

NATIONAL ACADEMY OF SCIENCES

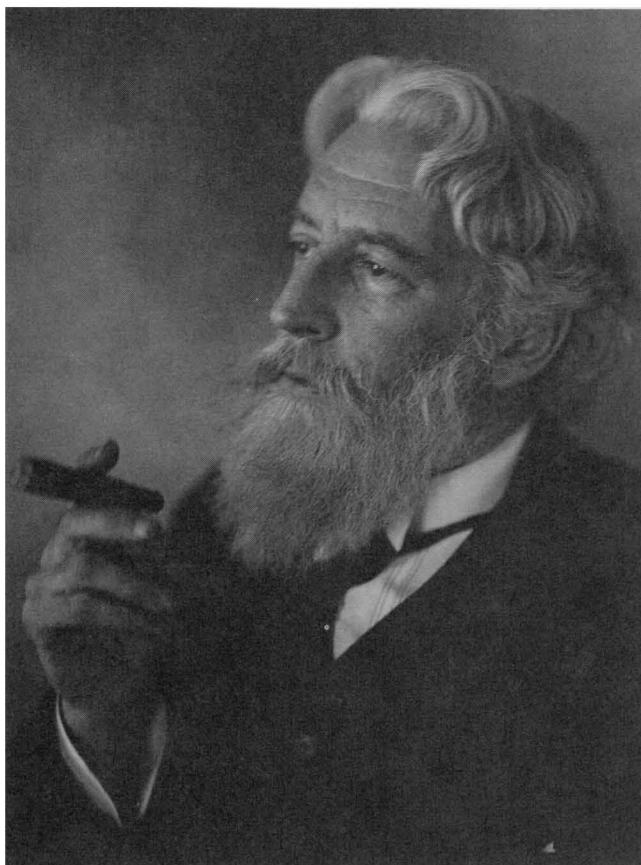
HENRY STEPHENS WASHINGTON
1867—1934

A Biographical Memoir by
CHARLES MILTON

*Any opinions expressed in this memoir are those of the author(s)
and do not necessarily reflect the views of the
National Academy of Sciences.*

Biographical Memoir

COPYRIGHT 1991
NATIONAL ACADEMY OF SCIENCES
WASHINGTON D.C.



Courtesy, NAS Archives

Hy W. Washburn.

HENRY STEPHENS WASHINGTON

January 15, 1867—January 7, 1934

BY CHARLES MILTON

The National Academy of Sciences memorializes its members in a series of Biographical Memoirs written by colleagues from their personal knowledge of and esteem for dear departed friends. Strangely, no Academy memorial exists in commemoration of Henry Stephens Washington, one of its most eminent members, whose name and work to this day—full fifty-five years since his death—are known and honored by geologists throughout the world. Aware of this, Dr. Elizabeth J. Sherman, editor of the Biographical Memoir series, searched for an author to write an appropriate memoir, realizing that it might be difficult, if not impossible, to find anyone now living who, besides having a vivid memory of seeing and hearing the great man, had also devoted many long hours to arduous study of his works. Yet I am one such—perhaps the only one who still remains—and so accepted the task despite the special difficulties posed by there being none whose memories I could share.

At first I did not know that so many had hastened to record, in words of moving eloquence, their admiration and even awe of a most extraordinary man. It then became clear to me that any conventional memoir of Washington belatedly written today would be untimely and incongruous. Better instead a summary, assembled from the many scattered sources, giving the known facts of his life. These I have duly listed and annotated, along with references to his many publications; the extensive citations from contemporary memorials and

tributes; available portraits; and lastly, appraisal by a recognized authority of the lasting significance of Washington's greatest achievement, the CIPW systematization of igneous rock taxonomy.

It is in pondering the lives and deeds of great men that we, too—to some degree at least—may approach greatness and thereby enlarge our own lesser lives. Henry Stephens Washington was indeed such a great man.

HENRY STEPHENS WASHINGTON was born in Newark, New Jersey, on January 15, 1867, the son of George and Eleanor Phoebe (Stephens) Washington and descendant in the collateral line from the family of George Washington. He died after several years of illness in his New York City home on January 7, 1934.

Washington's boyhood years were spent on the family homestead estate in Locust, New Jersey, where his father acted as his chief teacher. The family was wealthy, and "he was the product of a cultured home with plenty of servants" (Clark, 1978). When Washington was twelve years of age, an old smokehouse on the estate was remodeled into a chemical laboratory, and a year later the boy was making quantitative analyses.

After attending private schools and preparing for college under tutors, he entered Yale College at fifteen. There he received his first academic training under J. D. Dana, E. S. Dana, G. J. Brush, S. L. Penfield, and H. L. Wells. After graduating in 1886 with an A.B. and special honors in natural science, he held the Silliman Fellowship in physics and was assistant in physics until he took the A.M. degree in 1888. In his first paper (with W. F. Hillebrand in 1888), he described the crystallography of rare copper arsenates from Utah. He then spent four years in extensive travel in the West Indies, Europe, Egypt, Algeria, and Asia Minor. He acquired an unusual knowledge of languages—not only German, French, and Italian, all of which he could write and speak fluently—

but also modern Greek, Spanish, and Portuguese, even Arabic and Turkish.

During the winter semesters of 1891–92 and 1892–93 he studied under F. Zirkel and C. H. Credner at the University of Leipzig, where he took the Ph.D. degree with highest honors in 1893. His dissertation, *The Volcanoes of the Kula Basin in Lydia*, was published in New York in 1894.

