NATIONAL ACADEMY OF SCIENCES

WILLIAM BOWIE

1872—1940

A Biographical Memoir by

J. A. FLEMING

Biographical Memoir

William Bowie

WILLIAM BOWIE

1872–1940

BY J. A. FLEMING

William Bowie was born May 6, 1872, at Grassland, an estate near Annapolis Junction, Anne Arundel County, Maryland. He died August 28, 1940, at Mt. Alto Hospital in Washington, D. C., after an illness of about three weeks. Funeral services were held at St. Thomas Episcopal Church, Washington, D. C., August 30, 1940, followed by burial in Arlington National Cemetery.

His family, descended from a long line of English ancestors, many of whom were knighted, was traced back as far as 1325. His American forebears, all of whom played important parts in the history of Maryland, originated with John Bowie, Sr. (1688-1759), who emigrated from England to America about 1705-06. William Bowie's great grandfather Thomas Bowie (1767-1823) was Colonel of the 34th Regiment of the Maryland forces in the war of 1812, and his father Thomas John Bowie (1837-1898) served as Deputy Provost Marshal for Prince Georges County, Maryland, during the Civil War and was later elected for one term in the House of the Maryland Legislature. William Bowie's mother, Susanna Anderson (Bowie), whose English ancestors have been traced from early in the Fourteenth Century, was also descended from a well-known Maryland family, the activities of many of whom helped make history in Maryland. On June 28, 1899, William Bowie married Elizabeth Taylor Wattles of Alexandria, Virginia, who survives him and who is also of illustrious English and American ancestry. There were two children, William (deceased in infancy) and Clagett, an aeronautical engineer and designer, presently of Baltimore, Maryland. Bowie was also survived by two brothers: Edward Bowie, an eminent meteorologist, who has since died, and John Bowie, who resides at Grassland, the old family estate.

William Bowie received his early education in the public schools and at the venerable St. John's College of Annapolis,

Maryland. He later attended and received degrees from Trinity College, Hartford, Connecticut (B.S. 1893; M.A. 1907; Sc.D. 1919) and Lehigh University (C.E. 1895; Sc.D. 1922). He also received honorary degrees (LL.D. 1936) from the University of Edinburgh, Scotland, on the occasion of the meeting of the International Union of Geodesy and Geophysics of which he was President, and from the George Washington University (Sc.D. 1937).

He entered the service of the United States Coast and Geodetic Survey on July 1, 1895, first as a junior officer in the field and later as chief of parties engaged in triangulation and base-line measurements in many states of the Union as well as in the Philippines, Puerto Rico, and Alaska. He was appointed in 1909 as Inspector of Geodetic Work and Chief of the Computing Section, which was re-designated as the Division of Geodesy from October 15, 1915. He rendered distinguished service in this position until he was retired in May, 1936, having reached the age of 64, the retiring age for commissioned officers of the Survey, but he was recalled to active duty on June 1, 1936, and served until his final retirement on December 31, 1936.

During his connection of over 40 years with the Survey he won distinction both at home and abroad for his notable attainments in geodesy, related science, and engineering. Aside from directing the main function of the Computing Section and the Division of Geodesy, namely, extending control surveys consisting of triangulation, leveling, and pendulum and gravity work, throughout the country, he found time to make researches in earth-physics which were the basis of many official publications and his well-known book "Isotasy." In addition he publicized the general usefulness and public value of surveying and mapping by contributing hundreds of articles to current journals and newspapers. During World War I, he was commissioned a major in the Corps of Engineers, U. S. Army, and was assigned to the Mapping Division of the Office of the Chief of Engineers in Washington (August, 1918, to February, 1919).

Dr. Bowie's scientific activity was directed chiefly toward the accomplishment of three general objectives: (1) Promotion of

mapping of the United States and its territories and improvement of cartographic methods and technique. (2) Expansion of geodetic work and improvement of instruments and methods. (3) Promotion of interest and progress in geophysical sciences, particularly through the media of national and international bodies.

(1) Promotion of Cartography and of Improved Instruments and Technique

Earnest advocacy of more and better maps was an outstanding feature of Bowie's scientific career. Although from a professional standpoint his chief interest was in the somewhat limited field of geodesy, he always viewed his work from the broad concept of its value and general utility as a part of mapping which then sorely needed a champion. On this point he brought to bear all his energy and eloquence, never letting pass an opportunity to impress its importance upon his countrymen. To this end he addressed many scientific and engineering societies and contributed articles to newspapers and technical journals, always stressing the need for, and the great advantage to be derived from, adequate surveys and maps of the United States and its outlying territories. For this alone his contribution to posterity merits first consideration, notwithstanding his geodetic research for which he received nearly all his honors. He was always ready to support his assertions by citing instances of losses resulting from the destruction of highway structures because of lack of proper planning where highways had to be extended over unmapped areas. Another of his theses was the dependence on mapping in evaluating available water supplies and in the solution of certain biological problems. From the economic viewpoint he emphasized the fact that good maps and good control-surveys make possible the execution of our various enterprises in a more efficient way, thereby reducing the cost to our people of private and public works.

Of great practical advantage to geodetic operations was Bowie's initiation of a movement to place surveying and mapping in North America on a single geodetic datum known as the

North American Datum,[1] which was adopted by Canada and Mexico in 1913. By this the execution of surveys along their common borders in a uniform and systematic manner was assured and a mutual understanding in geodetic matters established.

The deplorable lack of co-ordination, uniformity, and standardization of methods in the various Governmental organizations engaged in this work could not long escape notice by one as assiduous as Bowie in the cause of maps and mapping. Working through the National Research Council, he pointed out the unsatisfactory and wasteful duplication of the work. He advocated, as the best means for correcting this condition, the establishment of an agency within the Government to study the problem and undertake the task of co-ordinating the services involved. The result of his campaign was the creation in 1919 of a Board of Surveys and Maps, later known as the Federal Board of Surveys and Maps. He was chairman of this Board during its early years. This Board rendered useful service to units engaged in mapping. Its functions were transferred to the Bureau of the Budget in 1942.

Under Bowie's supervision from October 10, 1909, there were added many thousand miles of arcs to the triangulation-net of the country. To make an equitable distribution of the closing errors among the arcs, which, using the old system, would have been impracticable, Bowie suggested the establishment of juncture figures and the adjustment of intervening arcs as separate sections. This simplified method was first successfully applied to the first-order control-arcs in the western part of the United States and later to the eastern half.

Bowie was also largely responsible for the organization in the American Society of Civil Engineers of a Division of Surveying and Mapping, of which he was Chairman until 1940. From the work of this Division has come a better appreciation of the economic advantages of good maps and the realization

[1] "For all connected triangulation in the United States, Canada, and Mexico, the initial point is the Triangulation Station, Meades Ranch, in the State of Kansas. Its adopted latitude and longitude and the azimuth from it to the Station Waldo are called the North American Datum." [W. Bowie, Jour. Frank. Inst., p. 665, June 1914.]

of their almost universal application to problems of the national services.

(2) Expansion of Geodetic Work and Improvement of Instruments and Methods

Bowie was placed in charge of the geodetic work of the Survey on October 10, 1909. At that time 10,000 miles of triangulation and 30,000 miles of leveling had been done. During the 27 years of his administration, these figures were raised to 68,000 and 261,000 miles, respectively. At the same time the number of gravity stations was increased from 60 to 720 and astronomical Laplace stations from about 32 to 390.

It was during this period that great changes in the tempo of field work of the Survey took place. During the early years of the present century, the field-equipment was transported from station to station by mules and horses, and the necessity of erecting wooden towers rendered progress comparatively slow. With the advent of the rapid autotruck with all modern conveniences and portable steel towers which could be quickly erected and dismounted, the geodetic field work was greatly improved and its progress accelerated. Bowie quickly envisioned the advantages of these innovations and adopted them in the field work of the Survey.

One of the problems which confronted Bowie pertained to the procurement of suitable instruments and the reconditioning of old ones which through usage had become incapable of yielding results of the accuracy required for first-order triangulation. One of the various improvements advocated by Bowie, after careful investigation, was the substitution of silver circles on the theodolites. This change was suggested for the purpose of eliminating any inaccuracy which might result from the displacement of the silver inlay originally set in the bronze circles of these instruments. These silver circles were found to be an important improvement and were gradually adopted for the theodolites of the Survey.

Bowie also improvised in the field a base tape-stretcher apparatus which was later improved and manufactured in the Survey's instrument-shop.

He was also responsible for improvements in gravity instruments and methods. At his suggestion observations were made in 1914 which showed the possibility of using the noon signals transmitted by the United States Naval Observatory over the wires of the Western Union Telegraph Company, in the determination of the periods of the pendulums in gravity work. Bowie had had much experience in time determinations for longitude work in which the program of observations at each station included an exchange of telegraphic signals with an existing station for the purpose of eliminating certain errors. He visualized the use of the daily Western Union signals for pendulum gravity determinations where, as was usually the case, a pendulum gravity station was in reasonable proximity to the telegraph office. The trial of the method in 1914 proved feasible and it was used thereafter until the development of new equipment. This so accelerated gravity observations that a single station could be completed on the average in about one week whereas before that time an average of about three weeks was required at each station. Furthermore, only one observer was required by the new method instead of two.

The subject of isostasy has been under investigation at the United States Coast and Geodetic Survey for many years. The first work there was done under the direction of Professor J. F. Hayford, Bowie's predecessor in geodetic operations, in connection with the deflection of the vertical and the determination of the size and shape of the earth. This work was later extended to include investigations of the effect of topography and isostatic compensation upon the intensity of gravity. These investigations of gravity and isostasy were continued under Bowie from 1909 and the results obtained were set forth in a number of publications of the Survey. It was found that the theory of isostasy was useful in accounting for abnormal values of gravity and for studying underground structure. Isostatic anomalies were shown to indicate a departure from normal conditions of specific gravity of the rock underlying the point of observation.

Bowie's investigations of gravity paved the way for the use of determinations of gravity in studying geological struc-

ture and the gravity method which has proved so valuable in geophysical exploration.

During the gravimetric survey of Holland, 1912-1922, the swampy nature of certain parts of that country made it impossible to find any fixed base for the pendulum apparatus. Measures had to be taken, therefore, for ensuring the accuracy of the observations in spite of the unsteadiness of the instrument. A method was accordingly developed by Dr. F. A. Vening Meinesz of swinging two pendulums simultaneously in the same swinging plane, thereby eliminating the effect of the horizontal accelerations. The success of this method when applied to the unstable terrain of Holland led to the idea that it could also be applied to ships at sea; experiments performed on board submarines while submerged demonstrated the feasibility of this method for making gravity determinations over ocean areas.

Bowie was greatly interested in this improved method in determination of gravity and warmly encouraged Vening Meinesz in pursuing his observations at sea. He took a leading part in arranging collaboration of Vening Meinesz and the Dutch authorities with the United States Navy and other American organizations so that values of gravity at sea might be obtained by the United States and other interested governments or organizations. Largely as a result of his efforts, three expeditions were successfully concluded in 1928, 1932, and 1936-37, chiefly in the vicinity of the West Indies. The results of these expeditions confirmed the theories of Airy[2] and Pratt[3] that the earth's crust under the oceans is in isostatic equilibrium with the crust in the continent—an idea which was ardently supported by Bowie. They also yielded vital supplemental data which permitted the interpretation of the geology and geophysics of the region surveyed.

