Geophysical Abstracts 167 October-December 1956

GEOLOGICAL SURVEY BULLETIN 1048-D

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

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INTRODUCTION

EXTENT OF COVERAGE

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

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

LIST OF JOURNALS

The following list supplements the List of Journals published in Geophysical Abstracts 160 (January-March 1955, Bulletin 1033-A) and the supplements published in Geophysical Abstracts 161 through 166. Full titles and abbreviations of journals cited for the first time in this issue (with the sponsoring organization and its address where these do not form part of the title) are given.

Acad. royale Sci. coloniales Bull.—Académie royale des Sciences coloniales Bulletin des Séances. Bruxelles.

Archiwum Mineralog.—Archiwum Mineralogiczno. Polska Akademia Nauk, Komitet Geologiczny, Warszawa.

Beograd Tekh. Velika Škola Zbornik radova geol. i rudarskog fakulteta—Tekhnička velika škola u Beogradu Zbornik radova geološkog i rudarskog fakulteta (Beograd Polytechnical School, Transactions of the Geological and Mining Faculties).

Canadian Jour. Technology—Canadian Journal of Technology. National Research Council of Canada, Ottawa.

Finn. Geod. Veröffentl.—Veröffentlichungen des Finnischen Geodätischen Institutes. Helsinki.

Géotechnique—Institution of Civil Engineers, London.

Intermountain Assoc. Petroleum Geologists Guidebook—Guidebooks of the Field Conferences of the Intermountain Association of Petroleum Geologists. Salt Lake City.

Internat. Geod. Geophys. Union Assoc. Sci. Hydrology Pub.—Union Géodesique et Géophysique Internationale, Association Internationale d'Hydrologie Scientifique Publications. Louvain, Belgium.

Irish Astron. Jour.—Irish Astronomical Journal. Irish Astronomical Society, Armagh Observatory, Ireland.

Jour. Marine Research—Journal of Marine Research. Sears Foundation for Marine Research, Bingham Oceanographic Laboratory, Yale University, New Haven, Conn.

Royal Soc. South Australia Trans.—Transactions of the Royal Society of South Australia. Adelaide.

Servicio geol. nac. El Salvador Anales—Anales del Servicio geologico nacional de El Salvador. San Salvador.

Texas Univ. Bur. Econ. Geology Pub.—The University of Texas, Bureau of Economic Geology, Publications. Austin.

Yorkshire Geol. Soc. Proc.—Proceedings of the Yorkshire Geological Society. Hull, England.

FORM OF CITATION

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

ABSTRACTORS

Abstracts have been prepared by J. R. Balsley, P. E. Byerly, W. H. Diment, Beryl T. Everett, R. G. Henderson, D. R. Mabey, Virginia S. Neuschel, L. C. Pakiser, and Isidore Zietz as well as by the principal authors. The notation "Author's abstract" followed by the initials of an abstractor indicates a translation of the author's abstract.

AGE DETERMINATIONS

167–1. Ahrens, L. H. Radioactive methods for determining geological age: Reports on Progress in Physics, v. 19, p. 80–106, London, The Physical Society, 1956.

A review.—*M. C. R.*

167–2. Geological Association of Canada. Symposium on Precambrian correlation and dating: Geol. Assoc. Canada Proc., v. 7, pt. 2, 135 p., 1955.

A collection of papers presented at the meeting in Toronto in 1953. In addition to the papers abstracted separately (see Geophys. Abs. 164–19, 166–25, 167–17, 167–20), discussion by P. M. Hurley, Sherwin F. Kelly, A. E. J. Engel, R. M. Hutchinson, J. F. Henderson, and J. M. Harrison is included. Hutchinson reported age determinations by the Larsen method for 6 samples of Precambrian intrusions of central Texas. The ages were confirmed by the field relations.—*M. C. R.*

167–3. Smart, W. M. The origin of the earth: 239 p., Cambridge, University Press, 1953.

A general review of the principal features of the solar system and the main theories of its origin and development. In discussing the age of the earth Smart includes chapters on the geologic record and conflict with physical science, radioactivity, and astronomical evidence.—*B. T. E.*

167–4. Öpik, E. J. The time-scale of our universe: Irish Astron. Jour., v. 3, no. 4, p. 89–108, 1954.

The figure 3.5×10^9 years can at present be accepted as a close approximation of the age of the earth—the time elapsed since its elements were uniformly mixed, probably in a molten state. The same figure, or one perhaps only slightly greater, can be considered the age of the solar system. Although it is likely that the true age of the elements is the radioactive age of the heavy isotopes—about 4×10^9 years—it is possible that the lighter elements have originated from two different processes during the primordial explosion and also currently in stellar interiors. Meteorites are of no avail in estimating the age of the universe because they are recent arrivals in the solar system, bearing evidence of catastrophes that took place well after the beginning of the solar system. Ages of white dwarf stars are estimated as 4×10^9 years on the basis of conversion of hydrogen into helium. Conclusions based on stability of star clusters and double clusters are overruled by the shorter lifetime of their components; estimates based on the red shift of extragalactic nebulae are 4.5×10^9, but with the considerable uncertainty involved, admissible ages range between 3 and 6×10^9. This would represent the time elapsed since the universe was in a highly condensed state, as yet undescribed.—*D. B. V.*

167–5. Patterson, Claire [C.]. Age of meteorites and the earth: Geochim. et Cosmochim. Acta, v. 10, no. 4, p. 230–237, 1956.

Within experimental error, meteorites have one age as determined by three independent radiometric methods. The most accurate method (Pb^{207}/Pb^{206}) gives an age of $4.55 \pm 0.07 \times 10^9$ years. Using certain assumptions which are apparently justified, one can define the isotopic evolution of lead for any meteoritic body. It is found that earth lead meets the requirements of this definition. It is therefore believed that the age for the earth is the same as for meteorites. This is the time since the earth attained its present mass.—*Author's abstract*

167–6. Allan, D. W., and Jacobs, J. A. The melting of asteroids and the origin of meteorites: Geochim. et Cosmochim. Acta, v. 9, no. 5/6, p. 256–272, 1956.

The radioactive heating of spherical bodies is discussed and the melting of asteroids is investigated quantitatively, as well as qualitatively. Very general conclusions include the following: a hot origin for asteroids leads to a reasonable thermal history, whether the time of origin was 4.5 or 5.5×10^9 years ago; an origin by cold accretion and subsequent radioactive heating is feasible for $t_o = 5.5 \times 10^9$ years, or if concentration of radioactive substances was higher than is at present thought reasonable. In either case, the asteroids from which the meteorites originated were probably about 1,000 km in diameter. There may be a contradiction between pressure and temperature requirements deduced from metallurgical studies, and the helium ages for iron meteorites are hard to reconcile with other data.—*D. B. V.*

167–7. Broecker, W. S., and Kulp, J. L[aurence]. The radiocarbon method of age determination: Am. Antiquity, v. 22, no. 1, p. 1–11, 1956.

An evaluation of the radiocarbon method including review of the principles and analysis in some detail of the sources of error. Charcoal (including thoroughly charred bone), fresh wood, and coarse marine shells are the most useful samples. For highest precision, the precision of estimate of original C^{14} must be taken into account. The probability that a radiocarbon age lies outside the limits of probable error is about 30 percent. A C^{14} determination gives an estimate of the time at which the carbon in a particular sample was removed from the CO_2 cycle; whether this date actually represents the time of a given archeological event must be determined carefully in the field. —*D. B. V.*

167–8. Tauber, Henrik. Copenhagen natural radiocarbon measurements: Science, v. 124, no. 3227, p. 879–881, 1956.

Dates for archeological samples from the earliest phases of the Neolithic period in Switzerland and Denmark as determined in the carbon-14 laboratory at Copenhagen between February 1953 and May 1955. —*M. C. R.*

167–9. Crane, H. R. University of Michigan radiocarbon dates I: Science, v. 124, no. 3224, p. 664–672, 1956.

The first installment of the radiocarbon ages determined at the Michigan laboratory from 1950 to the present. During 1950–52 the method used was similar to that developed by Libby. Because of increasing atmospheric contamination, operations were suspended in late 1952 until a system using a carbon dioxide-carbon disulfide Geiger counter was developed. Operations were resumed in

1954. Ages are given for samples from the Mississippi Valley, the Great Lakes region, and other parts of the United States, Mexico, Alaska, Eurasia, the Pacific Islands, and South America. —*M. C. R.*

167–10. Shima, Makoto. On the geochemical study of carbon 14. I. The Ozegahara peat: Chem. Soc. Japan Bull., v. 29, no. 4, p. 443–447, 1956.

Carbon-14 dating of peat samples from Ozegahara (a subtundra on the boundary of Tochigi, Fukushima, Niigata, and Gumma prefectures) indicates that the layer 2 m beneath the surface is 1,000 years old and the layer from 3 to 4 m deep is 5,000 years old. The rate of sedimentation is about 1.6 mm per year at present, and seems to have been 1 mm and 0.25 mm per year when the layers 2 m and 3 to 4 m beneath the surface were formed. —*M. C. R.*

167–11. Marler, George D. How old is Old Faithful geyser: Am. Jour. Sci., v. 254, no. 10, p. 615–622, 1956.

Radiocarbon dating of silicified wood found in the mound of Old Faithful supports the deduction that Old Faithful cannot be more than a few hundred years old. Study of the mound shows that the greater part was built by hot springs in at least two stages with a dormant period between long enough for the pine forest to encroach upon the mound. —*V. S. N.*

167–12. Schwarzbach, Martin. Beiträge zur Klimageschichte Islands. IV. Das Vulkangebiet von Hredavatn (West-Island) [Contributions to the climatic history of Iceland. Part 4. The volcanic region of Hredavatn, West Iceland]: Neues Jahrb. Geologie u. Paläontologie Abh., Band 104, Heft 1, p. 1–29, 1956.

A description of the Hredavatn volcanic area of western Iceland, about 70 km north of Reykjavík. Several lava flows have been dated by the radiocarbon method as between 1,100 and 3,700 years old (see also Geophys. Abs. 165–5).—*D. B. V.*

167–13. Zumberge, James H., and Potzger, John E. Late Wisconsin chronology of the Lake Michigan basin correlated with pollen studies: Geol. Soc. America Bull., v. 67, no. 3, p. 271–288, 1956.

Integration of geologic information and carbon-14 dates establishes an absolute chronology of events in the Lake Michigan basin as follows: Two Creeks–Bowmanville low-water stage, 11,000 years ago; end of Lake Algonquin 8,000 years ago; Lake Chippewa low-water stage, 5,000 years ago; beginning of Nipissing Great Lakes, a little less than 4,000 years ago. Climatic changes indicated forest succession in southwestern Michigan can be correlated by pollen studies and carbon-14 dating. The chronology proposed differs from those proposed by Antevs and Flint. —*M. C. R.*

167–14. Wright, H. E., Jr., and Rubin, Meyer. Radiocarbon dates of Mankato drift in Minnesota: Science, v. 124, no. 3223, p. 625–626, 1956.

Radiocarbon ages of samples of the Anoka sand plain and the Mississippi valley train, for basal organic sediments in lakes on the Mankato drift, and for deposits of Lake Agassiz which were presumed to record the retreat of the Des Moines lobe of the Keewatin ice sheet in Mankato time, suggest that the surface drift at the type locality in south-central Minnesota should be correlated with the Cary glacial substage rather than with the Valders advance. Use of the term Valders

instead of Mankato for the last major substage of the Wisconsin is suggested; adoption of the term would establish the several important intervals of the middle and late Wisconsin—Tazewell, Cary, Two Creeks, and Valders—as units of reference based on the activity of a single ice lobe (Lake Michigan lobe).—*M. C. R.*

167–15. Starik, I. Ye., Murina, G. A., and Krylov, A. Ya. Kriteriy prigodnosti mineralov dlya opredeleniya ikh vozrasta gelievym metodom [Criteria for the suitability of minerals for determination of their age by the helium method]: Akad. Nauk SSSR Izv. Ser. geol., no. 2, p. 67–71, 1955.

The form in which uranium and thorium are present in weakly radioactive minerals—whether isomorphously as part of the crystal structure, or disseminated as microinclusions of highly radioactive minerals, or as absorbed compounds—has a direct bearing on the helium retention and hence on the suitability of such minerals for helium age determinations. In an attempt to establish criteria for suitability, more than 20 garnets of different varieties were analyzed and dated. The results show that in spite of their abundance in nature and favorable lattice structure, suitable garnets are rare. Even well-formed crystals contain inclusions of different minerals, particularly the contact metamorphic garnets. The inclusions range from macroscopic to submicroscopic in size. Good results were obtained only for schorlomite from alkaline pegmatoid rocks; spessartite and andradite sometimes gave approximate results, but almandite and grossularite showed no agreement with the known age. It is concluded that titaniferous and manganiferous garnets, which often contain yttrium, probably are more favorable than other varieties because the radioactive elements occur in them isomorphously.—*D. B. V.*

167–16. Venkatasubramanian, V. S., and Aithal, V. S. The application of the α-helium method to some archaean specimens: Jour. Sci. Indus. Research (India), Sec. B, v. 15, no. 1, p. 3–5, 1956.

The geologic ages of 19 Archean specimens from Mysore and Bihar in India have been determined by the α-helium method and the results tabulated. The highest age obtained was 1,700 million years for magnetite crystals of Dhawar rocks from Holenarasipura; in view of the high retentivity factor of magnetite for helium, this may represent a good approximation of the correct age. The possibilities of helium leakage in some other specimens are discussed.—*D. B. V.*

167–17. Aldrich, L. T., Tilton, G[eorge] R., Davis, G. L., Nicolaysen, L. O., and Patterson, C[laire] C. Comparison of U–Pb, Pb–Pb, and Rb–Sr ages of Precambrian minerals: Geol. Assoc. Canada Proc., v. 7, pt. 2, p. 7–13, 1955.

A preliminary report on a comparative age study on rock-forming minerals. Minerals from five massive Precambrian granites were used to determine apparent ages by three radioactive decay schemes: uranium-lead, lead-lead, and rubidium-strontium. Analytical data are given together with data for several pegmatite minerals, two of which are presumed to be genetically associated with the granites. Disagreement among the calculated ages indicates need for many additional laboratory studies coordinated with comprehensive field observations.—*M. C. R.*

167–18. Rogues, M[aurice]. Graphique de calcul des âges apparent des minéraux par la méthode plomb-alpha [Graph for calculation of the apparent ages of minerals by the lead-alpha method]: Soc. Française minéralogie et cristallographie Bull., tome 70, no. 4–6, p. 293–300, 1956.

A table is given which permits construction of a graph for calculation of the apparent age of thoro-uraniferous minerals as a function of the lead content, of the total alpha radioactivity, and of the fraction F of alpha radioactivity due to uranium alone.—*Author's summary, D. B. V.*

167–19. Schurmann, H. M. E., Bot, A. C. W. C., Steensma, J. J. S., Suringa, R., Eberhardt, P[eter], Geiss, J[ohannes], Gunten, H. R. von, Houtermans, F. G., and Signer, P. Second preliminary note on age determinations of magmatic rocks by means of radioactivity: Geologie en Mijnbouw, jaarg. 18, no. 10, p. 312–330, 1956.

The uncorrected 206/208 age of average zircon isolated from the Lausitz granodiorite has been determined as 315×10^6 years; a clear sample yielded an age of 280×10^6 years. These ages are in the vicinity of that reported for monazite from the same rock (Geophys. Abs. 163–132). The clear zircon constitutes about 85 percent of the total zircon; the other 15 percent of dark zircon could be a residual zircon of Precambrian age, approximately 550×10^6 years old. Minerals from Nigeria, Singkep (Indonesia), and Egypt are also under investigation in the program in progress.—*D. B. V.*

167–20. Holmes, Arthur. Dating the Precambrian of peninsular India and Ceylon: Geol. Assoc. Canada Proc., v. 7, pt. 2, p. 81–106, 1955.

Age determinations on monazite are used in conjunction with other data to date the orogenies in peninsular India and Ceylon. Six main periods are recognized: 485, 735, 955, 1570, 2300, and 2450 million years ago.—*M. C. R.*

167–21. Grimbert, Arnold. L'uraninite de Grabo (Côte d'Ivoire) [The uraninite from Grabo (Ivory Coast)]: Soc. Géol. France Comptes Rendus, no. 11, p. 194–195, 1956.

A description of some details of the uraninite occurrence in pegmatite near Grabo on the Ivory Coast. Its age has been determined as 1935×10^6 years by the uranium-lead method by Pellas, Guillemin and Chervet and as $1940\pm20\times10^6$ years by the lead-isotope method by Lazard and Roth. These values have been confirmed by dating the zircon associated with the uraninite.—*D. B. V.*

167–22. Bernazeaud, Jacques; Grimbert, Arnold; Lazard, Bertrand; Roth, Raoul; and Sanselme, Henri. Conditions de gisement et âge de l'uraninite de Bas-Cavally (Côte d'Ivoire) [Conditions of deposition and age of the uraninite at Bas-Cavally (Ivory Coast)]: Acad. Sci. Paris Comptes Rendus, tome 242, no. 23, p. 2744–2746, 1956.

The primary uranium deposits of Bas-Cavally, Ivory Coast, occur in pegmatites intercalated in the metamorphic complex, near the villages of Grabo, Nekaounie, and See. The U_3O_8, PbO, and ThO_2, rare-earths contents have been determined for three samples from the Grabo deposit, and thorium for one of them. By using the Wickman graphs, an age of 1780×10^6 years was deduced by Pellas. On the basis of the lead isotope ratios (206=100; 204=0,19±0.001; 207=12.06±0.06; 208=0.76±0.02; Th/U=0.01) the age is calculated as $1950\pm20\times10^6$ yrs. The discrepancy between the two determinations may be due to loss of lead, partly

in the course of the history of the mineral and partly during chemical analysis. The isotopic age is probably closer to the true age.—*D. B. V.*

167–23. Besairie, Henri; Eberhardt, P[eter]; Houtermans, Friedrich Georg; and Signer, Peter. Deuxième série de mesures d'âge de galènes de Madagascar [Second series of measurements of age of galenas from Madagascar]: Acad. Sci. Paris Comptes Rendus, tome 243, no. 6, p. 544–545, 1956.

From mass spectrometer measurements of lead isotope ratios, the conventional ages of five galena specimens from different parts of Madagascar are determined as 330±50 million years (Ankitokazo); 390±60 million years (Migioky); 1,890±50 million years (Ambatomitsangana); 1,850±50 million years (Ankisatra); and 2,140±70 million years (Andrambo). The ages for the Ambatomitsangana and Ankisatra specimens are in close agreement with that of a specimen from Besakay in the same geologic setting (see Geophys. Abs. 164–35); the first two are manifestly too high. On the basis of the fifth determination the Vohibory series must belong earlier in the Precambrian than hitherto believed.—*D. B. V.*

167–24. Webber, G. R., Hurley, P. M., and Fairbairn, H. W. Relative ages of eastern Massachusetts granites by total lead ratios in zircon: Am. Jour. Sci., v. 254, no. 9, p. 574–583, 1956.

Lead ratios of zircon samples show two principal ages for the granites: 260 million years for places near Peabody, Rockport, and Cape Ann, north of North Attleboro, north end of Whitinsville, and near Fitchburg; and 355 million years for places northeast of Milford and east of Wrentham. It is probable that the Quincy-type granites north and south of Boston, as well as part of the area mapped as Dedham granodiorite, and some granites extending southward into Connecticut, are all approximately 260 million years old. The age of at least one area of granite mapped as Dedham granodiorite is 350 million years.—*V. S. N.*

167–25. Hamilton, Warren B. Precambrian rocks of Wichita and Arbuckle Mountains, Oklahoma: Geol. Soc. America Bull., v. 67, no. 10, p. 1319–1330, 1956.

The Precambrian rocks of the Wichita Mountains form a stratiform complex which is the upper part of a gabbroic lopolith formed under conditions of tectonic quiet or tension. Zircon age determinations indicate the rocks are 640 million years old and may be correlative with the Keweenawan of the Lake Superior region. The Arbuckle Mountains complex probably represents part of a composite batholith formed in an orogenic belt. Zircon age determinations indicate an age of 940 million years and indicate correlation with the granitic rocks of central Texas. Rhyolite and diabase dikes cutting the Arbuckle granitic rocks are probably related to the rocks of the Wichita Mountains.—*M. C. R.*

167–26. Wetherill, G[eorge] W., Tilton, G[eorge] R., Davis, G. L., and Aldrich, L. T. New determinations of the age of the Bob Ingersoll pegmatite, Keystone, S. Dak.: Geochim. et Cosmochim. Acta, v. 9, no. 5/6, p. 292–297, 1956.

Age determinations have been made on various minerals from the Bob Ingersoll pit No. 1. The uranium-lead ages agree at 1,600 million years; Rb-Sr ages of microcline, muscovite, and lepidolite are all about 2,050 million years, probably indicating that the currently accepted Rb decay-constant is incorrect. K–A ages

of the micas are in fairly good agreement with U-Pb ages when a K^{40} branching ratio of 0.100 is used. The K-A age of the microcline is definitely lower, probably indicating loss of argon from this mineral.—*Authors' abstract.*

167–27. Kulp, J. L[aurence], Eckelmann, W[alter] R., Gast, P[aul] W., and Miller, D. S. Age of the Black Hills gold mineralization: Geol. Soc. America Bull., v. 67, no. 11, p. 1557–1558, 1956.

The age of a galena sample from the Homestake mine determined by lead isotope analysis is 1500 to 1700 million years, similar to that of the uraninite from the Bob Ingersoll mine. A period of Precambrian mineralization is indicated. The age of a galena sample from the Spokane mine cannot be obtained accurately but is considerably younger or $\leq$400 million years.—*M. C. R.*

167–28. Wetherill, George W. An interpretation of the Rhodesia and Witwatersrand age patterns: Geochim. et Cosmochim. Acta, v. 9, no. 5/6, p. 290–292, 1956.

The regularities in the discordant U-Pb ages noted by Ahrens (see Geophys. Abs. 162–164, 163–131) for the Witwatersrand and Canadian and Rhodesian shields can be more easily explained by chemical leaching or alteration at a single episode of geological history than by some physical control of lead loss. The more difficult question of the uniqueness of this interpretation requires the results of more general theoretical discussion, which is being prepared. Aside from the possibility that the regularities are coincidental, there are a very limited number of similar geochemical processes that will produce such age patterns. Discovery of these regularities and their possible explanation indicates the possibility that discordant U-Pb ages may be used to determine some aspects of the common geologic history of large areas, even entire geologic provinces.—*D. B. V.*

167–29. Folinsbee, R. E., Lipson, J[oseph I.], and Reynolds, J. H. Potassium-argon dating: Geochim. et Cosmochim. Acta, v. 10, no. 1/2, p. 60–68, 1956.

The use of ultra-high-vacuum techniques in the argon extraction apparatus and of a new specially designed mass spectrometer, in the potassium-argon dating program now in progress at Berkeley, allows precise measurement of radiogenic argon in small and young samples. Data for 12 rocks and mineral separates (7 from the Yellowknife area in Canada, 3 from the Sierra Nevada batholith, a chondrite meteorite from Forest City, Iowa, and a Middle Devonian potash salt from Saskatchewan) are tabulated, with ages calculated according to alternative decay constants. For the Yellowknife specimens, the results show that micas retain more argon than feldspars and more orthoclase than plagioclase. Ages for biotites are consistent and in good agreement with earlier determinations, suggesting that biotite may retain argon quantitatively. A very short time is inferred for emplacement of the Yellowknife granite series. The Sierra Nevada batholith is dated at 100×10^6 years. The age obtained for the meteorite, 4500×10^6 years, is remarkably close to an earlier determination at another laboratory (see Geophys. Abs. 160–151). The age of 285×10^6 years for the sylvite is in agreement with the time scale of Holmes.—*D. B. V.*

167–30. Lipson, Joseph I. K-A dating of sediments: Geochim. et Cosmochim. Acta, v. 10, no. 1/2, p. 149–151, 1956.

The apparent ages of twelve sedimentary minerals, dated in the course of the Berkeley potassium-argon experiments and ranging from 16 to 285 million years,

are plotted against assigned stratigraphic age arrived at by interpolation on Holmes' B time scale. (Experimental data are tabulated. Radiogenic argon was determined by isotopic dilution techniques, K by flame photometry.) Agreement is generally good. Whether the discrepancy between an uncontaminated Miocene glauconite and several Oligocene glauconites is due to greater loss in argon in surface samples or inheritance of argon rich in A^{40} by the Miocene sample is as yet undetermined.—*D. B. V.*

167–31. Wasserburg, G. J., Hayden, R. J., and Jensen, Kenneth J. A^{40}–K^{40} dating of igneous rocks and sediments: Geochim. et Cosmochim. Acta, v. 10, no. 3, p. 153–165, 1956.

The discrepancy in A^{40}/K^{40} ratios between micas and feldspars reported by Wetherill (Geophys. Abs. 167–26) has been confirmed. From the suite of micas investigated, at least 85 percent of the radiogenic A^{40} seems to have been retained; in comparison, the potassium feldspars have lost about 30 percent. The branching ratio of 0.085 (see Geophys. Abs. 161–132) is therefore an empirical calibration constant that corrects for diffusional losses from the feldspars, bringing the calculated ages into reasonable agreement with the "true" age. If it can be assumed that no A^{40} is inherited in potassium minerals, it is always possible to assign a lower limit to the true age by the argon method. To evaluate the age obtained, the criterion of agreement between the A^{40}/K^{40} ratios for several different samples of a given mineral from a given occurrence should always be used. Although the micas seem to be suitable for absolute dating, it is still necessary to obtain minimal evidence of consistency before an age estimate can be made. Further comparisons between good Pb-U ages and A^{40}/K^{40} ages are necessary before the argon method can be considered established.

Ages determined from the A^{40}/K^{40} ratios in 4 authigenic sedimentary minerals (3 glauconites, 1 feldspar) are also presented and found to be in reasonable agreement with Holmes' time scale.—*D. B. V.*

167–32. Jeffery, P. M. The radioactive age of four Western Australian pegmatites by the potassium and rubidium methods: Geochim. et Cosmochim. Acta, v. 10, no. 3, p. 191–195, 1956.

The ages of 3 muscovite, 2 lepidolite, and 4 microcline samples from 4 Western Australian pegmatites have been determined using both the potassium-argon and rubidium-strontium methods. The values 1.13×10^{-11} and 0.56×10^{-9} were used for the decay constants of Rb^{87} and K^{40}, respectively, and a branching ratio of 0.10 ± 0.01 for K^{40}. The rubidium ages were corrected by 20 percent for comparison purposes. For the micas the ages are consistent, with the exception of one low argon age; for the feldspars the argon ages are considerably lower than the strontium ages in all but one case. It is concluded that the four pegmatites are contemporaneous and of an age of 2,800 million years.—*D. B. V.*

167–33. Herzog, Leonard F., and Pinson, William H., Jr. Rb/Sr age, elemental and isotopic abundance studies of stony meteorites: Am. Jour. Sci., v. 254, no. 9, p. 555–556, 1956.

The concentrations of rubidium and strontium in two chondritic meteorites have been determined by the stable isotope dilution method and strontium isotope abundances of the chondrites and an achondrite with a large strontium-rubidium ratio investigated. Meteorites and the Earth seem to have had identical strontium isotope compositions, including an "original" strontium concen-

tration (Sr_o) of 0.0683±0.0010 approximately 4.7×10^9 years ago. This evidence admits the possibility of a contemporaneous origin of these chondrites and Earth about 4.7 billion years ago.—*V. S. N.*

167–34. Ewald, H., Garbe, S., and Ney, P. Die Isotopen-Zusammensetzung von Strontium aus Meerwasser und aus rubidium-armen Gesteinen [The isotopic composition of strontium from sea water and from rubidium-poor rocks]: Zeitschr. Naturforschung, Band 11a, Heft 6, p. 521–522, 1956.

