africa Trans. and Proc., v. 55, p. 89–119, 1953.

The results of borehole-temperature surveys, presented here in detail, show that although the electronic thermometer is sound in principle, it could be improved considerably by substituting a more reliable reed frequency meter. The main advantage of the electronic thermometer over the slower clinical-thermometer measurements, where accuracy depends on skill and experience of the observer, is that the former offers an easy and rapid means of measurement, which is particularly useful in areas like the South African gold fields where, for economic reasons, surveys must be completed as soon as possible after drilling has stopped.

The main disadvantage, besides limited accuracy, is that under a fairly thick cover with low electrical conductivity (such as dolomite), and near high tension cables or at great depth, electrical interference masks the signal so that well defined readings of frequency cannot be made. Under these conditions some other method must be used.

In the Klerksdorp area it has been possible to relate temperature variations to structure, the Ventersdorp lava producing the major effect. The isothermal

diagrams reflect its westward increase in thickness. In this area, boreholes surveyed were sufficiently numerous and geological structure simple enough to permit calculation of reasonably reliable geothermic steps, from which temperatures could be estimated to a given depth with an accuracy sufficient for practical application to mining problems. This could not be done in the Orange Free State area, where fewer boreholes were surveyed.—*D. B. V.*

156–148. Bankovskiy, V. A. Novyye dannyye o geotermicheskikh usloviyakh v Donetskom basseyne [New evidence on geothermal conditions in the Donets Basin]: Pamyati Akademika P. I. Stepanova, p. 425–430, Moskva, 1952.

An analysis of thermal observations in drill holes in the region around Stalino-Makeyevka (Donets Basin) is presented. Measurements were made at depths down to about 1,000 m. It was found that the temperature of strata within the investigated area rises from north to south as a result of the increase in heat conductivity of more metamorphosed formations; the conductivity of formations increases from synclines to anticlines; cores of anticlines formed of more ancient formations having better conductivity affect the shape of isotherms; the crests of anticlines regularly show cracks deflecting isotherms toward the earth's surface. Extrapolation to depths of 1,500 to 1,700 m is considered justifiable on the basis of these results.—*S. T. V.*

156–149. Birch, Francis. Thermal conductivity, climatic variation, and heat flow near Calumet, Mich.: Am. Jour. Sci., v. 252, no. 1, p. 1–25, 1954.

Measurements of thermal conductivity are reported for some 90 samples of rock from the vicinity of Calumet, Mich. Mean values, in millicalories per (cm sec deg), are as follows: Jacobsville sandstone, 6.78±0.71; Freda sandstone, 6.81±0.24; Copper Harbor conglomerate, 4.98±0.25; Portage Lake lava series, 5.01±0.11. Some evidence is found for a correlation between conductivity and degree of alteration in the basic lavas. These measurements, and the older determinations of temperature in mines and borings of this region, are discussed with relation to the problem of geothermal evidence for climatic variations during and since the Pleistocene, and to the heat flow. It is concluded that no thermal effect definitely related to climatic change can be discovered with the available data. The local rate of heat conduction to the surface is 0.93 microcalories per (cm^2 sec), with an estimated uncertainty from all causes of about 10 percent.—*Author's Abstract*

156–150. Lyubimova, Ye. A. Rol' temperaturoprovodnosti v teplovom rezhime zemli [The effect of heat diffusivity on the thermal state of the earth]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 6, 523–525, 1953.

In a preceding study on the thermal state of the earth as affected by radioactive processes (see Geophys. Abs. 14352), Lyubimova used in computations the heat diffusivity, K, of 0.01 and assumed this to be constant for the whole globe. In the present paper calculations are repeated with K equal to 1.0, 0.1, and 0.01. The last is probably correct for the surface layer of the earth; it is sensibly greater for the interior of the globe, where it may be as much as 0.1 in the core. Thus the temperature distributions, computed for these values of K, are the probable limits of the physical reality.—*S. T. V.*

VOLCANOLOGY

156–151. Volcano Letter. Activity of Great Sitkin Volcano: Volcano Letter no. 520, p. 6, 1953.

On May 11, 1953, a column of steam rose 5,000 feet above Great Sitkin Volcano in the Aleutian Islands, lasting for about an hour. An earthquake, with intensity of 5 (modified Mercalli scale), occurred on May 12. Steam again rose, to 4,000 feet on May 14 followed by a slightly less severe earthquake. By May 19, steaming was diminished but still greater than normal. Subsequent observations to June 7 showed only weak emission of steam. No ash eruption was observed in the whole period, nor did the form of the basalt dome in the crater change appreciably.—*D. B. V.*

156–152. Wilcox, Ray E. Eruption of Mount Spurr, Alaska: Volcano Letter, no. 521, p. 8, 1953.