---

[2] G. B. Airy, On the Computation of the effect of the attraction of mountain masses as disturbing the astronomical latitude stations in geodetic surveys. Phil. Trans. Roy. Soc. London, vol. 145, pp. 101-104 (1855).

[3] J. H. Pratt, On the attraction of the Himalaya Mountains and of the elevated regions beyond them upon the plumb line in India. Phil. Trans. Roy. Soc. London, vol. 145, pp. 53-100 (1855).

(3) National and International Activities

Few Americans have wielded so great an influence in national and international scientific bodies concerned with geodesy and geophysics as William Bowie. He was present as the United States representative at the last General Assembly of the International Geodetic Association at Hamburg in 1912, when the Fiftieth Anniversary of that organization was celebrated. At the triennial conventions of that Association representative geodesists from the twenty or more adhering countries were brought together and their personal contacts and discussions resulted in the greatest benefit to the science of geodesy throughout the world.

With the outbreak of World War I, the activities of many international scientific organizations were either suspended or terminated, but the work of the International Geodetic Association was continued on a limited scale by the so-called Reduced Geodetic Association to which seven neutral countries, including the United States, belonged. After the United States entered the war in 1917, the work was carried on by the other six member-nations, to which too much credit cannot be given for preventing a break in international co-operation in geodetic matters during World War I.

Contrary to expectations, the old International Geodetic Association was not revived with the return of peace. At a meeting held in Brussels in 1919, at which Bowie was one of the leading delegates from the United States, the International Union of Geodesy and Geophysics was created and its Section (later designated Association) of Geodesy was destined to replace the old International Geodetic Association. At the first plenary meeting of the Section at Rome in 1922, all of the countries forming the Reduced Geodetic Association were represented.

Dr. Bowie was President of the Section of Geodesy from its establishment in 1919 until 1933. One of the troublesome questions which soon claimed the attention of the International Union was the admission of the Central Powers and their allies to membership. Although several of the European delegates were, from the first, bitterly opposed to their admission, Bowie

consistently denounced this limitation to the international character of the Union and, in his capacity as ex-officio Vice-President of the Union, threw his influence always on the side of tolerance and international understanding. In 1926, the statutes of the Union were revised and the clauses to which the Central Powers took umbrage were eliminated.

In all the deliberations of the Union as well as those of the Section (later Association) of Geodesy, the words of Bowie always carried weight. His dignified bearing and commanding presence assured him the respect of all and his clever diplomacy often succeeded in bringing about satisfactory settlements of questions where prolonged and heated discussion would have produced at best a doubtful solution. He was a past master of the art of conducting a meeting and under his general guidance even much-contested matters were often dispatched with surprising smoothness. He was strongly in favor of working through committees as the best manner of dealing with disputed questions, since spontaneous debate in international assemblies, where different languages are involved, often becomes interminable.

In token of his unusual ability in parliamentary practice, coupled with his high scientific attainments, he was elected President of the International Union of Geodesy and Geophysics from 1933 to 1936. In 1936 he received the degree of Doctor of Laws from the University of Edinburgh. Because of his intimate acquaintaince with the affairs of the Union, he was called upon to act as Secretary, in the absence of Brigadier Winterbotham, at the General Assembly of the Union held in Washington in 1939.

Bowie was instrumental in bringing about the adoption of the "Hayford Spheroid," known as the "international spheroid," at the meeting of the International Union of Geodesy and Geophysics at Madrid in 1924.

In the minutes of the Executive Committee of the American Geophysical Union one meets with Bowie's name at every turn because of the prominent part he took in shaping the destiny of the Union and in directing its policies. He was the first Chairman of its Section of Geodesy, holding that post from 1919

to 1922. He was General Secretary of the Union from 1929-1932.

His counsel, wise judgment, and enthusiasm had much to do with the development of the Union (which originally had a membership of only 50 and whose membership at the time of Bowie's death was over 1400, and in 1949 is over 4500) and with the encouragement of geophysics as a profession throughout the United States. That the Union was not unmindful of his outstanding service was attested by the establishment of the William Bowie Medal, endowed by friends and co-workers, for award for distinguished attainment and outstanding contribution to the advancement of co-operative research in fundamental geophysics.

The following extract from the citation (April 28, 1939) when the first award of this Medal was made to Bowie, epitomizes the regard in which he was held by his colleagues.

"It is particularly fitting that the first award of this Medal should be to the man whose name the Medal bears. It is not necessary here, among your intimate friends and colleagues in geophysics, to refer specifically to your long list of scientific accomplishments and honors. But we do feel that in presenting you with the first imprint of this Medal that has been created in your name and that of the organization for which you have worked so long and so lovingly, we are not handing you merely a bit of stamped and engraved metal, but rather a powerful talisman of those human forces, affection, esteem, and tradition so fundamental to your spirit of progress. It is sincerely hoped that in the years to come this Medal, through its future awards, will continue to promote and to recognize that spirit of helpfulness and friendliness in unselfish co-operative research which you have so bountifully displayed."

In all deliberations he stood for encouragement of scientific effort and co-operation with agencies which would advance the cause of geophysics. As a member of the National Academy of Sciences since 1927 he was affiliated with the Section on Astronomy. He did much to interest the Academy in geophysics and was one of those who took an active part in the organization and endowment of the Woods Hole Oceanographic Institution. He was a firm advocate of enlarging the scope

and membership of the American Geophysical Union, preferring that it should take the form of an association or society rather than that of a committee. He usually held definite

WILLIAM BOWIE MEDAL OF THE AMERICAN GEOPHYSICAL UNION

(PHOTOGRAPH OF REVERSE AND OBVERSE OF MEDAL AS FIRST AWARDED WILLIAM BOWIE.)

opinions on the various subjects that came up for discussion and by virtue of his oratorical ability and the felicitous expressions always at his command often carried his point in spite of opposition.

The secret of Bowie's great productivity was in the sharp differentiation he made between hours for work and for mental and bodily recreation. In a letter to Professor William H. Burger of Northwestern University on May 31, 1935 he wrote:

"I have schooled myself to leave my work at the office and therefore during the evening I can read, talk, listen to the radio, play a game of contract, or do other things without my mind being in a whirl concerning office matters. I believe that any one who has a big job must have freedom from it

for some of the day. I try to drive as hard as I can while I am at the office, but at the close of the official day I am through until the next morning. Under this plan I seem to be standing up in fine shape, as I have written you before."

(4) Leadership

Bowie's scientific ability was enhanced by his rare quality of leadership—one possessed by so few scientists. It has fallen to the lot of few American men of science to be endowed with the high qualities of leadership and organization which characterized Bowie throughout his long career in government service. His unswerving purpose was to build up a unified and contented group of efficient workers as the best way to advance the work in view. He had the rare faculty of effecting the accomplishment of his objectives through the co-operative efforts of the men under his direction, a large part of which was due to his honesty and generosity of bestowing credit where it was due—he thus assured zealous and loyal co-operation in the work.

His popularity as a leader was evidenced on many occasions but perhaps never to better advantage than at the time of his retirement from active service when his Division held a dinner and exercises in his honor. He was outstandingly successful as a chief of division and set an example of administration which others in like positions would do well to emulate.

Dr. Bowie took much interest in educational matters and held very sane views regarding public instruction, insisting that the object of study was to understand the subject and not to over-strive to obtain good marks.

Some of his cogent ideas on the subject are illustrated in the following extracts from letters to Professor Burger:

"I am inclined to think that your success with the Coast Survey and since may be due to the fact that you took a general science course rather than an engineering one. Hayford was quite convinced that the strictly engineering courses did not give a man a well-rounded education. I am becoming more convinced than ever that we should have in an engineering course more physics, mechanics, mathematics, English, history, and perhaps philosophy and economics. They are the things that enable one to understand life. Learning how to build bridges and highways, etc., makes men too narrow unless they

have these other things. When Hayford went to Northwestern he started the five-year course in order that the students would have some cultural courses. In this he was sound.

"These fundamental things that I have mentioned above are the basis of all engineering. A man well grounded in these fundamentals can soon learn the technical phases of any engineering job to which he may be called. I find in the Division of Geodesy that our field men who have had special courses in physics while in their Colleges and Universities are able to handle our work a little better than those who took merely structural and construction courses." (June 13, 1935.)

"I think there is too much attention paid by students at high schools and universities to marks. They think if they get a good mark they are doing good work. As a matter of fact the mark may be due merely to cramming for the recitation or the quiz without any real intention of understanding what the subject is all about.

"I am inclined to favor the system used at the Harvard Law School. They do have recitations in a sense. The students are required to get up and talk about certain cases and naturally they do not like to make a mess of it. But no marks are given or taken into consideration during the entire year. At the end of the year a comprehensive examination is given in each subject taken. The examination questions are designed to show whether a student really understands his subject and the fundamental principles of law. There are scarcely any questions involving merely memory tests. This it seems to me is the ideal way of conducting any course. Then the student tries to learn something about it rather than to get by in daily recitations and occasional quizzes.

"I believe outside activities of the school and college, if not overdone, are a great benefit to the student. After all when we get through college our dealings are principally with people and not with things. Of course we must know fundamental principles of science or anything else that we study, but dealing with people is very important. If one goes through college without contacting other students in extra-curricular activities, he is very much handicapped when he gets out into the world's work. I find that men who have had such extra-curricular work in college make better chiefs of parties. They know how to handle men, to pep up their morale, and to make them enjoy a rough and tumble life." (December 27, 1935.)

Despite his official responsibilities Bowie found time to do some teaching outside of the Coast and Geodetic Survey. From

1912 to 1917 he conducted a short course in geodetic surveying and practical astronomy at Columbia University summer surveying camp near Litchfield, Connecticut. He was also special lecturer at Lehigh University from 1924 to 1936. He never lost an opportunity to urge young men to make the most of the best in them and to encourage them to strive for leadership in their chosen work.

He was also an excellent public speaker and brilliant conversationalist, being never at a loss for something to say and how to say it. He was much given to citing telling examples to reinforce his statements. In an address given before the South Carolina Society of Engineers, in emphasizing the inadequacy of some descriptions of land-marks, in connection with his campaign for better maps, he cited an old deed which read "Beginning at a point on Powdermill Hill where Bill Jones killed the Indian." Another instance of his shrewd humor may be noted in a conversation with one of his friends when he said by way of precept: "If you want to make a name for yourself in science, choose for investigation some subject which nobody knows anything about and which, moreover, nobody cares anything about, such as isostasy. Then you will receive bouquets instead of bricks!"