Later that year he married Martha Rose Beckwith, and for the next two years they lived alternately in Navesink, New Jersey and Venice, Italy. He had also joined the American School of Classical Studies at Athens, taking part in and conducting archeological excavations (some of which he funded) at several Greek sites. The results of this work, done with his brother Charles at Phlius in 1892, were published many years later in the *American Journal of Archaeology* (1923).

IGNEOUS ROCK NOMENCLATURE AND CLASSIFICATION

In 1895 he returned to Yale, where he made rock analyses for Professor L. V. Pirsson, equipped his own New Jersey laboratory where he would work for the next ten years, and assisted Professor E. S. Dana in mineralogy. In 1897 he began analyzing a suite of rocks collected in Norway and comparing it with a suite from Essex County, Massachusetts. Finding rocks of practically the same mineralogical and chemical composition occurring in connection with magmas of quite diverse characters, he urged (in 1898) the need for systematization of igneous rock nomenclature and classification.

CROSS, IDDINGS, PIRSSON, AND WASHINGTON:

THE CIPW NORM¹

J. P. Iddings and Whitman Cross had been working on the same problem and they met with Washington and Pirsson

¹ The description of the CIPW norm that follows was contributed to this memoir by Felix Chayes.

in 1899. For three years the four worked together, producing in the end the first systematic, quantitative, chemico-mineralogical classification of igneous rocks.

His part in this project was certainly one of Washington's most significant and enduring contributions to the science of geology: transforming the "coordinates" of an igneous rock composition—the list of essential oxide amounts reported in the bulk analysis—into the chemical coordinates now known as the "CIPW norm." The new variables were clearly intended as proxies for mineral compositions. Each has the simplified, "end member" composition of the anhydrous mineral whose name is abbreviated to form the symbol. (The only exceptions to this rule are the rarely encountered alkali-silicates, which have only formula names, and for which, incidentally, mineral analogues are either unknown or vanishingly rare.)

The ingenious schedule of calculation that determines which of perhaps as many as a dozen of the thirty possible components are present in the norm of a particular analysis, and in what amounts, is one of the signal triumphs of the golden age of American petrography. Washington's actual role in the development of the system is not easily assessed, for its creation was one of the earliest and most successful examples of collaboration in our science, and none of the authors (W. Cross, J. P. Iddings, L. V. Pirsson, and H. S. Washington) ever said publicly which of them was responsible for any particular aspect of the system.

They described their new system in a series of articles in the *Journal of Geology*, reproduced in book form in 1902 under the editorship of Cross. (It is curious that, although the four authors continued scientific activity for many years and remained close friends, there is no further record that they ever published jointly again.)

From the original articles it is clear that—in the minds of

its authors—normative calculation was important primarily as a taxonomic device. The relative amounts of several subsets of the normative components, or “standard minerals,” formed the basis for an elaborate “quantitative classification of igneous rocks.”

This classification was used extensively by Iddings and Washington in their own further work. Indeed, it controls the structure both of Iddings’ magnificent petrological treatise, *Igneous Rocks* (2 vols., 1909–1913), and of Washington’s monumental *Chemical Analyses of Igneous Rocks* (USGS Professional Paper 99, 1903)—a quarto volume of some 600 pages containing the analyses essential to the CIPW project and discussions of numerous additional analyses as well. Perceiving the need for a textbook of instruction in the methods of rock analysis, Washington published a manual in 1904 that, with its three later editions, established standard analytical procedures in laboratories all over the world.

Yet during the first third of the century, the CIPW classification system was used rather gingerly, never achieving the general acceptance accorded a number of its contemporary competitors. This was perhaps because its basic parameters were chemical rather than petrological or mineralogical, and chemical analyses were both expensive and rare. Petrologists were also discouraged by the formidable complexity of a system that included specific suffixes to denote classes, orders, rangs, grads, subclasses, suborders, subrang, and pigeonholes. Today, though sometimes mentioned in theoretical discussions of taxonomy, it is hardly ever used in the practical classification of igneous rocks.

What survives—and thrives—of the CIPW system is the norm calculation itself. Generations of petrologists have discovered that the rules governing it neatly exploit an extraordinary familiarity with the mineral assemblages actually encountered in the commoner igneous rocks, and in many of

the relatively rare ones as well. Despite the oversimplified definitions of the "standard minerals" and their anhydrous character, the norm often provides a characterization of rock composition more immediately meaningful than the oxide vector. And even when qualitative agreement (or compatibility) of normative model assemblages is less than optimal, there is usually something to be learned from the discrepancy. Finally, in a development none of the authors could have anticipated, the norm proved invaluable in the critical business of characterizing the components and defining the "systems" studied in the phase equilibrium experimentation that was to begin in the next decade and would for so long remain central to experimental petrology.

At this time Washington and seven other earth scientists were also planning the research program for the Carnegie Institution of Washington's soon-to-be-established Geophysical Laboratory. He spent five months in 1905 collecting igneous rocks in the Mediterranean region, and in 1906 the Carnegie Institution published a 199-page volume of his petrologic studies of the Roman comagmatic volcanic region. In other publications his studies covered rocks from Liberia, Greece, Norway, Turkey, Germany, and America.