Mount Spurr, northeasternmost of the Aleutian volcanic arc, erupted explosively early on July 9, 1953, its first strong activity during 200 years of recorded history in the area. The eruption took place from a vent at about 7,000 feet on the south shoulder. A cloud of ash rose ultimately to an altitude of 60,000 to 70,000 feet, the diameter was estimated as 40–60 miles at 27,000 feet. The ash cloud completely darkened Anchorage, 80 miles away, from 1 to 3 p. m., and one-eighth to one-fourth of an inch of ash fell during the afternoon and evening.

By the next morning, the vent was steaming only, but at 3:30 p. m. ash-laden steam rose to 20,000 feet. From July 11–14, the activity consisted of liberation of moderately large quantities of steam, with little or no ash; activity diminished gradually after July 13. No lava was erupted, but floods and mud flows on July 9 or 10 (probably the result of melting ice in the crater as well as local torrential rain associated with the ash eruption) carried thousands of cubic yards of debris to dam up the Chakachatna River and form a lake nearly 5 miles long just below Chakachamna Lake.—*D. B. V.*

156–153. Volcano Letter. Eruption of Trident volcano, Alaska: Volcano Letter, no. 519, p. 7, 1953.

Trident Volcano in Katmai National Monument erupted on February 15, 1953, its first activity in historic times. On February 15 and 16, airplane pilots reported a cloud of "smoke" rising to about 30,000 feet. On February 18, the vent was located on the south slope. Between February 18 and 21 the flow had advanced 1,000 feet. The eruption column rose to about 11,000 feet. Trident was reported still active on March 11, with slow lava extrusion, and ash blanketing the area within a 20 mile radius south and east of the volcano.—*D. B. V.*

156–154. Volcano Letter. Activity of Trident volcano: Volcano Letter, no. 520, p. 5–6, 1953.

Continued mild activity of Trident Volcano [Geophys. Abs. 156–153] is reported. Between June 2 and June 17, the rate of growth of the flow increased markedly, but rate of gas emission decreased over that during March.

From the beginning of the eruption until March 11, the volume of ash and lava emitted has been estimated as between 2.2 and 4.5 billion cubic feet, with an additional 1–2.5 billion cubic feet extruded between March 11 and June 17. The material produced by the Katmai eruption in 1912 has been estimated at 6–7 cubic miles.—*D. B. V.*

156–155. Muller, Ernest H., Juhle, Werner, and Coulter, Henry W. Current volcanic activity in Katmai National Monument: Science, v. 119, no. 3088, p. 319–321, 1954.

By the summer of 1953, the spectacular eruption of Trident Volcano had subsided to slow extrusion of very viscous blocky lava, accompanied by steady vigorous steaming. The steaming continued both from the new fumarolic area at 4,200 feet southeast of the middle peak, and from a large fumarole several hundred feet downslope. The steam cloud, visible as far as 80 miles away on a clear day, contained occasional small amounts of ash.

Six other volcanoes in the area—Mount Martin, Mount Mageik, Novarupta, Knife Peak, Kukak, and Mount Douglas—steamed with varying degrees of intensity during the summer of 1953.—*D. B. V.*

156–156. Richards, Adrian F. Continued volcanic activity at San Benedicto Island, Mexico: Volcano Letter, no. 519, p. 7, 1953.

About November 12, 1952, further extrusions filled the crater of Boqueron half full with block lava, to which more was probably added on December 10. On December 8, lava escaped from the flank at the eastern base of the cone, about 60 feet above sea level. This fissure lengthened upslope to 192 feet altitude by December 11. The estimated temperature at the throat of the fissure was approximately 1,300° C. In 2 days this lava extrusion extended 900 feet out to sea and when last seen was advancing seaward at the rate of 150 feet per day. The elevation at the top of the cone was determined to be 1,250 feet, lower than previous estimates (see Geophys. Abs. 14970). On December 9, at approximately one-hour intervals, dense cauliflower clouds of steam and ash rose to 3,000 feet. On December 10 the crater rim was half a mile wide. Red incandescence of crater lava was occasionally seen in broad daylight. On December 12 and 13 activity increased to a continuous eruption. On January 5, 1953, rumbling sounds coincident with gas eruptions from the crater could be heard as far as 1 mile from Boqueron.—*D. B. V.*

156–157. Volcano Letter. Activity on San Benedicto Island: Volcano Letter no. 520, p. 7, 1953.