The Sr^{86}/Sr^{88} and Sr^{87}/Sr^{86} abundance ratios are given for samples of sea water (1), limestone (2), strontianite (3), and celestite (4). Ages calculated from the 87/86 ratios do not correspond well with those estimated from the stratigraphic position; the ratios of calculated/estimated age range from 0.9 to 3.4 and the best results, as expected, are from the unaltered limestone.—*D. B. V.*

167–35. Kantor, Ján, and Kupčo, Gejza. Absolútny vek lepidolitov od Rožnej na Morave na základe metódy radiogénneho stroncia [The absolute age of lepidolites from Rožna township in Moravia determined by the radiogenic strontium method]: Geol. Prace zpravy 7, p. 3–12, 1956.

The age of lepidolite from the deposit near Rožna was determined by the strontium-rubidium method, by the ratio of the intensities of the spectral lines of strontium and rubidium, suggested and developed by Ahrens, and by the method of direct quantitative spectral analysis of the mineral. From the ratio of the spectral intensities of strontium and rubidium and the Ahrens graph, the absolute age is $(450—460)\times10^6$ years. By quantitative spectral analysis the strontium content was determined to be 0.0024 percent and the rubidium —1.520 percent. Assuming that the entire strontium content is in the form of Sr^{87}, and the rubidium is present as Rb^{87}, and using the data of Brewer, Ecklund and others, the age is computed to be equal to 475×10^9 years.—*S. T. V.*

167–36. Aldrich, L. T., Wetherill, G[eorge] W., and Davis, G. L. Determinations of radiogenic Sr^{87} and Rb^{87} of an interlaboratory series of lepidolites: Geochim. et Cosmochim. Acta, v. 10, no. 4, p. 238–240, 1956.

Ratios of radiogenic Sr^{87}/Rb^{87} have been determined for five lepidolites ranging in age from 100 to 2,700 million years. The data agree with those obtained several years ago in this laboratory and demonstrate the reproducibility of the method of isotope dilution and the applicability of the Rb^{87} decay to mineral age measurements on lepidolites over the whole extent of geologic time.—*Authors' abstract*

167–37. Moret, Léon. Données nouvelles sur l'âge absolu et l'origine des argiles d'Eybens, près Grenoble, Isère [New data on the absolute age and the origin of the clays of Eybens near Grenoble]: Grenoble Univ. Lab. Géologie Travaux, tome 32, p. 11–14, 1954–55 (1956).

This paper was also published in the Comptes Rendus, Académie des Sciences (see Geophys. Abs. 166–10).—*D. B. V.*

EARTH CURRENTS

167–38. Burkhart, K[urt]. Konstruktionsunterlagen der induktiven Pulsations– und Erdstrom-Anlage am Erdmagnetischen Observatorium in Fürstenfeldbruck [Construction data for the inductive pulsation and

earth-current installation at the geomagnetic observatory in Fürstenfeldbruck]: Geofisica Pura e Appl., v. 33, p. 78–85, 1956.

A description and analysis of the installation at Fürstenfeldbruck. For the induction apparatus, mu metal bars 2 meters long are used. Experiments show that the largest amplitudes are attained if the resistance of the coils corresponds to that of the galvanometer.—*M. C. R.*

167–39. Olsson, B. H. The electrical effects of tidal streams in Cook Strait, New Zealand: Deep-Sea Research, v. 2, no. 3, p. 204–212, 1955.

Electric currents which are generated by tidal streams have been observed in the land near the coast of Cook Strait, New Zealand. In each tidal period, the vector representing the horizontal component of the potential gradient was found to rotate through 360° in a counter-clockwise direction. Corresponding rotary streams were observed in the Strait.

The potential gradient associated with those streams which are directed along the channel is explained by the theory worked out by Longuet-Higgins (1949) [see Geophys. Abs. 139–11553]. No theory is available for dealing with on-shore streams.

Using the potential-gradient measurements, the magnitudes of those streams directed along the channel were computed. These computed values agree with certain direct observations of the streams made by the survey vessel H. M. N. Z. S. Lachlan.—*Author's abstract*

EARTHQUAKES AND EARTHQUAKE WAVES

167–40. Savarenskiy, Ye. F., and Kirnos, D. P. Elementy seysmologii i seysmometrii [The elements of seismology and seismometry] 2d revised edition: Moscow, Gosudarstvennoye izdatel'stvo tekhniko-teoreticheskoy literatury, 543 p., 1955.

A revised and substantially enlarged edition of the book first published in 1949 [see Geophys. Abs. 143–12373]. As before, the book is divided into two parts: the first on seismology in general, written by Savarenskiy; and the second on the measurement of seismic waves, written by Kirnos.—*S. T. V.*

167–41. O'Connell, D. J. K. Earthquakes: What causes them, and where they occur: Irish Astron. Jour., v. 3, no. 1, p. 6–9, 1954.

The text of a popular talk on causes and distribution of earthquakes.—*D. B. V.*

167–42. O'Connell, D. J. K. Some famous earthquakes: Irish Astron. Jour., v. 3, no. 3, p. 65–68, 1954.

A popular description of some of the famous earthquakes of modern times, including the Lisbon (1755), Messina (1908), San Francisco (1906), Tokyo (1923), and Hawkes Bay, New Zealand (1931) shocks.—*D. B. V.*

167–43. Rothé, J[ean]–P[ierre]. Tableau de la séismicité du globe pendant les années 1953–1954 (Chronique séismologique) [Table of the seismicity of the earth during the years 1953–1954 (Seismological chronicle)]: Rev. Étude Calamités, tome 15, no. 33, p. 8–41, 1955.

During 1953 and 1954, the International Bureau of Seismology studied 3,610 earthquakes, and 2,496 epicenters were determined by the collaboration of numerous seismological services. The most important shocks are tabulated by

regions, giving date, time, latitude and longitude, magnitude (where possible), and focal depth (if calculated). The 21 principal destructive earthquakes are listed separately; 7 were in the Mediterranean region, 2 in Asia (Iran and Tibet), 10 in the Pacific and 2 in the West Indies. They caused a total of almost 2,000 deaths in 1953 and more than 1,300 in 1954.—*D. B. V.*

167–44. Omote, Syun'itiro. Aftershocks that accompanied the Tottori earthquake of Sept. 10, 1943. (The 2nd paper): Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 641–661, 1955.

Aftershocks of the Tottori earthquake in Japan on September 10, 1943, were observed instrumentally for about a month at eight stations set up for the purpose. The number of aftershocks decreased markedly after Sept. 14. Distribution of *S–P* times indicates shocks occurred throughout a wide area; most foci were apparently between the Sikano and Yosioka faults and the coast of the Japan Sea to the north. Magnitudes (computed by Tsuboi's formula) of shocks recorded at four stations ranged from 2.2 to 4.1.—*M. C. R.*

167–45. Iida, Kumizi. Earthquakes accompanied by tsunamis occurring under the sea off the islands of Japan: Nagoya Univ. Jour. Earth Sci., v. 4, no. 1, p. 1–43, 1956.

From 684 to 1955, 136 tsunamis have accompanied submarine earthquakes in the vicinity of Japan, chiefly off northeastern and southwestern Japan. The magnitudes of the earthquakes ranged from 5.5 to 8.6; all submarine shocks of magnitude 8 or more were accompanied by tsunami. The relation between the magnitude of the earthquake and that of the tsunami is given by $m=aM+b$ (m and M being the magnitude of the tsunami and earthquake, a and b constants). Earthquakes accompanied by tsunami are always followed by aftershocks, some of which may be accompanied by tsunami.—*M. C. R.*

167–46. Tamrazyan, G. P. Zemletryaseniya v Prikazbekskom rayone i uprugiye prilivy [The earthquakes in the Kazbek region and their relation to elastic tides in the earth]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 840–843, 1956.

The force producing earth tides varies periodically with the position of the earth on its ecliptic, being greater when the earth is in perihelion (nearest to the sun) and smaller in aphelion, and also with the phases of the moon, being greater during the new moon and full moon and smaller during the first and last quarters. A statistical study of 33 earthquakes in the Caucasus from 1932 to 1947 shows that the 3 most severe earthquakes occurred during the periods when the cosmic factors were the most favorable for the generation of earthquakes; 17 earthquakes occurred during the time when the cosmic factors were of average intensity, 11 during the time intervals when these factors were of the greatest intensity, and no earthquakes occurred during the intervals when cosmic factors were least favorable for the production of earthquakes.—*S. T. V.*

167–47. Poisson, [Charles]. Tremblements de terre ressentis à Madagascar en 1954 [Earthquakes felt in Madagascar in 1954]: Acad. Malgache Bull., tome 33, p. 17–18, 1955.

A list and brief description of the 12 earthquakes felt in Madagascar during 1954. The strongest was that of June 11; its intensity was estimated, from

macroseismic effects, to have been 7 at the epicenter, in the vicinity of Lake Alaotra.—*D. B. V.*

167–48. Wanner, Ernst. Die Lage der Erdbebenherde im Mittelwallis [The position of the earthquake foci in central Valais]: Eclogae geol. Helvetiae, v. 48, no. 2, p. 245–255, 1955.

The epicenters in central Valais, Switzerland, determined by different methods from instrumental data of European observatories, lie on the north side of the Rhône valley along the depression between the Aar and Mont Blanc massifs. The foci of the main shocks apparently are about 10 km deep, presumably in the crystalline basement, whereas the foci of most of the aftershocks are in the more shallow sedimentary cover. Seismograms at Neuchâtel, at a focal distance of 80–90 km, show typical double onsets. The aftershocks can be considered due to secondary effects in the cover material. For more precise determination of details of position and number of fractures, a denser permanent network of stations in the epicentral region would be necessary.

In the strongest earthquakes, such as those of January 25 and May 30, 1946, a secondary zone of damage was noted on the south side of the lower Rhône valley, in addition to the main zone of damage between Leuk and Sion. This is attributed to such factors as the nature of the ground and construction, or greater density of population, rather than to earthquake conditions themselves. The orientation of the zone of aftershocks, as well as the distribution of macroseismic effects of the main shocks, indicates an east-west-trending dislocation.—*D. B. V.*

167–49. Pinar, Nuriye. 1952 yılından 1954 yılına kadar Türkiy'de yapılmıs olan seismolojik çalışmalar hakkında rapor [Report on seismological research in Turkey from 1952 to 1954 (in Turkish and French)]: Türkiye Jeoloji Kurumu Bülteni, v. 6, no. 1, p. 182–187, 1955.

An outline of the seismological work done in Turkey during 1952–54 by the University of Istanbul, the Technical University of Istanbul, the Ministry of Public Works, and the Istanbul-Kandilli Observatory, most of which was directed toward understanding the seismicity of the country and thereby finding means to reduce earthquake damage. Major earthquakes during that period included: Adana, October 22, 1952, intensity 7 at epicenter, 35°40′ E. long. 37°05′ N. lat.; Yenice-Gönen, March 18, 1953, magnitude 7¾, epicenter at 27°30′ E. long., 39°85′ N. lat.; Islâhiye, March 24 and 25, 1953, epicenter at 36°45′ E. long., 37°05′ lat.; Izmir-Karaburum-Foça, May 1 and 2, 1953, intensity 6–7, epicenter at 26°35′–26°40′ E. long., 38°30′–38°40′ N. lat.; Edirne, June 18, 1953, intensity 7–8, epicenter at 26°35′ E. long., 41°45′ N. lat. Most noteworthy of the minor shocks were those of Germencik-Açut in October 1952 and Yeşilova in September–November 1953, with intensity 4–5.—*D. B. V.*

167–50. Kerr-Grant, C. The Adelaide earthquake of 1st March, 1954: Royal Soc. South Australia Trans., v. 79, p. 177–185, 1956.

The earthquake which occurred at 18^h10^m G.m.t. on February 28, 1954 (3:40 a.m. March 1, local time) was the first recorded in almost 100 years in the Adelaide vicinity. No instrumental records are available at stations closer than 400 miles from the epicenter. From macroseismic data the intensity at the epicenter (in the vicinity of Darlington and Seacliff) has been established as 8 on the modified Mercalli scale, with a second or minor epicenter of intensity 7

near Beaumont. The focus was evidently very shallow (less than 2 or 3 km); more precise determination is impossible. Many buildings were damaged, a few beyond repair. Numerous new springs and increased or renewed flow from existing springs were reported in parts of the area, and two wells stopped flowing. The cause of the earthquake seems to have been movement along the comparatively recent Eden thrust fault. It may be significant that the epicenter is in a bend of the fault trace, where slow adjustment along an active fault plane might be impeded and thus allow greater shearing stress to build up before slipping. The actual triggering mechanism cannot be surmised; tides and atmospheric pressure were not favorable for this purpose. Many witnesses reported a flash of light in the sky at the time of the earthquake; possible explanations are examined and none found satisfactory.—*D. B. V.*

167–51. Caloi, P[ietro], DePanfils, M., DiFilippo, D[omenico], Marcelli, L., and Spadea, M. C. Terremoti della Val Padana del 15–16 maggio 1951 [The earthquakes in the Val Padana May 15–16, 1951]: Annali Geofisica, v. 9, no. 1, p. 63–105, 1956.

The epicenters of both shocks were near Caviaga in northern Italy. Depth of the focus was 5 km. The velocities of longitudinal waves were 5.1, 6.1, 6.9, and 8.16 kmps. Overlying the "granite" in which the velocity is 5.1 kmps is a layer of sediment 6 km thick in which the velocity of longitudinal waves ranges from 3.8 to 4.0 kmps. The thickness of the granite is 8 to 9 km; the total thickness of the two succeeding layers, 15 km. S_g velocity was 3.1 kmps, and S_n 4.52 kmps. The distribution of compressions and rarefactions suggests that the motion at the focus was an outward thrust inclined toward the northwest. The shocks may result from decompression in deep strata as the result of the extraction of methane which escapes with pressures greater than 100 kg per cm^2.—*M. C. R.*

167–52. Poisson, Charles. Le tremblement de terre d'Andilamena [The Andilamena earthquake]: Acad. Malgache Bull., tome 33, p. 21–22, 1955.

The earthquake of November 19, 1955, in Madagascar occurred at $0^h59^m23^s$ local time; the intensity was 5 in Tananarive and may have been 7 at the epicenter, which is somewhat south of Andilamena, at the northern end of the large geologic fracture along which lie Lake Alaotra and the Mangoro valley. Seismic wave propagation seems to have been easier along this break. The strongest aftershock on November 12 at 13^h45^m was felt weakly in Tananarive, more than 200 miles from the epicenter.—*D. B. V.*

167–53. Coze, Jean. Note sur le séisme du 16 avril 1955 [Note on the earthquake of April 16, 1955]: Acad. Malgache Bull., tome 33, p. 19–20, 1955.

The intensity of the earthquake of April 16, 1955, in Madagascar at $9^h29^m32^s$ local time was at least 7 at Ampefy, Soavinandriana, Mandoto, and Miarinarivo. From available instrumental data and approximate isoseismal lines, the epicenter is somewhere between Soavinandriana and Faratsiho. Macroseismic effects throughout the felt area are described briefly.—*D. B. V.*

167–54. Rod, Emile. Earthquakes of Venezuela related to strike-slip faults?: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 10, p. 2509–2515, 1956.

In Venezuela the belts of greatest seismic activity seem to coincide with large strike-slip faults. However, population density must be taken into account in reaching such a conclusion because reports of shocks most frequently come from towns that, in the Mérida Andes, lie in longitudinal valleys.—*L. C. P.*

167–55. Koning, L. P. G. Preliminary note on the frequency-depth relation of earthquakes: K. Nederland. Akad. Wetensch. Proc., v. 56, no. 3, p. 301–302, 1953.

Provisional investigation of the frequency-depth relations of deep-focus earthquakes listed in Gutenberg and Richter's "Seismicity of the Earth" suggests a relative minimum at 60–80 km, a relative maximum at about 120 km, and in South America, Japan, the Sunda region, and New Zealand, a maximum at greater depth. A second relative minimum corresponds to the gap between intermediate and deep earthquakes.—*M. C. R.*

167–56. Yeres'ko, S. I. Issledovaniye oshibok opredeleniya polozheniya ochagov Krymskikh zemletryaseniy [Study of the errors in the determination of the foci of Crimean earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36 (163), p. 3–14, 1956.

The epicenters of six Crimean earthquakes during 1928–29 were determined by Wadati's method extended to multilayer horizontal planes. The records of four seismological stations on the Crimean Peninsula were used and as the earthquakes were relatively weak the accuracy was evaluated by the mean square error of each determination, assuming that the weight of the obtained result is inversely proportional to the square of the mean square error. The errors in the epicenter determination ranged from ±14.0 to ±18.0 km, and the error in the determination of the apparent velocity was not more than ±0.5 km per sec. Wadati's method gives reliable results only for the earthquakes near the center of the Crimean Peninsula; it cannot be used for epicenters at azimuths of 210° or more.—*S. T. V.*

167–57. Housner, G[eorge] W. Geotechnical problems of destructive earthquakes: Géotechnique, v. 4, no. 4, p. 153–162, 1954.

The three most important unsolved problems of soil mechanics related to the ground motion produced by destructive earthquakes are the influence of soil properties on local intensities, physical changes in soil due to passage of seismic waves and their effect on superimposed structures, and the interaction of structure and ground.—*M. C. R.*

167–58. Kanai, Kiyoshi; Suzuki, Tomisaburo; and Yoshizawa, Shizuyo. Relation between the property of building vibration and the nature of the ground. (Observation of earthquake motion at actual buildings) III: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 1, p. 61–86, 1956.

Observations of earthquake-induced vibrations of buildings show that the smaller the rigidity of the subsoil surrounding the foundation, the larger the damping of the vibration of the building and the larger the maximum amplitude of the earthquake motion. It now seems established that the scale of earthquake force that must be taken into account in calculating earthquake-proof construction is nearly proportional to the square root of the rate of maximum amplitude of earthquake motion ($M \propto T_0^{-0.55}$), where M is the maximum ratio of maximum amplitude of roof–floor to that of basement and T_0 is the predominant period of microtremor observed on ground, closely related to rigidity of the subsoil. The optimum conditions for earthquake-resistant construction are those in which the building stands in a limited area of soft ground within a large area of hard ground. (See also Geophys. Abs. 163–114, 165–46.)—*D. B. V.*

167-59. Subsoil Research Team, Earthquake Research Institute. Investigation into seismic characteristics of subsoils in Tokyo [in Japanese with English summary]: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 3, p 471–545, 1955.

Because earthquake damage is related to subsoil characteristics, the building code requirements in Japan are based on type of building, seismic activity of the region, and subsoil characteristics of the building site. Subsoil characteristics in Tokyo have been studied by observations of earthquakes and microtremors, seismic prospecting, and dynamic tests with a vibrator. Predominant periods in records of earthquakes and short-period microseisms were nearly proportional to the thickness of the soil layer above the most remarkable discontinuity in the velocity log. The "foundation coefficient for the enhancement of amplitude is not constant for all earthquake motions, but is a function of their period."—*M. C. R.*

167–60. Kawasumi, Hirosi. Notes on the theory of vibration analyser: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 1, p. 1–8, 1956.

After mathematical development of the fundamental theory of vibration analyzers, it is concluded that when a seismometer or a one-mass structure with no damping is subjected to earthquake acceleration $\varphi(t)$, the final amplitude y, after the earthquake is over, represents the spectrum function of the earthquake velocity. A seeming contradiction of Housner's definition of the spectrum of an earthquake is explained.—*D. B. V.*

167–61. Medvedev, S. V. Seysmometr dlya opredeleniya ball'nosti zemletryaseniy [Seismometer for determining the intensity of earthquakes]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36(163), p. 127–133, 1956.

A seismometer, designed for determination of the class of an earthquake according to the scale of intensities suggested by Medvedev and recently adopted in part by Russian seismological observatories, consists of a spherical pendulum suspended in a tripod and having a natural period of vibration of 0.25 sec and damping ratio of 0.50. The damping ratio is adjustable over wide limits by an electromagnetic arrangement. The pendulum mass is formed as a spherical cap carrying a stylus in its middle that traces the deflection of the pendulum on the record beneath.

A sample record is included. The seismic impulse was produced artificially by an explosion of 1,800 tons of TNT at a distance of 600 m. The polar diagram of the deflections shows that the greatest amplitudes were observed not in the plane directed from the point of observation to the shot point, but at an angle of about 45°.—*S. T. V.*

167–62. Miyamura, Setumi, and Hori, Minoru. Quelques essais au laboratoire pour utilisation pratique du sismographe accélérometrique du type d'Ishimoto [Some laboratory experiments on the practical use of the accelerometric seismograph of the Ishimoto type (In Japanese with French summary)]: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 733–747, 1955.

A report on laboratory tests of the magnification and damping of eight portable horizontal Ishimoto accelerometers constructed for use in the epicentral regions of large earthquakes.—*D. B. V.*

167–63. Nersesov, I. L. O koeffitsiyente svyazi sistemy seysmograf-galvanometr [The coefficient of coupling of the seismograph-galvanometer system]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36 (163), p. 134–143, 1956.

A detailed and rigorous analysis of the vibrations of the mechanical system consisting of a seismometer with its pendulum on one side and the galvanometer as the indicator of the vibrations on the other. Special attention is paid to the degree of coupling between the two partial systems and variations in the damping properties of the component systems caused by the changes in the degree of coupling. In galvanometric recording the degree of coupling should be small and the damping of component systems must not be equal.—*S. T. V.*

167–64. Miyamura, Setumi, and Tsujiura, Masaru. Line carrier telerecording chronograph (abbr. LTC) for local seismological network [in Japanese with English summary]: Tokyo Univ. Earthquake Research Inst. Bull., v. 3, pt. 4, p. 709–713, 1955.

A description of the improved telerecording chronograph apparatus LTC–II, which uses 100–300 kc carrier waves through civil telephone lines. Schematic diagrams and photographs compare the new apparatus with the original one. The new model was first used in Wakayama in 1954.—*D. B. V.*

167–65. Miyamura, Setumi, and Matumoto, Hideteru. Line carrier telerecording seismograph (abbr. LTS): Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 715–724, 1955.

A description of the improved telerecording seismograph LTS–II which was developed with the telerecording chronograph (see preceding abstract) for use with existing communication lines. Seismograms reproduced include one received at the unattended Santa station and transmitted by LTS–II to the Kotono-ura central recording station in Wakayama.—*D. B. V.*

167–66. Miyamura, Setumi, and Tsujiura, Masaru. A VHF radio telerecording seismograph (abbr. RTS) [in Japanese with English summary]: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 725–731, 1955.

A description of a portable very high frequency radio-linked telerecording seismograph (RTS–I) designed for an unattended substation of the Wakayama seismological network where no telephone lines were available. Schematic diagrams and photographs of the transmitter and receiver, graphs and tables of frequency, sensitivity, and other characteristics, and examples of seismograms obtained with the apparatus are given.—*D. B. V.*

167–67. Gutenberg, B[eno], and Richter, C. F. Magnitude and energy of earthquakes: Annali Geofisica, v. 9, no. 1, p. 1–15, 1956.

Discrepancies arise among magnitudes as derived from local earthquake data (M_L), body waves (M_B), and surface waves (M_S). The relation of M_L to the others is as yet not definitive; but $M_S - m_B = a(M_S - b)$. The latest revision gives $a=0.37$, $b=6.76$. Pending further research it is recommended that M_L continue to be used as heretofore, but M_S (and ultimately M_L) should be referred to m_B as a general standard, called the unified magnitude and denoted by m. Tentatively $\log E = 5.8 + 2.4\,m$ (E in ergs). Revised tables and charts for determining m are given. [See also Geophys. Abs. 166–78]—*Authors' summary*

167–68. Gutenberg, Beno. The energy of earthquakes: Geol. Soc. London Quart. Jour., v. 112, pt. 1, p. 1–14, 1956.

Calculation of the energy released during earthquakes, including all great shocks from 1904 to 1954, indicates that the average annual release of energy in earthquakes is roughly 10^{25} ergs. As this is only about 0.1 percent of the energy by disintegration of radioactive matter in the earth, processes maintained by the generation of heat could furnish the earthquake energy. In each of the three major depth ranges, shallow shocks, depth $h \leq 60$ km; intermediate shocks, $60 < h \leq 300$ km; deep shocks, $h \geq 300$ km; the frequency of earthquake increases about exponentially with decreasing earthquake magnitude m down to at least $m=2$, and in each the average energy release between 1904 and 1913 was greater than that in later decades. The largest energy calculated for a single shock during the 51 years, about 2×10^{25} ergs, was found for two shallow shocks. With increasing focal depth h the maximum energy of a single shock decreases to about 6×10^{23} ergs at $h=650 \pm$km and to about 4×10^{22} at $720 \pm$km. No deeper earthquakes are known. The rapid decrease in energy release near 700 km could be caused by flow processes if the apparent coefficient of viscosity decreases to the order of 10^{20} poises at a depth of about 700 km.—*Author's summary*

167–69. Gutenberg, B[eno]. Great earthquakes 1896–1903: Am. Geophys. Union Trans., v. 37, no. 5, p. 608–614, 1956.

Trace amplitudes of surface-wave maximums recorded by undamped Milne seismographs have been used to determine the magnitude and energy of large shallow earthquakes from 1896 to 1903. Fifty-nine shocks are tabulated for which a unified magnitude of 7.4 or more (corresponding to the earlier magnitude of 7¾ or more) has been found. The unified magnitudes of shallow earthquakes between January 1904 and July 1956 for which the magnitude exceeded 7¾ are also tabulated. The greatest energy release in a single calendar year was 5×10^{25} ergs in 1897 in which there were 4 shocks (in Assam, off northeast Honshu, and 2 in the Philippine Islands) of about magnitude 8. The smallest energy release from shallow shocks was about 10^{24} ergs in 1954. The greatest shock (magnitude 8.1–8.2) in the period 1896–1955 was probably that of January 31, 1906, off the Colombia-Ecuador coast.—*M. C. R.*

167–70. Hodgson, J[ohn] H. and Cock, J. Irma. Direction of faulting in the deep focus Spanish earthquake of March 29, 1954: Tellus, v. 8, no. 3, p. 321–328, 1956.

Analysis of the directions of first arrivals at stations around the world indicates that the earthquake originated on either an approximately vertical fault striking north-south or a horizontal fault striking east-west. If the former, the movement indicated is east side up with respect to the west; if the latter, the material above the focus moved east with respect to the material below the focus. No choice is possible on the basis of present techniques. This is the first solution for an earthquake of more than normal depth in which virtually no transverse displacement is indicated.—*M. C. R.*

167–71. Montandon, Frédéric. Sur la fréquence des séismes destructeurs et sur leur prévision hypothétique [On the frequency of destructive earthquakes and on their hypothetical prediction]: Rev. Étude Calamités, tome 15, no. 33, p. 42–50, 1955.

There are at present two very uncertain means of predicting earthquakes. The first takes note of certain electromagnetic phenomena that may appear be-

fore the initial shock of an earthquake, such as glimmers of color in the air, malaise in people, and agitation in animals; the second determines from the records the average interval between destructive earthquakes in a given seismic region. As the latter is subject to variations of several years, only the former can be taken seriously as a method of avoiding injury.—*D. B. V.*

167–72. Savarenskiy, Ye. F. Ob iskazheniyakh v kartakh seysmichnosti [On the distortions of seismicity maps]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 745–754, 1956.

Existing maps of the seismicity of different parts of the U.S.S.R. are based on the records of earthquakes between 1910 and 1953. However, the establishment of every new seismic station has produced an apparent increase in the seismicity of the surrounding region by recording weak earthquakes that had previously passed unnoticed. Seismicity maps can be corrected by extending the isoseismal lines into regions where there had been no seismic observations and few people, on the basis of the magnitude and energy of the earthquakes for which epicenters could be determined.—*S. T. V.*

167–73. Lapwood, E. R. Study of a series of Japanese earthquakes: Royal Astron. Soc. Monthly Notices, Geophys. supp., v. 7, no. 3, p. 135–146, 1955.

