

Biogeochemistry Of Amino Acids

**Edited by R.E. Hare, T.C. Hoering
and K. King, Jr.**

BIOGEOCHEMISTRY OF AMINO ACIDS

Papers presented at a conference at Airlie House, Warrenton, Virginia, October 29 to November 1, 1978

Edited by

P. E. HARE

T. C. HOERING

K. KING, JR.

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Biogeochemistry of Amino Acids

Carnegie Institution of Washington Conference ADVANCES IN BIOGEOCHEMISTRY OF AMINO ACIDS

List of Participants

Abelson, Philip H.
Carnegie Institution of Washington

Akiyama, Masahiko
Hokkaido University, Japan

Bada, Jeffrey L.
Scripps Institution of Oceanography

Belknap, Daniel F.
University of Delaware

Berger, R.
University of California

Blake, Weston, Jr.
Geological Survey of Canada

Blunt, David J.
U.S. Geological Survey

Bonner, William
Stanford University, California

Broecker, Wallace S.
*Lamont-Doherty Geological
Observatory*

Carey, Julia
*Virginia Polytechnical Institute and
State University*

Crawford, R. J.
University of Alberta

Cronin, John R.
Arizona State University

Cunningham, Robert
University of Texas, Dallas

Demarais, David J.
NASA Ames Research Center

DeNiro, Michael J.
California Institute of Technology

Dungworth, Graham
BP Research Centre

Ebert, James D.
Carnegie Institution of Washington

Eglinton, Geoffrey
University of Bristol, England

Engel, Michael H.
University of Arizona

Estep, Marilyn
*Geophysical Laboratory, Carnegie
Institution of Washington*

Eyre, David R.
*Children's Hospital Medical Center,
Harvard University*

Firsching, F. H.
Southern Illinois University

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- | | |
|---------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------|
| Gerow, Bert A.
<i>Stanford University, California</i> | Kriausakul, Nivat
<i>University of Texas, Dallas</i> |
| Gil-Av, E.
<i>Weizmann Institute of Science
Israel</i> | Kvenvolden, Keith A.
<i>U.S. Geological Survey</i> |
| Halstead, L. B.
<i>University of Reading, England</i> | Lajoie, Kenneth R.
<i>U.S. Geological Survey</i> |
| Harada, Kaoru
<i>University of Tsukuba, Japan</i> | Lee, Cindy
<i>Wood's Hole Oceanographic
Institution</i> |
| Hare, P. Edgar
<i>Geophysical Laboratory, Carnegie
Institution of Washington</i> | Liddicoat, Joseph
<i>Lamont-Doherty Geological
Observatory</i> |
| Hassan, Afifa
<i>U.S. Geological Survey</i> | Lowenstam, Heinz A.
<i>California Institute of Technology</i> |
| Hauschka, Peter V.
<i>Children's Hospital Medical Center,
Harvard University</i> | Lowenstein, Jerold M.
<i>University of California</i> |
| Hedges, John I.
<i>University of Washington</i> | Lugenbeal, Edward N.
<i>Andrews University</i> |
| Henrichs, Susan
<i>Wood's Hole Oceanographic
Institution</i> | Man, Eugene H.
<i>University of Miami</i> |
| Hoering, Thomas C.
<i>Geophysical Laboratory, Carnegie
Institution of Washington</i> | Masters, Patricia M.
<i>Scripps Institute of Oceanography</i> |
| Hood, Leroy
<i>California Institute of Technology</i> | Michaelis, Walter
<i>University of Hamburg, Federal
Republic of Germany</i> |
| Hoopes, E. A.
<i>Scripps Institution of Oceanography</i> | Miller, Gifford H.
<i>University of Colorado</i> |
| Joep, E. M. and
Joep, Margaret
<i>Queen's University, No. Ireland</i> | Mitterer, Richard M.
<i>University of Texas</i> |
| Katz, Barry J.
<i>University of Miami</i> | Nagy, Bartholomew
<i>University of Arizona</i> |
| Keenan, Everly
<i>University of Delaware</i> | Nelson, Alan R.
<i>University of Colorado</i> |
| Kennedy, George
<i>U.S. Geological Survey</i> | Peterson, Etta
<i>NASA Ames Research Center</i> |
| King, Kenneth, Jr.
<i>Lamont-Doherty Geological
Observatory</i> | Piez, Karl A.
<i>National Institute of Dental
Research</i> |
| | Rapp, John B.
<i>U.S. Geological Survey</i> |