By March 1953, Boqueron crater was quiet. The lava in the crater was cool at the surface but many active fumaroles were observed. The delta of blocky lava at the eastern base of the cone was three times as large as it had been in December 1952, extending seaward about 1,200 feet beyond the old shoreline. Forward growth evidently ceased during January. (See also Geophys. Abs. 14970).—*D. B. V.*

156–158. Weyl, R[ichard]. Aktiver und erloschener Vulkanismus in El Salvador (Zentralamerika) [Active and extinct volcanism in El Salvador (Central America)]: Geol. Rundschau, Band 42, Heft 1, p. 146–147, 1953.

Of the active volcanoes of El Salvador that have erupted within historic time, only (Volcán) Izalco showed mild eruptive activity in 1951–52; (Volcán de) Santa Ana, Boquerón, and (Volcán de) San Miguel showed only fumarole and solfatara activity. These volcanoes all have a history of short phases of strong activity following long periods of quiescence, which is reflected in the ash profiles.—*D. B. V.*

156–159. Bullard, Fred M. Condition of active volcanoes of Italy in 1952: Volcano Letter, no. 521, p. 1–5, 1953.

At present, a "hot" spot on the eastern side of Vesuvius, 200–300 feet below the rim of the outer slope (with temperatures reported to be more than 650° C.), suggests that the next outbreak may occur at this point. Numerous fumaroles were noted on interior walls of the crater.

Stromboli in the Lipari Islands (Isole Eolie) was visited 3 times in 1952. A lava flow began June 6 and continued for several days, reaching the sea. In December, mildly explosive activity was noted in 2 apparently unrelated vents. The crater on Isola Vulcano has been in a solfataric state since 1890.

A sharp earthquake occurred on the eastern slope of Mount Etna on March 22, damaging a number of towns. Vapor issues constantly from the northeast Bocca; when it is white (steam) it is accompanied by a roaring thunderlike noise; when it is dark (ash filled) there is no noise. A similar relationship between composition of eruptive cloud and noise was noted at Paricutin.—*D. B. V.*

156–160. Volcano Letter. Myojin Reef: Volcano Letter, no. 518, p. 13–14, 1952.

In mid-September 1952, a volcanic eruption in the southern Izu-shotō formed a new islet named Myojin Reef, at latitude 31°56.8′ north and longitude 139°59.5′ east. On September 18 the island was estimated to be several hundred yards in diameter and to rise about 60 feet above sea level. Explosions and wave erosion reduced its area greatly but part still projected above sea level on September 22. On September 23 a survey vessel of the Japanese Maritime Safety Board was destroyed, presumably by an explosion. Nine scientists were among the 31 persons lost. The violent explosions of September 23 and 24 largely destroyed the portion of the peak above sea level. By late December, however, it had rebuilt to a heightt of 150 or 200 feet. It appeared to be a dome of viscous dacite.

Similar submarine eruptions have been reported in the area in 1905, 1906, 1915, and 1946.—*D. B. V.*

156–161. Healy, J. Activity at Ngauruhoe, New Zealand, November 1952, to July 1953: Volcano Letter, no. 521, p. 7–8, 1953.

On November 29, 1952, Ngauruhoe began a continuous violent eruption which continued for nearly 3 months. Only spasmodic observations were possible, owing to the poor weather. At the climax toward the end of January, doors and windows 8 miles away were rattled by closely spaced detonations, which occurred every 8 to 10 minutes; earlier the interval had been as much as a half hour. After the middle of February active periods became shorter and were widely spaced, and since eruption of a single black ash cloud to about 20,000 feet on March 27, eruptions have been few.—*D. B. V.*

TECTONOPHYSICS

156–162. Lebedev, V. I. Ob odnom veroyatnom istochnike sil tektonicheskikh dvizheniy v zemnoy kore [Concerning a probable source of forces producing tectonic movements in the earth's crust]: Akad. Nauk SSSR Doklady, tom. 90, no. 2, p. 217–220, 1953.

As a source of stress in the crust Lebedev suggests changes in crystalline structure of different rocks caused by variations in temperature or pressure. Tem-

perature variations can often result from changes in the intensity of radioactive phenomena, pressure variations can be caused by sedimentary processes. Important in such reactions are volume changes resulting from the modifications of crystal lattice. A decrease in volume leads to formation of synclines, an increase to formation of a dome or a break in the adjoining layer. Several examples of metamorphism are cited which could have produced the enormous pressures in the crust to account for the tectonic forms observed.—*S. T. V.*

156–163. Vening Meinesz, F. A. Indonesian archipelago: a geophysical study: Geol. Soc. America Bull., v. 65, no. 2, p. 143-164, 1954.

