

NATIONAL ACADEMY OF SCIENCES

ERNEST HARRY VESTINE

*1906—1968*

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*A Biographical Memoir by*  
SCOTT E. FORBUSH

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*Biographical Memoir*

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WASHINGTON D.C.



*Ernest Harry Votine*

# ERNEST HARRY VESTINE

*May 9, 1906—July 18, 1968*

BY SCOTT E. FORBUSH

ERNEST HARRY VESTINE was born in Minneapolis, Minnesota on May 9, 1906, the son of Swedish parents, Frida Christine (Lund) and Olaf Vestine, who left the United States to live near Edmonton, Alberta. Here he received all his early education and a B.Sc. degree from the University of Alberta in 1931. In 1932 he joined the Canadian Meteorological Office in Toronto, where he was occupied with meteorological and geomagnetic measurements.

During the Second International Polar Year (1932–33), Vestine led the Canadian expedition to Meanook in northern Alberta, Canada, where he established and operated a new magnetic observatory, an installation which continues to provide important magnetic data from the auroral region. While at Meanook, he made some of the most significant observations of noctilucent clouds—authoritatively described in his comprehensive 1934 review article.

In September 1934 he left the Canadian Meteorological Office for graduate study in England, and in 1937 received a Ph.D. and a Diploma of the Imperial College of Science and Technology from the University of London. His Ph.D. thesis, done under Professor Sydney Chapman, dealt with the electric current-systems responsible for geomagnetic field variations during magnetic storms. There is no doubt that

this association with Professor Chapman profoundly influenced Dr. Vestine, who greatly admired Chapman's numerous classical contributions to geomagnetism and related subjects. Both had the greatest respect for thoroughness and objectivity, and each devoted his entire life to active research. There was even some similarity in their psychologically calm and logically objective approaches to problems.

Between July 1937 and January 1938, Dr. Vestine again became associated with the Canadian Meteorological Office in Toronto and later lectured in physics at the University of Toronto. In January 1938 he joined the Carnegie Institution of Washington's Department of Terrestrial Magnetism.

On May 20, 1943 Dr. Vestine married Lois Anne Reid. Their only child, Henry Charles Vestine, is a successful popular musician. Dr. Vestine was a persistent reader of scientific literature with a keen interest in history and biography. He and his wife often enjoyed cruising and fishing on the Chesapeake Bay in their comfortably equipped forty-foot motor launch. Dr. Vestine was quite proficient in maintaining his boat in excellent condition. He never appeared perturbed by ordinary misfortunes and, like his wife, was always interesting, courteous, and affable.

At the Department of Terrestrial Magnetism he made numerous outstanding, comprehensive contributions to the understanding of the earth's magnetic field, its secular, diurnal, storm-time, and other variations and related phenomena in the Earth's interior and in the aurora and the ionosphere. In recognition of these accomplishments, he was given the sixth John A. Fleming Award in April, 1957 by the American Geophysical Union of The National Academy of Sciences-National Research Council. In his citation, Professor Chapman, world authority on geomagnetism and related subjects, characterized Dr. Vestine as a world leader in geomagnetism and auroral science.

The association of Dr. Vestine with the Department of

Terrestrial Magnetism of the Carnegie Institution of Washington was extremely fortunate and beneficial for both. This Department was established in 1904, two years before Dr. Vestine's birth. Since its founding, the Department had completed an extensive world-wide survey comprising an enormous number of measurements of the earth's magnetic field on land and sea. At many points, these measurements were repeated at intervals to provide data for secular variation, while the observatories of many countries provided continuous data and additional land survey information.