(5) Affiliation with Scientific Bodies, Honors, and Awards

Scientific bodies—Bowie was interested in many scientific societies and organizations, to which he contributed much of his time, both as an active and as an honorary member. Among them may be mentioned the following:

National Academy of Sciences
National Research Council in its Division of Foreign Relations
Academy of Sciences of the Institute of France
Academy of Sciences of Norway
National Academy of History and Geography of Mexico
Russian Geographical Society
Finnish Geographical Society (Honorary membership had been unanimously voted but Bowie's death occurred before its finalization)

International Union of Geodesy and Geophysics (President, 1933-36)
International Association of Geodesy (President, 1919-33)
Federal Board of Surveys and Maps (Chairman, 1922-24, member of Executive Committee, 1920-36)
American Society of Civil Engineers (Chairman of Division of Surveying and Mapping from its organization in 1926)
American Institute of Consulting Engineers
American Geographical Society
American Association of Geographers
American Astronomical Society
American Engineering Council (Committee on Surveying and Mapping)
American Society of Photogrammetry
American Geophysical Union (President, 1919-22 and 1929-32)
American Association for the Advancement of Science
Pan American Institute of Geography and History (Honorary President from 1929)
Society of American Military Engineers (President, 1938, and Executive Officer and Editor of *The Military Engineer* from January 1-August 28, 1940)
Geological Society of America
Geological Society of Washington
National Geographic Society
Philosophical Society of Washington (President, 1926)
Seismological Society of America
South Carolina Society of Civil Engineers
Washington Academy of Science (President, 1930)
Washington Society of Engineers (President, 1914)

He was a member of the following Greek-letter fraternities:
Delta Kappa Epsilon
Phi Beta Kappa
Sigma Xi (President, District of Columbia Chapter, 1935-36)

He enjoyed memberships in the following clubs:
Cosmos Club of Washington (life member)
Army and Navy Club of Washington

Honorary awards and medals—Recognition of Bowie's scientific activities, other than awards of honorary degrees, may be noted as follows:

The Charles Lagrange Prize by the Royal Academy of Belgium in 1932

The Elliott-Cresson Medal by the Franklin Institute of Philadelphia in 1937 for contributions to the science of geodesy

Medal and Diploma as an Officer of Orange-Nassau by the Queen of The Netherlands in 1937 [The Medal and Diploma of the Order were presented through the Minister of The Netherlands at Washington with the following citation: "In recognition of outstanding achievements in the interests of international science and geodesy and his collaboration with Dr. F. A. Vening Meinesz, Professor of Geodesy at the University of Utrecht, The Netherlands, and a Member of The Netherlands Geodetic Commission, in the determination of gravity at sea."]

Decoration of the Cross of Grand Officer of the Order of St. Sava from Yugoslavia in 1939

First award of the William Bowie Medal by the American Geophysical Union in 1939

Sometimes the development of regard of scholars in other fields is reflected in doggerel rhymes so often used in friendly get-together meetings. Thus as regards Bowie's work in isostasy in the earlier days, about a quarter-century ago, before the geologist had altogether accepted isostasy, at a meeting of the Geological Society of Washington during December, 1923, Henry G. Ferguson and Frank C. Calkins submitted the following verses, which were sung to the tune of "Maryland, My Maryland" by the chorus of the Pick and Hammer Club:

What is it rules the upper crust?
  Isostasy! Isostasy!
What actuates the overthrust?
  Isostasy! Isostasy!
What gives the shore-line wanderlust?
What humbles highlands in the dust?
What makes the strongest stratum bust?
  Isostasy! Isostasy!

That all's in equilibrium,
  So Bowie says, so Bowie says,
Is proven by the pendulum,
  So Bowie says, so Bowie says,
And why the plumb line's never plumb,
And why the mountains go and come,
Is simple as the rule of thumb,
  So Bowie says, so Bowie says.

In vain conservatives have cussed
  Isostasy! Isostasy!
The strongest power on earth is just
  Isostasy! Isostasy!
So we must down our deep disgust;
If we'd be up-to-date, we must
Roll up our eyes and take on trust
  Isostasy! Isostasy!

It is recalled that on the occasion of a farewell party to Bowie by members of his staff and friends at the United States Coast and Geodetic Survey, the above verses were sung by all in attendance greatly to Bowie's delight, as indeed must have been the case when they were presented originally.

The appreciation of Bowie's personal qualities has been well stated by his friend Professor C. R. Longwell of the Department of Geology at Yale University in the following words:

"Bowie will be long remembered as an outstanding personality. He was a man of striking appearance and with a remarkably genial disposition. In scientific discussions his ready wit and good-natured banter were perhaps as effective as the force of his arguments. Undoubtedly his genuine interest in people, young and old, his uniform cheerfulness and kindliness on all occasions, and his unusual ability in forceful and entertaining conversation were large assets in the successful performance of his administrative and scientific tasks. Certainly these qualities won him the admiration and affection of numerous people, representing various sciences and professions, who now blend with their tribute to his accomplishments sincere mourning at the loss of a friend."

Bowie's breadth of vision, his encouragement of younger

men, his interest in other than his immediate field, his unselfish service in his every contact, and his unflagging zeal and devotion to bring together the seven main fields of geophysics as a real Union endear and perpetuate his memory, not only to his own countrymen but to all of those many colleagues in almost every country of the world who had the privilege of his acquaintance.

BIBLIOGRAPHY OF WILLIAM BOWIE

BY J. A. FLEMING AND H. D. HARRADON

It has been difficult to prepare a complete bibliography of publications and writings by Bowie. In the preparation of the following material the authors have had the generous assistance of Captain H. W. Hemple, presently Chief of the Division of Geodesy of the Coast and Geodetic Survey, of his assistants, and of the Librarian of the Survey. As will be noted, there are included, in addition to major scientific reports and addresses, numerous reviews, abstracts, and articles in newspapers; thus the increasing tempo of Bowie's activities, both as a scientist and as a public spirited citizen, is clearly indicated. Some of his publications doubtless have been omitted from this list, but such omissions are probably few in number.

Abbreviations used in references follow general conventions but in order to avoid any ambiguity, they are indicated in the key below:

Abbr'n.	*Meaning*	*Abbr'n.*	*Meaning*	*Abbr'n.*	*Meaning*
Abs.	Abstract	Frank.	Franklin	Phil.	Philosophical
	Abstracted	Gaz.	Gazette	Pop.	Popular
Adv.	Advancement	Geod.	Geodetic	Proc.	Proceedings
Aeron.	Aeronautical	Géod.	Géodésie	Pub.	Public
Amer.	America	Geog.	Geografía		Published
	American		Geographic	Pub'n.	Publication
Ann.	Annual	Geol.	Geological	Rep.	Reprint
App.	Appendix		Geologist		Reprinted
Ass'n.	Association		Geology	Res.	Research
Assoc.	Associated	Geophys.	Geophysics	Rev.	Review
Astro.	Astronomical	Géophys.	Géophysique		Reviewed
Astroph.	Astrophysical	ibid.	ibidem		Revista
Beitr.	Beiträge	Inst.	Institute	Sci.	Science(s)
Bol.	Boletin	Inst'n.	Institution	Scot.	Scottish
Bull.	Bulletin	Jour.	Journal	Sec.	Section
Bur.	Bureau	Mag.	Magazine	Ser.	Serial
Cal.	California	Mar.	Marine		Series
Chap.	Chapter	Mer.	Merchant	Serv.	Service
Circ.	Circular	Metal.	Metallurgical	Smith.	Smithsonian
Civ.	Civil	Mil.	Military	Soc.	Society
Conf.	Conference	mimeogr.	Mimeog'phed	Spec.	Special
Cong.	Congress	Mitteil.	Mitteilungen	Stand.	Standards
Conn.	Connecticut	Month.	Monthly	Supp.	Supplement
Conserv.	Conservation	Mss.	Manuscript	Surv.	Survey
Cont.	Contributions	Nation.	National	Tech.	Technical
C.-R.	Comptes Rendus		Nationale	Trans.	Transactions
Div.	Division	no.	number		Translation
Ed.	Edition	Obs.	Observatory	U. S.	United States
Eng.	Engineering	p.	page	vol.	volume
	Engineers	pp.	pages	Wash.	Washington, D. C.
Ext.	Extension	Petrol.	Petroleum	Zs.	Zeitschrift
ff.	following (pages)				
Jan.	January	———	May	Sep.	September
Feb.	February	———	June	Oct.	October
Mar.	March	———	July	Nov.	November
Apr.	April	Aug.	August	Dec.	December

Some recent triangulation in the southwest part of the United States (presented before Phil. Soc. Wash., Mar. 10, 1910).

Determination of the height and geographical position of Mt. McKinley. Bull. Amer. Geog. Soc., vol. 42, no. 4, pp. 260-261 (Apr., 1910).

Primary triangulation and base measurement by the Coast and Geodetic Survey (presented before Phil. Soc. Wash., in 1910).

The measurement of two primary base lines with invar tapes (presented before Phil. Soc. Wash., Jan. 28, 1911). Eng. News-Record, vol. 65, no. 11, p. 315 (Mar. 16, 1911).

The Texas-California arc of primary triangulation. Abs., Science, vol. 33, no. 849, pp. 838-839 (Apr. 7, 1911); also abs. Bull. Amer. Geog. Soc., vol. 43, no. 6, pp. 447-448 (June, 1911).

The completion of Texas-California arc of primary triangulation. Abs., Science, vol. 33, no. 854, pp. 748-750 (May 12, 1911); Amer. Geog. Soc., (June, 1911); Sci. Amer. Supp., vol. 74, p. 412 (Dec. 28, 1912). [Rev. by Dr. E. Hammer, Petermann's Mitteil., p. 209, Apr., 1913.]

Recent gravity-work by the Coast and Geodetic Survey (presented before Phil. Soc. Wash., May 6, 1911). Abs., Science, vol. 33, no. 858, pp. 911-912 (June 9, 1911).

Recent gravity work in the United States. Amer. Jour. Sci., vol. 32, pp. 101-113 (Aug., 1911).

Primary base lines at Stanton, Texas, and Deming, New Mexico. Ann. Rep. U. S. Coast Geod. Surv., 1910, App. 4, pp. 143-171, Gov. Printing Office, 1911.

Making practical use of the U. S. primary triangulation systems (presented before Amer. Ass'n. Adv. Sci., Sec. D, Wash., Dec. 28, 1911). Eng. News, vol. 67, no. 8, p. 341 (Feb. 22, 1912).

Some relations between gravity anomalies and the geologic formations in the United States. Amer. Jour. Sci., vol. 33, pp. 237-240 (Mar., 1912).

Some results of the Hayford method of gravity reductions. Jour. Wash. Acad. Sci., vol. 2, no. 21, pp. 499-504 (Dec. 19, 1912).

Effect of topography and isostatic compensation upon the intensity of gravity [with J. F. Hayford]. Spec. Pub'n. 10, U. S. Coast Geod. Surv., 132 pp., 1912.

Texas-California arc of primary triangulation. Spec. Pub'n. 11, U. S. Coast Geod. Surv., 141 pp., 1912. [Rev. in Bull. Amer. Geog. Soc., vol. 45, no. 1, p. 54 (Jan., 1913).]