The hypothesis of crustal downbuckling seems to account for the structure of the Indonesian archipelago [Malay Archipelago]. The main tectonic arc has been caused by movement of a great inner crustal block south-southeast relative to the outside of the arc; and the second tectonic arc, by movement of a northeastern block in a direction slightly diverging to the east. In most places the relative block movements not only brought about a component of compression at right angles to the arc but also a component of shear in the direction of the arc. This shear movement, strongest on the sides of the arc (for example, in Sumatra and Mindanao) took place in the inner arc, causing volcanic and seismic activity. This explains the presence in all island arcs of a volcanic arc inside the tectonic one.

The second part of the paper discusses the hypothesis of convection currents. Currents existing over the whole or at least a great part of the mantle would exert a drag on the crust which may account for the relative block movements and the crustal compression mentioned. Currents existing at a depth of 500–750 km below the crust may explain deep and intermediate earthquake foci, the sinking of the deep basins (for example, Banda basin, Celebes Sea), and the origin of a third ridge inside the volcanic arc. Still shallower currents reaching down only a few hundreds of kilometers may have brought about the basins of 2,000–2,500 km depth, for example, Makassar Strait, Gulf of Bone (Teluk Bone), Gulf of Tomini (Teluk Tomini). It is usually assumed that a homogeneous layer is required for convection. Although the mantle seems to fulfill this condition from a depth of 900–2,900 km, from 200–900 km the density increases too rapidly to allow this assumption. A gradual change or phase of chemical constitution must be assumed. An attempt is made to show that a convection current can break through a layer of phase change of this kind and thus account for the origin of the basins, which do not disappear when the currents stop. For this hypothesis, however, one must assume that the mantle has a certain strength which must be overcome before flow or creep can set in. A trigger effect must be supposed, brought about by a secondary phenomenon causing a horizontal temperature gradient, such as that proposed by Griggs in 1939 to explain the pseudoperiodicity of tectonic phenomena [Geophys. Abs. 5257].—*D. B. V.*

156–164. Heaps, H. S. An analysis of downpunching: Royal Soc. Canada Trans., 3rd ser., v. 47, sec. 4, p. 17–21, 1953.

This paper summarizes some quantitative results of a theoretical analysis of the stresses arising in the earth due to the effect of a surface load, such as an ice cap. Assuming that the crust is perfectly elastic and of constant density, that the density difference between the crust and fluidlike supporting material is 1 g per cm^3, and that the ice cap is cylindrical, for a crust with a shearing strength of granite (200 kg per cm^2), the lower portion of the crust below the center of

the load will fail when the ice thickness becomes greater than three quarters of a kilometer. Surfaces of constant maximum shearing stress in this region are dome shaped upward from the lower surface. Shear, and therefore presumably plastic flow, at the upper surface begins under the center when the ice reaches a thickness of about 0.9 km.

Beyond the perimeter of the ice cap, shear begins when the ice reaches a thickness of 1.1 km. This shear commences at the lower surface of the crust at 250–300 km from the axis of symmetry. The lines of constant maximum stress here are steeper than those near the center and give rise to the phenomenon of "downpunching." It is probable, however, that the downpunching stresses are modified by plastic flow, which has not been considered in this analysis. Also, these conclusions concerning ice thickness apply only when previously existing stresses, for example, gravity, are hydrostatically adjusted.—*D. B. V.*

156–165. Quiring, H[einrich]. Das Scheitelproblem [The tectonic crest problem]: Deutsch. Geol. Gesell. Zeitschr., Band 104, Teil 2, p. 321–325, 1953.

Quiring's tilted-block theory (1921, 1924), based on the idea of contraction and retardation, is capable of explaining not only the problem of tectonic crests, but all the transitions from ideally symmetrical through asymmetrical crests up to unilateral imbrication or isoclinal folding. Ashauer (1934) and Kraus (1951) have discussed the Llobregat crest in the Pyrenees essentially in the sense of the tilted-block theory. Their diagrams of the mechanism of formation of tectonic crests are reproduced and discussed.—*D. B. V.*

156–166. Rücklin, Hans. Schrumpft die Erde? [Is the earth shrinking?]: Umschau, Jahrg. 53, Heft 5, p. 129–130, 1953.

The decrease in volume of the earth's interior, the cause of which is an open question, is evinced at the surface in sporadic sinking of segments of the crust. All primary crustal movements are vertical and downward. All horizontal movements and consequent uplifts are secondary phenomena provoked by lateral pressure on sinking segments.

The major crustal segments are ocean basins and continents. The former, being underlain by heavier sima, sink first and become "megagrabens"; the lighter (sial) continents become "megahorsts." The direct results of the large-scale sinking are periods of mountain building.

The lowering of sea level due to subsidence of the ocean floor produces a decrease in temperature on the continents of half a degree centigrade per 100 m of subsidence. A 1500-m subsidence thus produces glacial climate. Every major subsidence, and therefore, every related orogenic period, is followed by a glacial period which lasts until the continents have sunk to their original height above sea level.