Ritland, Richard
Andrews University

Rutter, N. W.
University of Alberta

Schroeder, Roy
U.S. Geological Survey

Sellers, George A.
U.S. Geological Survey

Shou, M.-Y.
*Scripps Institution of
Oceanography*

Shimoyama, Akira
University of Maryland

Smith, Grant Gill
Utah State University

Taylor, R. E.
University of California

Towe, Kenneth M.
Smithsonian Institution

Tuross, Noreen
University of Idaho

Von Endt, David W.
Smithsonian Institution

Wallace, C. T. A.
Oxford University, England

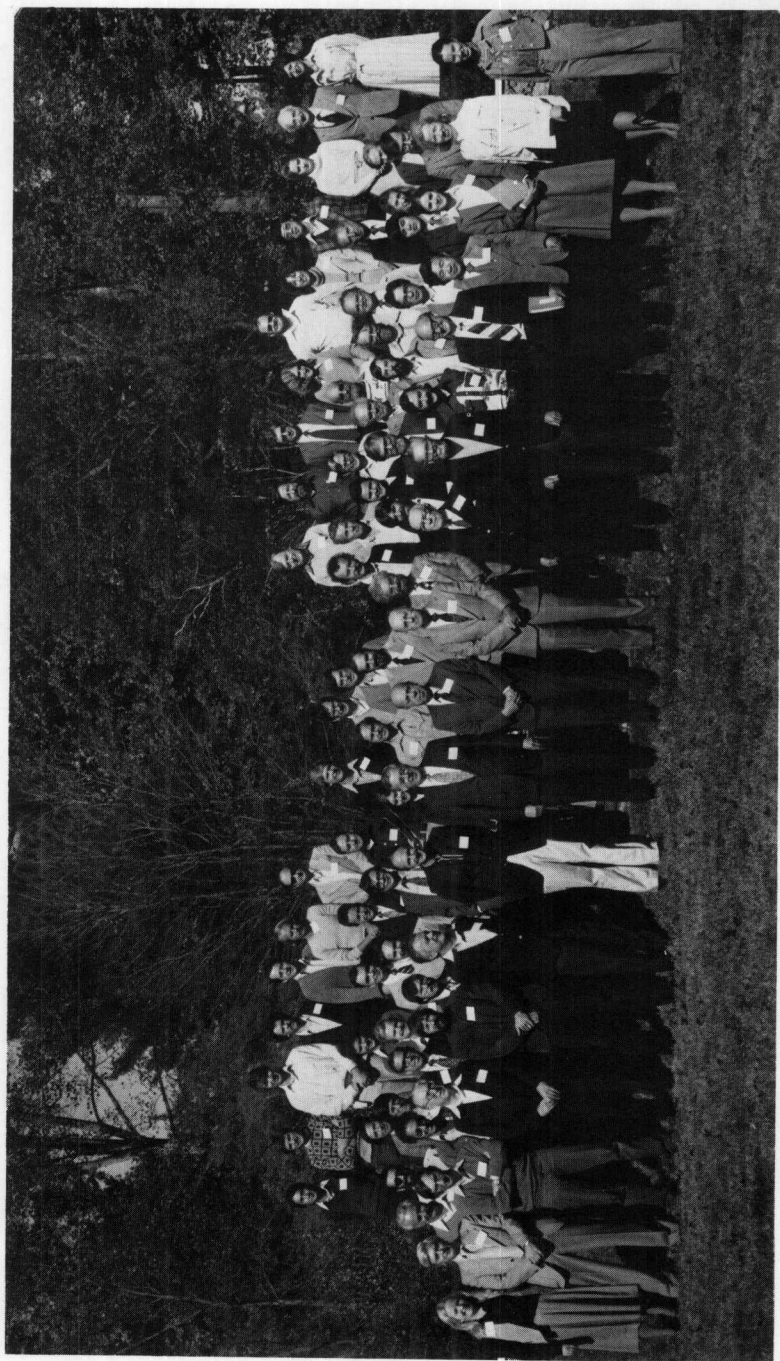
Wehmiller, John F.
University of Delaware