Effect of topography and isostatic compensation upon the intensity of gravity. Spec. Pub'n. 12, U. S. Coast Geod. Surv., 28 pp. with 5 maps, 1912. [Rev. as "Gravity publications" by Dr. Kohlschütter, Petermann's Mitteil., p. 260, May, 1913.]

The precise level net of the United States. Eng. News, vol. 69, no. 16, p. 775 (Apr. 17, 1913).

The 17th general conference of the International Geodetic Association. Bull. Amer. Geog. Soc., vol. 45, no. 5, pp. 351-356 (May, 1913).

The adoption of the North American Datum. Bull. Amer. Geog. Soc., vol. 45, no. 8, p. 614 (Aug., 1913).

Determination of time, longitude, latitude and azimuth. Spec. Pub'n. 14, U. S. Coast Geod. Surv., 177 pp., 1913 [Rev. by David Rines, Science, vol. 38, no. 980, pp. 515-518 (Oct. 10, 1913).]

Isostasy (presented at Naval Observatory, Washington, Jan. 16, 1914).

Washington Society of Engineers (presented before Baltimore Soc. Eng., Feb. 24, 1914).

Isostasy and the size and shape of the earth (address at Atlanta, Georgia, with supplement, Dec. 20, 1913). Science, vol. 39, no. 1011, pp. 695-707 (May 15, 1914).

Isostasy in India (presented before Phil. Soc. Wash., Apr. 11, 1914). Abs., Jour. Wash. Acad. Sci., vol. 4, no. 10, pp. 245-249 (May 19, 1914).

Some geodetic evidence of isostasy. Abs., Jour. Wash. Acad. Sci., vol. 4, pp. 382-383 (1914).

The substitution of metal tapes and wires for bars in base measurements. Jour. Frank. Inst., vol. 177, no. 6, pp. 665-672 (June, 1914).

Recent development of precise leveling in the United States (presented to Amer. Ass'n. Adv. Sci., Sec. D., Philadelphia, Dec. 31, 1914).

Fourth general adjustment of the precise level net of the United States [with H. G. Avers]. Spec. Pub'n. 18, U. S. Coast Geod. Surv., 328 pp., 1914.

Primary triangulation along the 104th meridian and along the 39th parallel in Colorado, Utah and Nevada. Spec. Pub'n. 19, U. S. Coast Geod. Surv., 141 pp., 1914.

Precise leveling from Brighen, Utah, to San Francisco, California. Spec. Pub'n. 22, U. S. Coast Geod. Surv., 67 pp., 1914.

Symposium on the factors producing change in positions of strandline during Pleistocene and Post-Pleistocene (discussion Geol. Soc. Wash., Mar. 24, 1915). Abs., Jour. Wash. Acad. Sci., vol. 5, no. 12, p. 446 (June 19, 1915).

Astronomical and geodetic work in Alaska (unpublished address of June 23, 1915).

The geodetic work of the Coast and Geodetic Survey (presented before Phil. Soc. Wash., Apr. 10, 1915). Abs., Jour. Wash. Acad. Sci., vol. 5, no. 15, p. 557 (1915).

The errors in precise leveling due to irregular atmospheric refractions. Science, vol. 42, no. 1090, pp. 712-718 (Nov. 19, 1915).

Omaha's position on the earth's surface. The Omaha Bee, Feb., 1916.

Determination of the intensity of gravity on land in the United States (presented before Phil. Soc. Wash., Feb. 19, 1916). Abs., Jour. Wash. Acad. Sci., vol. 6, no. 7, pp. 187-188 (Apr. 4, 1916).

The one hundredth anniversary of the United States Coast and Geodetic Survey—Account of celebration. Science, vol. 43, no. 1115, pp. 655-656 (May 12, 1916).

Review of "The elements of surveying and geodesy" by W. C. Popplewell (London). Science, vol. 43, no. 1120, pp. 856-857 (June 16, 1916).

The contributions of geodesy to geography. Geog. Rev., vol. 2, no. 5, pp. 342-353 (Nov., 1916); Sci. Amer. Suppl., vol. 83, no. 2145, pp. 82-83 (Feb. 10, 1917).

Modern methods of precise leveling by the U. S. Coast and Geodetic Survey. Eng. and Contracting, vol. 47, no. 5 (Jan. 31, 1917).

The gravimetric survey of the United States. Proc. Nation. Acad. Sci., vol. 3, no. 3, pp. 171-177 (Mar., 1917).

Our present knowledge of isostasy (presented before Phil. Soc. Wash., Mar. 17, 1917). Abs., Jour. Wash. Acad. Sci., vol. 7, no. 9, pp. 269-270 (May 4, 1914).

Some evidences of isostasy (presented before Geol. Soc. Wash., Mar. 14, 1917). Abs., Jour. Wash. Acad. Sci., vol. 7, no. 10, pp. 311-312 (May 19, 1917).

Local versus regional distribution of isostatic compensation. Amer. Jour. Sci., vol. 43, pp. 471-475 (June, 1917).

Review of "Mean Sea Level at Datum for Elevations" by E. Lester Jones. Science, vol. 46, no. 1181, pp. 164-166 (Aug. 17, 1917).

Our present knowledge of isostasy from geodetic evidence. Jour. Geol., vol. 25, no. 5, pp. 422-445 (July-Aug., 1917); abs., Jour. Wash. Acad. Sci., vol. 7, pp. 267-268 (1917).

Investigations of gravity and isostasy. Spec. Pub'n. 40, U. S. Coast Geod. Surv., 196 pp. with 9 maps, 1917. [Abs. in Jour. Wash. Acad. Sci., vol. 7, no. 6, pp. 159-160 (1917).]

Specifications and instructions for preparation fire control and training maps. Chief Eng. U. S. Army, Reproduction Plant, Washington Barracks, D. C., 4610, 44 pp., 1917 (?).

Primary triangulation and precise leveling as done by the Coast and Geodetic Survey (presented before Phil. Soc. Wash., Jan. 5, 1918). Abs., Jour. Wash. Acad. Sci., vol. 18, no. 4, p. 105 (Feb. 19, 1918).

Oceanography in the Coast and Geodetic Survey (address at Cosmos Club, Washington, in honor of Dr. Frithof Nansen, Feb. 26, 1918).

The advantage of having maps. Memo. Mar 7, 1919.

Mapping the United States for civil and military needs (presented before Phil. Soc. Wash., Apr. 12, 1912). Abs., Jour. Wash. Acad. Sci., vol. 9, no. 15, pp. 447-449 (Sep. 19, 1919).

Report on the connection of the arcs of primary triangulation, Texas and Mexico. Spec. Pub'n. 54, U. S. Coast Geod. Surv., 93 pp., 1919.

Grid system for progressive maps in the United States [with O. S. Adams]. Spec. Pub'n. 59, U. S. Coast Geod. Surv., 227 pp., 1919. [Abs., Jour. Wash. Acad. Sci., vol. 9, no. 19, pp. 597-598 (Nov. 19, 1919).]

Board of Surveys and Maps of the Federal Government. Science, vol. 51, no. 1314, pp. 233-235 (Mar. 5, 1920).

Present status of geodesy and some of the problems of this branch of geophysics. Proc. Nation. Acad. Sci., vol. 6, no. 10, pp. 545-555 (Oct. 15, 1920). [Rep. Circ. Ser., Nation. Res. Council, no. 11, pp. 545-555 (Oct., 1920).]

The Kilauea Volcanic Observatory [with others] (Report of a Committee of the Nation. Acad. Sci.). Proc. Nation. Acad. Sci., vol. 6, no. 12, pp. 706-710 (Dec. 15, 1920).

Some geological conclusions from geodetic data. Proc. Nation. Acad. Sci., vol. 7, no. 1, pp. 23-28 (Jan., 1921). [Rev. in Sci. Amer. (Sep., 1921).]

The Pan Pacific Scientific Congress (presented before Phil. Soc. Wash., Oct. 23, 1920). Abs., Jour. Wash. Acad. Sci., vol. 11, no. 7, pp. 165-166 (Apr. 4, 1921).

The relation of isostasy to uplift and subsidence. Amer. Jour. Sci., vol. 2, no. 7, pp. 1-20 (July, 1921).

The topographical map of the United States. Geog. Rev., vol. 11, no. 3, p. 441 (July, 1921).

Research in geodetic work in the Pacific. Proc. First Pan-Pac. Sci. Conf., 1920, Bernice P. Bishop Mus., Spec. Pub'n. 7, Part 2, p. 452 ff. (1921).

Ocean currents and isostasy. Proc. First Pan-Pac. Sci. Conf., 1920, Bernice P. Bishop Mus., Spec. Pub'n. 7, Part 2, p. 503 ff. (1921).

The bearing of geodetic investigations on the geologic structure of the Pacific. Proc. First Pan-Pac. Sci. Conf., 1920, Bernice P. Bishop Mus., Spec. Pub'n. 7, Part 3, pp. 882-885 (1921).

Remarks on symposium of training scientists for Pacific work. Proc. First Pan-Pac. Sci. Conf., 1920, Bernice P. Bishop Mus., Spec. Pub'n. 7, Part 3, p. 926 (1921).

Scientific phases of charting waters and mapping the land (address before Amer. Ass'n. Adv. Sci., Sec. D, Toronto, Canada, 1921).

Mapping and charting (address before Amer. Ass'n. Adv. Sci., Sec. D, Toronto, Canada, 1921).

The yielding of the earth's crust (presented before Phil. Soc. Wash., Mar. 11, 1922). Ann. Rep. Smith. Inst'n. 1921, Pub'n. 2683, pp. 235-247, 1922; abs., Jour. Wash. Acad. Sci., vol. 12, no. 11, pp. 269-270 (June 4, 1922).

Theory of isostasy—A geological problem (lecture at Nation. Bur. Stand., Oct. 31, 1921). Bull. Geol. Soc. Amer., vol. 33, no. 2, pp. 273-286 (June 30, 1922).

The earth's crust and isostasy. Geog. Rev., vol. 12, no. 4, pp. 613-627 (Oct., 1922). [Rev. in Scot. Geog. Mag., vol. 39, no. 2 (Apr. 16, 1923).]

Geodetic operations in the United States, January 1, 1912, to December 31, 1921 (Rome report). Spec. Pub'n. 81, U. S. Coast Geod. Surv.,

26 pp., 1922. [Rev. by J. F. Hayford in Science, vol. 55, no. 1433, pp. 645-646 (June 16, 1922).]

Report on meetings of International Geodetic and Geophysical Union (presented before Phil. Soc. Wash., Oct. 21, 1922). Abs., Jour. Wash. Acad. Sci., vol. 13, no. 3, p. 43 (Feb. 4, 1923).

Ignorance of the world's natural resources as a cause for wars. Advocate of Peace, vol. 85, pp. 58-59 (Feb., 1923).

Board of Surveys and Maps. Science, vol. 57, no. 1476, pp. 436-437 (Apr. 13, 1923).