THE DARK YEARS (1906–1912)

"One day disaster struck him. He came home from a trip to find that his wife had left him, taking most of his money with her. This almost wrecked his career. There followed a period of bewilderment and despair. He floundered like a rudderless ship. Finally, he had to face reality: for the first time in his life, he had to get a job." (Martin, 1953)

The preceding "period of intense activity . . . now gave place . . . to a six-year period of uncertainty and anxiety during which Washington traveled, and used his laboratory intermittently . . ." (Merwin, 1952). Then, "when [financial] re-

verses came, he grudgingly gave part of his time to consulting work as a mining geologist, and in this connection he maintained an office in New York from 1906 to 1912" (Lewis, 1935), though still finding time to serve—from 1909 until 1914—on the Board of Managers of the New Jersey Geological Survey.²

GEOPHYSICAL LABORATORY OF THE CARNEGIE
INSTITUTION OF WASHINGTON

Only in 1912, when he joined the staff of the Carnegie Institution of Washington's Geophysical Laboratory, could he once more devote himself wholly to research. Yet, even during the preceding sad interlude of his life,

"... under the less rigid laboratory routine, Washington gave thought to problems of a more general type; the distribution of the elements in igneous rocks, submarine volcanic eruptions, and ... mineral nomenclature; and in spite of interruptions, his analytical and petrographic work yielded nearly a dozen papers." (Merwin, 1962)

A year or two after joining the Geophysical Laboratory staff his (childless) marriage was ended with divorce. For the rest of his life he remained unmarried and worked continuously with the Geophysical Laboratory.

In 1914—with Arthur L. Day, director of the Geophysical Laboratory—he visited the active volcanoes of the Mediterranean. The analytical work he did there and throughout the world resulted in papers on igneous rocks from Sardinia, Pantelleria, Brazil, Colorado, India, Rockall, and Stromboli, in which he presented views on several chemical and mineralogical relationships. In 1917 he began giving his attention to sources and production of potassium salts. In 1919, while at the American Embassy in Rome, he served as an American

² *Who Was Who in America* (Chicago: Marquis Who's Who, Inc., 1968).

delegate to the International Geodetic and Geophysical Union's organizational meeting in Belgium.

The following January, once again home in Washington, D.C., he addressed the Arts Club regarding recent archaeological activity in Rome, published *Ave Roma immortalis*—an affectionate poetic tribute to Italy, and began preparing the report on the excavations he had conducted at Phlius nearly thirty years earlier. "His interest in archaeology was permanent, and he repeatedly applied chemical and petrographical methods to the study of its special problems" (Whitman Cross, 1936).

"That spring [of 1918], during the organization of the American Geophysical Union, he was made chairman for volcanology . . . a few weeks later he sailed for Honolulu as delegate to the First Pan-Pacific Scientific Conference, where he presented two papers on volcanoes and one on ocean currents. While in the Hawaiian Islands he and several of his many friends collected volcanic rocks from numerous localities for his future studies. At the final dinner, part of the entertainment was a poem by Washington, 'Pele³ to the Pan-Pacific'. . . ." (Merwin, 1952)

During the war years (1918–19), Washington served as chemical associate and scientific attaché at the American Embassy in Rome.

From 1920 to 1924, he collected—from the vast literature accessible in the library of the United States Geological Survey—a great number of new igneous rock analyses, whose good quality reflected the two decades in which his 1904 *Manual*, and its later editions, had instructed the world's analysts in proper procedures of rock analysis. In 1917, *Chemical Analyses of Igneous Rocks published from 1884 to 1913, inclusive, with a critical discussion of the character and use of analyses* appeared as *USGS Professional Paper 99*—a massive quarto

³ Pele is the Hawaiian goddess of volcanoes. *Editor's note.*

volume of 1,201 pages, containing 8,600 analyses, "all of them superior." (Cross, 1936)

"In 1922 he became vice-president of the Geological Society of America, and also of the Section of Volcanology of the International Geophysical Union . . . in 1924 he was President of the Mineralogical Society of America, and from 1926 to 1929 Chairman of the American Geophysical Union. . . . With the preparation, in 1930, of the fourth edition of his book on methods of chemical analysis came failing health through the remaining three years of his life, during which he wrote little. . . ." (Merwin, 1952)

In the forty-five years—1887 to 1932—of Washington's active professional life, he produced 169 publications (some four each year), practically all substantial contributions to archaeology, regional and descriptive petrology, geochemistry and geophysics, and mineralogy. Many of these, in their respective fields, are of major significance and enduring value.

HONORS AND SERVICE TO THE SCIENTIFIC COMMUNITY

Much honored throughout his life, Washington ". . . was happy in the recognition accorded his work by fellow-workers at home and abroad, as indicated by official positions and honorary memberships to which he was elected. He was a member of the National Academy of Sciences from 1921, the Geological Society of America (vice-president, 1922), Mineralogical Society (president, 1924), American Philosophical Society, American Geophysical Union (chairman, 1926–1929), International Geophysical Union (vice-president, 1922), the Académie de France, and the Washington Academy of Sciences. He was a cavalier of Italy's Order of the Crown, a foreign correspondent of the Geological Society of London and of the Sociedad Española de Historia Natural, a foreign member of the Academia dei Lincei, Società Geologica Italiana, the Modena, Norway and Turin

Academies, and an honorary member of England's Mineralogical Society. (Information taken from Fenner, 1934.)

WASHINGTON THE SCIENTIST
AS HIS CONTEMPORARIES SAW HIM

H. S. Washington's long scientific career brought him much acclaim from his scientific peers, whose assessments, excerpted here, can best give an idea of the importance and scope of his work:

"When one considers the complexity of the earth's crust, it may be concluded that anything beyond an intelligent guess as to the composition of the crust lies beyond the power of the human mind. And yet here are two men who not only gave us the composition, but gave it to three significant figures! Let us see what manner of men they were, and how they managed to analyze so huge a mass as the earth.