According to Landes' theory, the ultimate cause of contraction is volume loss resulting from solidification of the silicate melts which surround the nickel-iron core with a thickness of about 3,000 km. The consequent shortening of the earth's radius is about 225 km, of its circumference, about 1,400 km. It is assumed that consolidation up to the present time has progressed far beyond the zone of deep-focus earthquakes (300–600 km). Although Rücklin believes this theory explains many phenomena adequately, he does not believe it is yet possible to reconstruct a complete picture of deep processes as long as we can observe only their superficial manifestations.—*D. B. V.*

156-167. Lees, George Martin. The evolution of a shrinking earth: Geol. Soc. London Quart. Jour., v. 109, pt. 2, p. 217–257, 1953.

This paper is the anniversary address presented at the annual meeting of the Society in 1953.

Beyond the simple fact that fold and thrust mountain structures are the consequence of compression of the earth's crust, there has been wide divergence of opinion on the causal mechanism. The seen geologic evidence of the compression zones and the presumptive evidence that they continue into the oceans have been undervalued, and instead, deductions drawn from geophysical observations—seismic, gravity, and magnetic—have unduly influenced geologic opinion. The Mohorovičić discontinuity has been interpreted as a change in composition from a "granitic" layer to a "peridotitic" layer because at the surface these rocks give corresponding velocities. The continents are said to float on this mobile layer and hence the assumption of the isostatic principle.

Geologic evidence shows the extreme improbability that there can be a layered arrangment of this type and that the observed compression structures can terminate downwards within such a thin crust. A more acceptable explanation of discontinuities is that they result from phase modifications at critical pressure levels with consequent marked changes in density and elasticity. The compressed rocky crust with the same pattern as seen at the surface, but with metamorphism increasing downward, may be hundreds of kilometers thick. There is now no reason to assume any important change in chemical composition even at deeper levels. The theory of a nickel-iron core is no longer necessary to explain the physical data.

Contraction of the earth's surface due to shrinkage of the interior is the only adequate explanation of the compression zones, but the amount of shrinkage which can be attributed to cooling alone is inadequate. The earth's circumference has contracted at least 3,000 km and perhaps much more. The processes of compression, mountain building, and erosion were already established at the time of the oldest known rocks, consequently there is no geologic evidence of the nature of the primordial crust and certainly no hint that it was at one time molten. Assuming no important change in mass of the earth since the Archean, the average density at that already advanced stage of compression may have been about 4.5 g per cm^3 compared with the present value of 5.517 g per cm^3. Adiabatic compression may have generated more heat than has been lost by radiation, hence the basis of assumption of a cooling earth is very insecure. Chamberlin and Moulton's planetesimal theory of the origin of the earth is the most acceptable geologically. The present moon may illustrate the pre-Archean appearance of the earth, the craters being interpreted as meteor scars.—*D. B. V.*

INTERNAL CONSTITUTION OF THE EARTH

156–168. ter Haar, D[irk]. The origin of stars and galaxies: Sci. Monthly, v. 77, no. 6, p. 279–288, 1953.

After a brief survey of relevant observational data, ter Haar discusses five main cosmogonies: Hoyle's continuous creation theory and Jordan's modification of it; the theory developed by Gamow, Alpher, and Herman to account for the existence of the different chemical elements; the dust-cloud hypothesis, based on work by Bok, Whipple, and Spitzer; the accretion theory of Hoyle, which is somewhat complementary to the dust-cloud theory; and von Weizsäcker's general cosmogony. This last is discussed in most detail, for in ter Haar's opinion it

leads to most detailed understanding of the formation and evolution of stars and galaxies. It draws attention to the importance of turbulence and rotation and divides all celestial bodies into three groups according to degree of rotational symmetry. Stars are believed to be formed from protostars which are turbulence elements in a turbulent protogalaxy.—*D. B. V.*

156–169. Die Umschau. Der Ursprung der Hydrosphäre [The origin of the hydrosphere]: Umschau, Jahrg. 52, Heft 15, p. 469, 1952.

The origin of the hydrosphere is related to that of the atmosphere, and both have been explained as secondary phenomena attending the development of the earth. The abundance of the argon isotope A^{40} is an argument in favor of such origin.