The present status of geodetic work in the United States and its value to geology. Amer. Jour. Sci., vol. 5, pp. 378-382 (May, 1923). [Abs. in Bull. Geol. Soc. Amer., vol. 34, no. 1, p. 74 (Mar., 1923).]

Review of Nansen's "The Strandflat and Isostasy." Amer. Jour. Sci., vol. 5, no. 29, pp. 428-432 (May, 1923).

Some recent progress in isostatic investigations (address before Amer. Geophys. Union, Apr. 19, 1923). Jour. Wash. Acad. Sci., vol. 13, no. 13, pp. 267-270 (July 19, 1923); abs., Bull. Nation. Res. Council, vol. 7, part 5, no. 41, pp. 95-96 (Jan., 1924).

Remarking of the initial point for surveys and maps in North America. Geog. Rev., vol. 13, no. 3, p. 465 (July, 1923).

Mapping the Pan-Pacific area. Bull. Pan-Pac. Union, 43, pp. 11-12 (1923).

Isostatic investigations and data for gravity stations established in the United States in 1915. 1923 (?).

Study of time errors in precise longtitude determinations by U. S. Coast and Geodetic Survey. Spec. Pub'n. 92, U. S. Coast Geod. Surv., 9 pp., 1923.

Geodetic and topographic mapping. Eng. News-Record, vol. 92, no. 3, p. 111 (Jan. 17, 1924).

Abnormal densities in the earth's crust disclosed by analysis of geodetic data. Geog. Jour., vol. 63, no. 1, pp. 26-33 (Jan., 1924). [Rev. in Amer. Jour. Sci., Apr., 1924, and in Nature, vol. 112, no. 2823, pp. 843-844 (Dec. 8, 1923).]

General conference of the International Geodetic and Geophysical Union (in "Report of Meeting of the International Geodetic and Geophysical Union and Its Sections Held at Rome, May 2-10, 1922"). Bull. Nation. Res. Council, vol. 7, part 5, no. 41, pp. 27-29 (Jan., 1924).

Report of the Section of Geodesy [in "Report of Meeting of the International Geodetic and Geophysical Union and Its Sections Held at Rome, May 2-10, 1922"] Bull. Nation. Res. Council. vol. 7, part 5, no. 41, pp. 29-32 (Jan., 1924).

Precise triangulation and level nets of United States. Eng. News-Record, vol. 92, no. 8, p. 330 (Feb. 21, 1924).

The accuracy of longitude determinations by the U. S. Coast and Geodetic Survey by wire signals and General Ferrié's proposed radio longitude net. Abs., Bull. Nation. Res. Council, vol. 7, part 5, no. 41, pp. 87-88 (Jan., 1924).

Some recent progress in isostatic investigations (presented at Fourth Annual Meeting of the American Geophysical Union, Washington, D. C., Apr., 1923, before the Section of Geodesy). Abs., Bull. Nation. Res. Council, vol. 7, part 5, no. 41, pp. 95-96 (Jan., 1924).

Earth movements in California as disclosed by triangulation (abs., with discussion by A. Keith, L. C. Graton, and A. C. Lawson). Bull. Geol. Soc. Amer., vol. 35, no. 1, pp. 60-62 (Mar. 30, 1924); abs., Pan-Amer. Geol., vol. 41, no. 2, pp. 134-135 (Mar., 1924).

Mountain building without loss of isostatic equilibrium (abs., with discussion by F. P. Shepard and W. H. Hobbs). Bull. Geol. Soc. Amer., vol. 35, no. 1, pp. 62-63 (Mar. 30, 1924); abs. Pan-Amer. Geol., vol. 41, no. 2, p. 135 (Mar., 1924).

Tertiary history of the north Atlantic Ocean (abs., with discussion by W. P. Woodring, Charles Schuchert, A. C. Lawson, and W. H. Hobbs). Bull. Geol. Soc. Amer., vol. 35, no. 1, pp. 84-85 (Mar. 30, 1924); abs., Pan-Amer. Geol., vol. 41, no. 2, pp. 142-143 (Mar., 1924).

The function of geodesy in surveying. Mil. Eng., vol. 16, no. 6, pp. 140-143 (Mar.-Apr., 1924).

Review of "Geodetic Evidence for the Supposed Westerly Drift of Greenland" by Col. Sir Charles Close. Amer. Jour. Sci., vol. 7, pp. 332-333 (Apr., 1924).

Stability of geodetic bench marks in United States—Results by U. S. Coast and Geodetic Survey in locations showing elevation change is of value to construction. Eng. News-Record, vol. 92, no. 18, p. 762 (May 1, 1924).

The use of geodetic measurements in detecting horizontal and vertical earth movements. Jour. Wash. Acad. Sci., vol. 14, no. 10, pp. 21-29 (May 19, 1924).

Isostasy in Holland. Amer. Jour. Sci., vol. 7, pp. 405-410 (May, 1924).

Gravity results in the MacKenzie Basin. Amer. Jour. Sci., vol. 7, pp. 411-412 (May, 1924).

The gravimetric survey of California. Pub'n. Astron. Soc. Pac., vol. 36, no. 211, pp. 107-111 (June, 1924).

The bearing of the theory of isostasy on some major geological problems. Jour. Frank. Inst., vol. 198, no. 2, pp. 181-200 (Aug., 1924). [Abs. in Mining Mag., London, Nov., 1924.]

On the size of the block of the earth's crust which may be independently in isostatic equilibrium. Jour. Wash. Acad. Sci., vol. 14, no. 15, pp. 355-362 (Sep. 19, 1924).

The importance of isostasy in geodetic research. Bull. Géodesique, Union Internat. Géod. Géophys., no. 3, pp. 194-213 (July-Sep., 1924).

Gravity observations on Indian Ocean and the results of their isostatic reduction. Nature, vol. 114, no. 2878, pp. 930-931 (Dec. 27, 1924).

The accuracy of longitude determinations by the Coast and Geodetic

Survey and General Ferrié's proposed longitude net. Proc. Pan-Pac. Sci. Cong., Australia, 1923, vol. 2, pp. 516-518 (1924).

Practical and scientific value of geodetic surveys. Proc. Pan-Pac. Sci. Cong., Australia, 1923, vol. 2, pp. 557-563 (1924).

The limiting depth of earthquake foci as indicated by seismic investigations. Proc. Pan-Pac. Sci. Cong., Australia, 1923, vol. 2, pp. 575-580 (1924).

Isostasy: Its importance in geological and geophysical investigations and research. Proc. Pan-Pac. Sci. Cong., Australia, 1923, vol. 2, pp. 1165-1168 (1924).

The theory of isostasy in its relation to major earth movements. Proc. Pan-Pac. Sci. Cong., Australia, 1923, vol. 2, pp. 1360-1366 (1924).

Isostatic investigations and data for gravity stations established in the United States since 1915. Spec. Pub'n. 99, U. S. Coast Geod. Surv., iv + 91 pp., 1924. [Rev. Nature, vol. 114, no. 2872, pp. 730-731 (1924); also Amer. Jour. Sci., vol. 8, no. 43, p. 98 (July, 1924).]

Geodetic operations in the United States and outlying possessions, January 1, 1922, to December 31, 1923 (Madrid report). Spec. Pub'n. 104, U. S. Coast Geod. Surv., iv + 28 pp., 1924.

Earth movements in California. Spec. Pub'n. 106, U. S. Coast Geod. Surv., 22 pp., 1924.

A gravimetric test of the "Roots of Mountains" theory. Ser. Pub'n. 291, U. S. Coast Geod. Surv., 8 pp., 1924.

Scientist suggests inventory of goods in world as surest guarantee of peace. Nation. News Serv. Weekly, Feb. 15, 1925.

Results of meeting of Section of Geodesy held at Madrid in September and October, 1924, which are of geological interest. Amer. Jour. Sci., vol. 9, pp. 180-186 (Feb., 1925).

The causes and prediction of earthquakes. Science, vol. 61, no. 1580, pp. 379-382 (Apr. 10, 1925).

Board of Surveys and Maps and aeronautics. Nation. Aeron. Ass'n. Rev., vol. 3, no. 4, pp. 56, ff. (Apr., 1925).

Isostasy at Madrid meetings of International Union of Geodesy and Geophysics. Pan-Amer. Geol., vol. 43, no. 5, pp. 337-344 (June, 1925).

Report of the Section of Geodesy [in "Report of the International Geodetic and Geophysical Union, and Its Sections at Madrid, October 1-10, 1924"]. Bull. Nation. Res. Council, vol. 10, part 3, no. 53, pp. 14-16 (July, 1925).

Scientists to weigh "floating" earth crust—Dutch geodesists will use submarine to test truth of new theory. New York Times, Sep. 6, 1925.

Scientists to test "drift" of continents. New York Times, Sep. 20, 1925; most of this article under title "Are the Continents Anchored?" appeared in The World Rev., Sep. 28, 1925.

The results of the meeting of the Section of Geodesy of the Internat. Union of Geod. and Geophys. of interest to astronomers. Pop. Astr., vol. 33, no. 7, pp. 423-430 (Aug.-Sep., 1925).

Volcanic science to make earth safer. New York Times, Oct. 11, 1925.
How mountains are made (radio talk, Apr. 15, 1925). Sci. Month., vol. 21, no. 10, pp. 404-408 (Oct., 1925).
Mapping the earth (talk before Washington Women's Club, Nov., 1925).
The ups and downs of the earth (radio talk, Dec. 3, 1925).
Isostasy in the Southern Pacific. Jour. Wash. Acad. Sci., vol. 15, no. 20, pp. 445-450 (Dec. 4, 1925). [Rev. in Nature, vol. 117, no. 2937, p. 246 (Feb. 13, 1926).]
The deflection of the vertical in Porto Rico. Jour. Wash. Acad. Sci., vol. 16, no. 2, pp. 29-31 (Jan. 19, 1926).
Geology from the isostatic viewpoint. Sci. Month., vol. 22, no. 1, pp. 5-18 (Jan., 1926).
Swinging pendulum measures longitude. Daily Sci. News Bull., Apr. 27, 1926.
Isostasy in Western Siberia. Amer. Jour. Sci., vol. 11, pp. 113-118 (Feb., 1926). [Rev. in Nature, vol. 117, no. 2941, p. 395 (Mar. 13, 1926).]
Eliminating drag effect in triangulation. Mil. Eng., vol. 18, no. 97, pp. 34-35 (Jan.-Feb., 1926).
Proposed theory, in harmony with isostasy, to account for major changes in the elevation of the earth's surface. Gerlands Beitr. Geophysik, vol. 15, no. 2, pp. 103-115 (1926).
Mapping the sky-ways. Western Flying, pp. 7, 28-29, Feb., 1926.
Notes on the Airy on "Roots of Mountains" theory. Science, vol. 63, no. 1632, pp. 371-374 (Apr. 9, 1926).
Earthquakes from the isostatic viewpoint. Jour. Wash. Acad. Sci., vol. 16, no. 9, pp. 245-250 (May 4, 1926).
The work of the Coast and Geodetic Survey. Cornell Civ. Eng., p. 193, May, 1926; rep. (somewhat abridged) under title "The Coast and Geodetic Survey," Tech. Eng. News, Mass. Inst. Tech., pp. 168-171, 188, 200 (Oct., 1926).
Submarine used to study gravity of ocean beds. U. S. Daily News, Sep. 16, 1926.
Pendulum observations between Holland and Java. Amer. Jour. Sci., vol. 12, pp. 273-274 (Sep., 1926).
Isostatic reductions of Spanish gravity stations. Amer. Jour. Sci., vol. 12, pp. 354-356 (Oct., 1926). [Rev. in Nature, vol. 119, no. 2983 (Jan. 1, 1927).]
Long lines of triangulation. Geog. Rev., vol. 16, no. 4, pp. 638-641 (Oct., 1926).
Discussion following Symposium on the constitution of the earth and the inferences to be drawn from it [with others]. Bull. Nation. Res. Council, vol. 11, part 2, no. 56, pp. 33-39 (Nov., 1926).
The trend of geodesy. Bull. Nation. Res. Council, vol. 11, part 2, no. 56, pp. 58-61 (Nov., 1926).
Relation of earthquakes to isostasy. Bull. Nation. Res. Council, vol. 11, part 2, no. 56, pp. 72-73 (Nov., 1926).