"Frank Wigglesworth Clarke was chief chemist of the U.S. Geological Survey from 1883 until shortly before his death in 1931. Henry Stephens Washington (1867-1934) can only be described as a 'freelance' chemist. He was over 50 before he ever worked for a salary.

"Clarke was the pioneer in the great project of analyzing the earth's crust. He published his first estimate of the composition of the crust as early as 1889. Washington published his first estimate in 1903. . . . In 1908 Clarke published his great treatise, *The Data of Geochemistry*. This went through five editions and remains to this date the Geological Survey's all time 'bestseller.' . . . In 1920, Washington and Clarke collaborated on a revision of their estimates. It is thus evident that the project occupied a good portion of the professional careers of both men. . . . It is interesting to compare these various estimates. . . . It is astonishing how little these values changed through the years despite the accumulation of new data.

"It has been said that Washington and Clarke were mere compilers of other people's data. . . . On the contrary, their careers illustrate beautifully the proper idea of compilation. They did not compile data merely for the convenience of others, as do the makers of handbooks. Rather, they compiled data in order to learn the story the data had to tell. They were creative compilers. . . .

"In his writings, Washington revealed an idealism about quantitative analysis that transcends even the idealism of Stas or Richards. . . . 'The

balance and weights should therefore be regarded with a feeling akin to reverence, and the balance case looked upon, so to speak, as a sanctum sanctorum.' . . .

"These two men established an enduring record in the greatest analysis of all time." (Martin, 1953)

WASHINGTON THE MAN
AS HIS CONTEMPORARIES SAW HIM

Such were his achievements, but what of the man himself? For this, we must, once more, turn to the recollections of those who knew him:

"One of the most eminent and picturesque personalities in American science . . . always intensely interested in many intellectual fields . . . he possessed a remarkable store of knowledge regarding ancient peoples, their origins and mode of life and their monuments, inscriptions and art. He was widely read, had a very retentive memory, and there were very few topics on which he was not able to converse with much more than superficial knowledge. His familiarity extended to such varied subjects as botany, philology, literature, the development of social customs, and [the] culinary art. . . .

"Washington took much delight in associating with congenial friends, and was one of the most active members of the Cosmos Club of Washington. In more public assemblages his features and bearing were of a character to make him an outstanding figure. His was a many-sided and exceptional personality, in many ways almost unique. His contributions to science are of lasting value." (Fenner, 1952)

"*Professional Paper 99* . . . is known to every geologist in the world. To those of Washington's acquaintances unfamiliar with the more earnest side of his character—the amount of patient investigation and even drudgery to which he was willing to devote himself in this work is almost unbelievable." (Fenner, 1934)

"With a finely formed head surmounted by a thick mass of wavy white hair, large luminous brown eyes, a Roman nose and full red lips enmeshed in a dense curly white beard, Dr. Henry S. Washington . . . is a picturesque, distinguished, and attractive-looking man. He is as interesting as he looks . . . he is friendly and democratic . . . but never familiar. Learned, he is

never pedantic. He is delightful in conversation for he is an attentive listener, never argumentative, and when he differs, though definite, he is never autocratic or apostolic. . . . He is filled with the joy of living. His favorite sports are golf and billiards. He is fond of music and can strum an instrument. He enjoys poetry, and on occasion can compose a smooth-flowing, subtle sonnet. . . . With a gift of tongues . . . his reading ranges . . . all printed matter except gossip and scandal about which he is completely incurious. Curiously . . . though he has . . . had adventures galore, he is not anecdotally inclined, though most interesting when he is drawn out." (Munroe, 1925, cited by Merwin, 1952)

"Washington's magnetic personality was enriched by his brilliant intellect, broad culture, and his genuine interest in and knowledge of an astounding range of topics, not only in the physical and natural sciences, but in literature, history, music, art, archaeology, ethnology, and philology. Following the intense seriousness of his research and his writing he found relaxation in the lighter mood, and his lively wit and keen sense of humor were a constant source of delight to those who had the privilege of knowing him." (Lewis, 1935)

"He was hospitable and generous . . . and was popular in many circles. A cigar was his constant companion, and he handed one to whomever he met. It was playfully suggested that tobacco-ash accounted for the high percentages of potash in his analyses." (Spencer, 1936)

Much of Washington's nonprofessional life centered around the Cosmos Club in Washington, where he found among its distinguished members many congenial friends. Commemorating its centenary in 1978, the Club produced *The Cosmos Club of Washington, a Centennial History, 1878-1978*, edited by Wilcomb E. Washburn, in which pages 291-93, by Austin H. Clark, are devoted to Henry Stephens Washington:

"Henry Stephens Washington (1867-1934)—Harry to a few close friends—used to describe himself as the enemy of every wife in Washington. One of the most learned and versatile, and at the same time most jolly and companionable, of our Club members, he was the friend of everyone, old and young. For he had something in common with all. He

belonged to that coterie of scholars, now almost extinct, with an interest in everything . . . the product of cultured homes with plenty of servants and no distracting radios or television sets, and thus able to devote all their time to their special intellectual pursuits.

"He was convivial and highly gregarious . . . an enthusiastic devotee of bridge, billiards, and cowboy pool, a cheerful partner or adversary at any game. Their fondness for his company often led them to spend their evenings at the Club when they should have been at home with their wives.

"Harry was moderately good at all games, but he did not take them too seriously. He played for relaxation, with a complete absence of that grim tenseness that characterizes so many players. He did not seem to care whether he won or lost, which made him popular with some, much less popular with others. I can still hear his cheerful 'Sorry, partner' when he lost a game of bridge. His partner was sorry, too, but not cheerfully sorry.

