

# NASA Technical Memorandum 82182

NASA-TM-82182 19800025598

## Publications of the Exobiology Program for 1979: A Special Bibliography

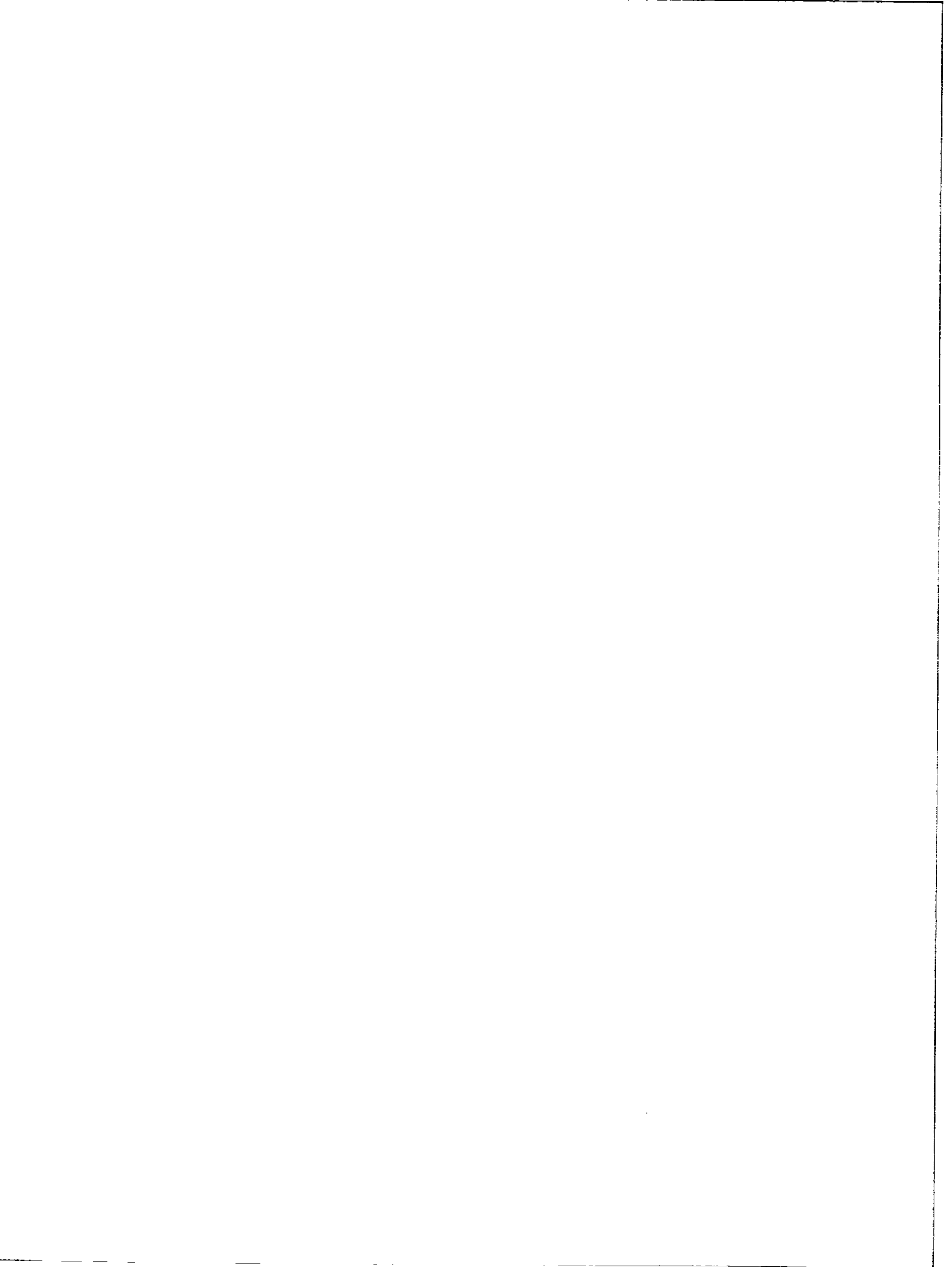
OCTOBER 1980

**LIBRARY COPY**

OCT 31 1980

LANGLEY RESEARCH CENTER  
LIBRARY, NASA  
HAMPTON, VIRGINIA

**NASA**



NASA Technical Memorandum 82182

Publications of the Exobiology Program  
for 1979: A Special Bibliography

*Compiled by*

Linda G. Pleasant and Donald L. DeVincenzi

*NASA Office of Space Science*

*Washington, D.C.*

**NASA**

National Aeronautics  
and Space Administration

**Scientific and Technical  
Information Branch**

1980



## CONTENTS

INTRODUCTION . . . . .	1
CHEMICAL EVOLUTION . . . . .	3
ORGANIC GEOCHEMISTRY . . . . .	7
ORIGIN AND EVOLUTION OF LIFE . . . . .	9
PLANETARY ENVIRONMENTS . . . . .	15
EXTRATERRESTRIAL LIFE . . . . .	17
PLANETARY PROTECTION . . . . .	18
MARS DATA ANALYSIS . . . . .	19
APPENDIX: PROGRAM PARTICIPANTS . . . . .	21



## INTRODUCTION

The Exobiology Program, within the Office of Space Science of the National Aeronautics and Space Administration, is the first and only integrated program to methodically investigate the planetary events which may have been responsible for, or related to, the origin, evolution, and distribution of life in the universe. Research supported by this program is divided into the areas listed below:

Chemical Evolution: The non-biological synthesis of biologically significant organic molecules under conditions presumed to have existed on the primitive earth or any primitive planet before the advent of life.

Organic Geochemistry: Analysis of ancient terrestrial rocks for organic molecules and inclusions of biological origin. The development of techniques for the isolation of organic matter and distinguishing organic matter of biological origin from that of non-biological origin.

Origin and Evolution of Life: Studies of the origin of essential life processes and systems including the nucleic acid and protein biopolymers, genetic information transfer, energy collection mechanisms, and cellular and sub-cellular structures. Understanding the evolution of primitive microbial ecologies.