The Aleutian Islands from the standpoint of the geodesist and chart-maker. Bull. Nation. Res. Council, vol. 11, part 2, no. 56, pp. 121-124 (Nov., 1926).

The relation of isotasy to seismology. Amer. Jour. Sci., vol. 12, pp. 415-418 (Nov., 1926).

Use of gravity pendulum as a timepiece. Ser. Pub'n. 356, U. S. Coast Geod. Surv., 4 pp., 1926.

Isostatic condition of the United States, as indicated by groups of gravity stations. Ser. Pub'n. 366, U. S. Coast Geod. Surv., 11 pp., 1926.

Use of the gravity pendulum in the search for petroleum. Oil and Gas Jour., vol. 25, no. 35, pp. 80-84 (Jan. 20, 1927).

Review of "Schwerekraft und isostatische Kompensation in Norwegen" by W. Heiskanen. Amer. Jour. Sci., vol. 13, pp. 87-90 (Jan., 1927).

Measurement of length of line used in determination of velocity of light. Astroph. Jour., vol. 65, no. 1, pp. 48-56 (Jan., 1927); also rep. as App. III, in Cont. Mt. Wilson Obs., no. 329, pp. 14-22 (1927).

Importance of isostasy to mapping. Mil. Eng., vol. 19, no. 103, pp. 19-23 (Jan.-Feb., 1927).

The part played by isostasy in geophysics and geology (presidential address, Phil. Soc. Wash., Jan. 8, 1927). Jour. Wash. Acad. Sci., vol. 17, no. 5, pp. 101-117 (Mar. 4, 1927).

Importance of gravity observations in disclosing sub-surface structures. Bull. Assoc. Eng. Soc. (Illinois), Apr., 1927.

Isostasy. Book published by E. P. Dutton and Co., 681 Fifth Avenue, New York, xvi + 275 pp., 39 figs., July, 1927.

The effect of the shape of the geoid on values of gravity at sea. Amer. Jour. Sci., vol. 14, pp. 222-227 (Sep., 1927).

Some phases of the vertical movement of crustal material. Amer. Jour. Sci., vol. 14, pp. 253-258 (Oct., 1927).

Rapport sur l'isostasie (Report on isostasy). Travaux de la Section de Géodésie, Union Internat. Géod. Géophys., Madrid, 1924, vol. 4, 38 pp. (1927).

Geodetic operations in the United States, January 1, 1924, to December 31, 1926 (Prague report). Spec. Pub'n. 134, U. S. Coast Geod. Surv., iii + 34 pp., 1927.

The triangulation of the United States. Cornell Civ. Eng., vol. 36, no. 5, pp. 117-121 (Feb.-Mar., 1928).

An early comment on isostatic compensation. Amer. Jour. Sci., vol. 15, pp. 433-434 (May, 1928).

Isostasy and geological thought. Sci. Month., vol. 26, pp. 385, ff. (May, 1928).

Gravity in Western Canada. Amer. Jour. Sci., vol. 16, no. 93, pp. 263-266 (Sep., 1928).

The triangulation of North America. Geog. Jour. (London), vol. 72, no. 4, pp. 348-356 (Oct., 1928).

Seismology (Comments on)—Report of Advisory Committee, Carnegie

Institution of Washington. Carnegie Inst. Wash. Year Book no. 27, 1927-28, pp. 411-412 (Dec. 13, 1928).

The reliability of the spheroid derived by the isostatic method. Bull. Géodésique, Union Internat. Géod. Géophys., no. 20, pp. 495, ff. (Oct.-Dec., 1928).

Comments of Wegener hypothesis (Chapter in "Theory of Continental Drift," pub. by Amer. Ass'n. Petrol. Geol., pp. 178-186, 1928).

The importance of gravity determinations at sea. Proc. Pan-Pac. Sci. Cong., Japan, 1926, vol. 1, pp. 631-634 (1928).

Rapport sur l'isostasie (Report on isostasy). Travaux de la Section de Géodésie, Union Internat. Géod. Géophys., Prague, août 29-septembre 10, 1927, vol. 6, 32 pp. (1928).

Causes and prediction of earthquakes (Chapter in "Papers in Honor of Charles Frederick Johnson—Trinity College, 1928"). 1928.

Comparison of old and new triangulation in California. Spec. Pub'n. 151, U. S. Coast Geod. Surv., 50 pp., 1928. [Rev. in Nature, vol. 123, no. 3102, pp. 583-584 (Apr. 13, 1929).]

The stability of the earth's crust as tested by triangulation. Abs., Jour. Wash. Acad. Sci., vol. 19, no. 4, pp. 88-89 (Feb. 19, 1929).

Leveling up Mt. Whitney. Sierra Club Bull., Feb., 1929.

Weighing the earth from a submarine. Sci. Amer., vol. 140, pp. 218-221 (Mar., 1929). [Trans. in Boletin de Pescas, Instituto Español de Oceanografía, Apr., 1929.]

Possible origin of oceans and continents. Gerlands Beitr. Geophysik, vol. 21, no. 2/3, pp. 178-182 (1929).

Isostasy and geological thought. Sci. Month., vol. 28, no. 5, pp. 385-392 (May, 1929).

Carey V. Hodgson. Science, vol. 69, no. 1799, pp. 657-658 (June 21, 1929).

The Ohio arc of first-order triangulation. Bull. Géodesique, Union Internat. Géod. Géophys., no. 22, pp. 51-53 (Apr.-June, 1929).

The figure of the earth derived from triangulation methods. Amer. Jour. Sci., vol. 18, pp. 53-59 (July, 1929).

Au sujet des prismes verticaux de la terre ayant même masse. C.-R. Acad. Sci., vol. 189, no. 9, pp. 350-352 (Aug., 1929) and Erratum, ibid., p. 412, Sep., 1929.

Activities of the Surveying and Mapping Division of the Society. Proc. Amer. Soc. Civ. Eng., vol. 55, no. 7, pp. 1899-1901 (Sep., 1929) [Rep. by W. and L. E. Gurley Co., 4 pp., 1929.]

Note on a change, by the Coast and Geodetic Survey, in precise leveling methods. Bull. Géodésique, Union Internat. Géod. Géophys., no. 23, pp. 98-100 (July-Sep., 1929).

Tilting of mean sea level. Gerlands Beitr. Geophysik., vol. 23, no. 2, pp. 97-98 (1929). [Rev. by McArthur in Pac. Eng., Feb., 1930.]

Notable progress in surveying instruments. Sci. Month., vol. 29, no. 11, pp. 402-406 (Nov., 1929).

Zones of weakness in the earth's crust. Science, vol. 70, no. 1825, pp. 589-592 (Dec. 20, 1929).

An approximate method of making the isostatic reduction of gravity values. Bull. Géodésique, Union Internat. Géod. Géophys., no. 24, pp. 210-222 (Oct.-Dec., 1929).

Geography. Pop. Sci. Month., vol. 116, no. 1, p. 21 (Jan., 1930).

The scientific and practical value of triangulation. Jour. Wash. Acad. Sci., vol. 20, no. 4, pp. 53-59 (Feb. 19, 1930).

The status and importance of isostasy. Min. Metal., vol. 11, no. 278, pp. 93-95 (Feb., 1930). [Rep. in Oil and Gas Jour., Feb., 1930.]

Discurso del sr. Dr. William Bowie, representando a la Sociedad Geográfico Nacional, pronunciado en la Assemblea del Instituto Pan-Americano de Geografía e Historia el 7 de septiembre de 1929. Rev. Soc. Estudios Astronómicos y Geofísicos, México, D. F., vol. 2, no. 1, pp. 5-11 (Feb., 1930).

The triangulation system of the United States. Sci. Month., vol. 30, pp. 127-131 (Feb., 1930).

Bench marks established on trees. Eng. News-Record, vol. 104, no. 3, pp. 532-533 (Mar. 27, 1930).

Status and progress in the art of surveying and mapping. Proc. Amer. Soc. Civ. Eng., vol. 56, no. 3, pp. 453-463 (Mar., 1930). [Rep. as "Progress in the Art of Surveying and Mapping," in Pac. Eng., 12 pp., Sep., 1930.]

Crustal changes due to moon's formation. Gerlands Beitr. Geophysik, vol. 25, no. 2, pp. 137-144 (1930).

International co-operation in geographical work (Mexican address). Science, vol. 71, no. 1843, pp. 425-429 (Apr. 25, 1930).

Test of the Wegener hypothesis by means of geodetic data in India. Science, vol. 71, no. 1844, pp. 459-460 (May. 2, 1930).

Topographic map of entire country grows in year. U. S. Daily, June 17, 1930.

Azimuths on the Mississippi River arc of triangulation. Bull. Géodésique, Union Internat. Géod. Géophys., no. 26, pp. 33-39 (Apr.-June, 1930).

The origin of the moon. Mil. Eng., vol. 22, no. 123, pp. 199-203 (May-June, 1930).

Accomplishments in field geodesy during the year April, 1928, to April, 1929. Trans. Amer. Geophys. Union 1929 and 1930, pp. 36-40 (June, 1930).

Progress in geodetic work, April, 1929, to April, 1930. Trans. Amer. Geophys. Union 1929 and 1930, pp. 129-135 (June, 1930).

Some international problems in geodesy. Bull. Géodésique, Union Internat. Géod. Géophys., no. 26, pp. 33-39 (Apr.-June, 1930).

Discussion on "Exploring the Hidden Earth" with George W. Gray. World's Work, July, 1930.

Meeting of the International Union of Geodesy and Geophysics, Stockholm, Aug., 1930.

Elements of isostasy—Observations and interpretation. Sci. Month., vol. 31, no. 2, pp. 163-175 (Aug., 1930).

La importancia de la astronómia en las triangulaciones. Rev. Soc. Estudios Astronómicos y Geofísicos, vol. 2, no. 4, pp. 59-64 (Sep., 1930).