"Conversationally, he was at home on almost any subject.

". . . the Club gave a reception to a group of foreigners which included the President of Haiti, a very large, very stately, and very courteous man. Most of the Club members did not seem to know he was in the room. Seeing the situation, Harry introduced himself, and the two had a long and cordial conversation in French.

"Although a rather extreme conservative in his views of society, Harry was perfectly willing to concede to others the right of having other ideas. I especially remember one evening after a dinner given by Cleveland Moffett, spent mostly in a lively though entirely friendly discussion of the merits and demerits of Socialism with that enthusiastic advocate of Socialism, Charles E. Russell.

"Although Harry Washington was so well known and so well liked by the Club members, most of them regarded him as a bit of a mystery, for his really intimate friends were few and he was very reserved about his personal affairs. The city clerk of Newark, New Jersey, where he was born, writes me that there seems to be no record of his birth in the Bureau of Vital Statistics. . . ." (Clark, 1978)

REFERENCES

1933

Edward B. Mathews. "Memorial to J. P. Iddings." *Bull. Geol. Soc. Amer.* 44:4-6.⁴

1934

S. Kozu. *J. Japan. Assoc. Min. Petr. Econ. Geol.* 12:41-44. With two portraits.

———. *Nature* 133:557-8.

C. N. Fenner. "Henry Stephens Washington." *Science*, New Series 79:47-48. Bibliography (89 titles). Portrait.

L. J. Spencer. *Quart. J. Geol. Soc. London* 90:xlix-l; *Mineral. Mag.*, 304-5.

J. Volney Lewis. Memorial of Henry Stephens Washington. *Amer. Mineral.* 28:178-84. Portrait.

1935

Obituary notice. Report of the Board of Management, Century Assoc.⁵

1936

Tom F. W. Barth. Henry Stephens Washington. *Mineralog. Petrogr. Mitt.* 47:371-2.

1936

W. Cross. Washington, Henry Stephens. *Dict. Am. Biog.* 19: 527-8.⁶

⁴ Mathews devotes two pages to the history of the CIPW System of igneous rock classification and Washington's participation therein.

⁵ This eight-line note suggests that Washington was a member of the Century Association (or Club), but the author could find no record of this elsewhere.

⁶ In addition to the printed biographical accounts cited here, Cross lists *Yale University Obituary Record* (1934) and *Washington Post* (January 8, 1934). He also refers to a memoir he was preparing for the National Academy of Sciences's *Biographical Memoirs*, which was never completed.

1952

Herbert E. Merwin. Memorial to Henry Stephens Washington. *Proc. Geolog. Soc. Amer.* Annual Report 1951, pp. 165–173. Bibliography (189 titles).⁷

1953

Albert R. Martin. The Great Analysis. *Journal of Chemical Education* 30:566–68. Portraits of Washington and Clarke. Reprinted from *The Capital Chemist* 3(1953):92.⁸

1968

Henry Stephens Washington. In: *Who Was Who in America*. Chicago: Marquis Who's Who, Inc.

⁷ With fourteen biographical references and a portrait, this is perhaps the most detailed memoir of Washington.

⁸ Frank Clarke was chief chemist of the U.S. Geological Survey from 1883 to 1931, author of *Data of Geochemistry*, and a most unusual scientist and human being. Martin is the only author who refers to the cause of Washington's unhappy period from 1906 to 1912.

BIOGRAPHICAL MEMOIRS
SELECTED BIBLIOGRAPHY

1891

Discovery of a temple of archaic plan (Plataia). *Am. J. Arch.* 7(1891):1b.

1894

The volcanoes of the Kula Basin in Lydia (Ph.D. diss., University of Leipzig). New York: Drummond. 67 pp.

1902

With W. Cross, J. P. Iddings, and L. V. Pirsson. A quantitative chemico-mineralogical classification and nomenclature of igneous rocks. *J. Geol.* 10:555–690.

1906

The Roman comagmatic region. *Carnegie Inst. Washington Publ.* 57. 199 pp.

1913

The volcanoes and rocks of Pantelleria. *J. Geol.* 21:653–70; 22:16–27.

1915

The correlation of potassium and magnesium, sodium and iron, in igneous rocks. *Proc. Natl. Acad. Sci. USA* 1:574–8.

1916

An apparent correspondence between the chemistry of igneous rocks and of organic metabolism. *Proc. Natl. Acad. Sci. USA* 2:623–6.

1917

Chemical analyses of igneous rocks, published from 1884 to 1913, inclusive, with a critical discussion of the character and use of analyses: a revision and expansion of *Professional Paper 14. U.S. Geol. Surv., Prof. Pap.* 99. 1201 pp.

1919

Manual of the chemical analysis of rocks. 3rd ed. New York: John Wiley & Sons.

1920

The chemistry of the earth's crust. *J. Franklin Inst.* 190: 757–815.

1923

The density of the earth as calculated from the densities of Mauna Kea and Halekala. *J. Washington Acad. Sci.* 13:453–6.

Remarks on the study of sedimentation by artificial precipitation. *Nat. Res. Council (U.S.) Rept. Comm. on Sedimentation*, pp. 66–8.

1924

Report of the section of volcanology. *Bull. Nat. Res. Council (U.S.)* 41.

With F. W. Clarke. The composition of the earth's crust. *U.S. Geol. Survey Prof. Pap.* 127.

1925

How petrography can aid stone producers. *Explosives Eng.* 3: 331–3.