Planetary Environments: Research dealing with characterization of microorganisms capable of surviving and/or growing in extreme conditions approaching those of planetary environments, development of methodologies and techniques for detection and characterization of life-related molecules in extraterrestrial environments, and development of methods for determination of planetary environmental characteristics important for chemical evolution processes.

Extraterrestrial Life: Development of a rationale, strategy and technology for the search for extraterrestrial intelligent life which is based upon detection of signals in the microwave region of the spectrum using existing radio telescopes augmented with program-specific ancillary equipment.

Planetary Protection: Environmental protection of planets of biological interest against potential harmful contamination from terrestrial sources, which might occur during the course of future exploration, following explicit guidelines established for each planet, as well as protection of the Earth from hazards posed by returned sample missions.

Mars Data Analysis: Research directed toward simulation and interpretation of data from the Mars Viking Landers' organic analysis and biology instruments. To develop models for the unusual reactivity exhibited by the Martian soil.

The arrangement of references in this bibliography follows the division of research described above. Articles are listed alphabetically by author under the research area with which they are most closely related. Only those publications which resulted from research supported by the Exobiology Program and which bear a 1979 publication date have been included. Abstracts, theses, contractor reports, and oral presentations are not included because of their preliminary nature or the frequent difficulty in obtaining them.

Our intent in compiling this bibliography is twofold. First, we would like to provide the scientific community with an annual listing, which began in 1975, of current publications resulting from research pursued under the auspices of NASA's Exobiology Program. Secondly, we hope to stimulate the exchange of information and ideas among scientists working in the different areas of the program. To facilitate the exchange process, we have identified for each publication, by asterisk, the author participating in the program. Current addresses for all principal investigators are given in the Appendix.

We wish to thank all the participants of the Exobiology Program for their cooperative response to our request for a listing of their 1979 publications.