The prodigious task of systematically organizing practically all of the useful aspects from this multitude of data covering a period of four decades into reliable, comprehensive, and usable forms was carried out under the direction of Dr. Vestine, who effected many original, comprehensive analyses of the results. Those who assisted him in this exacting task were so devoted to him—because of his humane and considerate appreciation of the involved details and reliability required—that all contributed their diligent, enthusiastic and vigorous cooperation. Thus, in 1947 the Department of Terrestrial Magnetism published the resulting two volumes, described by Professor Chapman as “two great collections of modern geomagnetic data, including brief but cogent analyses and discussions of the data.” The two large volumes, containing over 900 pages, are *The Description of the Earth's Main Magnetic Field and Its Secular Change, 1905–1945* and *The Geomagnetic Field, Its Description and Analysis*.

The contribution of these two volumes is best summarized in the following principal parts a and b of the two corresponding prefaces by Dr. Vestine. These show not only that he was thorough and most competent, but also charmingly modest and self-effacing:

a) The present volume summarizes a descriptive study of the Earth's main field and its secular change. It is the result of a very considerable outlay of persistent effort, with much attention to detail, on the part of

those who have tried to fit the many published observations of magnetic surveys into a consistent picture.

Perhaps students of geophysics will welcome most the comprehensive new world-charts descriptive of secular change. These have been drawn complete in all magnetic elements for the first time. They are also, we believe, the first set of isoporic charts reasonably consistent with all available carefully assessed measurements with each other and with the known character of electromagnetic fields. Since they are drawn at four epochs a decade apart, the phenomenon is apparent with good continuity for almost half a century. A new and rich store of information is thus afforded respecting deep-seated, rapid, and mysterious physical processes of the Earth's interior which to the best of our present knowledge are not reflected in any other way.

The new charts of secular change have permitted the use of the great majority of survey-measurements made since the beginning of the present century in constructing isomagnetic charts in seven elements for the epoch 1945.0. The rather successful use of older as well as more recent data has thereby increased by a thousand or more the number of observational points that would ordinarily determine the isomagnetic lines. In this way, a somewhat more detailed description of the Earth's main field is afforded, bringing into a little sharper focus a major geophysical phenomenon of unknown cause.

It is not implied that this new series of charts represents an accurate description of the geomagnetic field. There are many regions in which magnetic measurements have never been made. Much use was made of uncertain interpolations, particularly across polar and ocean areas.

I have not troubled the reader with the multitudinous details incidental to a project of this kind. To have done so would have extended the present book to many volumes. The aim rather has been that of providing a condensed readable account highlighting features of importance and interest.

b) This book continues a descriptive study of geomagnetism begun with Carnegie Institution of Washington Publication 578, which was principally concerned with the description of the Earth's main magnetic field and its secular change. The present volume extends this work to the various known geomagnetic variations, with inclusion of some analyses.

To a considerable extent, the present book is actually a by-product of Publication 578, since extensive information on geomagnetic variations was required for the improving of estimates therein of geomagnetic secular change for the period 1905 to 1945. Because the latter required descriptive

information respecting shorter-period time-variations on a world-wide scale and over these many years, the general scope of coverage is considerable. Moreover, the emphasis has been upon the description rather than upon the interpretation of results.

It is believed that the two volumes together comprise the first convenient detailed compendium of geomagnetic data especially suited to the needs of those engineering workers who are mainly concerned with the practical applications of geomagnetism. The wide use of illustrative diagrams (many initially drawn as a training exercise for the draftsmen who drew the maps of the first volume) enhances the effective description of geomagnetic phenomena of our environment. The books emerge therefore as a kind of picture supplement to the standard treatise *Geomagnetism*; the writer hopes that his teacher, Professor Chapman, senior author of that treatise, will not object to such suggestion, provided he be not held at fault for any mistakes we may have made.

In the course of pursuing the major descriptive objectives of this war project, the writers could not resist the temptation to undertake some serious investigations of the extensive new data available. Hence attempts at explanation of certain phenomena will be found at intervals, between the stacks of figures and tables, along with some short discussions linking the present with previous work. The writers hope that in this way a more interesting and readable account has been provided.