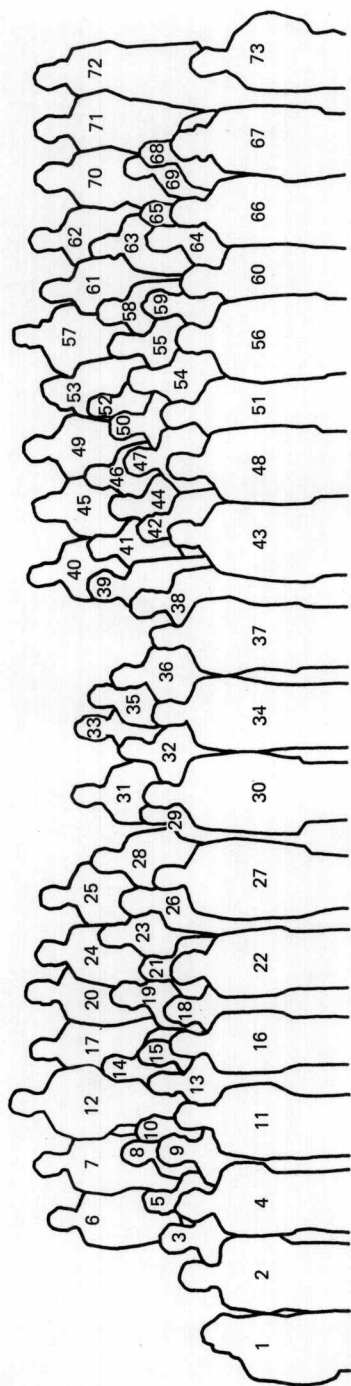
Weiner, Steven
*Weizmann Institute of Science,
Israel*

Wyckoff, Ralph W. G.
University of Arizona

Yoder, H. S., Jr.
*Geophysical Laboratory, Carnegie
Institution of Washington*

Zumberge, John E.
University of Arizona





1. Noreen Turross

2. L. B. Halstead

3. William Bonner

4. Barry Katz

5. Michael DeNiro

6. N. Kriauakul

7. Leroy Hood

8. Heinz Lowenstam

9. Michael Engel

10. Steven Weiner

11. Bert A. Gerow

12. Peter Hauschka

13. Kenneth Towe

14. Robert Cunningham

15. David Demarais

16. John Wehmiller

17. E. A. Hoopes

18. David Blunt

19. Bary Nagy

20. David von Endt

21. John Hedges

22. Tom Hoering

23. John Rapp

24. Jeffrey Bada

25. R. E. Taylor

26. Graham Dungworth

27. Ed Hare

28. George Sellers

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31. David Eyre

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34. Philip H. Abelson

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52. Eugene Man

53. Cindy Lee

54. George Kennedy

55. Ed Lugenbeal

56. Grant G. Smith

57. Roy Schroeder

58. Richard Ritland

59. Masahiko Akiyama

60. Kaoru Harada

61. Patricia Masters

62. Philip Shou

63. Jerold Lowenstein

64. Akira Shimoyama

65. Margaret Joep

66. Julia Carey

67. Etta Peterson

68. C. J. A. Wallace

69. E. M. Joep

70. Everly Keenan

71. E. Gil-Av

72. Afifa Hassan

73. Marilyn Estep

PREFACE

In the twenty-five years since amino acids were discovered in fossils, there has been steadily increasing growth in research on the distribution and transformation of amino acids and proteins in the geological environment. So many scientific disciplines are involved and the results are published in such a variety of journals that communication has been difficult.

To facilitate the exchange of ideas and information, a three-day conference on Advances in the Biogeochemistry of Amino Acids was held October 29 to November 1, 1978, at Arlie House, Warrenton, Virginia, under the sponsorship of the Carnegie Institution of Washington and the National Science Foundation. For the first time, most of the active participants in this area of research gathered together at one place to discuss concepts, techniques, and results. This book is a result of the conference and gives an overview of the wide range of studies that have been carried out. It is likely that few of the participants were totally aware of the quantity and quality of the research.

The papers presented here are representative of the major areas in which amino acid biogeochemistry is being developed. Some problems have come to a focus, but many are in a preliminary stage and are controversial and unresolved. As a result, the papers are not necessarily in agreement and in some cases present conflicting viewpoints. These differences and the lively debate they stimulated at the conference attest to the vitality of the field. Most important, the papers point to new areas for future research.

Amino-acid biogeochemistry is an interdisciplinary science. Methods of biochemistry, combined with principles from physical and organic chemistry, are applied to problems in geology, archeology, paleontology, geochemistry, and other fields. Because no one scientist can be expert in all of these, an interchange of ideas is essential. This goal of the conference was achieved and there was communication across the traditional boundaries of science. Organic chemists discovered mutual areas of interest with stratigraphers, and enzymologists compared notes with archeologists.