## Chemical Evolution

- Bonner\*, W.A.: 1979, 'Experiments on the Abiotic Origin and Amplification of Optical Activity', in Origins of Optical Activity in Nature (ed. by D.C. Walker), Elsevier, New York, pp. 5-20.
- Bonner\*, W.A. and Blair, N.E.: 1979, 'Enantiomeric Phases in Analytical Gas Chromatography', J. Chromatograph. 169, 153-159.
- Bonner\*, W.A., Blair, N.E., and Flores, J.J.: 1979, 'Attempted Asymmetric Radiolysis of D,L-Tryptophan with  $^{32}\text{P}$   $\beta$  Radiation', Nature 281, 150-151.
- Bonner\*, W.A., Blair, N.E., and Lemmon, R.M.: 1979, 'Racemization of Isovaline by  $\gamma$ -Radiation: Cosmological Implications', J. Am. Chem. Soc. 101, 1049.
- Bonner\*, W.A., Blair, N.E., and Lemmon, R.M.: 1979, 'The Radioracemization of Amino Acids by Ionizing Radiation: Geochemical and Cosmochemical Implications', Origins of Life 9, 279-290.
- Bonner\*, W.A., Blair, N.E., Lemmon, R.M., Flores, J.J., and Pollock\*, G.E.: 1979, 'The Radioracemization of Isovaline: Cosmochemical Implications', Geochim. Cosmochim. Acta 43, 1841-1846.
- Bunch, T.E., Chang\*, S., Frick, U., Neil, J., and Moreland, G.: 1979, 'Carbonaceous Chondrites. I. Characterization and Significance of Carbonaceous Chondrite (CM) Xenoliths in the Jodzie Howardite', Geochim. Cosmochim. Acta 43, 1727-1742.
- Capone<sup>1</sup>, L.A., Dubach, J., Whitten, R.C., and Prasad, S.S.: 1979, 'Cosmic Ray Ionization of the Jovian Atmosphere', Icarus 39, 433-449.
- Chang\*, S.: 1979, 'Comets: Cosmic Connections with Carbonaceous Meteorites, Interstellar Molecules and the Origin of Life', in Space Missions to Comets, Proceedings of a Conference, Goddard Space Flight Center, Greenbelt, Maryland, October 1977 (ed. by M. Neugebauer et al.), NASA, Washington, D.C., pp. 59-111. (NASA Conference Publication 2089)

---

<sup>1</sup>S. Chang, Principal Investigator

- Chang\*, S., Scattergood, T., Aronowitz, S., and Flores, J.: 1979, 'Organic Chemistry on Titan', Rev. Geophys. Space Phys. 17, 1923-1933.
- Edelson, E.H., Lawless\*, J.G., Wehr, C.T., and Abbott, S.R.: 1979, 'Ion-Exchange Separation of Nucleic Acid Constituents by High-Performance Liquid Chromatography', J. Chromatogr. 174, 409-419.
- Epps, D.E., Nooner, D.W., Eichberg, J., Sherwood, E., and Oro\*, J.: 1979, 'Cyanamide Mediated Synthesis under Plausible Primitive Earth Conditions. VI. The Synthesis of Glycerol and Glycerophosphates', J. Mol. Evol. 14, 235-241.
- Ferris\*, J.P.: 1979, 'HCN Did Not Condense to Give Heteropolypeptides on the Primitive Earth', Science 203, 1135-1136.
- Ferris\*, J.P., Edelson, E.H., Mount, N.M., and Sullivan, A.E.: 1979, 'The Effect of Clays on the Oligomerization of HCN', J. Mol. Evol. 13, 317-330.
- Ferris\*, J.P. and Joshi, P.C.: 1979, 'Chemical Evolution. 33. Photochemical Decarboxylation of Orotic Acid, Orotidine, and Orotidine 5'-Phosphate', J. Org. Chem. 44, 2133-2137.
- Folsome\*, C.E.: 1979, The Origin of Life, W.H. Freeman, San Francisco, California, 168 pp.
- Frick, U., Mack, R., and Chang\*, S.: 1979, 'Noble Gas Trapping and Fractionation during Synthesis of Carbonaceous Matter', Proc. Lunar Sci. Conf. 10, 1961-1973.
- Holzer, G. and Oro\*, J.: 1979, 'The Organic Composition of the Allan Hills Carbonaceous Chondrite (77306) as Determined by Pyrolysis-Gas Chromatography-Mass Spectrometry and Other Methods', J. Mol. Evol. 13, 265-270.
- Holzer, G., Oro\*, J., and Tornabene, T.G.: 1979, 'Gas Chromatographic-Mass Spectrometric Analysis of Neutral Lipids from Methanogenic and Thermoacidophilic Bacteria', J. Chromatogr. 186, 795-809.
- Hong, J.H. and Becker\*, R.S.: 1979, 'Hydrogen Atom Initiated Chemistry', J. Mol. Evol. 13, 15-26.
- Khare, B.N. and Sagan\*, C.: 1979, 'Organic Dust Synthesized in Reducing Environments by Ultraviolet Radiation or Electrical Discharge', Astrophys. Space Sci. 65, 309-312.