Straight lines were fitted to first arrivals of a series of 7 earthquakes off the east coast of Japan October 12–18, 1935, recorded at stations at epicentral distances of less than 10° and azimuths of 180° to 270°. The velocity thus determined was 7.77±0.04 kmps, in good agreement with velocities given by Jeffreys and Hodgson. Redeterminations of the epicenters indicate a linear pattern and suggest repeated fracturing at the ends of a fault. No evidence for either P^* or S^* was found; evidence for a 3-layer structure of the crust below Japan must be regarded as weak if other records of near earthquakes show the same characteristics. A delayed pulse (S+15.8 sec) is observed between 4° and 9°.—*M. C. R.*

167–74. Kasahara, Keichi. A short discussion on ripples in earthquake shocks. (Aftershocks of the Boso-Oki earthquake): Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 631–640, 1955.

Study of ripples in aftershocks of the Boso-Oki earthquake in Japan on November 26, 1953, was undertaken to determine the effect of a seismically active zone on waves propagated through it. Most of the aftershocks that brought the strongest ripples to Tokyo were located in the inner side of the active area and those with faint ripples, on the outer side. Because seismograms at Hachijojima and Torishima showed the same distribution as at Tokyo, generation at the origin is considered a more plausible explanation of ripples than abnormal absorption.—*D. B. V.*

167–75. Monakhov, F. I. Ugly vykhoda prodol'nykh seysmicheskikh voln v rayone Yuzhno-Sakhalinska [Angles of emergence of longitudinal seismic waves in southern Sakhalin region]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36 (163), p. 15–25, 1956.

The angles of emergence of the first arrivals at the seismograph station in southern Sakhalin were determined for 79 earthquakes during 1951–55 by the

Benndorf formula ($\cos e = V_p/V_a$) and by the relation $\cos e = (V_p/V_s)\ \cos \frac{1}{2}(90° + e)$, where V_a is the apparent velocity and V_p and V_s are the velocities of the longitudinal and the transverse waves respectively. In certain azimuths the results obtained by the two formulas were markedly different. In similar determinations for 31 earthquakes at the seismograph station of Uglegorsk, about 240 km to the north, there was close agreement between the two determinations. Microseisms were similarly related to the azimuth of arrival. The difference is attributed to an effect of the deep structure of the region around the southern tip of Sakhalin Island.—*S. T. V.*

167–76. Choudhury, Mansur Ahmed. Profondeur de la discontinuité de Mohorovičić dans la région de l'Hindou-Kouch [Depth of the Mohorovičić discontinuity in the Hindu Kush region]: Acad. Sci. Paris Comptes Rendus, tome 242, no. 23, p. 2755–2757, 1956.

In the deep earthquake of March 4, 1949, in the Hindu Kush, a phase between *P* and *pP* was clearly registered at most European stations. This phase can be explained in three ways: as a longitudinal wave reflected at a discontinuity near the epicenter (*pmP*), as a transverse wave reflected as a longitudinal wave at the discontinuity (*smP*), or as a doubly reflected wave. The last is ruled out on the basis of the recorded data. Using both the Gutenberg-Richter and the Jeffreys-Bullen tables, the depth to the reflecting discontinuity is calculated as about 75 km for the first hypothesis and about 140 km for the second. Although the Mohorovičić discontinuity is only 40 to 55 km deep under Georgia and Tien Shan, there is no other discontinuity known at present, to a depth of at least 250 km, that could account for such a reflection. Therefore the wave is considered to be *pmP*.—*D. B. V.*

167–77. Press, Frank. Velocity of Lg waves in California: Am. Geophys. Union Trans., v. 37, no. 5, p. 615–618, 1956.

Velocities determined for Lg waves traversing the Sierra Nevada or the Central Valley and Coast Ranges of California differ by less than 2 percent from those reported for transcontinental North America and Eurasian paths. This suggests that the shear velocity in the upper part of the continental crust is not anomalous in orogenic belts, but does not necessarily imply homogeneity of material. The local phase velocity of Rayleigh waves depends on the period, the thickness of the crust, and the elastic constants of crust and mantle. Variations in phase velocity can be correlated with changes in crustal thickness rather than changes in elasticity.—*M. C. R.*

167–78. Satō, Yasuo. Analysis of dispersed surface waves by means of Fourier transform III. Analysis of practical seismogram of South Atlantic earthquake: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 2, p. 131–138, 1956.

Satō applies his formula for analysis of dispersed surface waves to James T. Wilson's seismograms of the South Atlantic earthquake of August 28, 1933 (Geophys. Abs. 103–5801). Although the results seem to be valid, more data are necessary to yield dispersion curves that are trustworthy in detail. (See also Geophys. Abs. 165–90 and 167–86.)—*D. B. V.*

ELASTICITY

167–79. Müller, Erich. Experimente über Wellenausbreitung in Gesteinsproben [Experiments on wave propagation in rock samples]: Geol. Jahrb., Band 70, p. 127–142, 1954 (1955).

The propagation of longitudinal and transverse waves in samples of rock has been determined by means of schlieren photography of high-frequency head waves passing from a surrounding fluid medium into the sample; from the bending of these waves at the plane surface of the sample, the velocities and elastic constants can be calculated. Samples 3 cm or longer can be used. The measured velocities, especially the longitudinal, are valid for bodies of infinite extent. The apparatus and procedure are described and some results presented. These include tables giving the transverse and longitudinal velocities, Poisson's ratio, Young's modulus, shear modulus, and compressibility for 12 igneous rocks, 10 sedimentary rocks, and for anhydrites taken from different depths in various boreholes and measured both perpendicular and parallel to the bedding. Longitudinal velocities in the igneous rocks range from 5,100 to 8,000 m per sec, in the sedimentary rocks from 2,400 to 6,000 m per sec; transverse velocities in the igneous and sedimentary rocks range from 4,650 to 6,900 m per sec and 2,150 to 4,750 m per sec, respectively; these velocities correspond well with those obtained in seismic work. (See also Geophys. Abs. 163–193.)—*D. B. V.*

167–80. Brown, P. D., and Robertshaw, Jack. The in-situ measurement of Young's modulus for rock by a dynamic method: Géotechnique, v. 3, no. 7, p. 283–286, 1953.

Because of the close relationship between Young's modulus and the longitudinal velocity in rock, Young's modulus can be obtained by recording timed arrivals of seismic waves set up by detonating small charges or striking the rock a sharp blow with a sledge hammer. In experiments at a proposed dam site in northern Iraq, the elastic modulus in dolomite was found to be 7.5×10^6 psi parallel to the bedding planes and 3.5×10^6 psi normal to the bedding. The corresponding values for limestone were appreciably lower, about 1.2×10^6 psi and less than 1.0×10^6 psi.—*M. C. R.*

167–81. Evison, F. F. The seismic determination of Young's modulus and Poisson's ratio for rocks in situ: Géotechnique, v. 6, no. 3, p. 118–123, 1956.

The velocities of shear and compressional seismic waves in a rock may together be used to calculate the value of Poisson's ratio in situ, and if the density is known the value of Young's modulus may be calculated as well. Experiments have been carried out in which these two types of wave were generated first by means of an electrically driven vibrator in the volcanic rock ignimbrite, and secondly in the concrete of a dam. From the velocities measured in each case the following elastic constants were calculated: for ignimbrite, μ=0.41, E=460,000 psi; for concrete, μ=0.21, E=3,600,000 psi. The value of E for ignimbrite was much smaller than would have been deduced from the compressional velocity alone, with the usual assumption as to the value of μ, and much larger than that given by the standard static compression test. The value for concrete was nearly the same by all three tests.—*Author's abstract*

167–82. Omote, Syun'itiro; Yamazaki, Yoshio; Kobayashi, Naoyoshi; and Murauchi, Sadanori. Ice tremors generated in the floating lake ice (Part 1): Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 663–679, 1955.

Vibrations set up by the formation of cracks in floating sheets of ice on Lake Suwa, Japan, closely resemble those of natural earthquakes in many respects. *P*–wave velocities within the ice, measured by means of small explosions, ranged between 2,900 m per sec in the daytime (temperature 5°C, ice soft) and 3,230 m per sec at night (temperature —10°C). A second phase with a velocity of 1,820 m per sec (measured when V_1=3,200 m per sec) cannot be *S*, as V_1/V_2 is only 1.78; a third phase (1,460 m per sec) is apparently due to waves passing through the water beneath the ice; and a fourth (330 m per sec) is considered to be due to flexural waves of the ice sheet. Epicenters were located from *P*–wave arrivals at 12 precisely located detectors; as a check, the origin points of several known explosions were calculated in the same manner and found to be in good agreement with the true origin. A few foci were determined from the commencement time of the flexural waves, which, although not as distinct as the *P*–wave arrivals, were nevertheless clearer than those of surface waves in natural earthquakes. The two sets of foci so nearly coincide that it is reasonable to assume that the compressional and flexural waves started from the same point simultaneously.—*D. B. V.*

167–83. Matuzawa, Takeo. Reflexion und Refraktion der seismischen Wellen durch eine kontinuierlich verändernde Schicht. I. SH Welle. [Reflection and refraction of seismic waves through a continuously variable layer. I. *SH* wave]: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 543–548, 1955.

Seismic layer boundaries in nature are never clearly defined; even when contrast is strong, the transition must be continuous. Here the reflection and refraction of the *SH* wave is investigated mathematically for the case of a linearly variable layer, which passes continuously from one homogeneous layer to another.—*D. B. V.*

167–84. Knopoff, L. The seismic pulse in materials possessing solid friction, I: Plane waves: Seismol. Soc. America Bull., v. 46, no. 3, p. 175–185, 1956.

The propagation of seismic pulses through a material possessing solid friction is investigated. Problems are solved for both a simple impulse of displacement and a stress doublet impressed on the medium. For both cases the crest amplitude diminishes inversely with distance propagated, and the pulse width increases proportionally to this distance. For the stress doublet the shape of the pulses is asymmetrical.—*I. Z.*

167–85. Kanai, Kiyoshi. An explanation for the ground vibration caused by periodically exerted force: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 3, p. 283–286, 1955.

The curve showing the relation between the distance from the vibration origin and the amplitude of the actual ground vibration generated by a vibrator is sometimes sinuate as the result of superposition of direct and refracted waves. It is shown mathematically that the necessary condition for the sinuate curve is that $4H > vt$, where H is the thickness of the surface layer, v the velocity of propagation, and t the time, and that the greater $4H$ is compared to vt, the greater the number of waves.—*M. C. R.*

167–86. Satō, Yasuo. Analysis of dispersed surface waves by means of Fourier transform II. Synthesis of movement near the origin: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 1, p. 9–18, 1956.

A fundamental formula for movement near the origin is derived, simplified for practical purposes, and applied to an actual example. With phase velocity and spectrum at 141.75 m known from the previous paper (Geophys. Abs. 165–90), the motion at any point and at any time can be calculated. Results are tabulated.—*D. B. V.*

167–87. Kanai, Kiyoshi. On Sezawa-waves (M_2-waves). Part II: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 3, p. 275–281, 1955.

A precise study of the displacement distribution of Sezawa waves in the surface layer shows that there is a region where the distribution can be exponential, and therefore that Sezawa waves are not Rayleigh-type waves of higher order.—*M. C. R.*

167–88. Dürbaum, Hansjürgen. Note on a paper by Satō: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 1, p. 19–20, 1956.

The proof, left incomplete in the original paper, that Satō's formula for Rayleigh wave propagation (Geophys. Abs. 150–13843) has only one real positive root smaller than K/β in the equation in question.—*D. B. V.*

ELECTRICAL EXPLORATION

167–89. Roman, Irwin. Graphical scales for mapping potential functions: Geophysics, v. 21, no. 4, p. 1041–1046, 1956.

Graphical scales can be prepared and used for rapid determinations of potential field values which depend only on the distance between two fixed points. The method can be applied to determine the potential at the surface of a homogeneous earth due to a current pole at its surface, and to the potential at the surface of the earth considered as an infinite insulator separated from the surface by a parallel plate of finite resistivity. Portions of two typical scales and two sets of equipotential curves drawn by use of the scales are shown.—*Author's abstract*

167–90. Frankel, S. P., and de Witte, L[eendert]. Digital computation of resistivity departure curves on Whirlwind I: Texas Petroleum Research Comm. Bull., no. 18, p. 136–153, 1952.

Recent advances in instrumentation of resistivity surveys warrant the use of a complete set of departure curves that will give direct solutions for the in-place resistivities. The Whirlwind I will compute 22 points for one departure curve in 10 minutes and involves some 10 million arithmetic operations. The curves when completed will be made available to industry.—*V. S. N.*

167–91. Uryson, V. O. Ob umen'shenii vliyaniya pomekh na glubokoye elektricheskoye zondirovaniye [On the reduction of the effect of disturbances on deep electric profiling]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 801–812, 1956.

When measuring the apparent electric resistivity with the Wenner electrode configuration, there is added to the potential difference between the measuring

electrodes a potential difference produced by an additional electric field—the disturbing potential. This potential difference is the result of the polarization of the electrodes, of the presence of telluric currents, or of eddy currents from industrial installations. It consists of a constant part and a variable one. The constant part can be easily compensated; the variable term can sometimes cause difficulties, especially when the electrode spacing and the desirable depth of profiling are great. Changes in field practice, such as an increase of the feeding current or feeding voltage, can decrease the intensity of the disturbing potential differences. The advantages and disadvantages of different procedures are discussed; attention is called to the possibility of dangerous shocks to those making the measurements. Changes in the analysis of the data are also considered. The procedures are explained by an example of a profile composed of three layers with different electric properties.—*S. T. V.*

167–92. Bukhnikashvili, A. V., and Kebuladze, V. V. K voprosu o statsionarnosti elektricheskogo polya sul' fidnykh mestorozhdeniy [On the invariability of the electric field of sulfide deposits]: Akad. Nauk Gruzinskoy SSR Soobshchcheniya, tom 16, no. 2, p. 109–111, 1955.

The natural electric field in zones of sulfide or graphite deposits is usually assumed to be invariable in time but there are numerous exceptions to this rule. For example, the intensity of the electric field over chalcopyrite deposits was measured and recorded during 2 summer months and positive and negative potential variations of as much as 29 percent were found. These variations could not be related to changes in weather conditions or in the water content of the ground, but are attributed to changes in the electrochemical process within the deposits or on their boundary. Use of the self-potential method requires a regular check of the constancy of the electric field.—*S. T. V.*

167–93. Nosske, Gerhard. Erfolge und Misserfolge mit Eigenpotentialmessungen [Successes and failures with self-potential measurements]: Zeitschr. angew. Geologie, Band 2, Heft 5/6, p. 221–227, 1956.

The thesis that applied geophysics in general, and the self-potential method in particular, should be used as a technical aid in extrapolating from the known to the unknown is illustrated by two examples from Germany. In the former, near Jänkendorg, the results of a self-potential survey in a region of carbonaceous schists were meaningless alone and could be interpreted only in combination with magnetic and geologic data; in the latter, a known pyrite vein in the central Harz was successfully traced along the strike and downward.—*D. B. V.*

167–94. Orilia, N., and Petrucci, G. Su una attrezzatura adatta alla prospezione del sottosuolo col metodo elettrochimico (polarizzazione provocata) [On a device adapted for subsurface prospecting by the electrochemical (induced potential) method]: Geofisica Pura e Appl., v. 33, p. 101–110, 1956.

A device for measuring induced polarization has been tested in the laboratory and field. It uses a special commutator which closes the polarizing circuit and at the same time opens the measuring circuit and vice versa. Otherwise the measurements are made by the Poggendorff method.—*M. C. R.*

167–95. Tsitsishvili, D. A., and Lashkhi, A. S. Elektrofil'tratsionnoye pole nekotorykh ob"yektov gidroenergeticheskogo stroitel'stva v Gruzinskoy SSR [Electrofiltration field of some phenomena of hydroelectric projects in the Georgian SSR]: Akad. Nauk Gruzinskoy SSR Soobshcheniya, tom 16, no. 4, p. 269–275, 1955.

Underground streams can often cause local electrical fields of relatively high intensity by electrofiltration. In the Akhalkalaki highland, Georgian SSR water losses of as much as 1.8 m^3 per sec were observed in a relatively small lake. Natural potential measurements indicated an anomaly of 44 mv and made it possible to determine the point of loss and the direction of the underground stream. Another example is in a small basin formed by the Terek River, where there were significant losses of water along a natural dam about 80 m long. The maximum anomaly here was 350 mv, in an area where the normal background was only ± 20 mv. In many places the electrofiltration potential can be increased by oxidation of pyrite inclusions. Electrofiltration potential can be either positive or negative.—*S. T. V.*

167–96. Rao, M. B. Ramachandra, and Negi, B. S. Geophysical exploration in the arid tracts of Rajputana: Natl. Inst. Sci. India Bull., no. 1, p. 70–75, 1952.

In the arid areas of Rajasthan, patches of land containing potable water commonly occur adjacent to those in which the ground water is brackish. Resistivity surveys have been used by the Geological Survey of India to distinguish the areas on the basis of typical depth curves. Regional problems of finding water are best attacked by seismic surveys to delineate depressions in the bedrock, detailed electromagnetic inductive and resistivity surveys to evaluate the subsurface conductivity and determine depth to water table and salinity, and direct measurement of electrical conductivity, density, and temperature of the water in wells. As a corollary of the water problem, the resistivity measurements in wells have also been used to delineate areas where the salinity is high enough to be suitable for the manufacture of salt.—*M. C. R.*

167–97. Stefanović, D. Primena metode spetsifičnog električnog otpora radi rešavanja nekikh inzhenjersko-geoloških problema [Application of the electrical resistivity method in the solution of problems in engineering geology]: Beograd Tekh. Velika Škola Zbornik radova geol. i rudarskog fakulteta, p. 293–301, 1953–54.

The electrical resistivity method was used during the building of hydroelectric powerhouses in Yugoslavia to determine the depth of alluvium and terraces along 75 to 100 profiles upstream and downstream from the site of the future dam. Results of the measurements on the Drina River were within 15 percent of those found by drilling.—*S. T. V.*

167–98. Cook, John C. An electrical crevasse detector: Geophysics, v. 21, no. 4, p. 1055–1070, 1956.

The crevasse detector is a four-electrode system analogous to the Wenner-Gish-Rooney system of measuring effective conductivity but using dielectric displacement currents rather than conduction currents. Capacitive transfer reactance between pairs of electrode sleds or vehicles is continuously indicated or recorded. The method has been successfully used on traverses at speeds of 2 to 20 mph and with electrode spacing of 7 to 180 ft.—*M. C. R.*

ELECTRICAL LOGGING

167–99. Wade, R. T. Application of MicroLogs to the lower Glen Rose of East Texas: Texas Petroleum Research Comm. Bull., no. 28, p. 94–95, 1954.

The MicroLogs are used to pick out porous and permeable zones, for calculating the percent porosity of a formation, and with electrical surveys to calculate water saturation of a potential pay zone. Numerous logging examples from East Texas are given.—*V. S. N.*

ELECTRICAL PROPERTIES

167–100. Parasnis, D. S. The electrical resistivity of some sulphide and oxide minerals and their ores: Geophys. Prosp., v. 4, no. 3, p. 249–278, 1956.

The electrical resistivity of 60 pyrite, 31 chalcopyrite, 42 pyrrhotite, 8 arsenopyrite and löllingite, 6 cobaltite, 15 galena, 13 sphalerite, 26 hematite, 46 magnetite, 16 various manganese minerals, 23 complex ores, and 7 graphitic shale samples, mostly from Sweden, was measured by the four-point method. The electrical resistivity of ore samples varied "locally" on a single sample, often by factors of 10 to 100, but usually within about 30 percent; the resistivity varied by factors of 100 to 10,000 from one sample to another. Cracks, sometimes of microscopic size, layering or banding, and a porous structure all affect the resistivity. The variation from sample to sample depends in addition on the percentage of ore. The results indicate that, other things being equal, pyrite, chalcopyrite, pyrrhotite, arsenopyrite, magnetite, and graphite ore bodies are excellent objects of electrical prospecting, and galena, psilomelane, hollandite, and pyrolusite are also suitable. The suitability of hematite bodies for detection by electrical methods depends on the surrounding rock. Sphalerite and the manganese minerals bixbyite, braunite, hausmannite, manganite, and piemontite would be almost undetectable by electrical prospecting.—*M. C. R.*

167–101. Perkins, F. M., Jr., Osoba, J. S., and Ribe, K. H. Resistivity of sandstones as related to the geometry of their interstitial water: Geophysics, v. 21, no. 4, p. 1071–1084, 1956.

On the basis of experimental studies, Perkins and coworkers conclude that the resistivity factor, F, the tortuosity, T, and the porosity, p, in brine-saturated sandstones are related by $F=T^2/p$, that in sands containing both electrolyte and hydrocarbons the tortuosity of the interstitial water, T_s, the resistivity ratio, F_s, the electrolyte saturation, S, and the porosity, p, are related by $F_s=T_s^2/pS$, and that the saturation exponent, customarily used in interpretation of the electric log, may be expressed in terms of tortuosity and apparent cross-sectional area of the electrolyte through which electric current flows. M. R. J. Wyllie and A. J. de Witte in comments on following pages state their belief that tortuosities of porous media cannot be measured experimentally and that the Perkins experiments provide only a means of comparing porosities.—*M. C. R.*

167–102. Srivastava, S. S., Mehendru, P. C., and Puri, D. D. Microwave dielectric measurements: Part III—Solid dielectric materials of Indian origin: Jour. Sci. Indus. Research (India), Sec. B, v. 15, no. 4, p. 161–166, 1956.

Among the materials measured here for dielectric constant and dielectric loss in the 3-cm region by standing-wave techniques are four samples of marbles from four places in India. Two show low attenuation and are suggested for use as

supports in air-filled coaxial lines and microstrips in ultra- high frequencies.—*D. B. V.*

EXPLORATION SUMMARIES AND STATISTICS

167–103. Ogilvie, W. P. Seismic exploration in the North: Canadian Oil and Gas Industries, v. 9, no. 8, p. 58–60, 1956.

A discussion of such problems as access, anomalous velocity distribution in near-surface formations, and poor surface material, in seismic exploration of northern Alberta and northeastern British Columbia, Canada.—*V. S. N.*

167–104. Carlyle, R. H. Little Smoky geophysical exploration: Canadian Oil and Gas Industries, v. 9, no. 7, p. 39–42, 1956.

The Little Smoky oilfield in northwestern Alberta, Canada, was discovered by seismic exploration in 1952–53. Valuable experience was gained in methods of working in difficult muskeg areas.—*V. S. N.*

167–105. Wolff, Wilhelm. Die Mitwirkung der Geophysik bei der Klärung tektonischer Fragen in Steinkohlenbirge [The assistance of geophysics in the clarification of structural questions in coal mining]: Deutsch. Geol. Gesell. Zeitschr., Band 107, Teil 1, p. 261–274, [1956].

The use and limitations of gravity and seismic reflection methods in clarifying structural questions in coal-mining regions is illustrated by means of examples from the Ruhr and Aachen districts. For problems of overburden, particularly from the hydrological point of view, electrical methods can also be useful.—*D. B. V.*

GENERAL

167–106. Jones, V. L. Extrapolation and interpolation formulae adaptable to desk and other types of digital computers: Geophysics, v. 21, no. 4, p. 1047–1054, 1956.

The advent of high-speed digital computing machines requires extrapolation and interpolation methods which do not involve central differences and time-consuming tabular information. Extrapolation and interpolation formulae meeting these requirements are developed. These formulae are applicable to the desk calculator as well as to punched-card programming systems for electronic digital computers. Some applications of the usefulness of these formulae are noted in connection with the preparation of gravity and magnetic maps. Their usefulness may likewise be extended to other types of geophysical and experimental data where the time required to obtain computed results is an economic factor.—*Author's abstract*

GEODESY

167–107. Heiskanen, W. [A.] On the World Geodetic System: Finn. Geod. Inst. Veröffentl., no. 39, 25 p., 1951.

A discussion of the requirements for establishing a World Geodetic System—it is necessary either to span the oceans with measuring chains or to determine the exact geographic positions of the initial points of the existing geodetic systems referred to the same reference ellipsoid—and the possibilities of attaining them.—*D. B. V.*

167–108. de Graaff Hunter, J[ames]. Observing and using geoidal deflections: Finn. Geod. Inst. Veröffentl., no. 46, p. 35–41, 1955.

Any irregularity of density within the earth's crust will give rise at the surface not only to a vertical component, which contributes to gravity anomalies, but also to horizontal components contributing to deflections of the vertical and anomalies of curvature. Although the components are of the same order of magnitude, hitherto only vertical anomalies have been used for surveying underground resources. An untried survey method is proposed here, using observations of earth curvature. The method is based on the fact that the sum of the angles of elevation of the light ray joining two terrestrial points is the difference of the terrestrial curvature and optical curvature (refraction) of the ray. Two plans of operation are suggested. In the first, a pair of observers proceeds along any traverse line, observing mutually and simultaneously at adjacent points and determining the earth curvature of each interval between stations from their measures of reciprocal vertical angles. The rise of the geoid above its value at the starting point can be computed forthwith. In the second procedure, a modification which avoids certain practical objections, only one observer is required and reliance is placed on equality of refraction of fore and aft rays observed at a station midway between two targets, at the same mean time. For this to be true, the surfaces over which the two rays pass should be reasonably similar from a refraction point of view, and relative geoidal heights of the targets must be known from spirit levelling or other accurate means.—*D. B. V.*

167–109. Hirvonen, R. A. The removal of spherical harmonics of first order from a field of observed gravity anomalies: Finn. Geod. Inst. Veröffenl., no. 46, p. 59–67, 1955.

The derivation of Stokes' formula is based on developments of spherical harmonics which do not contain first order terms. Due to the defectiveness of observations, the field of gravity anomalies might reveal first order terms. These terms should be removed by an adjustment before Stokes' formula can be employed.

The removal of first order terms, however, has been neglected in the works hitherto published. The last and most extensive of them, accomplished by Tanni in 1948, is revised here. As a conclusion, it can be stated that the effect of the first order terms is large enough to be taken into consideration in the future applications of Stokes' formula.—*Author's abstract*

167–110. Vening Meinesz, F. A. On the possibility of applying Stokes's theorem and the formula for the plumb-line deflection derived from it: Finn. Geod. Inst. Veröffentl., no. 46, p. 171–174, 1955.

The mean uncertainties introduced into Stokes' formula and the equation for plumb-line deflections by the fact that we do not yet know the gravity anomalies over large areas of the earth's surface are calculated as 2.6 m for ΔN (N=Stokes' distance from geoid to reference spheroid) and 0.35'' for $\Delta \zeta$ and $\Delta \eta$ (ζ and η are plumb-line deflections). Stokes' theorem and the equations derived from it can be successfully applied and geodetic data successfully transferred from geoid to ellipsoid for those areas where the distance to the unsurveyed areas is sufficiently large. The limiting distance from the unsurveyed area of 3,000 km restricts application, at the moment, to the North American and European parts of the

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central east-west belt of the northern hemisphere, but allows tying together the American and European geodetic systems and corresponding parts of the geoid.—*D. B. V.*

167–111. Chovitz, Bernard, and Fischer, Irene. A new determination of the figure of the earth from arcs: Am. Geophys. Union Trans., v. 37, no. 5, p. 534–545, 1956.

A tentative size of the earth was derived on the basis of four arcs: a meridional arc extending from South Africa to Scandinavia, a meridional arc extending from Chile to Canada, a parallel traversing the United States, and a parallel extending from western Europe to Siberia. Two types of deflection data were used in the solutions: the astrogeodetic (free-air) deflection and the isostatic deflection calculated on the basis of the Pratt-Hayford theory with depth of compensation at 113.7 km. A flattening of $1/(297\pm1)$ was assumed. The semimajor axis was calculated as $6{,}378{,}260\pm100$ m with the free-air deflections and $6{,}378{,}285\pm100$ m with the isostatic deflections.—*M. C. R.*

167–112. Ölander, V. R. On the geoid in the Baltic area and the orientation of the Baltic Ring: Finn. Geod. Inst. Veröffentl., no. 38, 26 p., 1950.