Approximate value of the depth of compensation from Japanese gravity data. Amer. Jour. Sci., vol. 20, pp. 220-222 (Sep., 1930).

Tilting of mean sea level. Illinois Eng., Oct., 1930.

Modernizing triangulation practice. Civ. Eng., vol. 1, no. 3, pp. 189-193 (Dec., 1930). [Feb., Mar., and Apr. numbers Civ. Eng. contain letters concerning this paper.]

Geodetic work done in California by U. S. Coast and Geodetic Survey (Report Advisory Committee in Seismology, Carnegie Institution of Washington). Carnegie Inst'n. Wash. Year Book 1929-30, no. 29, pp. 428-430 (Dec., 1930).

Report on isotasy (prepared for General Assembly Internat. Union Geod. Geophys., Stockholm, Aug., 1930). Mimeogr. ed., 27 pp., 1930.

Geodetic operations in the United States, January 1, 1927, to December 31, 1929 (Stockholm report). Spec. Pub'n. 166, U. S. Coast Geod. Surv., iv + 38 pp., 1930.

Notes on the activities and personnel of Coast and Geodetic Survey; progress on expanded plan for control surveys. Jour. Ass'n. Amer. State Geologists, Jan., 1931.

Modernizing triangulation practice—Improved instruments and equipment by Geodetic Survey. [Rev. in Civ. Eng., vol. 1, p. 429 (Feb., 1931).]

Isostasy (Chapter 7 of vol. 2 of series "Physics of the Earth" on "Figure of the Earth"). Bull. 78, Nation. Res. Council, pp. 103-115 (Feb., 1931).

Shaping the earth [presidential address. Wash. Acad. Sci., Jan. 15, 1931]. Jour. Wash. Acad. Sci., vol. 21, no. 6, pp. 103-125, Mar. 19, 1931. [Rep. in Ann. Rep. 1931, Smith. Inst'n., pp. 325-345, 1932.]

The determination of astronomical longitudes at some triangulation stations. Bull. Géodésique, Union Internat. Géod. Géophys., no. 29, pp. 52-54 (Jan.-Mar., 1931).

Raoul Gautier. Science, vol. 73, no. 1900, pp. 579-580 (May 29, 1931).

The preservation of old surveying instruments. Mil. Eng., vol. 23, no. 128, pp. 114-116 (Mar.-Apr., 1931).

Thickness of the ice in Greenland. Amer. Jour. Sci., vol. 21, pp. 406-408 (May, 1931).

The earth as an engineering structure (radio talk over Columbia Broadcasting System, Jan. 30, 1931). Sci. Month., vol. 32, no. 5, pp. 457-460 (May, 1931); U. S. Coast Geod. Surv., Bull. Ass'n. Field Eng., no. 3, pp. 63-66 (1931).

Scientists consider recent progress in studies of earth, geodetic survey extends progress of field work, and how knowledge of earth's shape aids map making. U. S. Daily, May, 1931.

Progress in geodetic work during the past year. Trans. Amer. Geophys. Union 1931, pp. 51-58 (June, 1931).

Geodetic work lays the basis for study of earth-movements. Trans. Amer. Geophys. Union 1931, pp. 65-66 (June, 1931).

Triangulation. Sci. Amer., vol. 144, pp. 369-373 (June, 1931). [Spanish trans. under title "Triangulaciones—Como y por que se Hacen", Ingeniera (Mexico), pp. 243, ff., July 1931.]

Basis of surveys over country being adjusted. U. S. Daily, 1 p., Sep. 16, 1931.

Hitching the shore line to the stars. Bull. Mer. Mar., pp. 6-7, Oct., 1931.

Mapping our country. Cornell Civ. Eng., Dec. 23, 1931.

Azimuth lines established at triangulation station. Bull. Géodésique, Union Internat. Union Géod. Géophys., no. 32, p. 311 (Oct.-Dec., 1931).

Sur une cause possible des tremblements de terra ne se manifestent pas a la surface du globe. C.-R., Acad. Sci., vol. 194, no. 6, pp. 507-508 (Feb. 8, 1932).

A method of testing Airy and Pratt isostasy. Gerlands Beitr. Geophysik, vol. 36, pp. 171-176 (1932).

Comments on isostasy made by authors of geological and geophysical books and papers. Nation. Res. Council, 49 pp., Apr., 1932 (mimeogr.).

Reports of Committee on Improvement in Gravity Instruments. Nation. Res. Council, Div. Geol. Geog., Apr., 1932 (mimeogr.).

What can ocean surveys accomplish? Philadelphia Ledger, Apr. 22, 1932.

Working with maps. New York Times, May 15, 1932.

Geodetic work accomplished from May 1, 1931, to April 30, 1942. Trans. Amer. Geophys. Union 1932, pp. 81-85 (June, 1932).

The standard theodolite of U. S. Coast and Geodetic Survey. Civ. Eng., vol. 2, no. 6, pp. 355-357 (June, 1932).

The great control surveys of the United States. U. S. Daily, July 26, 1932.

Locating geographic positions of boundary lines. U. S. Daily, Sep. 23, 1932.

Can the problems of oceans and continents be solved? Assoc. Press, Oct. 4, 1932.

The surfaces of the earth. Jour. Geol., vol. 40, no. 8, pp. 739-744(Nov.-Dec., 1932).

Rapport sur l'isostasie (Report on isostasy). Travaux de la Ass'n. Géodésie, Union Internat. Géod. Géophys., Stockholm, 11-23 août, 1930, vol. 8 (1932).

Gravity data (in volume on "Yellowstone-Beartooth-Big Horn region). 16th Internat. Geol. Cong., 1933, Guidebook 24, Excursion C-2, pp. 63-64, 1932.

Pratt or Airy? (Isostasy). Jour. State Russian Geog. Soc., vol. 65, no. 1, pp. 13-23 (1933). [In Russian.]

Early American boundary surveys. Civ. Eng., vol. 3, no. 2, p. 96 (Feb., 1933).

Recent developments in gravity apparatus. Science, vol. 77, no. 1995, pp. 308-310 (Mar. 24, 1933).

Triangulating the Continent of North America. Eng. News-Record, vol. 110, no. 13, pp. 405-406 (Mar. 30, 1933).

Report of Committee on Isostasy. Ann. Rep. 1932-33, Nation. Res. Council, Div. Geol. Geog., App. I, Apr., 1933 (mimeogr.).

Precise geodetic measurements and their relation to seimological investigations. Trans. Amer. Geophys. Union 1933, pp. 284-286 (June, 1933).

Preserve the landmarks. Eng. News-Record, vol. 111, no. 6, p. 172 (Aug. 10, 1933).

One hundred years of control surveys. Civ. Eng., vol. 3, pp. 467-478 (Aug., 1933).

The use of Laplace azimuths in the adjustment of triangulation. Bull. Géodésique, Union Internat. Géod. Géophys., no. 39, pp. 237-249 (July-Aug., 1933).

Protect the surveying mark (orig. mss. title "Landmarks too valuable not to be carefully kept"). The State, Columbia, S. C., Oct. 15, 1933, and other newspapers.

Surveying and mapping the United States. Mil. Eng., vol. 25, no. 143, pp. 386-389 (Sep.-Oct., 1933).

Geodetic operations in the United States, January 1, 1930, to December 31, 1932 (Lisbon report). Spec. Pub'n. 178, U. S. Coast Geod. Surv., 25 pp., 1933.

Geodetic surveying (Chapter in "Vocational Guidance in Engineering Lines"). Amer. Ass'n. Eng., 1933 (?).

Gravity stations on the Nile Delta. Science, vol. 79, no. 2053, pp. 410-411 (May 4, 1934).

A comparison of isostasy in India and in the United States and Southern Canada. Gerlands Beitr. Geophysik, vol. 41, no. 2, pp. 250-260 (1934). [Abs. in Zs. Geophysik, vol. 10, no. 5/6, pp. 93-94 (1934).]

Planning without maps. Eng. News-Record, vol. 113, no. 2, p. 57 (July 12, 1934).

Resurveying the coast of Connecticut. Ann. Rep., Conn. Soc. Civ. Eng., pp. 44, ff., July, 1934.

Control surveys furnish framework for airway maps. Air Commerce Bull., vol. 6, no. 5, pp. 111-112 (Nov. 15, 1934).

The use in the United States of geodetic control surveys in testing the stability of the earth's surface (presented before Pac. Sci. Cong., Vancouver, Canada, June, 1933). Proc. Pac. Sci. Cong., vol. 2, pp. 1279-1283 (1934).

Isostasy and its importance in geological and geophysical investigations and research (presented before Pac. Sci. Cong., Vancouver, Canada, June, 1933). Proc. Pac. Sci. Cong. 1933, vol. 2, pp. 1165-1168 (1934). [Abs. in Pan-Amer. Geol., vol. 66, no. 3, pp. 232-233 (Oct., 1936).]

Working with maps (address before South Carolina Society of Engineers June 15, 1934). Geodetic Letter, no. 8, 1934.

Fundamental geodetic surveys in the United States nearing completion (address before Nation. Acad. Sci., Nov. 19, 1934). Proc. Nation. Acad. Sci., vol. 21, no. 1, pp. 32-36 (Jan. 15, 1935). [Rev. in Nature, vol. 135, no. 3414, p. 559 (Apr. 6, 1935).]

Appui donné a la Géodésie par le Gouvernement des États-Unis de l'America du Nord. C.-R. Acad. Sci., vol. 200, no. 5, pp. 366-368 (Jan. 28, 1935).

The work of the Coast and Geodetic Survey (lecture before Ass'n. Amer. State Geol., Washington, Feb. 23, 1935).

Geodetic control net aided by PWA-financed work. Eng. News-Record, vol. 114, no. 9, pp. 316-317 (Feb. 28, 1935).

The present status of geodetic surveys (lecture at Nation. Bur. Stand., Mar. 1, 1935).

The value of maps to all of us (radio interview between Prof. J. C. Dodds and W. Bowie at Iowa State College, Ames, Iowa, Mar. 6, 1935).

Review of "Measurements of Gravity over the Nippon Trench." Science, vol. 81, no. 2100, p. 309 (Mar. 29, 1935).

The work of the Coast and Geodetic Survey in Texas. Eleventh ann. short course in highway engineering, College Station, Texas, Apr. 13, 1935.

Dust storms cover survey monuments. Press release, Apr. 17, 1935.

Survey monuments do not mark buried treasure. Press release, Apr. 20, 1935.

Surveying and mapping entering a new era (presented in Seventh Ann. Inst. Government, Los Angeles, June 10, 1935).

Significance of gravity anomalies at stations in the West Indies. Bull. Geol. Soc. Amer., vol. 46, no. 6, pp. 869-878 (June 30, 1935).

Astronomical work of the United States Coast and Geodetic Survey. Astro. Soc. Pac., leaflet 77 (June, 1935).

The geodetic work of the Coast and Geodetic Survey and its uses (lecture before Iowa Eng. Soc. and Eng. Ext. Serv., Iowa State College, Mar., 1935). Geodetic Letter, vol. 2, no. 6, pp. 4-13 (June, 1935).