- Kotra, R.K., Shimoyama, A., Ponnampereuma\*, C., and Hare, P.E.: 1979, 'Amino Acids in a Carbonaceous Chondrite from Antarctica', J. Mol. Evol. 13, 179-184.
- Kuhn\*, W.R. and Atreya, S.K.: 1979, 'Ammonia Photolysis and the Greenhouse Effect in the Primordial Atmosphere of the Earth', Icarus 37, 207-213.
- Kuhn\*, W.R. and Atreya, S.K.: 1979, 'Solar Radiation Incident on the Martian Surface', J. Mol. Evol. 14, 57-64.
- Lawless\*, J.G. and Levi, N.: 1979, 'The Role of Metal Ions in Chemical Evolution: Polymerization of Alanine and Glycine in a Cation-Exchanged Clay Environment', J. Mol. Evol. 13, 281-286.
- Lawless\*, J.G. and Yuen\*, G.U.: 1979, 'Quantification of Monocarboxylic Acids in the Murchison Meteorite', Nature 282, 396-398.
- Lemmon, R.M. and Bonner\*, W.A.: 1979, 'Radioracemization of Amino Acids', in Origins of Optical Activity in Nature (ed. by D.C. Walker), Elsevier, New York, pp. 47-52.
- Nooner, D.W. and Oro\*, J.: 1979, 'Synthesis of Fatty Acids by a Closed System Fischer-Tropsch Process', in Hydrocarbon Synthesis from Carbon Monoxide and Hydrogen (ed. by L. Kugler and F.W. Steffgen), American Chemical Society, Washington, D.C., pp. 159-171. (Advances in Chemistry Series, No. 178)
- Odom, D.G., Lahav, N., and Chang\*, S.: 1979, 'Prebiotic Nucleotide Oligomerization in a Fluctuating Environment: Effects of Kaolinite and Cyanamide', J. Mol. Evol. 12, 259-264.
- Odom, D.G. Rao, M., Lawless\*, J.G., and Oro\*, J.: 1979, 'Association of Nucleotides with Homoionic Clays', J. Mol. Evol. 12, 365-367.
- Pearl, J., Hanel, R., Kunde, V., Maguire, W., Fox, K., Gupta, S., Ponnampereuma\*, C., and Raulin, F.: 1979, 'Identification of Gaseous SO<sub>2</sub> and New Upper Limits for Other Gases on Io', Nature 280, 755-758.
- Ponnampereuma\*, C.: 1979, 'The Emergence of Life', J. Roy. Swaziland Soc. Sci. Tech. 2(1), 9-13.
- Ponnampereuma\*, C.: 1979, 'Primordial Organic Chemistry', Chem. Britain 15, 560-568.