The computation and adjustment of the Baltic Ring of the Baltic Geodetic Commission has been carried out on the international (Hayford) ellipsoid, the starting coordinates being chosen in accordance with the system of coordinates used by the Geodetic Institute of Finland. Within the Baltic Ring are 87 stations with known deflections of the vertical, and others are available nearby; in some places the observations are close enough that the form of the geoid can be computed by "astronomical levelling." The baseline at Reval (Tallinn) was arbitrarily chosen as zero point. Elevations of the geoid above the reference ellipsoid are tabulated and shown on a map. The geoid so determined is compared to Tanni's gravimetrically determined geoid along certain profiles; agreement on the whole is not very good. An attempt is made to compute a new absolute orientation for the Baltic Ring, using corrections deduced from the divergences from Tanni's geoid, but results are regarded only as qualitative.—*D. B. V.*

167–113. Okada, Atsushi. Results of precise levelings in the neighborhood of Kurosawaziri, Iwate prefecture, northeastern Japan [in Japanese with English abstract]: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 749–753, 1955.

Precise leveling along an east-west route 28 km long in the vicinity of Kurosawaziri crossed the so-called Morioka-Sirakawa Line which Tsuboi has shown is characterized by Bouguer anomalies of steep gradient. Relative vertical displacements since the survey of 1933–34 are small. A slight upheaval took place east of the line but there was no conspicuous movement on the west side.—*D. B. V.*

GEOTECTONICS

167–114. Beloussoff, W. W. [Belousov, V. V.] Grundfragen der allgemeinen Geotektonik [Fundamental questions of general geotectonics]: Geol. Rundschau, Band 45, Heft 2, p. 352–369, 1956.

Some general basic problems of geotectonics are discussed which have resulted from a comprehensive treatment of geotectonic fundamentals by the author on

the basis of recent achievements in Soviet geology. Tectonic movements are classified as primary, or oscillatory, and secondary (plicative and ruptural). Under oscillatory movements, general vibrations and wave movements are defined and distinguished. Inside the earth's crust geosynclinal, parageosynclinal and "platform-like" oscillation forms are distinguished and the possibility of a stockwork-like layering discussed. The possibility of a pre-geosynclinal (Archaic) condition and possibility of an "activation of the platforms" beginning in a still earlier time is debated. In plicative deformation forms, complete folding, broken folding, and intermediate folding are distinguished, with discussion of their criteria and genesis.

The conclusion of the work consists of a discussion of the problems of continents and oceans. The beginning of the deep seas is laid in the Mesozoic. An increase in the amount of water in the course of earth history is probable. Presumably two levels of activity exist in the earth. The ultimate cause of the movements is to be sought in differentiation processes.—*Author's summary, D. B. V.*

167–115. Aslanyan, A. T. Issledovaniye po teorii tektonicheskoy deformatsii zemli [The study of the theory of the tectonic deformation of the earth]: Yerivan, Akad. Nauk Armyanskoy SSR, 290 p., 1955.

An attempt to explain the tectonic activity of the earth by the theory of elasticity, assuming contraction of the earth as the primary cause of tectonic processes. At the beginning of the geologic history the radius of the earth is assumed to have been about 7,000 km and the average density 4.2 gr per cm.^{3} Contraction was caused by the cooling of the earth and a certain physicochemical processes which released great amounts of gaseous substances. An immediate consequence was the folding of the external surface. This folding is analyzed in terms of the theory of elasticity as the "buckling of the plate (the crust) on an elastic foundation under the action of horizontal forces, distributed along its periphery." This general concept is applied to all tectonic processes in the formation of island arcs in the East Indies, Caribbean Sea, Japan Sea, Philippine Islands and other parts of the Pacific Ocean, and the orogenic phenomena producing the Caucasus Mountains. Folding of the crust is concentrated in its upper layer but inevitably involves the subcrustal zone and causes important vertical and horizontal dislocations of magmatic masses. Geologic evidence is considered, but the emphasis is on application of mechanical analysis to tectonic problems. Among the authorities cited are Marx, Engels, Lenin, and Stalin.—*S. T. V.*

167–116. Sheynmann, Yu. M. Zametki k klassifikatsii struktur materikov [Notes on the classification of structures of the continents]: Akad. Nauk SSSR Izv. Ser. geol., no 3, 19–35, 1955 .

Structures intermediate between geosynclines and platforms are divided into two groups: regions that have outlived geosynclinal development and are found in the course of changing into platforms, and regions where instead of a platform or a threshold folded zone there are formed structures similar to geosynclines. Geosynclines are considered to be structures characteristic of the first half of the geosynclinal (tectonic) cycle and subsequently transformed into folded regions. They arise within the boundaries of mobile belts, whose continuous existence is comparable to that of platforms.—*Author's abstract, D. B. V.*

167–117. Belousov, V. V. O geologicheskom stroeni i razvitii okeanicheskikh vpadin [On the geologic structure and evolution of the ocean basins]: Akad. Nauk SSSR Izv. Ser. geol., no. 3, p. 3–18, 1955.

In the light of knowledge of the relief of the ocean floor, and the geologic structure and history of the ocean basins, it is concluded that there are two critical stages in the evolution of the earth's crust. In the first, closely related to the formation of geosynclines and platforms at the surface, differentiation at depth gives rise to granitic massifs (originally, in the Archean, forming the entire surface of the globe but subsequently confined to geosynclinal belts); platforms are areas where the process has been completed. The second stage brings the rise of basic magma and partial destruction of the granitic layer. With its partial destruction great quantities of water are produced which enlarge the hydrosphere. Structural elements of the first stage, submerged under water or under submarine basalts, can sometimes be discerned in the topography of an ocean floor. Mediterranean seas (which according to geophysical evidence lack a granite layer) are considered to be embryo ocean basins; the west Siberian lowland is an "unsuccessful" ocean basin whose relations to the Urals are identical to those of the Piedmont plain of the Atlantic coast to the Appalachians.

Not only are geosynclinal zones eventually the site of ocean basins and "basification" of the crust, which may extend into neighboring platforms but, conversely, some parts of platforms are the scene of intense tectonic activity, such as the great uplift of Tyan Shan, central Asia, or southern Siberia, which may extend into adjacent geosynclines. Pamir, for instance, is abnormally uplifted in comparison to other parts of the Alpine geosyncline. In other words, evolution of the crust is active in areas of greatest contrast in composition structure, and surface relief. Analogous features of lumar relief suggest that the hypothesis is valid for the evolution of any planet of the "terrestrial type."—*D. B. V.*

167–118. Peyve, A. V. Obshchaya kharakteristika, klassifikatsiya i prostranstvennoe raspolozhenie glubinnykh razlomov. Glavneyshie tipy glubinnykh razlomov. Stat'ya I. [General characteristics, classifications, and spatial distribution of deep fractures. Principal types of deep fractures. Part I]: Akad. Nauk SSSR Izv. geol., no. 1, p. 90–105, 1956.

A summary of the results of Russian investigations of deep fractures of the earth's crust. The fractures penetrate the metamorphic basement, are characterized by great extent and persistence, and constitute a controlling factor in the distribution of igneous rocks, ore deposits, and, in geosynclines, of sediments. Surface (secondary) fractures are genetically related to the deep (primary) fractures. Three main groups are recognized: those of platforms, those of regional depressions, and, most diverse, those of geosynclines. They are further subdivided and discussed in some detail; of the numerous examples cited, most are from the U. S. S. R.—*D. B. V.*

167–119. Bucher, Walter H. Role of gravity in orogenesis: Geol. Soc. America Bull., v. 67, no. 10, p. 1295–1318, 1956.

Experiments with stitching wax, an elastico-viscous material, indicate that it is a suitable material for model studies of the kinematics and dynamics involved in crustal deformation. The material flattens under its own weight

if raised to slopes of more than a few degrees. In experiments with layers of stitching wax (representing limestones) and grease (representing shales) the flattening produced surficial folding. When layers of stitching wax were subjected to slow compression and one part kept a little warmer than the rest, a recumbent anticline was formed at the interface; the cooler "foreland" pushed under the uparching "welt," and it in turn pushed the former down, flattening it. Features which in alpine mountains have been believed to call for either an actively overriding master thrust sheet or an active downsucking were produced simultaneously, suggesting that orogenic belts, at least of the alpine type, arise because at the time of their formation they are weaker than the normal crust. Bucher suggests that belts of deep-focus earthquakes, which are genetically related to orogenic belts, are fracture zones produced by shrinkage in the "strictosphere," which lies between the deeper mantle and the outer zone, the "stereosphere." Compression is localized in the stereosphere as volatiles rise along the fracture zones and warm and weaken the crust. A pattern of cracks formed in a thin shell shrinking between solid boundaries is similar to the pattern of orogenic belts.—*M. C. R.*

167–120. Niskanen, E. On the buckling of the earth's crust: Finn. Geod. Inst. Veröffentl., no. 46, p. 145–155, 1955.

Deformation in zones of negative anomalies is estimated by considering the crust as a plate on an elastic foundation. If the modulus of elasticity is constant in the direction in which force is applied, the wavelength at the onset of buckling (or critical load) is unexpectedly small, 100 km at most. The inevitable inference is that it is not possible to speak of a buckling process but rather of a local, slowly developing plastic yielding, the effect of which is that the crust has continuously increased in thickness and the compressive force become more eccentric; owing to these circumstances the geosynclines have formed in the course of time in this plastic hinge.

Calculation of deformation of the plastic yield region is difficult as four boundary constants are involved. Stress and strain increments in a given crustal section must be coordinated with the time scale and studied by means of successive approximations, employing in each phase the constants which must be estimated from the stress-strain diagram of the crustal matter.—*D. B. V.*

167–121. de Sitter, L. U. The strain of rock in mountain-building processes: Am. Jour. Sci., v. 254, no. 10, p. 585–604, 1956.

The physical properties of rocks, as revealed by laboratory experiments determining their strain in a known stress field, can explain the different types of folding. The interval between the stress level and the elasticity limit appears to be the most important factor. This interval will increase either because of a fall in the resistance of the rocks or because of a rise in the stress. The two principal types of folding are concentric folding, a typical elastico-viscous kind of strain in which this interval is small, and cleavage folding, in which it is greater. An analogy of these two types of folding can be found in the paratectonic and orthotectonic types of orogenesis.—*Author's abstract*

167–122. Moody, J. D., and Hill, M. J. Wrench-fault tectonics: Geol. Soc. America Bull., v. 67, no. 9, p. 1207–1246, 1956.

The term "wrench fault," as suggested by Kennedy and Anderson, describes ruptures in the earth's crust in which the dominant relative motion of one block

to the other is horizontal and the fault planes are essentially vertical; the term is synonymous with strike-slip fault and transcurrent fault. It can be shown theoretically that in any given tectonic area at least eight directions of wrench faulting and four directions of anticlinal folding and (or) thrusting should accommodate the structural elements of the region and that these directions should have a more or less symmetrical disposition with respect to the direction of the primary compressive stress. Analysis of field examples of faults and associated phenomena in California, the Basin and Range province, the Pacific Northwest, and the Midcontinent region among others indicates that wrench-fault tectonic systems are alined systematically over large parts of the crust as suggested by Hobbs, Vening Meinesz, Sonder, and others. A shear pattern is suggested that may have resulted from stresses oriented essentially meridionally and acting in nearly the same direction throughout much of geologic time. Major wrench faults, which penetrate the entire outer crust of the earth and result in the segmentation of the crust into polygonal blocks, may constitute a fundamental type of yielding in the crust. The existence of more or less independent blocks separated by major faults would have an important bearing on "isostatic adjustment," the development of geosynclines, island arcs, and linear belts of igneous activity.—*M. C. R.*

167–123. Kasahara, Keichi. Strain energy in the visco-elastic crust: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 2, p. 156–165, 1956.

The effect of viscosity on energy transfer in the crust according to Matuzawa's concept (see Geophys. Abs. 165–125) is considered. The efficiency of energy transfer depends on the relaxation time of the crust and duration of the pressure. The effect of viscosity is negligible when relaxation time $\tau \sim 10^{10}$ sec and the duration of pressure T_0 is less than several decades, in which case Matuzawa's process would be valid. More accurate data on the viscosity of the crust (from rheological studies) and on T_0 (from surface deformation studies) are necessary before further discussion can be developed.—*D. B. V.*

167–124. Meinhold, Rudolf. Bemerkungen zur Frage des Salzaufstieges [Remarks on the question of salt emplacement]: Freiberger Forschungshefte, C22, Geophysik, p. 65–77, 1956.

The initial impulse that sets in motion the forces leading to the formation of salt domes must be tectonic. Recent geophysical results, mainly of seismic refraction work, lead to the conclusions that orogenetic processes cause the salt to flow pseudoviscously; that in saline beds there exists a "compensation surface of folding" which can involve a considerable pressure gradient; and that the nature of the border trough makes a reliable time indicator for the development of the salt dome.—*D. B. V.*

167–125. Marinov, N. A. O strukturnom znachenii razloma, obnovlennogo zemletryaseniem 1905 g. v Zapadnoy Mongolii [On the structural significance of the fault rejuvenated by the earthquake of 1905 in Western Mongolia]: Akad. Nauk SSSR Izv. Ser. geol., no. 6, p. 90–93, 1955.

Rejuvenation of the tectonic processes of a considerable area in western Mongolia by the earthquake of 1905, particularly the Khangaiskiy fault, suggests the irregularity in space and time of the development of large-scale faults and the importance of recent tectonic movements in creation of the present topographic features of Mongolia.—*D. B. V.*

167–126. Nielsen, Lawrence E., and Stockton, F. D. Flow patterns in glacier ice: Jour. Applied Physics, v. 27, no. 5, p. 448–453, 1956.

The mass of ice varies along the length of a glacier because of the accumulation of snow in its upper regions and the ablation of ice in the lower regions. This mass change brings about variable speeds of flow and complex streamlines. General equations are derived using a type of plug flow for ice for the following: glaciers of constant arbitrarily shaped cross sections, arbitrary rates of ablation and accumulation, and arbitrary variations of the longitudinal velocity across the glacier; and glaciers of rectangular cross section with varying widths and depths, arbitrary velocity profiles, and arbitrary rates of ablation and accumulation. Streamlines are calculated for five typical cases by using these general equations. The calculated flow behavior is in agreement with the known behavior of glaciers.—*Authors' abstract*

167–127. Miller, Maynard M. Glaciothermal studies on the Taku glacier southeastern Alaska: Internat. Geod. Geophys. Union Assoc. Sci. Hydrology Pub. 39, tome 4, p. 309–327, 1954.

Spectacular advance of the Taku glacier of the Juneau Icefield in Alaska during the past 50 years in an area where shrinkage is the rule has led to investigations in 1950–53 on the thermal regime of the upper glacier. The detailed glaciothermal data presented confirm and amplify the evidence of a present zone of maximum snowfall in the icefield's central névé and a net gain of this highest accumulation area for the past several years leading to the thickening and advance of the main branch of the glacier. By means of multiple thermistor cables inserted into boreholes a zone of annual chilling to a depth of 65 feet was observed at intermediate elevations (3600 ft) and evidence found of the retainment of subfreezing englacial conditions in the crestal firn (6000 ft) during the 1951–52 thermal year. This is attributed to the relatively colder temperatures and the shorter summer ablation season in this sector and is intensified by the excessive accumulation. The lower rocks of the glaciers are classified as geophysically temperate and englacial temperature conditions in the primary highland névé are considered as marginal between temperate and polar.—*B. T. E.*

167–128. Georgi, J. Temperatur und Dichtemessungen des Grönlandischen Inlandeises [Temperature and density measurements on the Greenland icecap]: Annales Géophysique, tome 12, no. 1, p. 102–110, 1956.

A discussion of temperature and density measurements in the névé. The density varies with depth according to Sorge's law, $d=0.917-(17.75/34.7+Z)$, where d=density and Z=depth. The mean temperature decreased below a depth of 8 m in 1930, and below the equivalent depth of 19 m in 1950. This is attributed to a colder climate in the years before 1920.—*P. E. B.*

167–129. Bourgoin, Jean-Paul. Quelques caractères analytiques de la surface et du socle de l'Inlandsis Groenlandais [Certain characteristics of the surface and base of the Greenland icecap]: Annales Géophysique, tome 12, no. 1, p. 75–83, 1956.

Formulas are presented for determining the topography of the basement surface under an icecap from the "micro-relief" of the surface. The ice is considered to be an ideally plastic material and the fundamental formula employed states the equality of the downslope component of the weight of the overlying

ice to the opposing tangential frictional force of the basement, taken to be the "yield shear stress" for the ice. Calculated basement topography for the outer part of the Greenland icecap is in good agreement with seismic depths and corroborates the theoretical conclusion that relative maximum and minimum altitudes of the basement surface along a given profile lie below the points of inflection of the curve representing the micro-relief of the surface. The formulas derived are shown to apply only when the slope of the surface of the ice is of sufficient magnitude.—*P. E. B.*

167–130. Förtsch, O[tto], and Vidal, H. Die Ergebnisse der seismischen Messungen auf dem Hintereisferner in den Ötztaler Alpen 1954 [The results of seismic measurements on the Hintereisferner in the Ötzaler Alps, 1954]: Gerlands Beitr. Geophysik, Band 65, Heft 2, p. 131–156, 1956.

A report of seismic investigations on the Hintereis glacier in the Ötztaler Alps [see Geophys. Abs. 164–153 and 165–169].—*D. B. V.*

167–131. Eriksson, E., and Welander, P. On the mathematical model of the carbon cycle in Nature: Tellus, v. 8, no. 2, p. 155–175, 1956.

A discussion is given of a simple mathematical model of the carbon dioxide cycle in the system atmosphere-biosphere-sea. The discussion is confined to phenomena with characteristic times of the order of 10 to 10^3 years. The results suggest that the increase of carbon dioxide indicated by recent measurements may represent part of a natural self-sustained oscillation and not necessarily be a response to an increased combustion of fossil fuels.—*P. E. B.*

167–132. Plass, Gilbert N. The carbon dioxide theory of climatic change: Tellus, v. 8, no. 2, p. 140–154, 1956.

The most recent calculations of the influence of CO_2 on the infrared flux show that if the CO_2 concentration in the atmosphere is doubled or halved, the average temperature rises 3.6° C or falls 3.8° C, respectively. If the total CO_2 in the atmosphere-ocean system is reduced slightly and held fixed at this new value, the atmospheric CO_2 is initially lowered. The temperature falls sufficiently to start a glacial epoch. Glaciers form decreasing the volume of the oceans by perhaps 5 percent so that they slowly release additional CO_2 into the atmosphere. Eventually the CO_2 in the atmosphere is increased sufficiently to raise the temperature enough to melt the glaciers, thus increasing the volume of the oceans which now slowly begin to absorb more CO_2 from the atmosphere. After a further period of time the decreased CO_2 in the atmosphere brings lower temperatures and the glaciers form again, repeating the cycle. The cycle of oscillations has an average period of tens of thousands of years because of the slow exchange of CO_2 between the atmosphere and oceans. The cycle will continue as long as the total amount of CO_2 in the atmosphere-ocean system is unchanged. The hypothesis is discussed in detail in terms of the new data presented and of present knowledge of pertinent factors.—*P. E. B.*

GRAVITY

167–133. Vajk, Raoul. Bouguer corrections with varying surface density: Geophysics, v. 21, no. 4, p. 1004–1020, 1956.

The Bouguer correction is applied to gravity data along with the terrain correction to eliminate the gravity effect of the topography and transform the

gravity data to a common level. The Bouguer correction is a function of the density of all the rocks lying above the level to which the gravity data are reduced. If density of the rocks forming the topography varies over the area of a survey, then the proper density should be used for every topographic feature. The Bouguer correction with varying density should be made only to a surface drawn through the low points of the topography. Below this surface a constant density should be used; otherwise, nonexisting gravity anomalies may be introduced into results of the survey, or existing anomalies may be distorted.—*D. R. M.*

167–134. Vening Meinesz, F. A. The second order corrections for pendulum observations at sea: K. Nederland. Akad. Wetensch. Proc., v. 56, no. 2, p. 218–227, 1953.

Formulas are derived for the effect of the component of the disturbing acceleration in the sense of the swinging plane of the pendulums and for that perpendicular to this plane. The first formula has a part that checks well with nearly all values for this correction computed by Worsley; these plus another part of the correction that must be considered agree with the formula derived by Browne. The new formula confirms Worsley's result that short-period vibrations are negligible if the knife edges of the pendulums follow the vibrations completely. For submarine observations it is desirable to dive deeply enough to avoid perceptible wave movements of periods less than about 6 sec, to avoid accelerations greater than a 150th part of gravity, and to avoid vibrations.—*M. C. R.*

167–135. Lecolazet, R[obert]. Application, à l'analyse des observations de la marée gravimétrique, de la méthode de H. et Y. Labrouste, dite par combinaisons linéaires d'ordonnées [An application of the method of H. and Y. Labrouste, using ordered linear sequences, to the analysis of the tidal variation of gravity]: Annales Géophysique, tome 12, no. 1, p. 59–71, 1956.

Discussion of a method for eliminating instrumental drift from periodic measurements of gravity, prior to harmonic analysis. The method applies to the removal of an aperiodic function in polynomial form from a function which is the sum of periodic and aperiodic functions. The method makes it possible to calculate the mean square error of the observations and the probable error of the results. An example of the analysis is given for 1 month of continuous hourly measurements at Strasbourg.—*P. E. B.*

167–136. Monnet, C. The use of integrators helps computing terrain corrections in gravimetry: Geophys. Prosp., v. 4, no. 3, p. 236–248, 1956.

To reduce the labor of calculating terrain correction a method has been devised in which the ground around each station is divided into sectors by equally spaced radial lines and the integral of the topographic section is calculated along each dividing radius. By means of a special computation chart the integration is reduced to the measurement of an area or the first moment of an area by a planimeter or integrator.—*M. C. R.*

167–137. Bulhanzhe, Yu. D. Formuly dlya vychisleniya oshibok gravimetricheskoy svyazi dvykh punktov pri mnogokratnykh izmereniyakh, vypolnyayemykh gruppoy gravimetrov [Formulas for the evaluation

of the errors in gravimetric tying of two points with repeated measurements performed with a bank of gravimeters]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 755–764, 1956.

Several second-class base stations were established in different parts of the U. S. S. R. and tied by repeated trips between the central observatory at Moscow and the station in question, the differences of gravity being measured by several gravimeters on every trip. The probable error and greatest attainable accuracy of such a method are discussed. Formulas derived for the error are applied to the tie between stations at Moscow and Kazan'.—*S. T. V.*

167–138. Koz'yakova, K. Ya. Nekotoryye resul'taty etalonirovaniya gravimetrov CH3 [Some results of the calibration of the CH3 gravimeter]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 765–775, 1956.

The CH3 gravimeter, an instrument similar to the Nørgaard but manufactured in the U. S. S. R., was calibrated by direct measurement of the angle of the deformation of the quartz system by an instrument such as the Hildebrand vertical circle. By attaching an accurately ground small mirror to the instrument (deviations of less than $\frac{1}{10}$ wavelength from a perfect plane) it is possible to determine the constant of the gravimeter with an error of less than ± 0.1 milligal. The experiments indicate that though it is possible to attain this desired precision, the instruments are, as a rule, poorly manufactured and errors may be as much as ± 3 milligals. One source of error is heat from the lamp built into the instrument to illuminate the scale.—*S. T. V.*

167–139. Bulanzhe, Yu. D. O tochnosti izmereniy kvartsevymi gravimetrami s gorizontal'noy krutil'noy nit'yu [On the precision of the measurements with quartz gravimeters having horizontal torsion wire]: Akad. Nauk SSSR Izy. Ser. geofiz., no. 8, p. 927–939, 1956.

Analytical and experimental study of the sources of errors and the possible improvements of the gravimeters with horizontal quartz fiber, specifically the Nørgaard and the Russian CH3 and GAE–2 gravimeters, indicates that the error of an individual determination is $15\pm$ (0.20—0.30) milligal. The errors of the micrometer readings are very small; the main source of errors is in the optical system which makes collimation of the indices difficult. The errors increase rapidly with decreasing angle of the opening of the torsion system. Improvements can be achieved by selection of a smaller rigidity constant of the torsion wire or by an increase of the magnification of the eyepiece of the microscope.—*S. T. V.*

167–140. Perrin, René. Explication possible des anomalies de la pesanteur sans recourse à l'isostasie [Possible explanation of gravity anomalies without recourse to isostasy]: Acad. Sci. Paris Comptes Rendus, tome 243, no. 15, p. 997–1001, 1956.

The explanation of gravity anomalies need not invoke the hydrostatic equilibrium of the theory of isostasy; Perrin proposes a theory based on physico-chemical equilibrium in the solid earth. The surface alteration and erosion and sedimentation on the initial crust would destroy the initial physico-chemical equilibrium between the different relatively superficial layers. When the temperature rose sufficiently, owing to burial or some other cause, metamorphism and granitization would take place, tending toward reestablishment of the equilibrium between solid phases by diffusion over great distances. Metamorphism

and granitization would entail upward migration of Na, K, and Si and a downward migration of Al, Mg, and Fe. Erosion and sedimentation would tend to concentrate iron at certain points, conversely decreasing the density of the rest of surface terrains. The end result would be that the surface layers forming the continents and mountain ranges would become less dense than the layers below them, with consequent decrease of gravity. The anomalies calculated according to this theory (assuming an initial homogeneous density of 2.9) are of the same order of magnitude as the observed anomalies.—*D. B. V.*

167–141. Goguel, Jean. Sur les caractères de la compensation isostatique dans le Berry [On the characteristics of the isostatic compensation in Berry] : Acad. Sci. Paris Comptes Rendus, tome 242, no. 15, p. 1914–1915, 1956.

Bouguer anomalies in the Berry region of central France follow the topography except in the valleys whereas classic theories of isostasy would indicate a widespread anomaly. Calculation of Putnam corrections results in a uniform residual anomaly of 5 to 10 milligals. This distribution of gravity would suggest "antiregional" compensation that would call for light masses in the lower part of the crust in juxtaposition to deep roots of the granulite massifs. A narrow positive anomaly in the Jurassic covered region north of Argenton indicates the presence of denser rocks within 6 km of the surface. The limit of erosion of Mesozoic rocks apparently is on a flexure that isostatic adjustment tends to accentuate—*M. C. R.*

167–142. Bott, Martin Harold Phillips. A geophysical study of the granite problem : Geol. Soc. London Quart. Jour., v. 112, pt. 1, p. 45–67, 1956.

Hypotheses for source and emplacement of granite are classified as magmatic, metasomatic, and combined magmatic and metasomatic. The evidence of negative gravity anomalies, analyzed from various aspects, and of the low-velocity lithosphere channel of Gutenberg (Geophys. Abs. 162–234) indicate that batholiths have considerable extent in depth, hence forcible intrusion is unlikely to be the main mechanism in post-tectonic emplacement. The negative anomalies demonstrate that the emplacement involves considerable over-all removal of mass from the regions now occupied by granite, but they do not support the hypothesis that the bulk of this now resides in the country rocks as a basic front. The evidence suggests that both downward diffusion of surplus mass and stoping are possible primary mechanisms. Taken together, geophysical, geochemical and geological observations support the idea that a true granitic layer, underlying the metasedimentary rocks, provides the source material for granite. Syn- and postemplacement uplift of batholiths and the origin of mantled gneiss domes are attributed to isostatic-type phenomena depending on the granite mass deficiency—*D. B. V.*

167–143. Jones, L. Note introductive sur les levés gravimétriques au Congo belge at au Ruanda-Urundi [Introductory paper on the gravimetric surveys in the Belgian Congo and Ruanda-Urundi] : Acad. royale Sci. coloniales Bull. tome 2, no. 3, p. 429–461, 1956.

Gravimetric missions have completed 4 years' work in the Congo basin and graben of Central Africa. This has led to the establishment of 3 pendulum stations tied to Uccle (Belgium), 7 stations of the international network, 27 stations of the base network, 6,000 stations in the Congo basin, 95 reconnaissance

stations in the graben, and a general survey across the northeastern part of the Congo and the territories of Uganda and Tanganyika. Jones describes in detail the problems which were confronted in this area and the methods and instruments used. Four schematic maps showing the general geography, gravimetric networks, and levelling in the area are included.—*B. T. E.*

167–144. Goguel, Jean. Remarques sur la gravimétrie du Nord du Massif Central (présentation de la carte gravimétrique au 320000e "Poitou-Marche" publiée par le B. R. G. G. M. en 1956 [Remarks on the gravimetry of the northern Massif Central (presentation of the gravimetric 1:320,000 map of "Poitou-Marche" published by the Bureau des Recherches géologiques, géophysiques et minières in 1956)]: Soc. géol. France Comptes Rendus, no. 10, p. 139–141, 1956.