1926

Review of B. K. de Prorok. *Digging for lost African gods.* New York: G. P. Putnam's Sons, 1926. *Art Archaeol.* 22:103–4.

The eruption of Santorini in 1925. *J. Washington Acad. Sci.* 16:1–7.

1927

Abstract of F. Zambonini and G. Carobbi. A chemical study of the yellow incrustation on the Vesuvian lava of 1631. *Am. Mineral.* 12:1–10.

1928

Europe's volcanoes. *Sci. News Lett.* 13:215–6.

Review of J. Jakob. *Anleitung zur chemischen Gesteinsanalyse*, Berlin. *J. Am. Chem. Soc.* 51:955–6.

1929

The rock suites of the Pacific and the Atlantic ocean basins. *Science* 69:554-5.

1930

The analysis of rocks. New York: John Wiley & Sons.

The earliest recorded rock analysis. *J. Maryland Acad. Sci.* 1: 253-4.

1932

Review of A. N. Winchell. *A descriptive petrography of the igneous rocks*, vol. 1. *Introduction, textures, classification, and glossary*. Chicago. *J. Geol.* 40:182-5.

1939

The crust of the Earth and its relation to the interior. Reprinted in *Physics of the Earth V. Internal constitution of the Earth*, ed. B. Gutenberg, pp. 91-123. New York: McGraw-Hill.

1951

With L. H. Adams. The chemical and petrological nature of the earth's crust. Reprinted in *Physics of the Earth V. Internal constitution of the Earth*, 2nd ed., B. Gutenberg, pp. 81-106. New York: McGraw-Hill.

Post Scriptum

*On October 4, 1990, while this manuscript was in press, its author, Charles Milton, died. He was 94 and so eloquent geologist Brian Skinner was once moved to write to him: "Perhaps you would have been a professional storyteller had not mineralogy claimed you first. It would have been mineralogy's loss. . . ."*⁹ *Dr. Milton's correspondence with the editor of the Biographical Memoirs includes much of interest—not only to geologists (many of whom are mentioned therein)—but to all who treasure elegance of style or have considered the nature and purpose of biography. We are, therefore, reproducing these letters in their entirety for our readers' information and pleasure. Their quality honors the memory of the splendid author who wrote them. Editor's Note*

On April 7, 1989, I wrote to Charles Milton (still to be found, at 93, in his office at the U.S. Geological Survey) and invited him to prepare a memoir of Henry Stephens Washington. Dr. Milton replied immediately and at length:

Dear Dr. Sherman:¹⁰

When I read your letter of April 7, my first reaction was amazement. For, incredible as it may seem to you, this last month or two Henry S. Washington has been very much in my thoughts, and I have wanted to know a good deal more of his life and work than I do now, and wondered how to obtain such information. And then out of the blue sky, came your letter, offering me just that!

Let me explain: For a long time I have been worrying, myself and

⁹ In a letter from Brian J. Skinner to Charles Milton, dated August 16, 1988, regarding Milton's historical review of the Oldoinyo Lengai "natrocarbonate lava" and the account of his long association with Hans Eugster. A copy of this essay is now in the possession of the National Academy of Sciences archives.

¹⁰ Dr. Milton wrote all his letters to the Academy on a computer, with the type extending to the extreme edges of the page. The letters printed here are unedited and include his somewhat idiosyncratic style of punctuation.

other people, about PSEUDOLEUCITE; a mineral which, early in this century, and following his studies of volcanic leucite-bearing lavas in Italy, Washington first identified and named; and ever since, pseudoleucite has become established in petrologic science; notably in studies of Arkansas igneous geology, with which I have long been concerned; e.g. and most recently, Flohr and Ross, 1989. For many years I have hoped that someone would take a very close look at pseudoleucite and its history, seeing that I did not have the data to do it myself. So for that reason alone, were there no other, I would be inclined to give very serious consideration to the pro's and con's of your offer.

Some of the pros: I have vivid memories of Henry S. Washington. I saw him, a towering eminence, at G.S.A. meetings, in years long past; only I may yet remain, with such memories. And many, many were the days when I—and countless students more—pored over his monumental CIPW System of igneous rock classification. From Professor W. S. Bayley (a hundred years ago, he was the first Johns Hopkins geology Ph.D.) did I come to know of the rocks of the earth, and of Henry S. Washington. It is incumbent on us, a pious duty, to record chronicles of the great of our times, for instruction and inspiration of those who will come, when we are gone.

Cons: I am a very old man and know from experience that you propose for me no simple or easy task. And with present commitments, it may well be a year before I could commit myself to steady work on the project, and well take another year, for completion. The odds on being alive, *compos mentis et corpore sano*, at 95, are dubious. . . .

So; if you still wish to consider me for the job, we should meet and discuss it further, with the understanding that it would be next year before I could really get to work on it.

You will understand my natural curiosity as to how you thought of me; we have never met before; and a modest and reclusive disposition has preserved me from public notice. It is however possible that your colleague and my good friend Bill Benson drew your attention to me. If such be the case, please tell him that on the occasion of the Hans Eugster Memorial Symposium in Baltimore last year, I compiled a review of the history of the Oldoinyo Lengai Natrocarbonatite Lava in Tanzania; in which, he figures most creditably indeed. Copies will be available, for anyone interested at the International Geological Congress Alkaline Rock and Carbonatite Symposium in Washington this summer; and I shall send him a copy.

One other possibility is my friend Felix Chayes, former president of the Mineralogical Society of America, and leading authority on chemical

igneous rock classification and the Washington-Cross-Iddings-Pirsson (CIPW) System.