- Raulin, F., Bossard, A., Toupance, G., and Ponnampereuma\*, C.: 1979, 'Abundance of Organic Compounds Photochemically Produced in the Atmospheres of the Outer Planets', Icarus 38, 358-366.
- Sagan\*, C. and Khare, B.N.: 1979, 'Tholins: Organic Chemistry of Interstellar Grains and Gas', Nature 277, 102-107.
- Shimoyama, A., Ponnampereuma\*, C., and Yanai, K.: 1979, 'Amino Acids in the Yamato Meteorite 74662, an Antarctic Carbonaceous Chondrite', Mem. Natl. Inst. Polar Res. 15 (Spec. Issue), 196-205.
- Shimoyama, A., Ponnampereuma\*, C., and Yanai, K.: 1979, 'Amino Acids in the Yamato Carbonaceous Chondrite from Antarctica', Nature 282, 394-396.
- Sleeper, H.L., Lohrmann, R., and Orgel\*, L.E.: 1979, 'Template-directed Synthesis of Oligoadenylates Catalyzed by Pb<sup>2+</sup> Ions', J. Mol. Evol. 13, 203-214.
- Sleeper, H.L. and Orgel\*, L.E.: 1979, 'The Catalysis of Nucleotide Polymerization by Compounds of Divalent Lead', J. Mol. Evol. 12, 357-364.
- Su, H.Y. and Becker\*, R.S.: 1979, 'Photochemical and Hot H Atom Reactions of Acetaldehyde', J. Phys. Chem. 83, 1929-1936.
- Tornabene, T.G., Langworthy, T.A., Holzer, G., and Oro\*, J.: 1979, 'Squalenes, Phytanes and Other Isoprenoids as Major Neutral Lipids of Methanogenic and Thermoacidophilic Archaeobacteria', J. Mol. Evol. 13, 73-83.
- Zitzewitz, P.W., VanHouse, J.C., Rich\*, A., and Gidley, D.W.: 1979, 'Spin Polarization of Low-Energy Positron Beams', Phys. Rev. Letters 43, 1281-1284.

## Organic Geochemistry

- Barnes, P.J., Brassell, S.C., Comet, P., Eglinton<sup>1</sup>, G., McEvoy, J., Maxwell, J.R., Wardroper, A.M.K., and Volkman, J.K.: 1979, 'Preliminary Lipid Analyses of Core Sections 18, 24, and 30 from Hole 402A', in Initial Reports of the Deep Sea Drilling Project, Vol. XLVIII (ed. by J.L. Usher), U.S. Government Printing Office, Washington, D.C., pp. 965-976.
- Ciccioli, P., Hayes\*, J.M., Rinaldi, G., Denson, K.B., and Meinschein, W.G.: 1979, 'Graphitized Carbon in Gas-Liquid-Solid Chromatography and Gas Chromatography/Mass Spectrometric Analysis of High Boiling Hydrocarbon Mixtures', Anal. Chem. 51, 400-408.
- Cronin\*, J.R., Pizzarello, S., and Gandy, W.E.: 1979, 'Amino Acid Analysis with o-Phthalaldehyde Detection: Effects of Reaction Temperature and Thiol on Fluorescence Yields', Anal. Biochem. 93, 174-179.
- Cronin\*, J.R., Pizzarello, S., and Moore, C.B.: 1979, 'Amino Acids in an Antarctic Carbonaceous Chondrite', Science 206, 335-337.
- Eglinton<sup>1</sup>, G., HajIbrahim, S.K., Maxwell, J.R., Quirke, J.M.E., Shaw, G.J., Volkman, J.K., and Wardroper, A.M.K.: 1979, 'Lipids of Aquatic Sediments, Recent and Ancient', Phil. Trans. R. Soc. Lond. A 293, 69-91.
- Holser, W.T., Kaplan\*, I.R., Sakai, H., and Zak, I.: 1979, 'Isotope Geochemistry of Oxygen in the Sedimentary Sulfate Cycle', Chem. Geol. 25, 1-17.
- Javor, B., Brassell, S.C., and Eglinton<sup>1</sup>, G.: 1979, 'A Laboratory/Field Method for Radiolabeled Incubation Studies in Algal-Bacterial Mats and Other Microbial Ecosystems", Oceanolog. Acta 2, 19-22.
- Kvenvolden, K.A., Weliky, K., Nelson, H., and Des Marais\*, D.J.: 1979, 'Submarine Seep of Carbon Dioxide in Norton Sound, Alaska', Science 205, 1264-1266.