Dr. Vestine's logical, objective, and imperturbable approach to perplexing problems characterized all his activities and his attitude in personal discussions of scientific questions with colleagues. He always searched for independent tests of conclusions, which he made without personal bias or preferences. This accounted for the many fruitful, pleasant, and profitable discussions enjoyed by his colleagues. From his many investigations throughout his career of the secular change of the geomagnetic field and its rate of change with time, Dr. Vestine made several fundamental contributions. His improved determination of the westward drift showed this to be correlated with the previously unexplained variations in the rate of the earth's rotation. When he considered independent geophysical evidence on the rigidity of the earth, Dr. Vestine concluded that "the source of the geo-

magnetic field lies within a large-scale fluid-circulation inside the central core of the earth and that this fluid circulation in the core (relative to the mantle) must be considered established as real, since no other adequate large source needed to conserve the total angular momentum (core plus mantle) is apparently available.”\* Over a period of about 120 years, the geomagnetic field pattern was found to have drifted (with variations in the rate of drift) about 3300 km west and about 2900 km north. He also showed that surface fluid motions of the earth’s core that can closely approximate secular change also show features compatible with four of the generator models that might account for the geomagnetic field—but that these comparisons did not indicate a preferred choice among these models. Such tests of models for secular change are presently of much interest, since they provide some basis for reliable estimation of the time scale for reversals of the earth’s dipole field. This reversal time is a useful tool in geological investigations involving plate movements and related phenomena. Thus, as in the nature of most research, the studies initiated by Dr. Vestine have come to have important consequences for other phenomena.

The phenomena of secular change was only one of Dr. Vestine’s many interests. He reliably located the northern and southern auroral zones and showed the dependence of their morphology upon the geomagnetic field. Related investigations provided estimates on the maximum total energy of particles in the Van Allen trapped radiation belts.

In 1944 and 1945, Dr. Vestine published the results of a thorough, comprehensive investigation of the geographical incidence of aurora and magnetic disturbances in the northern and southern hemispheres respectively. The study derived detailed curves showing the three geomagnetic com-

\* Ernest Vestine, “On Variations of the Geomagnetic Field, Fluid Motions, and Rate of the Earth’s Rotation,” *Journal of Geophysical Research*, 58 (1953):127.



ponents of the disturbance diurnal variation,  $S_D$  ( difference for magnetically disturbed, less that for quiet days), and the variation from pole to pole of the maxima and minima of  $S_D$ . These outstanding, authoritative studies indicate the thoroughness and reliability for which Dr. Vestine's work was regarded with the highest esteem by geophysicists everywhere.

Dr. Vestine contributed much to the mathematical methodology of techniques for analyses of the geomagnetic field. In addition, he developed theoretical models for aspects of magnetic storms and for the geomagnetic control of the aurora. His investigations included the effect of solar influences on magnetic storms and other geomagnetic phenomena. His analytical investigation of seismic waves and waves from blasts was most useful in seismology.

In addition to his research contributions, Dr. Vestine wrote many excellent survey articles on geomagnetism and related phenomena for encyclopedias, handbooks, dictionaries, and some survey books.

After he joined the Rand Corporation in January 1959, Dr. Vestine's interests were logically extended to include the use of rockets for measuring the geomagnetic field at great heights and for determining the lunar magnetic field. His later work in space science included scientific uses of satellites, astronautics and its applications, space vehicle environment, and the evolution and nature of the lunar atmosphere.

A most fitting tribute to the memory of Dr. Vestine is the dedication to him of the publication *World Magnetic Survey 1957-1969*, published in 1971 as IAGA Bulletin No. 28 of the International Union of Geodesy and Geophysics International Association of Geomagnetism and Aeronomy World Magnetic Survey Board. Dr. Vestine served as secretary general of the World Magnetic Survey Board and formed the center for planning and guidance of the activities of this

international enterprise. *World Magnetic Survey* was edited by the late Dr. Alfred J. Zmuda, a very close friend of Dr. Vestine. This interesting, authoritative volume describes geomagnetic surveys by land, sea, air, and satellite, and presents charts, discussions of survey results, theories for the origin of the geomagnetic field, discussion of the interpretation of magnetic anomalies, and comments on seafloor spreading. It is an outstanding monument to the memory of Dr. Vestine.