This paper accompanied presentation to the Société géologique de France of the recently published Poitou-Marche gravimetric map, Bureau des Recherches géologiques, géophysiques et minières, covering the northern part of the Massif Central between the Poitou and the Limagne regions. The close relation between the distribution of gravity intensity and structure of the basement is illustrated by reference to several details on the map. Over the granulites, in particular, the isogams closely parallel the structure contours.—*D. B. V.*

167–145. Joesting, H. R., and Byerly, P. Edward. Aeromagnetic and gravity profiles across the Uravan area, Colorado: Intermountain Assoc. Petroleum Geologists Guidebook 7th ann. field conf., 4 p., 1956.

Gravity, magnetic, and geologic profiles drawn from Disappointment Valley to Tabeguache Creek and across Paradox Valley, Colorado, illustrate the use of magnetic and gravity surveys in an area where the structure of the older rocks differs in many places from that of the overlying rock. In general, the magnetic anomalies are caused by the contrasting magnetic effects of the basement rocks. The gravity anomalies are caused by contrasting densities in both the crystalline and sedimentary rocks. The largest gravity anomalies in the Uravan area are associated with the piercement salt anticlines of Gypsum and Paradox Valleys. The density of the cores of these structures is about 2.2 g per cm^3, whereas the density of the adjacent rock is about 2.5 to 2.6 g per cm^3.—*B. T. E.*

167–146. Whetton, J[ohn] T., Myers, J. O., and Watson, I. J. A gravimeter survey in the Craven district of northwest Yorkshire: Yorkshire Geol. Soc. Proc., v. 30, pt. 3, p. 259–287, 1956.

A gravity survey consisting of 230 stations in an area of approximately 170 square miles was undertaken to study the deep-seated effects of the North and Middle Craven fault systems. The maximum standard error of any single Bouguer anomaly is estimated to be no more than 0.19 milligal. Results indicate the Craven fault system is not associated with any large gravity variations because of the lack of a bulk density contrast between Lower Paleozoic and Lower Carboniferous rocks. Deposition and deformation of the Ingletonian and Lower Paleozoic rocks and the general direction of the North and Middle Craven faults have apparently been controlled by existence of a low-density structurally rigid Precambrian massif.—*M. C. R.*

167–147. Cattala, Louis. Mesures de la marée gravimétrique à Madagascar [Measurements of the gravimetric tide at Madagascar]: Acad. Malgache Bull., tome 33, p. 3–8, 1955.

The diurnal variations of gravity at Tananarive, Madagascar, determined in four series of observations at intervals of approximately 2 weeks in February–April 1954 are shown in curves. The calculated values of theoretical gravity and the observed values were treated by the method of least squares to give the ratio of observed to theoretical amplitude. The average ratio of 1.141 is lower than that of 1.20 generally accepted for the whole earth but it is within the extremes noted by other authors in different countries.—*D. B. V.*

167–148. Cattala, Louis. Position géographique, valeur de la déclinaison magnétique et intensité de la pesanteur à l'îlot Tromelin [Geographic position, value of magnetic declination and intensity of gravity at Tromelin Islet]: Acad. Malgache Bull., tome 33, p. 1–2, 1955.

According to measurements made in September 1955, the position of Tromelin Islet (east of Madagascar) is 54°30′54″±7″ E. long., 15°53′01″±7″ S. lat. (precision of the order of 250 m); magnetic declination is 10.9°±0.05° toward the west; absolute gravity is 978.64022 milligals, and there is a positive Bouguer anomaly of 207.8 milligals. This anomaly is consistent with those of other islands far at sea and surrounded by deeps of the order of 4,000 m, such as Reunion, +235 milligals, and Mauritius, +260 milligals.—*D. B. V.*

167–149. Dibble, R. R., and Suggate, R. P. Gravity survey for possible oil structures, Kotuku-Ahaura district, North Westland: New Zealand Jour. Sci. Technology, sec. B., v. 37, no. 5, p. 571–586, 1956.

The gravity map of the Kotuku-Ahaura district (North Westland, New Zealand) shows that the Grey-Inangahua depression contains two major synclines arranged en echelon and separated by an anticline on which there is a minor closed structure, the Ahaura dome, 12 miles northeast of the oil seepages at the Kotuku dome. The strata at the Ahaura dome inferred from the geologic history probably contain no impermeable layers capable of trapping oil, but as this is not certain a test boring is recommended.—*D. B. V.*

167–150. Timofeyev, A. N. O prichinakh gravitatsionnykh anomaliy v zapadnoy chasti Zapadnosibirskoy nizmennosti [On the causes of the gravity anomalies in the western part of the West Siberian plain]: Akad. Nauk SSSR Izv. Ser. geol., no. 1, p. 122–124, 1955.

The gravity anomalies of the western part of the West Siberian plain are due to changes in relief in the pre-Mesozoic basement. Being rather weak, they are difficult to distinguish and interpret without the aid of reconnaissance surveys by magnetic or other geophysical methods.—*D. B. V.*

167–151. Shurbet, G. Lynn, Worzel, J. Lamar, and Ewing, Maurice. Gravity measurements in the Virgin Islands: Geol. Soc. America Bull., v. 67, no. 11, p. 1529–1536, 1956.

Ten gravimeter observations were made on St. Thomas and 21 on St. Croix islands. Contours of the simple Bouguer anomalies on St. Thomas are essentially parallel to the strike of the surface structures and agree in trend and absolute value with those on Puerto Rico. A gravity minimum of about 20 milligals

on St. Croix can be correlated with the Tertiary sedimentary basin. The gravity data indicate that these sediments form a wedge with the maximum thickness, about 2 km, near the eastern margin of the basin. Seismic and gravity data in the Virgin Islands region indicate the crust is 29 km thick in both the Puerto Rico and Virgin Islands platforms but that there is a relatively thin crust beneath the Anegada trough, perhaps as the result of extension of the crustal rocks.—*M. C. R.*

167–152. Prosen, D. Jedan prilog ostvarenju gravimetriske mrežhe u jugoslaviji [A contribution to the establishment of a gravimetric network in Yugoslavia]: Beograd Tekh. Velika Škola Zbornik radova geol. irudarskog fakulteta, p. 99–103, 1953–54.

A brief report of the observations of gravity in 1953 in Macedonia, southern Yugoslavia. Seven stations were occupied with a Worden gravimeter. The measurements are tabulated.—*S. T. V.*

HEAT AND HEAT FLOW

167–153. Lyumbimova Ye. A. Pervoye vsesoyuznoye soveshchaniye po geotermicheskim issledovaniyam v SSSR [The first all-union conference on geothermal investigations in the U. S. S. R.]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 874–876, 1956.

A report on the highlights of the conference. These included: the importance of thermal studies in the elucidation of the history of the earth [see Geophys. Abs. 164–180 and 165–212]; thermal measurements in drill holes as indicators of structure in oilfields or the composition of the upper layers of the crust (for example, in the Caucasus the geothermal gradient varies from 7 m per 1°C to 40–50 m or even 100 m per °C in accordance with the structure of the region); and the possibility of using the internal heat, coming to the surface as hot springs, for residential heating or for agricultural purposes or, in volcanic regions such as Kamchatka and the Kurile Islands, for production of electric energy.—*S. T. V.*

167–154. Korzhinskiy, D. S. Preuvelicheniye roli solnechnoy energii v energetike zemnoy kory [Exaggeration of the role of solar energy in the "energetics" of the earth's crust]: Akad. Nauk SSSR Izv. Ser. geol., no. 1, p. 52–64, 1955.

The theory of Lebedev and Belov, that solar energy absorbed in weathering of aluminum silicates serves as a fundamental source of energy in endogenic processes, is shown to be based on erroneous assumptions. It is shown that in the reactions involving changes in the atomic coordinates of aluminum—for instance, kaolinitization of feldspars—other factors such as temperature and alkalinity of the solutions enter in and invalidate the analogy to photosynthesis in organic substances. Lebedev's theory is contrary to the second law of thermodynamics. The predominent metamorphic reactions, dehydration and decarbonatization, undoubtedly require a vast consumption of energy in comparison to which the production of energy by weathering is insignificant.—*D. B. V.*

167–155. Zierfuss, H., and van der Vliet G. Laboratory measurements of heat conductivity of sedimentary rocks: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 10, p. 2475–2488, 1956.

From a study of the heat conductivity of various building bricks, it has been deduced that heat conductivity increases with decreasing porosity and with in-

creasing pore water content. Laboratory measurements of the thermal conductivity of representative rock samples were made, therefore, to determine whether similar relationships hold for sedimentary rocks. The thermal conductivity apparatus used causes heat to flow at an unknown but constant rate through a pile consisting of a cylindrical rock sample and a standard sample of known thermal conductivity. The heat conductivity of the rock sample can then be calculated from the measured temperature gradients in the rock and standard and the known heat conductivity of the standard. Radial heat transfer is largely prevented by a cylindrical brass shield heated to a longitudinal temperature distribution as nearly as possible to that of the pile.

In addition to porosity and pore water content, permeability also effects heat conductivity through the influence of convective heat transport in the wider pores. A quantitative relationship was found between porosity and the product of thermal conductivity and the formation resistivity factor of sedimentary rocks. Differences between heat conductivities of cores either partly filled with water and gas, or with oil or water, are small. Heat conductivity can be calculated from the porosity and resistivity factor for certain rock types.—*L. C. P.*

167–156. De Vries, D. A.; Webb, John. Thermal conductivity of soil: Nature, v. 178, no. 4541, p. 1074–1075, 1956.

De Vries points out that Webb overlooked the fact that his calculation of the thermal conductivity of a cubic arrangement of spheres (Geophys. Abs. 165–215) is based on an inadmissible simplification and that he has derived an approximate method for calculating the thermal conductivity of soils from their composition, moisture content, and dry density. Webb, in reply, states that he realizes the formula is nonrigorous but that his purpose in writing was to challenge the validity of Gemant's method of determining the conductivity of dry soil in which the air-phase conductance is neglected.—*M. C. R.*

167–157. Kintzinger, Paul R. Geothermal survey of hot ground near Lordsburg, New Mexico: Science, v. 124, no. 3223, p. 629–630, 1956.

In 1954 live steam and boiling water were reported as issuing from shallow wells being drilled in an area between the Pyramid and Peloncillo Mountains, 15 miles southwest of Lordsburg, N. Mex. Geothermal measurements were made by inserting resistance thermometers into holes driven 4 feet into the ground. The anomalous area covers approximately two sections. The maximum observed temperature 1 meter below the surface was 23°C, approximately 12°C higher than readings outside the anomalous region. At three places in the warmest area a mean vertical gradient of 10°C per m was observed. The source of the heat may be hot steam and vapors ascending from great depth along faults and fractures, a relatively recent intrusive body beneath the rhyolite bedrock, or the rhyolite itself (although this last is improbable if the rhyolite is of mid- to late-Tertiary age as are similar rhyolites in adjacent areas).—*M. C. R.*

167–158. Herrin, Eugene, and Clark, Sydney P., Jr. Heat flow in west Texas and eastern New Mexico: Geophysics, v. 21, no. 4, p. 1087–1099, 1956.

Geothermal gradients, in the salt section of the Solado formation of Permian age as indicated by temperature logs, are nearly uniform in west Texas and eastern New Mexico. The gradients range from 7.70°C per km to 9.00°C per km. From measurements of thermal conductivity and a review of the litera-

ture, the thermal conductivity of rock salt is estimated as about 13×10^{-3} cal per cm sec °C with an uncertainty of about 10 percent. The heat flow is calculated as $1.1\pm0.1\times10^{-6}$ cal per sq cm.—*M. C. R.*

167–159. Robson, G. R., and Willmore, P. L. Some heat measurements in West Indian soufrières: Bull. volcanolog., tome 17, p. 13–39, 1955.

Measurements of the flow of hot streams, emission of steam from fumaroles, and heat loss from the surface of hot pools in several soufrières in the Lesser Antilles yield rough estimates of the thermal output of the region. The highest heat output observed was at the Boiling Lake of Dominica, 1.44×10^{7} cals per sec; the lowest, 2,900 cals per sec at Mount Misery in St. Kitts. As steam temperatures range as high as 185°C, well above that which can be obtained by expanding saturated steam down to atmospheric pressure from any initial condition, it is suggested that much of the steam may come directly from magma rather than from meteoric water in contact with heated rock. The total heat output of the soufrières ($<10^{8}$ cals per sec) is of the same order of magnitude as the average heat of major eruptions in historic times (1.3×10^{8}) and the combined figure is of the same order of magnitude as heat flow through a nonvolcanic area of the same size (1.3×10^{8}). Unless substantial additional heat flow remains to be detected, it must be concluded that the West Indian activity is a very minor anomaly in the terrestrial heat flow pattern.—*D. B. V.*

INTERNAL CONSTITUTION

167–160. Dauvillier, A[lexandre]. L'origine des éléments chimiques et l'évolution de l'universe [The origin of the chemical elements and the evolution of the universe]: Ciel et Terre, 72e année, no. 7–8, p. 325–344, 1956.

In Dauvillier's theory of the origin of the universe, the role of the solar system may be summed up as follows: The chemical elements constituting our solar system were born with the sun (then a red giant star) 5 billion years ago at the center of a globular cluster. The solar system itself resulted from an interaction which took place 10^{9} yrs later at the center of the galactic nucleus. During the ensuing thirty-odd revolutions of the spiral the solar system has worked outward from the center of the galaxy, and the sun has used up almost all its hydrogen. Soon it will explode as a supernova, sterilizing the earth, evaporating the oceans and melting the lithosphere, and become a hyperdense star. In several billion years it will escape from the spirals into the galactic domain, where it will be captured by a globular cluster. The sun, hyperdense and dark, will explode in a stellar encounter at the center of the cluster, engendering new chemical elements and a new red giant, thus initiating a new cycle.—*D. B. V.*

167–161. Öpik, E. J. The origin of meteorites and the constitution of the terrestrial planets: Irish Astron. Jour., v. 3, no. 7, p. 206–225, 1955.

The Widmanstatten pattern of iron meteorites and the theoretical time of cooling of a solid sphere indicates that all meteorites originated from breakdown presumably by collision of a planet or planets 1,000 to 2,000 km in diameter. If the discontinuity at the boundary of the earth's core is not due to a difference in chemical constitution but to a phase transition of the silicate material in

the mantle, the energy released in transition of an unstable planetary core is too small to cause ejection of meteoritic fragments to space. Moreover, the stresses are too small to cause rupture of the planetary mantle; in such a case transition is regulated by viscosity and is extremely slow. The ejection of meteoritic fragments from the surface of the unstable planet is then completely ruled out. Phase transitions of complex materials are expected to take place in several steps. The sharpness and isolated occurrence of the discontinuity at the boundary of the earth's core is probably due to a difference in chemical composition; namely, the presence of an iron core.—*D. B. V.*

167–162. Magnitskiy, V. A. Vnutrenneye stroyeniye zemli [The internal structure of the earth]: Priroda, tom 45, no. 7, p. 3–15, 1956.

A critical review of hypotheses on the internal structure of the earth, such as the composition and physical state of the core, the sources of terrestrial magnetism, the composition of the lower portions of the mantle, the nature of the transitional layer under the effect of high temperature and pressure, the genesis of the crust, and the processes going on in the crust.—*S. T. V.*

167–163. Haalck, H[ans]. Physik des Erdinnern [The physics of the earth's interior]: 183 p., Leipzig, Akad. Verlagsgesellschaft Geest u. Portig K.-G., 1954.

A thorough discussion of what has been learned of the earth's internal constitution by geophysical research. The introduction includes the most fundamental principles related to the behavior of matter; state, viscosity, elasticity; isotropy and anisotropy; and effects of temperature and pressure. Chapters are devoted to the following topics: properties derived from geodetic measurements, such as shape, size, acceleration of gravity, mass, density, and moment of inertia; properties found by astronomical observation; secular variations of the solid earth as related to the magnitude and direction of the force of gravity; seismophysical investigation of the deep interior; density distribution; gravity, pressure, elasticity and viscosity as functions of depth; temperature; the chemical composition of the earth and solar system; the physical constitution of the crust and distribution of land masses; magnetism and electric currents. Also included is an index of geophysical constants and magnitudes.—*B. T. E.*

167–164. Egyed, L[ászlo]. The change of the earth's dimensions determined from paleogeographical data: Geofisica Pura e Appl., v. 33, p. 42–48, 1956.

Study of paleogeographic maps by Strahow and the Termiers shows there has been a tendency toward a decrease in the area of water-covered continental areas during geologic time, and thus an expanding earth. The rate of annual increase of the radius is estimated to have been, on the average, 0.5 mm per year. The formation of continents and ocean basins can be explained on this basis as the result of the disruption of a continuous crust and the rise of ultrabasic magma along the line of rupture to a level corresponding to hydrostatic equilibrium, about 5 to 6 km lower than the average level of the surface of the continental areas. Periodicity of stress accumulation and release is a consequence of expansion of volume; the duration of the period (which must agree with that of transgression and regression) is estimated as 50 million years.—*M. C. R.*

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167–165. Egyed, L[ászlo]. A new theory on the internal constitution of the earth and its geological-geophysical consequences: Acta Geol. Acad. Sci. Hungaricae, tomus 4, fasc. 1, p. 43–83, 1956.

The earth's interior becomes more and more homogeneous toward the center. The core consists of matter in an ultra-high pressure phase that is unstable, resulting in a steady expansion of the earth's volume. The expansion of the earth and attendant stresses and energy transfers account for the formation of the crust, continents, and ocean basins; the energy of tectonic forces and earthquakes; the origin of deep-focus earthquakes; surface structural features, such as fracture systems, deep-sea troughs, and the African Rift Valleys; continental drift; periodicity of geologic phenomena; and mountain building.—*D. B. V.*

167–166. Öpik, E. J. The origin of the moon: Irish Astron. Jour., v. 3, no. 8, p. 245–248, 1955.

The theory that the moon was originally an independent planet and was captured by tidal forces when it happened to pass the earth at a distance of 26.1 earth's radii is mathematically simpler than the theory that the moon originated from material of earth's core, undergoing sudden transitions at pressures exceeding 4×10^6 atmospheres and explosively ejected into nearby space; the moon can also be more completely traced back in time. "Unfortunately, we cannot be sure that nature actually chose the simpler method of attaching the moon to our planet."—*D. B. V.*

167–167. Gutenberg, B[eno]. Neue Ergebnisse über den Aufbau der Erde [New information on the structure of the earth]: Geol. Rundschau, Band 45, Heft 2, p. 342–353, 1956.

This is a review of recent observations and opinions on the structure of the earth, based on laboratory experiments and on seismological research. Previous concepts have been too simple. Questions of crustal layering, mountain roots, seismicity of the earth, fault movement in the Kern County, Calif., earthquakes of July 21, 1952 and succeeding months, heat flow from the earth's surface, and constitution of the mantle and core are treated more or less briefly.—*D. B. V.*

167–168. Ewing, Maurice, and Press, Frank. Seismic measurements in ocean basins: Jour. Marine Research, v. 14, no. 4, p. 417–422, 1955.

A discussion of seismic effects and measurements in ocean basins of earthquakes and explosions, delivered at a convocation celebrating the dedication of the Laboratory of Oceanography at Woods Hole, Mass., June 1954.—*M. C. R.*

167–169. Nishimura, Eiichi, and Kishimoto, Yoshimichi. On the local structural character of the earth's crust: Tellus, v. 8, no. 3, p. 329–334, 1956.

Regional differences in crustal structure in Japan were investigated by analysis of the duration of the refracted wave observed ahead of the direct wave. The thickness of the crust is estimated to range from 25 to 50 km. The depth of focus is also related to the thickness of the crust; in general, the foci seem to be a little above the bottom of the crust in the area concerned.—*M. C. R.*

167–170. Research Group for Explosion Seismology. The fifth explosion seismic observations carried out in northeastern Japan: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 699–707, 1955.

Seismological observations of a large blast at the Kamaisi Mine in northeastern Japan on September 13, 1953, were concentrated within a distance of 300 km south of the blast point. The *P*-wave data indicate that a layer in which the velocity is 6.05 kmps overlies a layer in which the velocity is 7.2 or 7.6 kmps at a depth of 22 or 25 km. The result is supported by observation of reflected waves. *S*-wave data indicate that a layer in which the velocity is 3.46 kmps overlies a layer in which the velocity is 4.5 or 4.8 kmps at a depth of 32 or 36 km. Discrepancies probably arise from the assumption that the crustal structure is horizontally uniform. (See also Geophys. Abs. 166–247.)—*D. B. V.*

167–171. Voytkevich, G. V. Izotopnyy sostav svintsa i problema pervichnoy magmy [Isotopic composition of lead and the problem of primary magma]: Akad. Nauk SSSR Izv. Ser. geol., no. 4, p. 50–56, 1955.

Isotopic investigations or radiogenic lead in rocks and meteorites, here reviewed, show that the chemical differentiation resulting in accumulation of radioactive elements in an outer silicate portion of the planet and their impoverishment in the deeper subcrustal regions (metallic phase), took place 4,500 million years ago. The primary magma, from which the hydrosphere and the granitic and basaltic layers of the crust were formed by further differentiation, must have been derived from the upper aluminosilicate phase of the outer portion rather than the deeper magnesian silicate phase; such ultrabasic magma does not contain enough potash to produce granites on differentiation, whereas a primary magma close to present-day basalts does.—*D. B. V.*

ISOSTASY

167–172. Gutenberg, B[eno]. Geophysical data implied in isostatic calculations: Finn. Geod. Inst. Veröffentl., no. 46, p. 43–50, 1955.

Calculations of pressure as [a] function of depth under a rock column in a region of high mountains, a second under continental lowlands, and a third under a deep ocean basin are carried out on the basis of the most recent data on layering in the earth's crust and on density of rocks. At depths below about 50 km the calculated pressure is nearly the same in all three columns, indicating approximately hydrostatic equilibrium. In the continents the mean density of a column above the Mohorovičić discontinuity seems to be at least 0.1 greater than the value of 2.67 g per cm^3 which is being used in isostatic calculations, and the difference between the density of the material below the discontinuity and the average density above it is probably closer to 0.5 g per cm^3 than to the value of 0.6 which is now in use. Since in most of the Pacific basin and in a large part of the Atlantic basins the depth of the water and the thickness of the rock layers above the Mohorovičić discontinuity are of the same order of magnitude, separate treatment of these two layers seems to be preferable.—*Author's summary*

167–173. Jung, Karl. Das harmonische Glied erster Ordnung bei Isostasie [The first order harmonic term in isostasy]: Finn. Geod. Inst. Veröffentl., no. 46, p. 81–87, 1955.

In developing the external space potential according to spherical functions, it is known that the first-order harmonic term is lacking if the origin of the co-

ordinate system lies in the center of gravity. This is also the case if first-order terms are included in the mass distribution. This paper shows mathematically how the first-order term can be adjusted to known isostatic theories by assuming displacement of the center of gravity.—*D. B. V.*

167–174. Price, Charles A. Crustal movement in the Lake Ontario-Upper St. Lawrence River Basin: 5 p. and 20 illus., Ottawa, Canada Dept. Mines and Tech. Surveys, Surveys and Mapping Br., 1954.

Changing gage relations and water-level data at Port Dalhousie, Toronto, Oswego, Kingston, and Cape Vincent over the period 1860–1952 show that the crust in the Lake Ontario-Upper St. Lawrence River Basin is being differentially uplifted at rates that range from 0 at Port Dalhousie to 1.29±ft per 100 years at Cornwall.—*M. C. R.*

167–175. Jelstrup, Hans S. The earliest essays on isostatic explanations in Norway: Finn. Geod. Inst. Veröffentl., no. 46, p. 77–80, 1955.

A review of the contributions of Schiötz and Nansen, pioneers in isostatic research in Norway.—*D. B. V.*

ISOTOPE GEOLOGY

167–176. Parwel, A., Ubisch, H. von, and Wickman, F[rans] E. On the variations in the relative abundance of boron isotopes in nature: Geochim. et Cosmochim. Acta, v. 10, no. 3, p. 185–190, 1956.

The relative abundance of the boron isotopes has been measured on 43 samples of boron minerals and sea water. Contrary to an earlier investigation, no variations could be observed except for sea water, where boron seems to be about 2 percent "heavier" than in the minerals. If variations do occur, they are less than a few parts per thousand.—*Authors' abstract*

167–177. Roth, Étienne. Composition isotopique de l'hydrogène des gaz de Lacq [Isotopic composition of the hydrogen of the gases at Lacq]: Acad. Sci. Paris Comptes Rendus, tome 242, no. 26, p. 3097–3100, 1956.

The deuterium content of the hydrogen in methane from the Lacq oilfield in southern France is the same as the average content of deuterium in the surface waters, about 150 ppm. The hydrogen in hydrogen sulfide, however, has a deuterium content of 90±10 ppm. This value is interpreted as the effect of isotope exchange reactions between hydrogen and water. The reaction depends on the temperature of the deposit (here taken as 140°C); conversely, the temperature of the deposit can be estimated from the deuterium content of the H_2S gas, given the volumes of water and gas present.—*D. B. V.*

167–178. Bateman, A[llen] M., and Jensen, M[ead] L[eRoy] Notes on the origin of the Rhodesian copper deposits: Isotope composition of the sulfides: Econ. Geology, v. 51, no. 6, p. 555–564, 1956.

A program of investigation of the relative abundance of the stable isotopes of sulfur in the sulfides of bedded ore deposits for which both epigenetic and syngenetic origins have been proposed was begun with a study of the Rhodesian copper belt deposits. The S^{32}/S^{34} ratios fall within the range for those known to date for hydrothermal, magmatic, and pegmatitic sulfides, and also come within part of the range established for H_2S of biogenic origin. Isotope ratios

in sulfides of other deposits determined for comparison give some support to an epigenetic origin for the Kipushi (Katanga) deposits and indicate that the Luisha (Katanga) deposit is also of epigenetic origin. The Messima digenite ratios are close to that of meteoritic sulfur. Field and microscope evidence should be considered with isotope evidence and more investigation is needed of sulfur isotope ratios from deposits of unquestioned sedimentary origin.—*V. S. N.*

MAGNETIC FIELD OF THE EARTH

167–179. Namikawa, Tomikazu. Magnetohydrodynamic oscillations of a conducting liquid mass rotating in a uniform magnetic field: Jour. Geomagnetism and Geoelectricity, v. 7, no. 4, p. 97–104, 1955.

The basic magnetohydrodynamic equations for small oscillations are derived with the aid of the field equations. Solutions are obtained in terms of infinite series; but Namikawa is primarily interested in the effect of Coriolis forces of cosmic magnitudes. Solutions for an infinitely long cylinder with a rigid bounding surface indicate that when the Coriolis force is much greater than the electromagnetic force, two periods result—one longer and one shorter than that of a nonrotating cylinder.—*R. G. H.*

167–180. Rikitake, Tsuneji. Magneto-hydrodynamic oscillations of a conducting fluid sphere under the influence of the Coriolis force: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 2, p. 139–155, 1956.

Study of the magnetohydrodynamic oscillations of a highly conducting fluid sphere rotating in a uniform magnetic field shows that previous discussion (See Geophys. Abs. 164–219, 165–246, 166–256) concerning the stability of the earth's dynamo should be altered to take into account the Coriolis force.—*D. B. V.*

167–181. Jirlow, K. Experimental investigation of the inhibition of convection by a magnetic field: Tellus, v. 8, no. 2, p. 252–253, 1956.