---

<sup>1</sup>M. Calvin and A.L. Burlingame, Co-Principal Investigators

- Meili, J., Walls, F.C., McPherron, R., and Burlingame\*, A.L.: 1979, 'Design, Implementation, and Performance of a High Resolution Gas Chromatography/High Resolution Mass Spectrometry/Real-Time Computer System for the Analysis of Complex Organic Mixtures', J. Chromatogr. Sci. 17, 29-42.
- Quirke, J.M.E., Eglinton<sup>1</sup>, G., and Maxwell, J.R.: 1979, 'Porphyrins. I. Preliminary Characterization of the Porphyrins of Gilsonite', J. Am. Chem. Soc. 101, 7693-7697.
- Quirke, J.M.E., Marei, A.S.M., and Eglinton<sup>1</sup>, G.: 1979, 'The Degradation of DDT and Its Degradative Products by Reduced Iron (III) Porphyrins and Ammonia', Chemosphere 8, 151-155.
- Schopf\*, J.W., Dolnik, T.A., Krylov, I.N., Mendelson, C.V., Nazarov, B.B., Nyberg, A.V., Sovietov, Yu.K., and Yakshin, M.S.: 1979, 'Mikrofossilii v stromatolitovykh porodakh dokembriya SSSR', in Paleontologiya dokembriya i rannego kembriya (ed. by B.S. Sokolov), Akad. Nauk, Moscow, pp. 104-109
- Simoneit, B.R.T., Mazurek, M.A., Brenner, S., Crisp, P.T., and Kaplan\*, I.R.: 1979, 'Organic Geochemistry of Recent Sediments from Guaymas Basin, Gulf of California', Deep-Sea Res. 26A, 879-891.
- Sklarew<sup>2</sup>, D.S.: 1979, 'Analysis and Simulated Diagenesis of Kerogen in a Recent Bottom Mud from Mono Lake, California: A Comparison with Selected Ancient Kerogens', Geochim. Cosmochim. Acta 43, 1949-1958.
- Sklarew, D.S. and Nagy\*, B.: 1979, '2,5-Dimethylfuran from  $\approx 2.7 \times 10^9$ -year-old Rupemba-Belingwe Stromatolite, Rhodesia: Potential Evidence for Remnants of Carbohydrates', Proc. Natl. Acad. Sci. USA 76, 10-14,
- Vogler, E.A. and Hayes\*, J.M.: 1979, 'Carbon Isotopic Fractionation in the Schmidt Decarboxylation: Evidence for Two Pathways to Products', J. Org. Chem. 44, 3682-3686.

---

<sup>1</sup>M. Calvin and A.L. Burlingame, Co-Principal Investigators

<sup>2</sup>B. Nagy, Principal Investigator

## Origin and Evolution of Life

- Balch, W.E., Fox\*, G.E., Magrum, L.J., Woese\*, C.R., and Wolfe, R.S.: 1979, 'Methanogens: Reevaluation of a Unique Biological Group', Microbiol. Rev. 43, 260-296.
- Berger, B., Thorington, G., and Margulis\*, L.: 1979, 'Two Aeromonads: Growth of Symbionts from Hydra viridis', Current Microbiol. 3, 5-10.
- Bonen, L., Doolittle, W.F., and Fox\*, G.E.: 1979, 'Cyanobacterial Evolution: Results of 16S Ribosomal Ribonucleic Acid Analyses', Can. J. Biochem. 57, 879-888.
- Bradley<sup>1</sup>, P.B.: 1979, 'Micromanipulation of Cyanelles and a Cyanobacterium into Higher Plant Cells', Physiol. Plant. 46, 293-298.
- Bradley<sup>1</sup>, P.M. and Leith, A.: 1979, 'Uptake of Cyanobacteria Contained in Oil Drops by Plant Protoplasts', Naturwissenschaften 66, 111-112.
- Campbell<sup>2</sup>, S.E.: 1979, 'Soil Stabilization by a Prokaryotic Desert Crust: Implications for Precambrian Land Biota', Origins of Life 9, 335-348.
- Dayhoff\*, M.O. (ed.): 1979, Atlas of Protein Sequence and Structure, Volume 5, Supplement 3, National Biomedical Research Foundation, Washington, D.C.
- Fox\*, S.W. and Brooke, S.: 1979, 'Microcapsule in Protobiology and Industry', in Microencapsulation (ed. by T. Kondo), Techno, Inc., Tokyo, pp. 257-290.
- Fox\*, S.W., Syren, R.M., and Windsor, C.R.: 1979, 'Thermal Copoly(amino Acids) as Inhibitors of Glyoxalase I, in Submolecular Biology and Cancer (ed. by G.E.W. Wolstenholme, D.W. Fitzsimons, and J. Whelan), Excerpta Medica, Amsterdam, pp. 175-193. (Ciba Foundation Symposia, Vol. 67)
- Gibson\*, J., Stackebrandt, E., Zablen, L.B., Gupta, R., and Woese\*, C.R.: 1979, 'A Phylogenetic Analysis of the Purple Photosynthetic Bacteria', Current Microbiol. 3, 59-64.
- Greene, R.V. and Lanyi\*, J.K.: 1979, 'Proton Movements in Response to a Light-driven Electrogenic Pump for Sodium Ions in Halobacterium halobium Membranes', J. Biol. Chem. 254, 10986-10994.