Status of national control surveys. Bull. Amer. State Geol., July 1, 1935.

Surveying and mapping in the curricula of departments of civil engineering of our universities. Sent to Civ. Eng., July 29, 1935.

Gravity at sea (embodied in Report of Special Committee on Geophysical and Geologic Study of Oceanic Basins). Trans. Amer. Geophys. Union 1935, part I, p. 7 (Aug., 1935).

Mapping the country. Trans. Amer. Geophys. Union 1935, part I, pp. 61-62 (Aug., 1935).

Isostasy (lecture before Iowa Eng. Soc. and Eng. Ext. Serv., Iowa State College, Ames, Iowa, Mar. 6, 1935). Sci. Month., vol. 41, no. 3, pp. 234-239 (Sep., 1935).

The use of triangulation in boundary surveys. Bull. Pan-Amer. Union, vol. 69, pp. 694-699 (Sep., 1935).

Use of ball bearings as leveling turning points. Bull. Géodésique, Union Internat. Géod. Géophys., no. 47, pp. 367-370 (July-Sep., 1935).

Absolute gravity survey in Gulf Coast States would be of great value to petroleum industry [with W. L. Baker and others]. Oil Weekly, vol. 79, no. 9, pp. 38, 39, 42, 44, 46 (Nov. 11, 1935).

The origin of oceans and continents. Sci. Month., vol. 41, no. 5, pp. 444-449 (Nov., 1935).

U. S. Coast and Geodetic Survey helps to map nation. Bull. Balto. Eng. Club., vol. 10, no. 6, pp. 5-9 (Dec., 1935).

Science in the United States Coast and Geodetic Survey (presented before Nation. Acad. Sci., Apr. 22, 1935). Jour. Frank. Inst., vol. 220, no. 6, pp. 719-731 (Dec., 1935).

Basic survey data essential to industry. Oil Weekly, vol. 79, no. 9, pp. 40-46 (1935).

Can the national control surveys help engineers? Illinois Soc. Eng., 1935 (?).

Working with maps (address before South Carolina Engineering Society, meeting June 14-15, 1934, at Charleston, S. C. [Pub. as "Importancia de las cartas geográficas", Pan-Amer. Inst. Geog. e Historia, Pub'n. 16 (1935).]

Control survey costs lowered by engineering parties of the Coast and Geodetic Survey. 1935.

Employment on control surveys. 1935.

Astronomical work of the United States Coast and Geodetic Survey. 1935.

The national mapping plan (address before Ass'n. State Geol., Oct. 1, 1935). Jour. Ass'n. Amer. State Geol., vol. 6, no. 4, pp. 8-10 (Jan., 1936).

The national mapping plan of the National Resources Board (address before Nation. Acad. Sci., Charlottesville, Virginia, Nov. 20, 1935). Science, vol. 83, no. 2144, pp. 94-95 (Jan. 31, 1936).

No maps in a mapping age. Civ. Eng., vol. 6, no. 2, pp. 88-90 (Feb., 1936); also in Amer. Soc. Photogrammetry, Jan.-Mar., 1936, Canadian Surveyor, Apr., 1936, Geodetic Letter, June, 1936, Jour. Ass'n. Chinese Amer. Eng., p. 298, Sep.-Oct., 1936, Louisiana Conserv. Rev., Jan., 1937.

Status of geodetic surveys in the United States of North America. Amer. Soc. Civ. Eng., Feb., 1936.

Benefits of Arkansas boundaries. Arkansas Gaz., vol. 12, no. 5, pp. 1-2 (Mar. 29, 1936).

Status of work of the Coast and Geodetic Survey of importance to geologists. Jour. Ass'n. Amer. State Geol., vol. 7, no. 2, pp. 21-28 (Apr. 1, 1936).

State co-operation in Geodetic Survey to bring topographic maps up to date: The leveling of California. Cal. Highways and Pub. Works, pp. 22-24, Apr., 1936.

Science in the United States Coast and Geodetic Survey. Hydrog. Rev., Internat. Hydrog. Bur., vol. 13, p. 99 (May, 1936).

Geodetic surveys in the United States of North America. Jour. Ass'n. Chinese Amer. Eng., vol. 17, pp. 99, ff. (Mar.-Apr., 1936).

Vertical movements of earth's crust as determined by leveling. Jour. Geol., vol. 44, no. 3, pp. 387-395 (Apr.-May, 1936).

Local densities affect values of gravity. Jour. Geol., vol. 44, no. 4, pp. 510-514 (May-June, 1936).

Coast Geodetic Survey—Explanation of its hydrographic work being with geodetic work (communication to Geodetic Survey of Canada, July 6, 1936).

The place of geodesy in geophysical research (paper in Symposium on recent trends in geophysical research). Trans. Amer. Geophys. Union 1936, part I, pp. 15-20 (July, 1936).

More levels and maps needed. Eng. News-Record, vol. 117, no. 7, p. 247 (Aug. 13, 1936).

Maps aid engineering and planning (address before Eng. Club of Trenton, New Jersey, Dec. 10, 1936).

Highway location can be helped by geodetic surveys. Texas Parade, Dec., 1936.

Geodetic operations in the United States, 1933-1935. Spec. Pub'n. No. 207, U. S. Coast Geod. Surv., 25 pp., 1936.

Geodetic work of the United States of America. Jour. Russian Geog. Soc., 1936 (?).

Maps aid oil and gas industries. Oil and Gas Jour., 1936.

The place of surveying and mapping in the curricula of educational institutions (report as Chairman, Committee on Surveying and Mapping in Engineering Industries, Division of Engineering and Mapping, Amer. Soc. Civ. Eng.). 1936 (?).

The need for maps (talk before British Ass'n. Adv. Sci., Blackpool, England, Sep. 14, 1936). Mil. Eng., vol. 29, no. 163, pp. 42-43 (Jan.-Feb., 1937).

Isostasy (address before British Ass'n. Adv. Sci., Blackpool, England, Sep. 10, 1936). Sci. Month., vol. 44, no. 4, pp. 353-357 (Apr., 1937).

Map makers and map users. Civ. Eng., vol. 7, no. 4, pp. 273-276 (Apr., 1937).

Response on occasion of exercise in honor of Major William Bowie on his retirement from the Coast and Geodetic Survey held on Jan. 4, 1937. Bull. Géodésique, Union Internat. Géod., Géophys., no. 54, pp. 162-168 (Apr.-June, 1937).

The need for maps. Jour. Ass'n. Chinese Amer. Eng., Mar.-Apr., 1937.
Address as President of Internat. Union Geod. Geophys. at Edinburgh, Sep. 17, 1936. Union Internat. Géod. Géophys. Sixième Assemblée Générale réunie à Édinbourg, 14-25 septembre 1936, pp. 30-38 (1937).
Map makers and map users. Jour. Ass'n. Chinese Amer. Eng. vol. 18, no. 5, pp. 336-346 (Sep.-Oct., 1937).
The objectives of the Pan-American Institute of Geography and History. Pan-Amer. Inst. Geog. History, 8 pp., 1937.
Topographic maps a national asset. Virginia Eng., 1937.
Geologists need maps. Min. Metal., vol. 19, no. 374, pp. 99-101 (Feb., 1938).
Taking stock of national mapping. Civ. Eng., vol. 8, no. 4, pp. 266-267 (Apr., 1938).
Survey and map control (lecture before Inst. Government, Los Angeles, June, 1938).
Map projection (lecture before Inst. Government, Los Angeles, June, 1938).
Adjustments in the crust of the earth (lecture before Inst. Government, Los Angeles, June, 1938).
National mapping. Eng. Bull., Colorado Soc. Eng., July, 1938.
Otto Hilgard Tittmann. Science, vol. 88, no. 2283, pp. 292-294 (Sep. 30, 1938).
Shape and size of the earth. Sci. Month., vol. 47, no. 12, pp. 506-510 (Dec., 1938).
Use of triangulation. Mil. Eng., vol. 30, no. 174, pp. 397-399 (Nov.-Dec., 1938).
Life work in geodesy. Lehigh Alumni Bull., Mar., 1939.
The importance of co-operation in international science. Finnisches Geodätisches Inst. 1918-1938. Veroff. no. 261, p. 15 (1939).
The gravity anomaly, an important factor in earth science. Science, vol. 91, no. 2355, pp. 158-160 (Feb. 16, 1940).
Isostasia. Rev. Geografica, Inst. Geog. e Historia, vol. 1, no. 1, pp. 12-19 (Jan., 1941).

Memorandum of Biographical Accounts of William Bowie Consulted

William Bowie. *Bull. Géodesique,* No. 54, pp. 150-188 (1937). [Includes: William Bowie, by F. A. Vening Meinesz and G. Perrier; International Scientist honored, William Bowie retires from Coast and Geodetic Survey, Press Memorandum of January 4, 1937; Exercises in Honor of Major William Bowie on his retirement from the Coast and Geodetic Survey held on January 4, 1937, with remarks by Commander C. L. Garner, H. G. Avers, W. D. Lambert, Lieutenant H. W. Hemple, Commander J. H. Hawley, and reply by Major Bowie; Papers by Dr. William Bowie which appeared in Special Publications

of the Coast and Geodetic Survey; and List of Articles and Papers by Dr. William Bowie.]

Captain William Bowie (Retired). Report No. 2185, submitted by E. J. Hart for the Committee on Merchant Marine and Fisheries (to accompany S. J. Res. 247), House of Representatives, 75th Congress, Third Session, April 21, 1938, 6 pp.

Dr. William Bowie by H. St. J. L. Winterbotham. *Nature,* vol. 146, p. 645 (Nov. 15, 1940).

William Bowie by C. R. Longwell. *Amer. Jour. Sci.,* vol. 238, pp. 889-890 (1940).

William Bowie. Obituary in *Bull. Coast and Geodetic Survey,* 1940.

El Dr. William Bowie by P. C. Sanchéz. *Revista de Historia de America,* no. 9, pp. 1-4 (Aug., 1940).

Memorial to William Bowie by N. H. Heck. *Proc. Geol. Soc. Amer.,* 1940, pp. 163-166 (1941).

William Bowie. *Geog. Rev.,* vol. 31, pp. 156-157 (1941).

William Bowie as an Isostasist and as a Man by W. Heiskanen. *Trans. Amer. Geophys. Union,* vol. 30, no. 5, pp. 629-635 (Oct., 1949).

Also consulted were:

Various publications of William Bowie issued by the United States Coast and Geodetic Survey during 1912-1937, and correspondence between Professor W. H. Burger of Northwestern University and William Bowie.

Much helpful information was supplied by Dr. Bowie's old associates, namely, Captain Clement L. Garner (Bowie's immediate successor as Chief of the Division of Geodesy), Captain H. W. Hemple, Hugh C. Mitchell, C. H. Swick, J. A. Duerksen, and others at the Coast and Geodetic Survey. Librarian H. D. Harradon of the Department of Terrestrial Magnetism of the Carnegie Institution of Washington, a long-time friend of Dr. Bowie, assembled much of the material for this memoir.