If neither of these, could you tell me who?

And one final thought: surely among the obituaries and Memorial pages of many learned journals, there should already be ample recording of the career and accomplishments of a scientist of such great renown as Henry S. Washington? If not, it would indeed be a sad commentary on the evanescence of human fame, that not so long after his death, only some obscure scrivener could be found, to take note, that a great man once lived.

Upon receiving the information that Michael Fleischer, of the National Museum of Natural History, had suggested him as a possible author along with offprints of the memoirs of A. F. Buddington (volume 57) and James Gilluly (volume 56), Dr. Milton immediately replied:¹¹

Your letter of April 18 with its most interesting enclosures has given me great pleasure. The impressive picture of Henry S. Washington is just as I remember seeing him; and the accompanying correspondence and his colleagues' memoirs tell me much about him personally that I could not otherwise have known. This material at first glance appears ample for compiling an article such as the two of Arthur ("Bud") Buddington and James ("Jim") Gilluly, two splendid men whom I have known more than just casually: Professor Buddington most helpfully critically reviewed one of my first beginner's publications; and Jim Gilluly some 50 years ago nominated me for G.S.A. Fellow.

And the authors of these memoirs: Harold ("Hal") L. James, senior geologist, U.S.G.S.; and Thomas ("Tom") B. Nolan, former director, U.S.G.S., to whom I owe more than I can ever repay; this was alluded to in a memoir written last year on the occasion of the Johns Hopkins Symposium honoring the memory of a very great geologist, Hans Eugster. (In that memoir, also gratefully acknowledged, by name, is the help at a critical juncture of my life, of National Science Foundation Bill Benson and Dick Ray. Mike Fleischer also had a significant, if unrecorded, part in the tale And so it was Mike ("my best friend and implacable critic"), and not Bill Benson or Felix Chayes, who gave you my name. Well, I'll be seeing him at the Museum and will thank him accordingly.

¹¹ Letter of April 21, 1989.

Strange how your more or less random selection "from a vast majority," of these two memoirs, has evoked this surge of memory . . . there comes to mind the old Arabian tale, wherein Shaharazad tells of the traveler in the desert, throwing aside pits from his frugal date repast; and suddenly the sky darkened and from it appeared a monstrous *jinni*, scimitar drawn, crying "O vile wretch, prepare to die, for with that stone so cruelly cast, thou did'st slay my beloved only son!" Whereby, we are instructed, that only Allah, the All-Knowing, knows all of what we do . . . and, perhaps more to the point here, what we are—or were.

For Henry Stephens Washington has now been dead fifty-five years, and all who knew him, are gone too; and I may be the only one living who knew him, even distantly. What then can we now know of him? We have some contemporary biographic material, and an impressive bibliography of over 150 books and papers, all solid contributions to science, many outstanding, even classics, in their day. Obviously he was immensely capable and productive; and furthermore, well endowed with social graces: a *bon vivant*, and fluent in ten languages, ancient and modern.

His long-time colleague at the Geophysical Laboratory, C. N. Fenner, a well-known geologist, and Austin H. Clark, fellow-member of the (all-male) Cosmos Club¹² have written most of what we know of him. Fenner, in four typed, double-spaced pages, describes him, justly, as "one of the most eminent and picturesque personalities in American science," and "he took much delight in associating with congenial friends . . . a many-sided and exceptional personality, in many ways almost unique." Clark, in three printed pages, emphasizes his bonhomie and conviviality. Yet, "although so very well known and so well liked by the Club members, most of them regarded him as a bit of a mystery, for his really intimate friends were few, and he was very reserved about his personal affairs."

Now glance at the two memoirs, of Buddington and Gilluly. I have read them once more, with close attention; as I also did, the recollections of H. S. Washington by those with whom he worked and lived. Reading James on Buddington, and Nolan on Gilluly, was a joy: besides it being my good fortune to have known all four personally, the two memoirs convey a warmth of feeling for an honored and beloved friend; they also tell of cherished relationships with students and colleagues; of lifelong happy

¹² At the time when Dr. Milton wrote this letter, the Cosmos Club's all-male status was being challenged in the courts. The reference demonstrates Dr. Milton's keen involvement with the world, despite his advanced years. (The Club subsequently resolved the matter by voting to admit women members.) *Editor's note.*

marriages, blest with loving children—on all of these, the recordings of those who once knew and worked with Henry S. Washington, are silent. In his lifetime, he loomed, a towering presence, over lesser mortals; and now he is gone, vanished in thin air; with but a few dry bones and dusty scrolls remaining, to tell us that he once lived among us.

You have asked me, and I have agreed, to write a memoir. But what can I do, more than re-arrange and assemble the wording of the records you have given me; as a palaeontologist would assemble scattered bones, hoping at best to construct a plausible skeleton, not an image, of a creature that once lived and died, long, long ago? A biographer should only write what he knows as fact; and he should not moralize over what he does not know.

With such limitations, if you still wish, I shall try to prepare, to the best of my ability, a Henry S. Washington memoir acceptable for the Academy series, by the end of this year; which of course you are free to accept or reject. But should you now feel that this might be in better hands than mine, please don't hesitate to tell me.