A^{40} is several hundred times more abundant in the atmosphere in relation to the A^{36} than elsewhere in the cosmos. It is derived from radioactive decomposition of K^{40}, but its abundance is much too great to be due entirely to the K^{40} of the outermost crust; therefore it must be assumed that atmospheric A^{40} for the most part comes from very much deeper layers. Water probably behaved in the same manner as A^{40}, for as long as the temperature in the mantle was more than 1,000° K, practically no minerals could contain water; both would be transported to the lithosphere and atmosphere by convection and diffusion. Only in the uppermost 20–30 km of solid strata could water behave differently from argon and combine with the crust. The surface water of the earth can thus be attributed to release from the interior. Numerical calculations are presented, based on the amount of water in stony meteorites and giving the distribution of water in the atmosphere, hydrosphere, and different rock types, to support this theory.—*D. B. V.*

156–170. Valle, P. E. Una equazione di stato per i solidi [An equation of state of solid bodies]: Annali Geofisica, v. 6, no. 2, p. 183–197, 1953.

Valle makes an attempt to evaluate the pressure developed inside a solid body owing to interaction of its constituent particles, with a further application of the derived relations to the problem of determining pressure and temperature inside the earth. Using the recent equations established by theoretical physicists and applying them to three alkaline metals, lithium, sodium, and potassium, he makes a comparison of his theoretical deductions with the results of the experiments of P. W. Bridgman, as well as with known seismological data, and concludes that discrepancies among them remain within experimental errors.—*S. T. V.*

156–171. Jacobs, J. A. Some aspects of the cooling of the earth: Royal Soc. Canada Trans., 3d ser., v. 47, sec. 4, p. 33–38, 1953.

Most theories of the origin of the earth agree that it passed through a molten stage before separating into layers, which according to Birch (Geophys. Abs. 14075) consist of an inner core of crystalline iron, an outer core of liquid iron, and a mantle of silicate material. Jacobs attempts to explain how the inner core could be solid under such conditions of origin.

As the earth cooled from the molten state, the temperature gradient would be adiabatic owing to convection currents and surface cooling. The curves for adiabatic temperature and melting point temperature would intersect twice. Solidification would begin first at the center, forming the solid inner core, and

later at the bottom of the mantle; the liquid layer trapped between would be insulated by the thickening silicate shell and the already solid inner core.

Geomagnetic secular variations are best explained by convection currents in the fluid outer core, set up by radioactivity of the inner core. Jacobs has shown that about 90 percent of heat flow in the core at the boundary between core and mantle can be carried away by conduction (Geophys. Abs. 14349). Although this does not disprove the existence of convection in the mantle, it adds weight to the contraction theory of orogenesis recently examined by Scheidegger and Wilson (Geophys. Abs. 14077, 14078).—*D. B. V.*

156–172. Jacobs, J. A. Problems connected with the cooling of the earth: Am. Geophys. Union Trans., v. 35, no. 1, p. 161–163, 1954.

Jacobs suggests that solidification of the earth as it cooled from the molten state began at the center of the earth, and that a solid inner core continued to grow until a curve representing the adiabatic temperature intersected the melting-point curve twice, at the boundary of core and mantle, and at a point which is now the boundary of the inner core. As the earth continued to cool, the mantle solidified from the bottom upward, thus leaving a liquid layer essentially at its original temperature between the silicate shell and solid inner core. Convection can arise in the core if the radioactive content of the inner core is only about 2 percent of that in the crust. Conduction alone will probably suffice to transfer heat from the core through the surrounding mantle. Thus in order to have convection currents in the core to account for the earth's magnetic field it is not necessary to have convection in the mantle as well.—*M. C. R.*

156–173. Runcorn, S. K. The earth's core: Am. Geophys. Union Trans., v. 35, no. 1, p. 49–78, 1954.

The modern view of the origin of the geomagnetic field associates it with motions in the liquid core of the earth. Irregular fluctuations in the rate of rotation of the earth may also be attributed to such motions. Bullard has suggested these motions arise from thermal convection. It may be demonstrated also that the motions are dominated by the Coriolis forces arising from the earth's rotation. Model experiments at Cambridge University give rise to an explanation of the westerly drift of the geomagnetic field and give patterns of motion involving jet streams which are similar to motions in the upper atmosphere. The essentially two-dimensional motions which result from the dominance of the Coriolis forces are thought to supply a fundamental reason for the axial character of the geomagnetic field. The mechanism by which the motions in the core set up electromotive forces are still obscure, but two lines of approach look promising. The first is that the motions maintain the field by a dynamo action and the second is that they set up temperature distributions which give rise to thermoelectric currents. Discussion followed by Vestine and Elsasser on the origin of the earth's field and by Morley, Graham, and Balsley on remanent magnetization. The paper and discussions formed part of the Symposium on the Interior of the Earth at the 34th Annual Meeting of the American Geophysical Union.—*M. C. R.*

156–174. Birch, Francis. Elasticity and constitution [of the earth's mantle]: Am. Geophys. Union Trans., v. 35, no. 1, p. 79–85, 1954.