To foster investigation on a national and international scale in his own and related fields, he unselfishly contributed the benefits of his knowledge, experience, and judgment to the work of numerous committees. As a participant in the International Geophysical Year, Dr. Vestine was an alternate member of the Executive Committee of the U.S. National Committee for the IGY, a member of the Committee on Aurora and Airglow, and a member of the Committee on Geomagnetism. As a member of the National Academy of Sciences, he served as a member of the Committee on Particles and Fields, the Committee on International Relations, the Space Science Board, and U.S. Commission IV to the Union Radio Scientifique Internationale, as chairman of the U.S. Panel on World Magnetic Survey, as a member of the Committee on Polar Research, and as a member of the U.S. Committee for the Year of the Quiet Sun. Dr. Vestine's involvement with the International Union of Geodesy and Geophysics included terms as chairman of the Committee on Magnetic Secular Variation Stations, chairman of the Committee on World Magnetic Survey and Magnetic Charts, chairman of Commission II, Magnetic Charts, and secretary general of the World Magnetic Survey Board, International Association of Geomagnetism and Aeronomy. For the American Geophysical Union, Dr. Vestine served as a member of Working Group II, Committee on Space Research, as chairman of the Committee on Cosmic Terrestrial Relationships,

as a member of the Committee on Planetary Sciences, president of the Section on Geomagnetism and Aeronomy, and as a member of the Council.

Few investigators have enjoyed such a lifetime of extraordinarily fruitful research that has contributed so solidly to the understanding of so many phenomena in a wide field of geophysical interest. This achievement resulted from Dr. Vestine's sustained singleness of purpose and persistent effort, without deflection by irrelevant activities, toward his laudable goal.

BIOGRAPHICAL MEMOIRS  
HONORS AND DISTINCTIONS

## EDUCATION

University of Alberta, 1928–32; B.Sc., 1931

University of Toronto, 1933–34

Imperial College of Science and Technology, University of London, 1934–37; D.I.C. (Diploma of Imperial College) and Ph.D., 1937

## PROFESSIONAL POSITIONS

Canadian Meteorological Office, 1937

University of Toronto, Instructor in Geophysics and Meteorology, 1937

Carnegie Institution of Washington, Department of Terrestrial Magnetism, 1938–56

Johns Hopkins University, Applied Physics Laboratory, Consultant on Missile Guidance, 1946–56

Battelle Memorial Institute, Consultant, 1956–59

National Aeronautics and Space Administration, Consultant, 1959–66

National Science Foundation, Consultant, 1960–66

The Rand Corporation, 1957–68

University of California, Los Angeles, Professor of Meteorology, 1966–68

## PROFESSIONAL SOCIETIES

American Geophysical Union

American Seismological Society

Institute of Electrical and Electronics Engineering

Society of Terrestrial Magnetism and Electricity (Japan)

Washington Academy of Sciences

International Scientific Radio Union (URSI)

## HONORS

National Academy of Sciences, Member, 1954

John A. Fleming Award by the American Geophysical Union of the National Academy of Sciences–National Research Council, 1967

Moon Crater named Crater Vestine by the International Astronomical Union

World Magnetic Survey Summary Volume of the International Union of Geodesy and Geophysics dedicated to the memory of Dr. Ernest Harry Vestine, 1971

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1938

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1939

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1941

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1942

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1943

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1944

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1945

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1946

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1947

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With L. Laporte, I. Lange, and W. E. Scott. *The Geo-Magnetic Field—Its Description and Analysis*. Wash., D.C.: Carnegie Inst. Publ. 580.

1948

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1953

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1966

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1967

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