A layer of mercury, enclosed by two plexiglass plates and a plexiglass cylinder was subjected to constant downward vertical fields of 600 and 10,000 gauss. The layer was heated from below and cooled above by circulating water. The results confirm the theoretical inhibition of the onset of convection of an electrically conducting fluid by a magnetic field.—*P. E. B.*

167–182. Runcorn, S. K[eith]. The present status of theories of the main geomagnetic field: Geologie en Mijnbouw, jaarg. 18, no. 11, p. 347–349, 1956.

A review of recent theories on the geomagnetic field.—*D. B. V.*

167–183. Olczak, Tadeusz. Über die Säkularänderungen des Erdmagnetismus in Polen im Zeitraum von 1901,0 bis 1935,0 [On the secular variations of geomagnetism in Poland in the period from 1901.0 to 1935.0]: Frieberger Forschungshefte, C22, Geophysik, p. 29–35, 1956.

With the aid of tables and sketch maps, the secular changes in declination, inclination, and horizontal and vertical intensity of the earth's magnetic field in Poland from 1901 to 1935 are presented.—*D. B. V.*

167–184. Barta, G[yörgy]. A 40–50 year period in the secular variation of the geomagnetic field: Acta Geol. Acad. Sci. Hungaricae, tomus 4, fasc. 1, p. 15–42, 1956.

Analysis of data from observatories in different parts of the world shows an unmistakable secular variation of a period of approximately 44 years in each of the geomagnetic elements. In equatorial regions the wave is halved, corresponding to the 22-year period of sunspot magnetization; for the H wave at Oslo, an 11-year sunspot period can be discerned. The superimposed waves for declination and east component proceed from west to east around the earth; for the other magnetic elements the maximum values are synchronous over the entire earth. Referred to the adjusted secular variation, the actual variation is sometimes fast and sometimes slow.—*D. B. V.*

167–185. Pudovkin, I. M. Magnitnyye variatsii v vysokikh shirotakh [Magnetic variations at high latitudes]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 835–837, 1956.

During the summer of 1953, variations of the geomagnetic field were continuously recorded on 7 stations 150 to 300 km apart between latitudes 67° and 73° N. Brunelli's variometers were used. It was found that simultaneous variations of the geomagnetic field at stations 200 to 300 km apart were of very different character, sometimes of the same phase, others opposite, with absolute differences in intensity of the magnetic vector of 200 to 300 gammas. Differences between stations at greater distances were sometimes as much as 700 gammas.

Vector charts of the variations showed the sources were 150 to 1,500 km above the earth. Other geomagnetic variations were produced by induced telluric currents at depths of about 150 km. Detailed study of these variations using an extended and dense enough network of geomagnetic stations is necessary. The morphology of these magnetic disturbances is of importance in aerial navigation at high altitudes, especially in airborne magnetic surveys.—*S. T. V.*

167–186. Okhotsimskaya, M. V. Sezonnoye raspredeleniye korotkoperiodicheskikh kolebaniy elektromagnitnogo polya zemli [Seasonal distribution of short-period variations of the electromagnetic field of the earth]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 999–1000, 1956.

Statistical study of the variations of the geomagnetic field observed at Alma-ata between September 1, 1953, and August 25, 1954, indicates an annual periodicity of two forms of magnetic disturbances related to the equinox (maximum) and to the solstice (minimum). These variations are attributed to changes in the intensity of the corpuscular stream from sunspots. Typical magnetograms are reproduced.—*S. T. V.*

167–187. Mayaud, P[ierre-Noël]. Activité magnétique dans les régions polaires [Magnetic activity in the polar regions]: Annales Géophysique, tome 12, no. 1, p. 84–101, 1956.

A discussion of data from 52 observatories in both hemispheres. Two types of activity are distinguished and defined, and their connections with magnetic storms, aurorae, and bays are discussed.—*P. E. B.*

167–188. Cattala, Louis. Quelques mesures de la déclinaison magnétique dans la partie centrale de Madagascar [Some measurements of magnetic declination in the central part of Madagascar]: Acad. Malgache Bull., tome 33, p. 13–15, 1955.

Using the same instruments and procedure as in the western and southern part of the island (see following abstract), magnetic declination was measured at six stations in central Madagascar in April 1954. Because diurnal variations were weak on the days of the survey, the results listed will not differ significantly from the corrected values.—*D. B. V.*

167–189. Cattala, Louis. Quelques mesures de la déclinaison magnétique dans l'ouest et le sud de Madagascar [Some measurements of magnetic declination in western and southern Madagascar]: Acad. Malgache Bull., tome 33, p. 9–11, 1955.

Between September 27 and November 3, 1954, magnetic declination was measured by reoccupying 10 old stations (mainly those of Besairie) in different regions in western and southern Madagascar. Results are listed, uncorrected for diurnal or seasonal variation. (See also Geophys. Abs. 163–54.)—*D. B. V.*

167–190. Burkhart, K. Der Erdstrom, seine Entstehung und wahrscheinliche Rückwirkung auf das erdmagnetische Feld [The earth current, its origin and apparent effect on the geomagnetic field]: Geofisica Pura e Appl., v. 33, p. 49–77, 1956.

In this paper an attempt is made to bring the empirical results of year-round earth current observations into harmony with the theory of simple, inductively coupled current circuits. Proceeding from the simple Laplace law of electrodynamics, a satisfactory correspondence can be found between observation and theory for the magnetic reaction of the earth current. The original observations needed for more exact calculations are lacking; also the number of observations should be significantly greater. Finally, the calculation of the magnetic reaction could yield better results if the curvature of the earth is taken into account.—*Author's conclusions, D. B. V.*

167–191. Block, L., and Herlofson, N. Numerical integration of geomagnetic field lines: Tellus, v. 8, no. 2, p. 210–214, 1956.

One hundred twenty-three geomagnetic field lines have been integrated by an electronic computer, taking into account also the quadrupole terms of the potential. A table gives the coordinates of the two points of intersection, one in the northern and one in the southern hemisphere, between the earth's surface and each calculated field line.—*Authors' abstract*

167–192. Serson, P. H., and Hannaford, W. L. W. A portable electrical magnetometer: Canadian Jour. Technology, v. 34, no. 4 p. 232–243, 1956. Reprinted as Dominion Observatory Ottawa Contr., v. 1, no. 28.

A portable electrical magnetometer, consisting of a magnetic detector of the saturated transformer type mounted on the telescope of a nonmagnetic theodolite built at the Dominion Observatory, can be used to make a complete observation of declination, inclination, and total intensity in 15 minutes at any magnetic latitude. Probable errors are $\pm 0.3'$ in declination, $\pm 0.2'$ in inclination, and

±0.02 to ±0.1 percent in total intensity depending on the frequency of standardization. A circuit diagram is given.—*M. C. R.*

MAGNETIC PROPERTIES

167–193. Fröhlich, F[riedrich]. Zur Verfahrenstechnik von Untersuchungen des Eruptivgesteinsmagnetismus [On the techniques of investigations of the magnetization of igneous rocks]: Gerlands Beitr. Geophysik, Band 65, Heft 1, p. 64–69, 1955.

An accurate magnetic balance is described and its specifications given. One arm contains the sample of volume 5 cu mm or less, heating coils, and thermocouples. An electromagnet producing maximum fields of 7,500 oersteds acts on the sample. Cooling of the sample is achieved through the evaporation of liquid air. The apparatus should prove useful in the analysis of inverse magnetization of volcanic rocks. After the Curie point of magnetite is passed, a magnetization parallel to the earth's field is produced. Subsequent oxidation in the cooling rock allows TiO_2 to combine with FeO in the magnetite, with the production of γ–Fe_2O_3. The apparatus should be useful in evaluating the influence of γ–Fe_2O_3 in producing inverse magnetization. Formulas for determining the relative amounts of different magnetic constituents from measurements on a sample and a qualitative graph of the expected influence of TiO_2FeO and γ–Fe_2O_3 on the magnetization of magnetite are presented.—*P. E. B.*

167–194. Selzer, E. Détermination expérimentale du champ d'un cylindre d'alliage perméable, supposé placé dans un champ magnétique uniforme, parallèlement à son axe de révolution [Experimental determination of the field of a permeable alloy cylinder, in a uniform magnetic field parallel to its axis of revolution]: Annales Géophysique, tome 12, no. 2, p. 144–146, 1956.

The tangents to field lines were determined for a cylinder of molybdenum mu-metal 1 m long with the aid of a small compass. The background field was removed by duplicate measurements with the cylinder at a distance. A map of field lines is presented.—*P. E. B.*

167–195. Clegg, J. A. Rock magnetism: Nature, v. 178, no. 4542, p. 1085–1087, 1956.

A report of a meeting of Section A of the British Association on September 4, 1956. P. M. S. Blackett presented a brief account of the history and present state of the subject; A. E. M. Nairn gave an account of the work carried out by members of the group working under S. K. Runcorn; and Clegg described paleomagnetic research at the Imperial College of Science and Technology.—*M. C. R.*

167–196. Hospers, J. Reversals of the main geomagnetic field: K. Nederland. Akad. Wetensch. Proc., v. 56, no. 5, p. 467–491, 1953; v. 57, no. 1, p. 112–121, 1954.

Studies of the remanent magnetization of lava flows in Iceland indicate that since Miocene time the magnetic pole has centered on the geographic pole. Reverse magnetizations in both igneous and sedimentary rocks are also found. Mechanisms involving chemical action, proposed by Néel, cannot be reconciled with the field evidence. Laboratory experiments are believed to cast doubt on the remaining two mechanisms proposed by Néel. Reversal of the main geomagnetic

field is suggested. Four periods of reversal are observed. The theory of polar wandering is incompatible with the magnetic evidence.—*M. C. R.*

167–197. Runcorn, S. K. Paleomagnetism, polar wandering and continental drift: Geologie en Mijnbouw, jaarg. 18, no. 8, p. 253–256, 1956.

Study of the paleomagnetic directions of the geologic column in various parts of the world indicates that there has been little continental displacement around the North Atlantic since late Precambrian times, but it seems probable that in the southern hemisphere displacement may have been very extensive, of the order of 6,000 miles since the end of the Paleozoic era.—*D. B. V.*

167–198. Öpik, E. [J.] Paleomagnetism, polar wandering and continental drift: Irish Astron. Jour., v. 3, no. 7, p. 234–236, 1955.

The most important conclusion that can be drawn at present from recent paleomagnetic determinations is that since Precambrian times Europe and North America cannot have drifted any appreciable distance with respect to one another. There is still the possibility of polar wandering, or a displacement of the axis of rotation with respect to the solid crust, while the position of the axis in space and the relative position of the continents remain unaltered. The magnetic pole does not necessarily coincide with the pole of rotation and paleomagnetic data cannot be used to check the position of the latter. If terrestrial magnetism is controlled by the pattern of convection currents in the earth's liquid core, as is now widely believed, the type of currents and magnetic elements would be determined by the distribution of radioactive sources in the mantle, distribution of land and sea, and other factors regulating heat flow to the surface; rotation would influence but not control geomagnetism. The hypothesis of close coincidence of mean magnetic and rotational axes is therefore not well founded, in the light of present knowledge of the earth's magnetic field.—*D. B. V.*

167–199. Runcorn, S. K[eith]. Applications of remanent magnetization of rocks: Geophys. Prosp., v. 4, no. 3, p. 221–225, 1956.

If one assumes that the remanent magnetization of sediments is stable and represents the direction of the earth's magnetic field at the time of their formation, one can study the movement of the earth's magnetic pole throughout geologic time. If this slow steady change of the pole and its rapid reversals can be considered established, the magnetism of sedimentary rocks can be used to study the rate of deposition of sediments, the relative movement of continents, and the thermal history of rocks; and to establish a means of correlating lava flows or other igneous intrusions.—*J. R. B.*

167–200. Rao, V. Bhaskara. Magnetic properties of magnetite: Geophysics, v. 21, no. 4, p. 1100–1110, 1956.

Laboratory studies of a sample of crushed magnetite mixed with plaster of paris from the Gudur area (South India) show that: the coercivity increases linearly with decrease in percentage by weight of magnetite and with decrease in grain size of magnetite; remanence increases with increasing percentage of magnetite and decreasing grain size; the field at which maximum susceptibility occurs increases with decrease in grain size; the ratio of the maximum susceptibility to that at zero field is nearly constant with varying grain size; susceptibility increases rapidly with increasing magnetite content; the suscepti-

bility increases with decreasing field and decreasing percent of voids, and the variation of susceptibility shows an increase with decrease in magnetic fields. The susceptibility of magnetite is considerably reduced by crushing the material.—*J. R. B.*

167–201. Manley, Horace. The effects of weathering and alteration on the magnetic properties of a doleritic basalt: Geofisica Pura e Appl., v. 33, p. 86–90, 1956.

Samples of dolerite from the Blundefield quarry in northern England were found to contain at least three magnetic components. In the initial stage of weathering nearly 30 percent of the magnetic component vanishes, presumably by chemical change, and as much as 60 percent of the remaining component readily decomposes on heating.—*M. C. R.*

167–202. Nagata, T[akesi], and Ozima, M. Anomalous increase in thermoremanent magnetization of ferromagnetic minerals.—Magnetic interaction between different constituents in ferromagnetic minerals: Jour. Geomagnetism and Geoelectricity, v. 7, no. 4, p. 105–120, 1955.

The thermoremanent magnetization of magnetite sand from Nii-sima decreases with increasing temperature but increases abruptly near the Curie point. Experimental heating and quenching indicate there are two magnetically different constituents with different Curie points. Heat treatment changes the degree of intergrowth of a constituent into others in a mineral grain and also the magnetic interaction between these magnetic constituents. Chemical, microscopic, and X-ray analyses combined with the magnetic measurements of titanomagnetite grains separated from the sand indicate that the two components have Curie points of 470° and 540°C and are of the spinel type with lattice parameters of 8.404 and 8.395 Å. The constituent with the higher Curie point can be produced by oxidation and developed as lamellae in the matrix of the constituent with lower Curie point.—*M. C. R.*

167–203. Roquet, J[uliette]. Sur les propriétés magnétiques des roches volcaniques riches en pyrite [On the magnetic properties of volcanic rocks rich in pyrite]: Annales Géophysique, tome 12, no. 2, p. 147–150, 1956.

Cylinders of kaolin containing disseminated pulverized pyrite were heated to 600°C for varying periods of time, in vacuum or in an atmosphere of nitrogen, and then allowed to cool in a field of 0.192 oersted. After short periods of heating in vacuum large thermoremanent magnetizations were observed. These were of the same magnitude as those produced previously in similar samples of magnetite and kaolin and were due to the alteration of the pyrite to pyrrhotite. Prolonged heating at 600°C was accompanied by the alteration of pyrrhotite to iron monosulfide, of negligible magnetization.—*P. E. B.*

167–204. Lundbak, Asger. Combined analysis of gravimetric and magnetic anomalies and some palaeomagentic results: Geophys. Prosp., v. 4, no. 3, p. 226–235, 1956.

The gravimetric and magnetic anomalies at the surface of the ground in Denmark and Northern Holland are supposed to originate from the same deep-seated bodies. From a combined analysis of these anomalies it is concluded that the intensity of magnetization in these bodies is of the order of magnitude 10^{-2} cgs units.

On the tentative assumption that the direction of remanent magnetization in these deep rocks is uniform, this direction is such that it corresponds to an attracting magnetic pole (the southpole) near that part of the Antarctic coast which lies south of South America. Similarly the other pole (the northpole) may be situated somewhere in the neighbourhood of the central part of the Arctic Siberian coast. At the present time, the first of these poles is situated northwest of Greenland, and the other is situated south of Australia.—*Author's conclusion*

167–205. Roche, Alexandre. Sur la date de la dernière inversion du champ magnétique terrestre [On the date of the last inversion of the terrestrial magnetic field]: Acad. Sci. Paris Comptes Rendus, tome 243, no. 11, p. 812–814, 1956.

Study of the remanent magnetism in a series of 18 French plateau basalts (all but one from the Velay flows, Auvergne) shows that the geomagnetic field from the time of the first eruption of the Velay volcanoes, in the Villafranchian, was opposite to the present earth's field. This inverse orientation continued through the early Pleistocene (Saint Prestian and Cromerian), changed during the lower Pleistocene (sometime before the emission of the slope basalts and the last glaciation) to the direction that persists today. It is suggested that this change in direction of magnetization be used as a horizon marker in dating Quaternary volcanic rocks; care must be exercised to make certain that the original thermoremanent magnetization is actually being measured.—*D. B. V.*

167–206. Nairn, A. E. M. Relevance of palaeomagnetic studies of Jurassic rocks to continental drift: Nature, v. 178, no. 4539, p. 935–936, 1956.

Paleomagnetic data for rocks of Jurassic age in Yorkshire indicate that Britain in Jurassic time must have had approximately the same position relative to the pole as at present; Runcorn's data for Arizona indicate that the movement of America is not significant, but data on the Rhodesian lavas indicate a movement of about 2,000 miles and Irving's results on dolerite sills in Tasmania indicate a movement of about 2,800 miles. If the axial dipole field coincides with the axis of rotation, continental drift must be accepted.—*M. C. R.*

167–207. Krinari, A. I., and Salikhov, A. G. Plotnost'i magnitnaya vospriimchivost' porod paleozoya vostochnoy chasti Tatarii i ikh vliyaniye na gravitatsionnyye i magnitnyye anomalii [Density and magnetic susceptibility of Paleozoic rocks of the eastern part of the Tatar SSR and their effect on gravity and magnetic anomalies]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 8, p. 940–947, 1956.

The density and magnetic susceptibility of about 4,000 specimens of Paleozoic strata from different drill holes in the eastern part of the Tatar SSR were determined, the density by hydrostatic weighing of the specimens covered with a paraffin film, and the magnetic susceptibility with a Dolginov astatic magnetometer. The densities of the specimens varied with composition, geologic age, depth, and the degree of metamorphism and ranged from 2.19 g per cm^3 in sandstones to 2.86 g per cm^3 in anhydrites. The magnetic susceptibility ranged from 1×10^{-6} cgs in gypsum to 3×10^{-6} in dolomites and 7×10^{-6} in siltstones. These data indicate that the magnetic anomalies of as much as 4,000 to $5{,}000\times10^{-6}$ cgs observed in this area can be explained by the presence of magnetic rocks in the crystalline basement.—*S. T. V.*

167–208. Flawn, Peter T. Basement rocks of Texas and southeast New Mexico: Texas Univ. Bur. Econ. Geology, Pub. no. 5605, 261 p., 1956.

A description of the geology of the Precambrian basement rock of Texas and southeast New Mexico as determined by a study of well cores and cuttings furnished by oil companies operating in the area. Besides discussions on each of the main lithologic units, a chapter on the analysis of gravity data is included. Major lithologic-structural divisions of the basement in general agree well with regional gravity trends. The margin of the Texas craton and the Van Horn and Red River mobile belts are well expressed whereas rootless stratiform terranes are not separately reflected.

Magnetic susceptibility measurements on 96 samples of Precambrian rock from deep wells in west Texas and southeast New Mexico are tabulated in an appendix. Susceptibilities of major rock types, such as granite and gabbro, show an extremely wide range (gabbro: 220×10^{-6} cgs to $6{,}900\times10^{-6}$ cgs) with considerable overlap of maximum and minimum values, suggesting that an "average susceptibility" for a particular rock type means little and that susceptibility of a particular rock mass cannot be determined by random sampling of wells.—*B. T. E.*

167–209. Campbell, C. D., and Runcorn, S. K[eith]. Magnetization of the Columbia River basalts in Washington and northern Oregon: Jour. Geophys. Research, v. 61, no. 3, p. 449–458, 1956.

The remanent magnetization of late-Tertiary lavas in seven sections of Columbia River basalts has been examined. Approximately equal numbers of normally and reversely magnetized lava flows have been found. At least three field reversals during their eruption are indicated, if the reversed magnetization is interpreted as the result of a reversed geomagnetic field at the time of cooling of the lavas.—*Authors' abstract*

MAGNETIC SURVEYS

167–210. Smellie, D. W. Elementary approximations in aeromagnetic interpretations: Geophysics, v. 21, no. 4, p. 1021–1040, 1956.

Total magnetic intensity anomaly expressions are derived for four simple sources: the point pole, line of poles, point dipole, and line of dipoles. Type curves are presented for the point pole and dipole. For all cases, factors are calculated which may be multiplied into the half-maximum distances on the anomaly profiles to yield depth estimates . These methods serve as a first approximation in the interpretation of aeromagnetic data, but their limitations must be kept in mind. Two examples of the application of the methods are given.—*Author's abstract*

167–211. Fanselau, Gerhard. Über die Reduktion von Messungen mit den magnetischen Feldwaagen, speziell der kombinierten Fadenwaage [On the reduction of measurements with the magnetic-field balances, especially the combined-suspension balance]: Freiberger Forschungshefte, C22 Geophysik, p. 5–19, 1956.

A detailed review of the various corrections, such as the adjustment of the horizontal balance for the effect of Z, and temperature compensation, that must be considered for greatest precision in magnetic field balance measurements. Although elementary, these factors are frequently neglected in evaluating magnetic

surveys. These corrections are especially important for the precise combined-suspension balance.—*D. B. V.*

167–212. Castet, Jean, Dubief, Jean, and Lagrula, Jean. Sur une zone d'importantes anomalies gravimétriques et magnétiques au Nord du Tanezrouft [On a zone of large gravity and magnetic anomalies in the northern Tanezrouft]: Acad. Sci. Paris Comptes Rendus, tome 243, no. 16, p. 1137–1139, 1956.

The gravity surveys which revealed large negative anomalies between Adrar and Reggane in the Tanezrouft desert, Algeria (see Geophys. Abs. 154–14618 and 163–14) have been supplemented by more detailed gravity measurements and a magnetic survey. The gravity anomalies show very strong gradients and correlate strikingly with the magnetic anomalies, gravity minimums (as much as —60 mgal) corresponding to magnetic maximums (more than 200 gammas) and vice versa. The depth of the structure thus reflected is not calculated, but the enormous thickness of the "intercalary continent" which is suggested merits further prospecting.—*D. B. V.*

167–213. Rao, V. Bhaskara, and Narain, H. Regional magnetic survey of the South Sydney Basin: Royal Soc. New South Wales Jour. and Proc., v. 89, pt. 4, p. 194–211, 1956.

Seven hundred thirty magnetic stations were established in a regional survey of 1,500 square miles in the southern part of the Sydney basin. The magnetic results indicated the broad outline of the basin, and indicated areas of interest where detailed work may be undertaken. Correlation between magnetic and gravity profiles on four geological sections has shown that the degree to which the lithological and structural changes are reflected depends on variations of magnetic susceptibility and density. General conclusions were obtained from the application of laboratory susceptibility determinations to explain magnetic anomalies in the field.—*V. S. N.*

167–214 Bürgl, Hans, and Kunz, Bruno. Magnetische Messungen im Wiener Becken [Magnetic measurements in the Vienna basin]: Geol. Jahrb., Band 70, p. 7–41, 1954 [1955].

A map of the vertical magnetic anomalies of the Vienna basin and its environs has been compiled, chiefly from surveys made from 1934 to 1941 by the Eurogasco company and its successor, the Gewerkschaft Austrogasco, and partly from surveys by the former Amt für Bodenforschung of Bohemia and Moravia. The first part of this paper, by Bürgl, is concerned with the geologic interpretation of Austrogasco's work. Maximum magnetic intensities are found over the inner phyllites (almost 1,400 gammas) and locally over crystalline limestones (almost 3,000 gammas) of the Thaya dome. The magnetic anomalies reflect composition and in some places structure: in the Trnava basin, for instance, basement ridges are correlated with magnetic minimums and depressions with magnetic maximums. Gravity anomalies reflect lithology in the basement rather than structure.

The second (geophysical) part of the paper, by Kunz, describes the field procedures and reduction of measurements to the same normal field. (The latter could not be done for the Bohemia-Moravia surveys because the field data and base maps were not available, hence the results in the marginal areas of the map are only relative.) Magnetic profiles made by the Montanistische Hochschule Leoben of Salzburg in 1933 (see Geophys. Abs. 76–2630, 84–3098, and 87–3486) agree in general with the new map.—*D. B. V.*

167–215. Custódio de Morais, J. Algunas observações do magnetismo terrestre nos Açores [Some observations of terrestrial magnetism in the Azores]: Coimbra Univ. Mus. Mineralog. Geol. Mem. e Noticias, no. 37, p. 1–19, 1954.

Measurements of vertical magnetic intensity were made at 73 stations on San Miguel and 32 in the other islands of the Azores except Santa Maria. Anomalies are particularly irregular on San Miguel and Terceira Islands, where magnetite-rich basalts cut and are cut by trachytes. The normal value of Z is taken as 0.3780 gauss. On San Miguel the highest value obtained was 0.4126 in the extreme west of the island; negative anomalies were noted over the craters of the Caldeira das Sete Cidades and of the Lagõa das Furnas, with a minimum of 0.3578 at the former. A notable west-northwest-trending structural line follows a series of volcanic peaks from west of Lagõa do Fogo to near the Caldeira das Sete Cidades. The highest values in the whole archipelago were found on Flores Island. Sketch maps show positive and negative anomalies for San Miguel and for the whole archipelago.—*D. B. V.*

167–216. Durr, F., and Stober, G. Nota sobre mediciones magnéticas en los ausoles de Ahuachapán [Note on magnetic measurements in the fumaroles of Ahuachapán]: Servicio geol. nac. El Salvador Anales, Bol. no. 2, p. 33, 1956.

A magnetic survey of the Ahuachapán fumaroles and surrounding area to a distance of several kilometers (complementing McBirney's investigations, Geophys. Abs. 167–280) was found useless to trace underground steam deposits because of the small range of variations (75 gammas maximum) and their apparent lack of relation to fumarole activity.—*D. B. V.*

167–217. Małoszewski, Stanisław. Wybitna anomalia magnetyczna w Karpatch w okolicach Jordanowo. [The important magnetic anomaly near Jordanowo in Carpathian Mountains]: Przeglad geol., zeszyt 6, p. 242–247, 1956.

During the recent regional magnetic survey by the Przedsiębiorstvo Poszukiwan' geofizychnych [Polish Bureau of Geophysical Exploration] an important magnetic anomaly was found in the region of Jordanowo; over an area some 25 km long and about 8 km wide there is a positive magnetic anomaly of more than 200 gammas produced by a body elongated in the NNW–SSE direction. Using the method of Andreyev (see Geophys. Abs. 164–248) and that of line poles, the depth of the lower and the upper boundaries of the disturbing body was found and the average magnetic susceptibility determined as 0.0024. The economic value of the source of this anomaly is questionable.—*S. T. V.*

167–218. Rossman, Darwin L., Henderson, John R., Jr., and Walton, Matt S., Jr. A reconnaissance aeromagnetic survey of the southern part of Prince of Wales Island, Alaska: U. S. Geol. Survey Geophys. Inv. Map GP 135, 1956.

An aeromagnetic survey was made of 700 square miles in the southern part of Prince of Wales Island, Alaska, in 1945 in reconnaissance exploration for magnetic iron and associated copper deposits. The survey primarily succeeded in delineating the intrusive igneous rocks of the area along the margins of which contact-metamorphic ore bodies have developed. Strong positive anomalies on a total intensity magnetic contour map suggest places for further geological or

geophysical investigation. The two most attractive areas for exploration are thought to be north of the head of Hetta Inlet and north of Cholmondeley Sound.—*Authors' abstract*

167–219. Canada Geological Survey. Aeromagnetic maps of the Province of Alberta: Dept. Mines and Tech. Surveys, Geophysics Papers 243–248, 308–315, 322, 325–331, 334–337, 339–350, 352–358, 461, 497, 498, 1956.