As part of the Symposium on the Interior of the Earth Birch reviewed briefly the principal facts contributing to modern ideas of the mantle. An interpre-

tation of seismic velocities and their variations with depth by a method recently discussed (see Geophys. Abs. 14075) leads to the following conclusions: the mantle as a whole is not homogeneous; there may be a reasonably homogeneous layer between the depths of 900 and 2,900 km, consisting of high-pressure phases, presumably of the composition of a ferro-magnesian silicate; the gradual changes of composition, of the proportion of high pressure phases, or both, take place in a transitional layer between the depths of 200 to 900 km. Discovery of the nature of this transitional layer is considered to be of crucial importance for dynamic geology and petrology.—*M. C. R.*

GENERAL GEOPHYSICAL EXPLORATION

156–175. Mayne, S. J. Geophysics for the geologist in mineral exploration: Pakistan Jour. Sci., v. 3, no. 4, p. 145–155, 1951.

Having defined applied geophysics as the study of the problems of geology and mineral exploration by physical methods, Mayne then gives a brief description of the magnetic, electrical, gravitational, seismic, and radioactive methods of prospecting. Many graphs illustrate typical anomalies observed in practice.—*S. T. V.*

156–176. Ozegovic, Franjo. Geologija i njena uloga pri istrazivanju nafte [Geology and its application in prospecting for oil]: Nafta (Yugoslavia), godina 4, broj 1, p. 1–11, 1953.

The application of gravimetric, magnetic, electric, and seismic methods in exploration for oil is briefly described. Results of surveys of several promising oil deposits in Yugoslavia are presented in the form of geologic profiles.—*S. T. V.*

156–177. Enslin, J. F. Geophysics as an aid to foundation engineering: South African Inst. Civil Engineers Trans., v. 3, no. 2, p. 49–60, 1953.

Enslin defines applied geophysics as the technique of studying and delineating near-surface structure by the measurement of certain properties or forces at the surface and discusses the physical principles of the magnetic, gravitational, and electrical methods. The gravitational method is used only occasionally for investigating foundation problems, and yet it can sometimes be quite effective, for instance, in areas underlain by dolomite containing fault planes that could give rise to sink holes. The magnetic method is very useful in distinguishing many sedimentary formations from the underlying igneous rocks. Among the electrical methods the resistivity method is most applicable to problems of foundation engineering. Several examples are included.—*S. T. V.*

156–178. Noble, E. B. How to plan an exploration program: World Oil, v. 138, no. 1, p. 84–86 and 92, no. 2, p. 90–92 and 104, 1954.

An effective exploration program can be conducted only as long as management is willing to supply the necessary funds. With the necessary financial backing, planning should proceed as follows: Size up the area, including not only the necessary geologic background but also the working conditions and terrain accessibility. Choose the method or combination of methods to be employed, ordinarily in geophysical work considering the airborne magnetometer, the gravity meter, and the reflection seismograph, in that order. Estimate the cost. Select the proper personnel to perform the exploration program.

It is advisable to conduct ground magnetic exploration and gravity exploration simultaneously. The combination of the two methods can assist in the separation of anomalies that are caused by changes in rock properties from those that are caused by structure or topographic relief on the basement surface. If the person interpreting the geology of an area is predisposed to thinking in terms of faults rather than flexures, it is often a good idea to have the area reworked by someone with the other point of view, so that the benefit of both kinds of thinking can be obtained.—*L. C. P.*

156–179. Cook, Kenneth L. Annual review, geophysics: Mining Engineering, v. 6, no. 2, p. 184–189, 1954.

The most significant success in mining geophysics during 1953 was the discovery of huge lead-zinc copper sulfide ore deposits in New Brunswick, Canada. The trend for more mining companies to set up their own geophysical departments was continued in 1953, and one mining company spent a total of $240,000 for geophysics alone during the year. In oil exploration, the use of magnetic tape recording equipment for seismic reflection work expanded. The United Geophysical Company has developed a continuous-recording vehicle-mounted magnetometer. Regional gravity studies for basic geologic investigations are receiving more emphasis. The use of geophysics in ground-water and engineering investigations is widespread. Analysis of geophysical activity throughout the world indicates an expansion of effort and greater success than in previous years.—*L. C. P.*

156–180. World Oil. Geophysical activity: World Oil, v. 138, no. 3, p. 93, 1954.

A total of 716 geophysical crews were operating at the end of 1953 in oil exploration, slightly fewer than the 722 at the end of 1952. Seismic activity was slightly less, but all other geophysical activity increased. There was more core drilling at the end of 1953 than 1952.—*L. C. P.*

156–181. Frost, V. L. (Jack). Denver-Julesburg Basin, résumé of exploration and development during 1953: Mines Mag., v. 43, no. 10, p. 57–62 and 152, 1953.