The organization of this volume parallels the conference program. It is divided into four major areas. The first presents data on the occurrence

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of proteins and amino acids in geological environments, discusses the relationships between ultrastructural integrity of fossils and the degree of organic preservation, and attacks the problem of organic contamination. The second deals with the all-important topic of methods and techniques. The papers in this section show how a variety of available analytical tools can be applied to the detection and characterization of organic molecules at low concentration levels. The third contains papers describing how theoretical and experimental methods of physical and organic chemistry can be used as a guide for studies of naturally occurring materials and for the interpretation of their results. The fourth, and probably most significant, section presents a number of applications of amino acid biogeochemistry. The most heated arguments and most vigorous dissents of the conference happened during the oral presentation of this group of papers. Obviously this area is in a state of rapid development.

The conference took place during the year of the twenty-fifth anniversary of Philip H. Abelson's discovery of amino acids in fossils. It also marked the occasion of his retirement as President of the Carnegie Institution of Washington. Everyone doing research on the biogeochemistry of amino acids acknowledges and appreciates Dr. Abelson's pioneering research and vision. The vigor and excitement of this area of science reflects his efforts.

The organizers of the conference and editors of this volume thank Sheila McGough and A. David Singer of the Carnegie Institution of Washington for their assistance in the operation of the meeting and the preparation of its proceedings.

P. EDGAR HARE
THOMAS C. HOERING
KENNETH KING, JR.

*Washington D.C.
March, 1980*

Introductory Remarks

H. S. Yoder, Jr.

*Geophysical Laboratory, Carnegie Institution
of Washington*

It is a pleasure to extend a warm welcome to the participants of the First International Conference on the Biogeochemistry of Amino Acids. The Carnegie Institution has fostered many innovative and imaginative programs, and the field of biogeochemistry has proven to be one of the most successful. Many of you have no doubt wondered why a geophysical laboratory would support such studies. The initiative was taken by Dr. Philip H. Abelson some 25 years ago, and an incredible number of achievements have been recorded by a small group of people focusing on biogeochemically related topics. You have all received a copy of their collective bibliography. Needless to say, the Carnegie Institution of Washington supports excellence in research across field boundaries or wherever a bright idea emerges—and will continue to do so irrespective of the site of origin. The relationship of biogeochemistry is closer to other projects, or areas of focus, at the Geophysical Laboratory than one might first imagine. I believe the organic geochemistry group has contributed significantly to many areas of petrology, the principal field of research at the Geophysical Laboratory.

I would like to suggest three areas where organic geochemistry might make substantial contributions in the future. Oil formation is believed by some investigators to be at a maximum in the temperature range 66°–150°C at pressures in the order of 1–2 kilobars. You may disagree with these ranges of temperature and pressure, but they are the ranges in which the great lead and zinc ore deposits of the world also form. Organic material is present in those ore deposits, and one would like to know if the kerogen or bitumens, or both, played an active or passive role in the ore formation. Organic geochemistry will probably play a significant part in the ore deposits program now evolving at the Geophysical Laboratory.

The groundwork laid for the stable isotopes of hydrogen, carbon, oxygen, and sulfur in organic compounds is equally applicable to the hy-

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drous, carbonaceous, and sulfide minerals of the igneous and metamorphic rocks. These isotopes help in defining the source of volatile constituents in the earth, and I believe they will eventually provide geobarometric and geothermometric calibrations of the conditions of origin of their host rocks.

A third opportunity that lies primarily in organic geochemistry, biomineralization, concerns practically all the disciplines that you represent here today. Consider a 0.1 micron thick organic substrate that produces 1 micron of perfect, optically oriented single crystals of calcite, aragonite, or even strontianite, barite, or hematite in a shell. We need to understand the processes at the organic membrane. How does the structure of the organic substrate influence the crystallography, structure, and composition of the inorganic crystals and vice versa? What is the memory device whereby the organic and inorganic layers alternate repetitively? The trace elements concentrated in those crystals are very specific, and we need to understand the biologically controlled partitioning mechanisms that were operative even in the Precambrian. Do they follow Henry's Law or is the process more complex? The applications of such knowledge to problems in bone, teeth, gall and kidney stone growth, not to neglect sea bottom ore deposits, are obvious to you all.

These are only a few of the many exciting opportunities in organic geochemistry. Each of you probably has his or her own list of future projects, but I hope sufficient numbers of you will be attracted to those problems relating organic compounds to ore deposits so that we can meet here again in November 1980, to discuss the results.

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