No thought of "better hands" could follow such a letter, and I sent Dr. Milton offprints of memoirs on W. H. Bradley (volume 54), Milton N. Bramlette (volume 52), Ernst Cloos (volume 52), and Chester Ray Longwell (volume 53). Later in our correspondence, Dr. Milton offered the following thoughts on the purpose of biography:¹³

These last few weeks I have been thinking about meeting with you to discuss the Henry Stephens Washington Memorial, on which I have been working: and it was a pleasant surprise to find in your letter of October 3, that you had been thinking likewise. So if convenient for you, a day in November after the 10th would also be [good] for me; I shall have returned from a couple of weeks of meetings in Arkansas and California; and will call you to arrange a day and time, perhaps simplest, in the afternoon at your Academy office.

However, before I leave Washington, you will have a rough draft of what I would think would be appropriate in a Henry Stephens Washington Memoir written today, a half century after his death. You may approve it or disapprove it; in either case, it will certainly be an interesting topic to discuss at our meeting.

¹³ Letter of October 5, 1989.

However, you should consider, as my study of the matter has led me to believe, that very special circumstances argue against the National Academy now publishing a Memoir of Washington, modeled on the six splendid examples you gave me to follow (on Gilluly by Nolan, Bradley by McKelvey, Longwell by Rodgers, Buddington by James, Cloos by Waters and Stanley, and Bramlette by Gilluly). Because it has been my good fortune to have known personally most of these thirteen men, there is in my mind no question, but that these Memoirs have well served their purpose of ritual memorialization; written timely, they evoke in their readers responsive sentiments, of taking part in grateful tribute to a departed friend.

For Washington such a Memoir, written now, would be incongruous and redundant. Incongruous, because all who once knew and esteemed him, are now long departed with him. Redundant, because many dear friends did write Memoirs, some wonderfully eloquent and revealing; and in them, ancillary services, bibliographies and portraits. There is a time for everything; and in my opinion, worthy Memoirs of Washington have already been duly written, thirty, forty, fifty years ago. One more such, appearing today, would only be perceived as a belated and awkward gesture by the Academy, in discharge of a duty long neglected.

Then what may there be, that should be done? There is a way, that would both honor his memory, and be a service to geologists of this generation, and of those to come. In my reading of all I could find on Washington's life and work, I learned that Henry Stephens Washington was truly a most memorable, indeed almost super-human being. And it is by pondering the lives of great men, that we ourselves become inspired to strive for whatever small measure of achievement we may attain.

As a child, I read Longfellow's

"Lives of great men all remind us
We can make our lives sublime,
And departing, leave behind us
Footprints on the sands of Time."

and now that I am an old man, and perhaps a bit wiser, I will say that this jingle, for all its preachy patter, really has a grain of truth.

Washington's story has been told, and told well; but in scattered, fragmentary articles, often difficult to find. A comprehensive and definitive account of the main events of his life and works, assembled from many sources and retold in the eloquent words of their authors; with an annotated listing of sources of information, and of published bibliographies; portraits; and a critical summary and evaluation, by an outstanding

authority in the fields of geochemical and petrological science, of Washington's role in establishing their basic standards—this I think would be a project which the Academy might consider.

I already have the first four of the six biographic notices which you list. The fifth is presumably in Italian, but I would like to see it, and will try to get it translated. The sixth, also by Pelloux (?) may be in French; I have not seen it and will read it. Both are probably in our Geological Survey Library.

... Since you have expressed some interest in my style of writing, a few more items are enclosed: the unfortunate Wilhelm Eitel Memoir;¹⁴ something I wrote last year in connection with a Memorial Symposium honoring Hans P. Eugster (1925–1987); and a recent contribution, read in July at the International Geological Congress Symposium on Alkalic Rocks and Carbonatites.¹⁵ You may find them mildly interesting. (Lots of others didn't, though.)

After a trip to Arkansas and California, Dr. Milton sent in a draft of the Washington memoir and promised to come to the Academy for lunch. He also submitted his article to Felix Chayes, Michael Fleischer, and Hatten S. Yoder for review. On December 27, the Academy received a revised version of the Washington memoir forwarded by Dr. Nancy J. Byrd at Dr. Milton's request.¹⁶ She informed us that Dr. Milton had fallen down his steps, fracturing his cheekbone and five ribs. On March 23, 1990, I sent back the edited manuscript and received a reply from Dr. Milton's son, Daniel J. Milton (also a geologist with the U.S. Geological Survey in Reston, Vir-

¹⁴ Dr. Milton had written a biography of Eitel for Scribners' *Dictionary of Scientific Biography*, only to have it "bowdlerized, amputated, gutted" when that publication came under new management. "There was nothing I could do about it," the unhappy author wrote, "not even wipe my name off the mutilated carcass; for they had paid me \$50 and it was legally their property."

¹⁵ See n. 9 above.

¹⁶ She also sent several papers Dr. Milton had published, including the "Note on a Drawing by M. C. Escher," *Journal of the Washington Academy of Sciences* 63(1973):91, in which Dr. Milton (citing the contribution of David Fleischer) discusses the philosophical significance of the chess position, "smothered doom," pictured in the Escher drawing, *Metamorphose*.

ginia), who kindly read over the manuscript and answered my queries:

My father is very pleased to see the edited H. S. Washington ms. . . . [He] is much better. Earlier in the winter I would have thought the chance of his reaching his 94th birthday, which is three weeks from tomorrow, was negligible, but he is getting along pretty strongly. He can read, which he couldn't for the first two or three months, and even get out of bed with help and take a few steps with a walker. Most important, his mood is vastly improved, and consequently that of everyone involved with him also. . . .

Charles Milton lived well into his 94th year. His letters reflect a breadth of education, engagement with the world, and enthusiasm rare at any age. It is a pleasure to include his correspondence here, together with his final published work—a tribute to a scientist he so much admired. E. J. Sherman, Editor