Exploration in the Denver-Julesburg basin in 1953 has resulted in the discovery of 17 new oil pools, 7 gas pools, 3 extensions to pools, and 2 new pay zones for Colorado and 11 oil pools, 1 gas pool, 3 extensions, and 1 new pay zone for Nebraska. Only 9 pools had been found in the 86 years between 1863 and 1949; 115 oil and gas pools have been found since. The reflection seismograph is credited with the majority of all discoveries in 1953.—*L. C. P.*

156–182. Roberts, W. H. III, and Woodside, Forrest. Four Corners area—vigorous growth: Mines Mag., v. 43, no. 10, p. 51–55 and 152, 1953.

The Four Corners area surrounding the common corners of Colorado, New Mexico, Arizona and Utah includes the diverse geologic elements of the Rocky Mountains, the Colorado Plateaus, the Basin and Range Province, and several intermontane basins. Of the 60 discoveries of commercial oil and gas accumulations since 1908, perhaps 40 are structural traps and 20 are stratigraphic traps. Gas reserves in the area are currently estimated at more than 20 trillion cubic feet. However, only one important oil discovery has been made in the last 18

years, the Pettigrew-Tocito sandstone discovery at Doggie Canyon (now named South Blanco), in 1951.

The greatest exploration emphasis is still on surface structures, but geophysical exploration has become very important during the last 3 years. Although geophysics has not yet been credited with a discovery in the Four Corners area, such discoveries may be expected in the future inasmuch as it takes from 3 to 5 years for a geophysical program to produce results.—*L. C. P.*

156–183. Hager, Dorsey. Gas and oil possibilities in the Uinta Basin of Utah: Mines Mag., v. 43, no. 10, p. 81–83, 1953.

Accumulations of oil and gas in the Uinta Basin are governed largely by changes in sedimentation, lensing of sands up dip, and fractured shales. There has been practically no geophysical work in the basin during 1953, but in 1951 and 1952 there was intensive geophysical work. To find possible traps will require much new drilling, much new geophysical work, and the most careful testing. Possible oil and gas "pays" range through a thickness of 20,000 to 40,000 feet.—*L. C. P.*

156–184. O'Malley, F. Ward. Williston Basin—exploration frontier: Mines Mag., v. 43, no. 19, p. 38–48 and 154–155, 1953.

The Williston Basin is the largest basin of marine sediments on the North American continent and has oil reserves conservatively estimated at 500 million barrels and an estimated ultimate production of 5 billion barrels. It is not a Rocky Mountain Tertiary intermontane structural depression but a true depositional basin that started to develop in Ordovician time and continued to subside into Tertiary time.

Exploration in the Williston Basin includes the following methods: photogeologic mapping and surface mapping, gravity and magnetometer studies, seismograph mapping, core drilling, and stratigraphic tests. Of the geophysical methods, gravity and magnetic work have not yet been credited with finding an oil field, but the reflection seismograph is without question the most effective exploratory tool used. Both radioactivity and electric logs are also used extensively.—*L. C. P.*

156–185. Brasil Conselho nacional do petróleo. Relatório de 1951 [Annual report for 1951]: 269 p., Rio de Janeiro, 1952.

This annual report of the Conselho nacional do petróleo of Brazil contains a short description of geophysical exploration during the year 1951 in different regions of Brazil. Both gravimetric and seismic methods were used; the results are shown on several maps.—*S. T. V.*

156–186. Bentz, Alfred. Die Entwicklung der deutschen Erdölproduktion [The development of the German petroleum industry]: Erdöl u. Kohle, Jahrg. 6, Heft 12, p. 823–827, 1953.

This is an address to the Wirtschaftsverband Erdölgewinnung in Hannover (Economic Association for Petroleum Production), which included a review of the historical development of the oil industry in Germany. Bentz emphasizes the important part played by geophysics in this development and points to the fact that in 1935–1938 many geologists considered German oil deposits to be approaching exhaustion. Nevertheless the Preussische Geologische Landesamt undertook

a regional seismic survey of northwestern Germany in the course of which, in addition to some 50 known salt domes, more than 180 new salt domes, which now form the basis of the whole German oil industry, were discovered.—*S. T. V.*

156–187. García Siñeriz, José. Memoria General 1952: Inst. geol. min. España, 104 p., 1953.

The geophysical work of the Instituto geológico y minero de España during the year 1952, reported in the third section of the volume, consisted of several investigations in search for water and carboniferous deposits, using gravimetric, electric, and seismic refraction methods. Brief summaries of the results are given.—*S. T. V.*

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