Advance editions of blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles west of fourth meridian: 243, Calling River; 244, Breynat; 245, Philomena; 246, Corrigal Lake; 247, Ranch; 248, Logan Lake; 308, Goodwin Lake; 309, Wiau Lake; 310, Winefred Lake; 311, Grist Lake; 312, Fawcett Lake; 313, Calling River; 314, McMillan Lake; 315, Wandering River, 322, Howard Creek; 325, Winefred River, 326, Christina Lake; 327, Conklin; 328, Thornbury Lake; 329, Medusa Lake; 330, Parallel Creek; 331, Pelican Mountain; 334, January River; 335, Waddell Creek; 336, Bohn Lake; 337, Cowpar Lake; 339, Wabasca; 340, Pelican Lake; 341, Pelican Portage; 342, Dropoff Creek; 343, Watchusk Lake; 344, Quigley; 345, Christina River; 346, House River; 347, Serpentine Creek; 348, Boivin Creek; 349, Sittingman Lake; 350, Muskwa River; 352, Horse River; 353, Gregoire Lake; 354, Kinosis; 355, Teppe Creek; 356, Wood Buffalo River; 357, Livock River; 358, Algar Lake; 461, Gipsy Lake; 497, Victor Creek; and 498, Caribou Lake.—*B. T. E.*

167–220. Canada Geological Survey. Aeromagnetic maps of Newfoundland: Dept Mines and Tech. Surveys, Geophysics Papers 268, 274, 276, 1955; 249–251, 269–273, 275, 316–318, 1956.

Blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles: 249, Howley Lake; 250, Puddle Pond; 251, Main Gut; 268, Stephenville; 269, Harrys River; 270, Star Lake; 271, Little Grand Lake; 272, Corner Brook; 273, Rainy Lake; 274, Mainland; 275, Serpentine; 276, Shag Island; 316, St. Fintans; 317, Little Friars Cove; and 318, Flat Bay.—*B. T. E.*

167–221. Canada Geological Survey. Aeromagnetic maps of Northwest Territories: Dept. Mines and Tech Surveys, Geophysics Papers 105–108, 359–364, 366, 369–373, 375–401, 404–406, 1956.

Blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles in the District of Mackenzie: 105, Pointe Ennuyeuse; 106, Landry Creek; 107, Desklanata Lake South; and 108, Brule Point. Advance editions: 359, Deering Island; 360, Striding River; 361, Meyrick Lake; 362, Dehoux Bay; 363, Suggitt Lake; 364, Lone Lake; 366, Sherwood Lake; 369, Dolby Lake; 370, Arnot Lake; 371, Nicol Lake; 372, Nixon Lake; 373, Edwards Lake; 375, Bouskill Lake; 376, Turner Lake; 377, Thomas Lake; 378, Wignes Lake; 379, Burslem Lake; 380, Eaton Lake; 381, Bertran Lake; 382, Flett Lake; 383, Innes Island; 384, Wright Lake; 385, Southby Lake; 386, Ruttledge Lake; 387, Atkinson Lake; 388, Mountain Lake; 389, Cochrane Lake; 390, Anaunethad Lake; 391, Millar Lake; 392, Veira Lake; 393, Andrecyk Lake; 394, Gozdz Lake; 395, Vermette Lake; 396, Bull Lake; 397, Sanderson Lake; 398, Crowe Lake; 399, Broad Lake; 400, Jarvis Lake; 401, Knowles Lake; 404, Sammon Lake; 405, Sinclair Lake; and 406, Foster Lake.—*B. T. E.*

167–222. Canada Geological Survey. Aeromagnetic maps of the Province of Ontario: Dept. Mines and Tech. Surveys, Geophysics Papers 277, 278, 282, 283, 288–303, 1956.

Advance editions of blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles: 277, Obabika Lake (Nipissing, Sudbury, and Timiskaming Districts); 278, Solace Lake (Sudbury District); 282, Lady Evelyn Lake (Timiskaming and Sudbury Districts); 283, Elk Lake (Timiskaming District); 288, Charlton (Timiskaming District); 289, Kirkland Lakes (Timiskaming District); 290, Radisson Lake (Timiskaming District); 291, Muskasenda Lake (Timiskaming and Sudbury Districts); 292, Dana Lake (Cochrane, Timiskaming and Sudbury Districts); 293, Timmins (Timiskaming and Cochrane Districts); 294, Lipsett Lake (Cochrane and Timiskaming Districts); 295, Ramore (Cochrane and Timiskaming Districts); and in Cochrane District: 296, Matheson; 297, Porquis Junction; 298, Pamour; 299, Kamiskotia Lake; 300, Thorburn Creek; 301, Crawfish Lakes; 302, Iroquois Falls; and 303, Bingle.—*B. T. E.*

167–223. Canada Geological Survey. Aeromagnetic maps of the Province of Saskatchewan: Dept. Mines and Tech. Surveys, Geophysics Papers 423–426, 430–436, 1956.

Advance editions of blue-line aeromagnetic maps which show by contour lines the total magnetic intensity at about 1,000 feet above ground level have been published for the following quadrangles: 423, Cautaru Bay; 424, William Point; 425, Beartooth Island; 426, Easter Head; 430, Crackingstone; 431, Maurice Bay; 432, Forget Lake; 433, Uranium City; 434, Thluicho Lake; 435, Harper Lake; and 436, Goldfields.—*B. T. E.*

167–224. Gerard, V. B., and Lawrie, J. A. Aeromagnetic surveys in New Zealand, 1949–52: New Zealand Dept. Sci. Indus. Research, Geophys. Mem. 3, 20 p., 6 maps and profiles, 1955.

Aeromagnetic surveys have been made with a modified AN/ASQ–1 magnetometer installed in a Miles Aerovan plane. Results of surveys in the North Island thermal area are shown in maps and profiles. A well-defined belt of positive anomalies from Nelson across Cook Strait through Taranaki and along the west coast of Auckland Province is believed to indicate a belt of igneous rock and may be related also to a major upper Paleozoic-lower Mesozoic geosyncline. There seems to be a tendency for the oceanic areas to be negative; if real, this may mean that New Zealand as a whole has a positive anomaly relative to the main geomagnetic field of the southwest Pacific.—*M. C. R.*

MICROSEISMS

167–225. Shurbet, D. H., and Ewing, Maurice. Microseisms with periods of seven to ten seconds recorded at Bermuda: Am. Geophys, Union Trans., v. 37, no. 5, p. 619–627, 1956.

Bermuda seismograms from September 1951 through December 1954 included 34 periods when microseisms of 7–10-sec periods were recorded. With one exception these were related to a low-pressure area or cold front in the near vicinity of the continental shelf along eastern America, and in the exception the low-pressure area was in the vicinity of the Mid-Atlantic Ridge. Comparison

with the Palisades records indicates that the mechanism of transmission of the 7–10-sec microseisms is probably the same as that of short-period surface waves from earthquakes, and that the microseisms are propagated very well along purely continental or purely oceanic paths but the continental margin acts as a barrier to them as it does to short-period earthquakes waves.—*M. C. R.*

167–226. Darbyshire, J. Refraction of microseisms at island stations: Royal Astron. Soc. Monthly Notices. Geophys. supp., v. 7, no. 3, p. 147–152, 1955.

If microseisms are surface waves between the ocean and the sea bed of the type first described by Stoneley, their velocity will be the greater the more shallow the water, and energy will tend to be refracted away from islands and usually reduced. Refraction diagrams for 6-sec microseisms for the island of Bermuda show the effect on the energy of incident waves is marked, particularly for waves approaching from the northeast and southwest quadrants. Anomalies in the recording of microseisms at Bermuda, such as those reported by Carder (Geophys. Abs. 163–118), can be explained in terms of this refraction.—*M. C. R.*

167–227. Bernard, Pierre. L'agitation microséismique en Normandie [Microseismic activity in Normandy]: Annales Géophysique, tome 12, no. 2, p. 151–156, 1956.

Microseisms have been recorded at Evreux in 1949 and at Coutainville (Manche) in 1953. The measurements at Evreux show that periods of relative microseismic inactivity correlate with periods of relative inactivity in the Moroccan swell. The $N:E$ ratio is approximately unity in the Norman stations, but $N>E$ in Paris and Uccle, and $N<E$ in Kew and De Bilt.—*P. E. B.*

167–228. Ikegami, Ryōhei. Relation between the periods of microseisms and the situation of typhoon: Tokyo Univ. Earthquake Research Inst. Bull., v. 33, pt. 4, p. 681–687, 1955.

Periodograms of microseisms for September 11–15, 1950, when typhoon Kezia passed over Japan, fall into two groups: one (September 11–12) showing a sharp peak with a correlation ratio >0.5, and the other (September 13–15) without a sharp peak. The former are considered to have been directly related to the typhoon, but did not always approach the station from the center of the storm. The individual waves of the very irregular microseisms of the latter group may be of different origin. Microseismic period spectra constructed according to Tomoda's correlation method give similar results.—*D. B. V.*

RADIOACTIVITY

167–229. Wetherill, G[eorge] W., Wasserburg, G. J., Aldrich, L. T., Tilton, G[eorge] R., and Hayden, R. J. Decay constants of K^{40} as determined by the radiogenic argon content of potassium minerals: Phys. Rev., v. 103, no. 4, p. 987–989, 1956.

It is shown that the potassium-argon age of young minerals depends almost linearly on the decay constant for electron capture in K^{40} and is very insensitive to the decay constant for beta emission. This fact permits calculation of λ_e by comparing the concordant uranium-lead age of cogenetic uraninite with A^{40}/K^{40} ratios found in young samples of mica. It is found that $\lambda_e=(0.557\pm0.26)\times 10^{-10}$ yr^{-1}. Similar comparisons with older mica samples indicate that satis-

factory agreement with the uraninite ages are obtained by use of this value of λ_e together with $\lambda\beta = (0.472 \pm 0.05) \times 10^{-9}$ yr^{-1}. It is concluded that there is no conflict between the decay constants inferred by this geological method and those found by direct counting experiments.—*Authors' abstract*

167–230. Diamond, Herbert, and Barnes, Raymond F. Alpha half-life of Pu^{244}: Phys. Rev., v. 101, no. 3, p. 1064–1066, 1956.

The half-life of Pu^{244} was found to be $(7.6 \pm 2) \times 10^7$ years by measuring the activity of its Np^{240} decay product. If the elements were formed 5.5×10^9 years ago, and the amount of Pu^{244} formed were comparable to half the amount of Th^{232} in the earth today, the current Th^{232}: Pu^{244} ratio in thorium ores might be estimated as 10^{22}. If the half-life of Pu^{244} were 9.6×10^7 years then ore containing 34 kg of thorium might contain a detectable (10^{-13} g) amount of Pu^{244}. The ratio of heat emission shows that Pu^{244} and its U^{236} descendant may have been important in the heat balance of the earth during its early history.—*M. C. R.*

167–231. Aldrich, L. T., Wetherill, G[eorge] W., Tilton, G[eorge] R., and Davis, G. L. Half-life of Rb^{87}: Phys. Rev., v. 103, no. 4, p. 1045–1047, 1956.

A comparison of the ratio, radiogenic Sr^{87}/Rb^{87}, found in eight Rb minerals of differing Rb content from the same rock unit has shown this ratio to be constant for a given mineral assemblage. This ratio has been measured on Rb minerals from six rock units for which concordant U-Pb ages ranging from 375 to 2,7000 million years have also been obtained. From the ratio radiogenic SR^{87}/Rb^{87} and the age of the mineral obtained from the U-Pb age, the half-life of Rb^{87} is calculated to be $(5.0 \pm 0.2) \times 10^{10}$ yr. This lies in the range of values found by direct counting experiments.—*Authors' abstract*

167–232. Reiter, Reinhold. Registrierung des Potential gradienten, Messungen de polaren elektrischen Leitfähigkeit der Luft sowie der relativen Luftradioaktivität und Bestimmung des NO_2'—Gehaltes von Niederschlägen und Nebeln auf dem Zugspitzplatt (2580 m NN) im Sommer 1955 [Recording of potential gradients, measurements of the polar electrical conductivity of the air as well as the relative radioactivity of the air and determination of the NO_2' content of precipitation and clouds on the Zugspitzplatt (2,580 m above sea level) in the summer of 1955]: Geofisica Pura e Appl., v. 33, p. 187–222, 1956.

The results of atmospheric radioactivity measurements, published separately elsewhere (see Geophys. Abs. 164–267, 165–303), are included in this detailed report on meteorological studies on the Zugspitzplatt in the Bavarian Alps.—*D. B. V.*

167–233. Sievert, Rolf M. Records of gamma radiation from the ground and beta radiation from radioactive debris in Sweden, 1950–55. Part I: Tellus, v. 8, no. 2, p. 117–126, 1956.

The γ radiation of the ground from natural and artificial radioactivity, and the β radiation from radioactive debris in the atmosphere, have been recorded in Sweden since 1950. Observations are reported on the influence of rain and snowfall, with and without the effects caused by transportation of radioactive debris from nuclear explosions.—*P. E. B.*

167–234. Deutsch, S[arah], Houtermans, F. G., and Picciotto, E. E. Étude de la radioactivité de météorites métalliques par la méthode photographique [Study of the radioactivity of metallic meteorites by the photographic method]: Geochim. et Cosmochim. Acta, v. 10, no. 3, p. 166–184, 1956.

Study of the alpha-radioactivity of two samples of metallic meteorites—Toluca (Hamburg) and Carbo—by means of nuclear emulsions shows that in spite of all precautions more than 85 percent of the alpha rays emitted can be attributed to contamination of the surface of the specimen by polonium (corresponding to 100 atoms of Po per cm^2). The maximum U and Th concentrations for each sample, calculated solely on the basis of alpha tracks having a residual track in the emulsion less than 15 microns (α track from Th^{232}), are found to be $U<0.6\times 10^{-8}$ g per g (Th=0) and $Th<2\times 10^{-8}$ g per g (U=0). These values are very close to those found by Paneth (Geophys. Abs. 163–151, 164–18) for the same meteorites. A maximum uranium concentration of 10^{-7} g per g was also determined for the Toluca troilite. At present, the technique is limited to detection of U and Th concentrations on the order of 5×10^{-8} g per g; it is hoped that it can be refined to reduce the background factor, 90 percent of which is due to radon in air, by a factor of 10 to permit detection of concentrations of 5×10^{-9} g per g.—*D. B. V.*

167–235. Wendt, Immo. Kalibestimmung im Labor und unter Tage mit dem Zählrohr [Potash determination in the laboratory and underground with the counter]: Geol. Jahrb., Band 70, p. 385–404, 1954 [1955].

Laboratory measurements of the β-radioactivity of potash minerals indicate that the β-ray count, which is proportional to K_2O content, varies with grain size and with density of powdered samples. A new, rapid radioactivity method for determining the K_2O content in boreholes in potash mining practice has been developed to replace chemical analysis of chip samples or well cuttings. The open side of an arrangement of three aluminum β-ray counters, shielded at the back by a brass plate 1 mm thick, is placed against the surface to be analyzed, and the beta and gamma activity measured. The open side is then closed by a 1-mm brass plate and the measurement repeated on the same place, giving the gamma-ray count alone. The K_2O content (p) can then be calculated from the formula $p=(u-Nv/A$, where u=total count, V=gamma-ray count, and N and A are constants. The results of a series of borehole measurements by this method are compared with chemical analyses of well cuttings; in 75 percent of the cases, the accuracy is within ± 2 percent K_2O.—*D. B. V.*

167–236. Aithal, V. Seetharam. The measurement of alpha activities of Indian rocks and minerals using proportional counter: Jour. Sci. Indus. Research (India), Sec. B, v. 15, no. 4, p. 204–205, 1956.

The results of radioactivity measurements on 50 rocks and minerals from various parts of India are tabulated, giving alpha activity (as number of alphas per mg per hr) and equivalent uranium (in parts per million). Some specimens of magnetite, magnetite apatite, pegmatite, and hornblende contain the equivalent of more than 0.001 percent of uranium. The highest, equivalent uranium 1,733 ppm in a magnetite from Bihar, is attributed to the presence of a higher percentage of thorium (see following abstract). Alpha activities of traprocks from different localities are nearly of the same order.—*D. B. V.*

167–237. Aithal, V. Seetharam. Determination of thorium and uranium concentration ratios in Indian rocks and minerals: Jour. Sci. Indus. Research (India), Sec. B, v. 14, no. 10, p. 519–523, 1955.

Thorium-uranium concentration ratios in 10 Indian rocks and minerals were calculated from scintillation counter measurements, estimating the range of the α-particles emitted by thorium and uranium. The results are tabulated. The highest ratio obtained (Th/U=8.92) was in a magnetite apatite from Bihar, the lowest (Th/U=0.10), in a garnetiferous pegmatite from Andhra.—*D. B. V.*

167–238. Sastry, A. V. R., and Aswathanarayana, U. Distribution of radioactivity in the rocks of South India: Part II—Khondalites of Andhra State: Jour. Sci. Indus. Research (India), Sec. B, v. 15, no. 3, p. 112–117, 1956.

The mean β-radioactivity of 36 representative specimens of khondalites from the Eastern Ghats of Andhra State was determined as 9.32×10^{-6} g eU per g rock, with a standard deviation of 4.74×10^{-6} g eU per g rock. The radioactivity is conditioned by three mutually related factors: mineralogical constitution (radioactivity is proportional to heavy-mineral content), nature of association (radioactivity is higher near pegmatites, charnockites, and interaction rocks, lower near calc-granulites, quartzites and quartz veins), and petrogenetic history (it is suggested that the khondalites may have acquired their significant radioactivity content by absorption of radioactive matter in a colloidal environment syngenetic with sedimentation, rather than during hypometamorphism).—*D. B. V.*

167–239. Szwacka, C. J. Analiza promieniotworczosci granitu z Karkonoszy [Analysis of the radioactivity of granite from Karkonosze Mountains]: Archiwum Mineralog., tom 19, zeszyt 1, p. 9–16, 1955 [1956].

The radioactivity of a specimen of granite from the Karkonosze mountains [Riesengebirge] in Lower Silesia was studied in the Institute of Experimental Physics of the University of Warsaw by the nuclear emulsion method. Exposures as long as 781 hours were used. Uranium content was found to range from 0.56×10^{-5} to 0.75×10^{-5} g per g, and thorium content from 1.22×10^{-5} to 1.49×10^{-5} g per g.—*S. T. V.*

167–240. Pienkowski, S., Rygierowa, D., Szwacka, C. J., Twarowska, B., and Zmysłowska, S. Typy rozmieszczenia substancji promieniotworczych w skalach polskich [Modes of distribution of radioactive substances in Polish rocks]: Archiwum Mineralog., tom 19, zeszyt 1, p. 1–8, 1955 [1956].

The distribution of radioactive substances in seven specimens of Tatra granite, nine from Lower Silesia, and one from Volhynia was investigated in the Institute of Experimental Physics of the University of Warsaw by the nuclear emulsion method. The highest radioactive content was found in granite from Lower Silesia; the radioactive materials are concentrated in small inclusions dispersed in the rock or extended along microscopic fissures.—*S. T. V.*

167–241. Wierzbicka, Zuzanna. Badanie promieniotwórczości γ i β próbek skał [Analysis of γ and β radioactivity of rock specimens]: Acta Geophys. Polonica, v. 3, no. 4, p. 195–207, 1955.

This describes γ- and β-ray measurements made with Geiger-Müller counters in the laboratory of the Institut Naftowy (state petroleum institute) in Cracow

on 80 specimens from drill cores from Polish oilfields. The results are tabulated, giving depth, lithologic description, density where known, proportion of radioactive material per gram of rock, γ-ray count, total $\beta+\gamma$ count, and $\gamma/\beta+\gamma$ ratio for each sample.—*D. B. V.*

167–242. Rivière, André. Sur la radioactivité de sédiments actuel et récents de la côte méditerranéenne. Étude particulière du golfe du Lion. Interprétation sédimentologique. [On the radioactivity of present and recent sediments of the Mediterranean coast. Particular study of the Gulf of Lion. Sedimentologic interpretation]: Soc. géol. France Bull., tome 5, fasc. 7–9, p. 495–506 (with discussion by M. A. Vatan, p. 506–508), 1955 [1956].

Gamma-ray measurements of the radioactivity of post-Pleistocene sediments were made along the shore of the Gulf of Lion on the Mediterranean coast of France, using a portable C. E. R. E. "gammaphone." Comparison of the results with granulometric and mineralogic data indicates that such radioactivity measurements provide a useful tool for field study of the sedimentological evolution of beaches. (See also Geophys. Abs. 164–261.)—*D. B. V.*

167–243. Wendt, Immo. Versuche zur Dichtebestimmung an Sandschüttungen durch Messung der Absorption von Gamma-Strahlung [Attempts at the determination of density of sand deposits by measurement of the absorption of gamma radiation]: Geol. Jahrb., Band 70, p. 1–6, 1954 [1955].

Gamma-ray measurements are the basis of a new method for determining the density of sandy soils in place, more reliable and quicker than sampling. A metal rod is introduced into the ground, the tip of which contains a radioactive preparation of known gamma-ray intensity. As the absorbing material consists essentially of the same elements (Si and O), the absorption coefficient depends only on the density of the material, and the latter can be calculated from the measured intensity, which varies with the square of the distance between the preparation in the rod and the counter. Test measurements have shown the usefulness of the method.—*D. B. V.*

167–244. Balavadze, B. K. Radioaktivnost' nekotorykh termal'nykh istochnikov Tkvarcheli [The radioactivity of some hot springs of Tkvarcheli]: Akad. Nauk Gruzinskoy SSR Soobshcheniya, tom 16, no. 10, p. 781–784, 1955.

The radioactivity of several hot springs of the Tkvarcheli region, Georgian SSR, was measured with a universal electrometer as 20.9 to 39.5 curies per liter.—*S. T. V.*

167–245. Miholić, Stanko. Kemijska analiza termalnog vrela u Fojnici [Chemical analysis of thermal water at Fojnica]: Geol. Vjesnik, sv. 8–9, god 1954–55, p. 225–236, 1956.

The thermal spring at Fojnica, Bosnia, issues from a fault in bituminous Carboniferous shales at the western margin of an extensive terrace of calcareous sinter. Analysis of its water and that of 3 wells in the vicinity shows that the Ca, Mg, and free CO_2 content and temperature decrease with distance from the fault, but radioactivity increases several fold. Evidently the water takes up radon generated from uranium that has been precipitated along with iron in the sinter.—*D. B. V.*

RADIOACTIVITY LOGGING AND SURVEYING

167–246. Glazov, A. N. Ispol'zovaniye radioaktivnykh izotopov v praktike inzhenernykh izyskaniy [The utilization of radioactive isotopes in engineering investigations]: Gidrotekhnika i melioratsiya, no. 9, p. 13–19, 1956.

A discussion of the different radioactive methods of exploration for water or hydrocarbons and for determination of the density, porosity, and water content of soil.—*S. T. V.*

167–247. Shashkin, V. L. Metod opredeleniya natural'nogo fona schetchikov gamma-izlucheniya [Method of determining the natural background of gamma-radiation counters]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 838–839, 1956.

The reading on a gamma-ray counter at a point on the earth's surface is the result of several radiation effects: gamma-radiation of the surrounding rock and the effect of the contamination of different parts of the counter and cosmic radiation. If the reading is repeated with a screen formed of a lead jacket 1.5 to 2 cm thick covering the tube of the counter, the new reading will be the sum of cosmic radiation, counter contamination and the radiation from rock as modified by the effect of the lead jacket. This coefficient can be readily determined experimentally, the cosmic radiation can be determined by measurements in a mine or at a sufficiently protected place, and therefore the counter background can be computed without difficulty.—*S. T. V.*

167–248. Gregory, Alan F. Analysis of radioactive sources in aeroradiometric surveys over oil fields: Am. Assoc. Petroleum Geologists Bull., v. 40, no. 10, p. 2457–2474, 1956.

A re-evaluation of published airborne radioactivity surveys of the Redwater field, Alberta, and the Coalinga field, California, shows that the distinct gamma-ray patterns of these oilfields can be explained by sources of radioactivity at or near the surface of the ground that are unrelated to subsurface accumulations of oil. The surface distribution of radioactive elements can be correlated with areal geology, the distribution of soils, and surface and ground waters. A brief survey of the literature describing radioactivity anomalies over other oilfields supports these conclusions. Any correlation of these anomalies with deeply buried oil pools is believed to be fortuitous.—*L. C. P.*

167–249. Rothé, Jean-Pierre. Présentation d'une carte de la radioactivité des Vosges hercyniennes [Presentation of a radioactivity map of Hercynian Vosges]: Acad. Sci. Paris Comptes Rendus, tome 242, no. 24, p. 2849–2852, 1956.

The map of the radioactivity of the Hercynian Vosges, based on 3,500 uniformly spaced measurements, shows several large distinct petrographic units; by establishing numerous geological correlations, the map disentangles some of the fundamental features of the Hercynian basement. The maximum radioactivity seems to correspond to the paroxysmal phase of the Hercynian orogeny.—*Author's abstract, D. B. V.*

167–250. Morais, Marilia Xvier de, and Correia Neves, J. M. Observações de campo sobre radioactividade na Sierra da Estrela [Field observations of radioactivity in the Sierra da Estrela]: Coimbra Univ. Mus. Mineralog. Geol. Mem. e Noticias, no. 39, p. 60–64, 1955.

The average radioactivity measured with two Geiger counters at several places high in the Sierra da Estrela, Portugal, was 0.05 milliroentgens per hour. High values (maximum 0.5 milliroentgens per hour) at the Nave de St. Antonio fountain probably indicate a local source of radioactivity; it is hoped that systematic prospecting will soon be undertaken.—*D. B. V.*

167–251. Vickers, R. C. Airborne and ground reconnaissance of part of the syenite complex near Wausau, Wisconsin: U. S. Geol. Survey Bull. 1042–B, p. 25–44, 1956.

Carborne counter surveys, using Geiger counters, and scintillation counter surveys of interroad areas indicated relatively high variations over background. Test flights indicated the anomalies could be detected from the air if flight elevations of 20 or 30 ft were used. As a result of the combined ground and air reconnaissance, 12 radioactive mineral occurrences were found.—*M. C. R.*

SEISMIC EXPLORATION

167–252. Evison, F. F. Seismic waves from a transducer at the surface of stratified ground: Geophysics, v. 21, no. 4, p. 939–959, 1956.

Vibration impulses of variable frequency and duration have been generated by means of an electrically excited vibrator and the resulting seismic waves recorded at the ground surface along a 200-ft traverse. The first arrivals were refractions from the water table and a deeper clay-siltstone interface, and these were checked with the results of a standard refraction survey. The amplitudes of displacement of the refracted waves varied in each case with approximately the inverse square of the distance; the critical distance was marked by a discontinuity of amplitude. Two later impulsive arrivals recorded within 50 msec of the first were interpreted respectively as a transformed reflection from 85-ft depth and an ordinary compressional reflection from 200-ft depth. A dispersive Rayleigh wave gave an independent estimate of the shear velocity and thickness of the surface layer. Air-coupled waves of frequencies 70.8 cycles per second and 330 cycles per second were recorded and have been related to the first- and third-mode Rayleigh waves, respectively.—*Author's abstract*

167–253. Jolly, R. N. Investigation of shear waves: Geophysics, v. 21, no. 4, p. 905–938, 1956.

A series of measurements were made to investigate some of the fundamental properties of shear waves and to explore the possibility of using horizontally polarized (*SH*) shear waves for reflection prospecting. A special source was devised to produce a shearing motion which was detectable as far as 400 feet vertically and 1,000 feet horizontally. Direct, refracted, and reflected *SH* and *SV* (vertically polarized) shear waves were identified on a series of surface and subsurface recordings. A strong, highly dispersive surface wave, which satisfies the theoretical criteria of Love waves, was also observed. Certain anomalous features of the data which did not conform to the predictions of simple isotropic theory were readily explained by considering the stratified section under obser-

vation to be transversely isotropic. It was found that horizontal *SH* velocity exceeded vertical *SH* velocity by 100 percent whereas the corresponding compressional wave velocities differed by only 12 percent. *SV* anisotropy was manifested by a complex variation of velocity at intermediate directions of travel. Other theoretical predictions were confirmed in detail by the experimental data. An evaluation of *SH* reflection recording was made in four different areas. It was possible at one location, using multiple horizontal geophones and the shear source, to obtain an *SH* reflection from the base of a thick weathered layer. However, the results in general indicate that the method is not likely to have much practical importance.—*Author's abstract*

167–254. Matschinski, Matthias. Statistical method in geophysical prospecting: Annali Geofisica, v. 9, no. 2, p. 151–165, 1956.

Statistical methods are applied to the propagation of seismic waves within the earth's crust. Two formulas are discussed, both representing a proportionality between the components of the tension tensor and the velocity vector measured on or near the surface of the ground. One formula represents the classical approach; the other formula, which is, in a sense, statistical, introduces the average value of the components. By using these theoretical results and the measurement on or near the surface, the thickness of the horizontal layers can be determined to a first approximation. The physical properties of the layers can also be evaluated by considering higher-order terms.—*I. Z.*

167–255. Van Nostrand, Robert G. Kontinuierliche Geschwindigkeitsmessung in Bohrung [Continuous-velocity measurement in boreholes]: Erdöl u. Kohle, Jahrg. 9, Heft 9, p. 583–587, 1956.

A summary, by W. Palme, of a lecture on the theory, apparatus, procedure, and application of the continuous-velocity logging method (see Geophys. Abs. 150–13964 and 166–329), presented at the January 1956 meeting of the Hannover section of the Deutsche Gesellschaft für Mineralölwissenschaft und Kohlchemie.—*D. B. V.*

167–256. Baillie, W., and Rozsa, T. The effect of topography on near-surface velocities: Geophysics, v. 21, no. 4, p. 960–968, 1956.

Fictitious seismic anomalies sometimes result from use of inadequate techniques to correct for weathered layer, for surface elevation changes, and unusual velocity gradient. The effect of differential overburden on the velocities in the underlying layers, usually referred to as the load effect, is also generally neglected in routine seismic interpretation. Its importance is demonstrated by an example from a survey in western Canada in which a fairly attractive anomaly is shown to be the result of velocity variations associated with topography. Corrections for load effect require reliable near-surface velocity measurements to supplement conventional surveys.—*M. C. R.*

167–257. Favre, B. Sur la détermination des coefficients d'une loi de vitesse linéaire en fonction de la profondeur en sismique réflexion [On the determination of the coefficients of a linear velocity function as a function of the depth in seismic reflection]: Rev. Inst. Français de Pétrole, v. 11, no. 7/8, p. 863–868, 1956.

To determine the coefficients V_0 and k in the linear velocity function $V=V_0+kz$ (where V is velocity at depth z, V_0 is velocity at datum plane, k in practice is

between 0 and 3) giving the best fit to data from a well velocity survey or a T & T statistical analysis, a unique theoretical curve is constructed, using reduced coordinates, and the experimental curve is matched to it to obtain the best possible fit; logarithmic scales are used in constructing the graphs. V_0 and k are easily found by a relative translation of the theoretical graph with respect to the experimental graph. Unlike the seismic logging method, this method, mathematically speaking, is not rigorous. The reasoning is based on rectilinear wave paths (velocity constant and equal to mean velocity) whereas they are in fact curved. In practice the error is negligible if the dips are slight.—*D. B. V.*

167–258. Grunebaum, Bernard. Relation between reflection time increment, inclination of reflecting layer and integration coverage: Geophysics, v. 21, no. 4, p. 992–1003, 1956.

The principal limitation on the number of traces that can be composited (either for the McCollum Geograph or conventional reflection shooting) is the time displacement of a reflection from one trace to the next which, in turn, is mainly dependent on the dip of a reflecting layer. If y is designated as the time increment as a fraction of one wavelength, it is shown that, for sinusoidal waves, integrations can be performed for all values of y up to 0.6 with signal-to-noise ratio losses of less than 50 percent. Experimental results verify this conclusion.—*L. C. P.*

167–250. Korschunow, A[lex]. On the reliability of harmonic analysis of seismograms: Geophys. Prosp., v. 4, no. 3, p. 303–309, 1956.

A check analysis of a seismogram from a blast of 125 g of explosive at a distance of 200 m, previously analyzed (see Geophys. Abs. 166–124) demonstrated a functional connection between reliability of phase values and magnitude of Fourier coefficients. At best harmonic analysis yields a 6-percent phase scattering and at worst 13 percent.—*M. C. R.*

167–260. Krey, Th[eodor], and Helbig, K. A theorem concerning anisotropy of stratified media and its significance for reflection seismics; Geophys. Prosp., v. 4, no. 3, p. 294–302, 1956.

A medium consisting of layers in which Poisson's ratio is approximately the same can be considered as isotropic for reflections of quasi-longitudinal waves if dips are small. Calculations of steeper dips can be made from curves of the correction for the effect of anisotropy.—*M. C. R.*

167–261. Bohanenko, L. I. Opredeleniye chastotnykh i fazovykh kharakteristik elektrodinamicheskikh seysmopriyemnikov pri pomoshchi dopolnitel'nykh katushek vozbuzhdeniya [Determination of the frequency and phase characteristics of electrodynamic seismometers by means of additional exciting coils]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7, p. 776–793, 1956.

By inserting an additional coil into the moving system of an electrodynamic seismometer and exciting it by an external electromotive force, the principal coil of the instrument is displaced and the phase characteristics and the frequency spectrum can be determined without shaking-table experiments. Results are more accurate and obtained more quickly because only electric quantities are recorded and used in the seismometer equations. The additional coil must be

placed in the homogeneous magnetic field and not too near the main coil of the instrument so that coupling between the two coils is avoided.—*S. T. V.*

167–262. Fedoseyenko, N. Ye. Perenosnaya vysokochastotnaya stantsiya dlya parametricheskikh izmereniy [A portable high-frequency installation for parametric measurements]: Akad. Nauk SSSR Izv. Ser. geofiz., no. 7 p. 794–800, 1956.

A special portable apparatus for recording higher-frequency reflected and refracted waves in seismic prospecting includes an oscillograph, 8 amplifiers, 10 seismographs, storage batteries, cable, and a controlling switchboard. The recording is made with greater speed, and the starting of paper drive is synchronized with the shooting of the charge. Two types of seismographs were used. Electromagnetic seismographs were used for frequencies up to 500 cycles per second and piezoelectric seismographs for higher frequencies.

A detailed description of various elements of the installation is given, including wiring diagrams and the characteristic amplifier curves.—*S. T. V.*

167–263. Hermont, A. J. Design principles for seismic reflection amplifiers: Geophys. Prosp., v. 4, no. 3, p. 279–293, 1956.

A review of the principles of design of seismic reflection amplifiers. Filtering, sensitivity, noise, gain control, and harmonic distortion are included in the treatment.—*M. C. R.*

167–264. Jakosky, J. J[ay]., and Jakosky, John [J.], Jr. Characteristics of explosives for marine seismic exploration; Geophysics, v. 21, no. 4, p. 969–991, 1956.

The history of offshore seismic shooting in California is reviewed with respect to charge type and damage to marine life. Several substitutes for the currently required black powder charges of low efficiency and high cost are examined. Experimental data in the form of pressure vs time oscilloscope recordings are presented. Explosives were developed that can be employed more advantageously than black powder. These explosives will minimize damage to marine life, decrease present hazards of handling, and decrease the cost of explosives. "Multipulse" charges, composed of alternating layers of 40 percent gelatin and an inert substance enclosed in a tube, seemed to be the most satisfactory. Conventional seismic records obtained with black powder (90 lbs) and multipulse charges (10 lbs) are presented to demonstrate the superiority of the latter.—*W. H. D.*

167–265. Ioseliani, M. S. O seymologicheskoy prirode Vnutrennekartalinskoy ravniny [Seismologic nature of the inner Kartalin plain]: Akad. Nauk Gruzinskoy SSR Soobshcheniya, tom 16, no. 7, p. 525–530, 1955.

Recent geophysical surveys of the inner Kartalin plain and its surrounding ridges, whose complicated geologic structure has been a subject of controversy by the Geophysical Institute of the Georgian Academy of Sciences, indicate that two essentially horizontal formations 400 and 2,000 m thick overlie limestones of Cretaceous age. Seismic velocities in the two layers and the limestones are 2,000, 3,150 and 4,700 m per sec, respectively. No epicenters have been located in this flatland, although there have been shocks of intensities 8 and 9 in the

surrounding ridges. Thus the seismological evidence confirms the results of the geophysical exploration.—*S. T. V.*

167–266. Schulze, G. A., and Trappe, H. J. Das Kartieren von Salzflanken mit seismischen Methoden [The mapping of salt dome flanks with seismic methods]: Erdöl u. Kohle, Jahrg. 9, Heft 9, p. 580–583, 1956.

The boundaries of the Rethem salt dome in northern Germany have been determined graphically by seismic methods, using the Gardner method (see Geophys. Abs. 136–10826).—*D. B. V.*

167–267. Martin, Hans. Talsperrengeophysik [Dam geophysics]: Freiberger Forschungshefte, C22, Geophysik, p. 37–44, 1956.

The Rappbode dam site in Germany was investigated in 1942 by means of seismic registration of explosions in a quarry 700 m upstream. Velocities ranged from 1.8 kmps in weathered rock to 4.5 kmps in pure diabase; in the immediate vicinity of the dam velocities at the surface (0–5 m) were from 2.2 to 2.6 kmps, and in the unconsolidated formations below the depth of 5 m, 3 to 3.7 kmps. In 1952, more exact measurements with a 6-trace refraction apparatus indicated the velocity in the unconsolidated layers was from 2.8 to 2.9 kmps, and increased to 3.6 to 5 kmps in layers that had been consolidated by grouting.—*D. B. V.*

167–268. Day, Arthur Alan; Hill, Maurice Neville; Laughton, Anthony Seymour; and Swallow, John Crossley. Seismic prospecting in the Western approaches of the English Channel. With an appendix on the results at two additional seismic stations, by R. D. Adams and A. A. Day: Geol. Soc. London Quart. Jour., v. 112, pt. 1, p. 15–44, 1956.

Seismic refraction measurements at 25 seismic stations in the area of the Western approaches to the English Channel indicate 4 layers correlated respectively with semiconsolidated sediments of Cretaceous-Tertiary age, the New Red system, the Paleozoic system, and a metamorphic basement. The basement forms a long, deep trough; the Paleozoic floor is depressed in a trough of variable depth, bounded on the north by an outcrop of the basement rock that may be the westward extension of the upthrust Lizard-Start metamorphic belt.—*D. B. V.*

STRENGTH AND PLASTICITY

167–269. Windes, S. L. Physical properties of mine rock, Part 1: U. S. Bur. Mines Rept. Inv., no. 4459, 79 p., 1949; Part 2: Rept. Inv. no. 4727, 37 p., 1950; Blair, B. E., Physical properties of mine rock, Part 3: U. S. Bur. Mines Rept. Inv., no. 5130, 67 p., 1955; Part 4: Rept. Inv., no. 5244, 69 p., 1956.

A report on the physical properties and related geologic and petrographic data of rocks from operating mines, quarries, or blasting-research test sites. Data determined from laboratory tests on diamond-drill core are given for the following: apparent specific gravity, apparent porosity, compressive strength, tensile strength, flexural strength (modulus of rupture), impact toughness, abrasive hardness, scleroscope hardness, elastic properties (modulus of elasticity, modulus of rigidity, apparent Poisson's ratio, specific damping capacity, and longitudinal bar velocity). In parts 3 and 4, stress-strain curves are presented where available.—*V. S. N.*

167–270. Lomnitz, C. Creep measurements in igneous rocks: Jour. Geology, v. 64, no. 5, p. 473–79, 1956.

The Benioff torsion apparatus for creep testing of slender cylindrical specimens is described. Continuous creep and creep recovery curves for granodiorite and gabbro at room temperature and atmospheric pressure are given. For constant-torque tests of up to 1 week's duration, the results are closely represented by the equation $\epsilon(t)=\frac{\sigma}{\mu}[1+q\ln(1+at)]$ which was found valid for low stresses up to 0.05 percent of the rigidity modulus. The results are compared with early torsion creep experiments by A. A. Michelson. The strain behavior of rocks at low stresses is discussed.—*Author's abstract*

167–271. Turner, Francis J., Griggs, David T., Clark, R. H., and Dixon, Roberta H. Deformation of Yule marble. Part 7: Development of oriented fabrics of 300° C–500° C: Geol. Soc. America Bull., v. 67, no. 9, p. 1259–1294, 1956.

Petrofabric analyses and detailed studies of the internal structures of specimens of Yule marble deformed at 400° and 500° C and confining pressure of 5,000 atmospheres lead to a general hypothesis of homogeneous deformation in which strain is assumed to be approximately the same in every grain and due to twin gliding on $\{01\bar{1}2\}$=e and translation gliding in the opposite sense on $\{10\bar{1}1\}$=r. Reorienting of grains is the result partly of twinning and partly of external rotation of the grain in the sense opposite to that of internal twin or translation gliding.—*M. C. R.*

167–272. Kats, A. Z. O metodike izemereniya dinamicheskikh deformatsiy v gruntakh i sooruzheniyakh [Methods of measuring dynamic deformations in the ground and in structures]: Akad. Nauk SSSR Geofiz. Inst. Trudy, no. 36(163), p. 48–61, 1956.

Deformation can be measured on the basis of the variation of the distance between two ends of a wire stretched between two poles buried in the ground at some distance from each other. The electrical resistance of the wire is affected by the degree of stretching; this resistance can be measured by a Wheatstone bridge. Variation in length can also be measured by a circular dynamometer inserted at one end of the stretched wire. To use the dynamometer in the measurements of dynamic deformations, the frequency of its natural vibrations should be higher than the frequency of the impulses acting on the wire. Optical magnification is necessary. The length of the wire is critical; if the length of the wire is equal to the length of the seismic wave, no deformation will be measured. From the measurements in the field Kats concludes that in weak formations, such as sediments or sand, both temporary and permanent deformations of 10–15 microns can be observed with a base length of 0.5 m.—*S. T. V.*

SUBMARINE GEOLOGY

167–273. Fairbridge, Rhodes W. Some bathymetric and geotectonic features of the eastern part of the Indian Ocean: Deep-Sea Research, v. 2, no. 3, p. 161–171, 1955.

The crust beneath the eastern Indian Ocean is not all of one character; it is marginally continental in origin with a primary simatic oceanic crust (thalasso-

craton) occupying the main eastern ocean. Both the continental shelf and the deep-sea floor are intimately related to the features of the continent; the shelves and deep-sea basins are broadest and deepest opposite the basins on the mainland, and positive blocks in the Precambrian framework of the mainland are reflected by deep-sea ridges and narrow ridges and shallowness on the continental shelf. The main India-Australian Basin apparently does not possess this basic pattern. Geophysical data are not yet complete and therefore cannot adequately support the above description. The seismicity of the area is low, but long-range determinations of Rayleigh-type waves emanating from earthquakes in the Solomon Islands and the Mid-Indian Ridge may be instructive. Formal names given to sectors of the Western Australian shelf and the deep-sea floor are listed.—*B. T. E.*

167–274. Bruun, Anton Fr., Langer, Ebbe, and Pauly, Hans. Magnetic particles found by raking the deep sea bottom: Deep-Sea Research, v. 2, no. 3, p. 230–246, 1955.

The Danish Deep Sea Expedition, the Galathea Expedition, of 1950–52, using a magnetic rake over an area of 45,000 square meters (mainly in the southeastern oceans), collected more than 300 magnetic particles of remarkable character. Most of the particles were spheres with diameter of less than half a millimeter and were composed of magnetite or a silicate groundmass loaded with magnetite crystallites. Spherical cavities occur in most of them, and the structure and composition of metallic particles found in them seem to require high temperatures and rapid cooling in the process of formation.

Comparison of these particles with similar material from Swedish Deep Sea Expedition and with certain features in the crusts of two Danish stony meteorites seems to favor the theories of Murray and Renard, of the Challenger Expedition of 1872–76, that these particles were torn off from meteorites in their passage through the atmosphere. Stony meterorites were obviously an important source. The name "caudaites" is suggested to distinguish particles from meterorites and cosmic dust.—*V. S. N.*

VOLCANOLOGY

167–275. Neumann van Padang, M. Present position regarding the catalogue of the active volcanoes of the world: Bull. volcanolog., ser. 2, tome 17, p. 141–144, 1955.

A progress report on the catalogue of the active volcanoes of the world. Of the 19 sections into which the world's volcanoes have been divided, those on Indonesia and the Philippines (and Cochin China) have already been published, the section on Hawaii is in the process of publication, those on Africa, Arabia, and the Indian Ocean will be finished within the year, and nearly all the rest have been assigned to experts in each area and should be finished within the 5 years allotted for the compilation.—*D. B. V.*

167–276. Matschinski, M[atthias]. "Densité" dans un arc volcanique et quantité relative d'alumine dans ses roches ["Density" in a volcanic arc and relative amount of alumina in its rocks]: Soc. géol. France Comptes Rendus, no. 12, p. 221–224, 1956.

The correlation between density of a volcanic arc and the chemical composition of its rocks is even more important than that between density and "charac-

teristic radius" (see Geophys. Abs. 148–13395, 13396, 154–14743). The reciprocal values of density (after Sapper) and the mean percentage of Al_2O_3 (based on analyses of 255 rocks from 179 volcanoes) are given for 15 volcanic arcs; plotted graphically, the results fall on a straight line.—*D. B. V.*

167–277. Buljan, Miljenko. Deep submarine volcanisms and the chemistry of ocean: Bull. volcanolog., ser. 2, tome 17, p. 41–56, 1955.

Deep submarine volcanism as a geochemical factor plays an extraordinarily important role in strengthening the biological potential of the oceans. Whereas sedimentation causes sea water to become deficient in inorganic nutrient matter, volcanism adds phosphorus, nitrogen, and other nutrient elements and thus increases the productivity of organisms. The enrichment of the Tyrrhenian and Caribbean seas in phosphorus and nitrogen is discussed and the silicon content of the Atlantic and Pacific Oceans compared. The abundance of marine life near Japan, the Aleutians, Indonesia, and the Antarctic should be correlated to some extent with volcanic activity. Shallow submarine volcanism has no particular effect on the chemistry of the sea water because gases can escape to the atmosphere and the normal balance is quickly restored.—*D. B. V.*

167–278. Machado, Frédérico. The fracture pattern of Azorean volcanoes: Bull. volcanolog., ser. 2, tome 17, p. 119–125, 1955.

The main volcanic vents of the Azores, including Agua-de-Pau on San Miguel, Cinco Picos on Terceira, and Fayal, are calderas which lie in the center of spider-weblike patterns formed by a combination of ring and radial fractures. The rims are usually steep fault scarps, and the basins seem always to be caused by engulfment along one of the ring faults. Removal of magma in the Azores volcanoes is usually accomplished by explosive ejection of pumice and cinder. Subsidence is probably by single-block stoping of the Glen Coe type rather than by piecemeal subsidence of the Krakatoa type.—*D. B. V.*

167–279. Bartolucci, Giorgio. Sulla manifestazioni fumaroliche, solfatariche ed idrotermali nel nw della Repubblica Argentina e loro possibilità di utilizzazione industriale [Fumaroles, solfataras, and hot springs in northwestern Argentina and the possibility of their industrial use]: Annali Geofisica, v. 9, no. 1, p. 31–42, 1956.

A description of fumaroles and hot springs in the provinces of Salta and Jujuy. They are classed into two groups on the basis of the presence of Quaternary volcanoes to which they can be related. In general, those not related to igneous activity are believed to be more suitable for industrial use.—*M. C. R.*

167–280. McBirney, Alexander R. An appraisal of the fumarolic activity near Ahuachapán, El Salvador: Servicio geol. nac. El Salvador Anales, Bol. no. 2, p. 19–32, 1956.

Preliminary studies of the more important fumarolic regions in El Salvador were carried out intermittently during 1953, 1954, and 1955 to investigate the possibility of exploiting geothermal power. The Ahuachapán region is recommended as most promising because of the extent of the surface manifestations, accessibility, and indications that the steam is of primary magmatic origin and thus probably of high quality and volume. A conservative estimate places the heat output of the area at 46,836,000 g-cal per min, or 3,260 kw, enough to supply the entire town of Ahuachapán with power. Several test drilling locations are suggested.—*D. B. V.*

167–281. Meyer-Abich, Helmut. La erupción del volcán de Izalco (El Salvador) del 28 de febrero de 955 y su actividad hasta principios de 1956 [The eruption of the volcano Izalco (El Salvador) of February 28, 1955, and its activity up to the beginning of 1956]: Servicio geol. nac. El Salvador Anales, Bol. no. 2, p. 3–18, 1956.

A dense cloud of ash was erupted from Izalco volcano in El Salvador at approximately 1:00 p. m. on February 28, 1955, and was followed immediately by flow of lava in two streams from the principal crater at the summit. Six tremors were felt in the vicinity during the afternoon and evening of the first day, of which three were registered instrumentally at the capital. By March 8, explosions were less violent, occurring at intervals of 3 to 18 minutes. In mid-May 1956 this type of activity was still going on, but, with the exception of several strong explosions early in November 1955, had diminished gradually. Lava had practically ceased to flow by the end of November. Several miniature glowing cloud eruptions were observed on January 3, 1956.—*D. B. V.*

167–282. Grebe, Willi-Herbert. Las fumarolas y fuentes termales en las montañas volcánicas de mayor edad de El Salvador [The fumaroles and thermal springs in the older volcanic mountains of El Salvador]: Servicio geol. nac. El Salvador Anales, Bol. no. 2, p. 34–43, 1956.

The more important fumaroles and thermal springs in the coastal ranges, in the old volcanics in the interior of El Salvador, and in the northern part of the country are individually described. In comparison to the manifestations in the youthful volcanoes, there is less hydrothermal alteration of the surrounding rock and little or no sulfur deposition, indicating that juvenile waters are not being produced. Moreover, the location of the vents and springs seems to be more closely related to fracture patterns.—*D. B. V.*

167–283. Klemmer, Konrad. Eine Ätna-Besteigung [An ascent of Etna]: Natur u. Volk, Band 86, Heft 2, p. 50–52, 1956.

A popular description of the activity of the Gran Cratere Nordèst of Mt. Etna on July 14, 1955, noteworthy for a night color photograph of the eruption.—*D. B. V.*

167–284. Tsuya, Hiromichi; Okada, Atusi; and Watanabe, Tasuku. Evolution of Mihara Crater, Volcano Ōshima, Izu, in the course of its activities since 1874: Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 1, p. 33–59, 1956.

Topographic changes in Mihara Crater (the summit crater of the central cone of Mihara volcano, Ōshima Island, Japan) brought about by the ten eruptions that have occurred since 1874 are described. The activity of 1953–54 and resulting changes are treated in greatest detail. Numerous sketch maps, diagrams, and photographs are given.—*D. B. V.*

167–285. Yokoyama, Izumi. Energetics in active volcanoes. 1st paper. (Activities of Volcano Mihara, Ooshima Island during the period 1953–54): Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 2, p. 185–195, 1956.

Quantitative data on the energy of the Strombolian-type volcano Mihara on Ōshima Island, Japan, during its moderate activity in 1953 and 1954 were

obtained from seismologic observation of volcanic tremors (related to surface activity) and local earthquakes (associated with release of energy deeper in the volcano) and from magnetic observations (from which the depth and thermal state of the magma reservoir could be deduced). Local earthquakes and volcanic tremors do not occur simultaneously and they involve almost the same total energy, suggesting that they share the same energy source but differ in the place where it is released. Also, the total seismic energy of Mihara over a period of activity is of the same order as that of the vulcanian type Mount Asama, although individual paroxysms of the latter may be 10^2 or 10^5 times stronger. Comparison of the relation of thermal energy estimated to have been received from below with energy released by the various volcanic and seismic manifestations indicates that a volcano is a very inefficient heat engine.—*D. B. V.*

167–286. Yokoyama, Izumi. Geomagnetic studies of Volcano Mihara. 7th paper. (Possible thermal process related to changes in the geomagnetic field): Tokyo Univ. Earthquake Research Inst. Bull., v. 34, pt. 1, p. 21–32, 1956.

Anomalous changes in the geomagnetic field during the 1953-54 eruption of Mihara volcano, Ōshima Island, Japan, are explained in the light of possible thermal processes beneath the volcano. The considerable heat supplied from below the magma reservoir causes demagnetization; cooling (by heat conduction at the surface and by expansion of water vapor) causes magnetization and is restricted by external conditions. The heating process can be explained quantitatively by considering the subterranean mass to be divided by cracks into many small unit spheres. Cooling by expansion of water vapor from a depth of about 2 km to the surface must account for about half the heat involved.—*D. B. V.*

167–287. Foshag, William F., and Gonzalez, Jenaro R. Birth and development of Parícutin Volcano: U. S. Geol. Survey Bull., no. 964–D, 134 p., 1956.

Parícutin Volcano is the most recent volcano of the Michoacán volcanic province of Mexico. Its initial eruption on February 20, 1943, was preceded by 2 weeks of local earth shocks and subterranean noises. The cone grew with great rapidity, reaching a height of 167 m in 6 days of activity. Activity during the first 2½ years can be divided into 3 periods: Quitzocho period during which the volcano built its cone centered about the original Cuiyúsuru vents, 2 km southeast of the village of Parícutin; Sapichu period when principal activity shifted to new vents at the northeast base of the main cone and formed the adventitious cone, Sapichu; and Taquí period during which lava issued alternately from the Taquí and Ahuan vents on the west and south base of the main cone. During the eruption of Sapichu the activity of the main cone was greatly reduced but during the Taquí period activity in the main crater was erratic and variable and showed no apparent correlation with the emission of lava from the new vents. After 3 years of activity the cone reached a height of about 350 m above the original vent. Lava flows covered an area of about 18½ square km and destroyed the villages of Parícutin and San Juan Parangaricutiro.—*V. S. N.*

167–288. Gregg, D. R. Eruption of Ngauruhoe 1954–55: New Zealand Jour. Sci. Technology, sec. B, v. 37, no. 6, p. 675–688, 1956.

The andesite volcano Ngauruhoe erupted from May 1954 to March 1955, producing its greatest outflow of lava in historic time. There were ten main flows, with a total volume of the order of 8 million cubic yards. Molten lava was high in the throat from May 1954 to June 1955, but flowed from the crater only during the months from June to September 1954. The period of lava emission was characterized by prolonged lava fountaining that built a spatter-and-cinder cone within the old crater. Hot avalanches accompanied some of the flows. Ash emission continued intermittently throughout the eruption but reached a peak about the end of September. From the evidence of older lava flows it seems probable that Ngauruhoe has reached its maximum height consistent with the available magmatic pressure and that any further growth will be lateral.—*D. B. V.*

167–289. McBirney, A. R. Thoughts on the eruption of the Nicaraguan volcano Las Pilas: Bull. volcano, ser. 2, tome 17, 113–117, 1955.

During the renewed activity of the volcano Las Pilas in Nicaragua in 1952, a fissure almost 1 km long opened adjacent to one of the largest collapse craters, which served as a collecting basin. Occurring at the climax of the rainy season, the eruption was clearly phreatic. Such eruptions seem to be brought on by the chilling effect of ground water, which, after saturating the magma with water vapors, lowers its temperature until a critical point is reached and a sudden release occurs, accompanied by a great volumetric increase capable of producing such an expansion crack as the Las Pilas fracture.—*D. B. V.*

167–290. McBirney, A. R. The origin of the Nejapa pits near Managua, Nicaragua: Bull. volcanolog., ser. 2, tome 17, p. 145–154, 1955.

The eight coalescing pits including the one holding Lake Nejapa near Managua, Nicaragua, are not true explosion craters but evolved as follows: basalt was erupted from a fissure through the major axis of the present pits, after which the magma subsided; fluxing by hot gases in the void thus created weakened the basalt roof; as collapse occurred at one point after another the suddenly released gases scattered fragments of rock about the rims, but no magma was ejected.—*D. B. V.*

167–291. Neumann van Padang, M. A Swedish sketch of Krakatau in 1748: Bull volcanolog., ser. 2, tome 17, p. 135–139, 1955.

Comparison of a sketch of Krakatoa made in 1748 with other early maps and sketches shows that little if any change in shape occurred between 1596 and 1883. This is to be expected inasmuch as the only activity during that pre-explosion interval consisted of the weak eruption of 1680–81.—*D. B. V.*

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