---

<sup>1</sup>J.F. Danielli, Principal Investigator

<sup>2</sup>S. Golubic, Principal Investigator

- Holmquist<sup>1</sup>, R.: 1979, 'The Method of Parsimony: An Experimental Test and Theoretical Analysis of the Adequacy of Molecular Restoration Studies', J. Mol. Biol. 135, 939-958.
- Holmquist<sup>1</sup>, R.: 1979, 'Molecular Phylogenetic Trees: On the Validity of the Goodman-Moore Augmentation Algorithm', J. Mol. Evol. 13, 173-178.
- Holmquist<sup>1</sup>, R. and Conroy, T.: 1979, ' $\beta$ -Galactosidase and Selective Neutrality', Science 206, 235.
- Jahnke\*, L. and Klein\*, H.P.: 1979, 'Oxygen as a Factor in Eukaryote Evolution: Some Effects of Low Levels of Oxygen on Saccharomyces cerevisiae', Origins of Life 9, 329-334.
- Julius, D.J., Fraser, T.H., and Rich\*, A.: 1979, 'Isomeric Specificity of Aminoacylation of Wheat Germ Transfer Ribonucleic Acid and the Specificity of Interaction of Elongation Factor Tu with Aminoacyl Transfer Ribonucleic Acid', Biochemistry 18, 604-609.
- Jukes\*, T.H. and King, J.L.: 1979, 'Evolutionary Nucleotide Replacements in DNA', Nature 281, 605-606.
- King, G.I., Stoeckenius\*, W., Crespi, H.L., and Schoenborn, B.P.: 1979, 'The Location of Retinal in the Purple Membrane Profile by Neutron Diffraction', J. Mol. Biol. 130, 395-404.
- Klein\*, H.P. and Jahnke\*, L.: 1979, 'Effects of Aeration on Formation and Localization of the Acetyl Coenzyme A Synthetases of Saccharomyces cerevisiae', J. Bacteriology 137, 179-184.
- Lacey\*, J.C., Jr. and Mullins, D.W.: 1979, 'The Origin of Protein Synthesis: Matters Relating to Coding, Initiation and Direction of Growth', Polymer Preprints 20(2), 12-16.
- Lacey\*, J.C., Jr., Stephens, D.P., and Fox\*, S.W.: 1979, 'Selective Formation of Microparticles by Homopolyribonucleotides and Proteinoids Rich in Individual Amino Acids', BioSystems 11, 9-17.
- Lacey\*, J.C., Jr., Yuki, A., and Fox\*, S.W.: 1979, 'Coprecipitation of Thermal Lysine-Rich Proteinoids with Polyribonucleotides', BioSystems 11, 1-7.

---

<sup>1</sup>T.H. Jukes, Principal Investigator



- Lanyi\*, J.K.: 1979, 'Life at Low Water Activities Group Report', in Strategies of Microbial Life in Extreme Environments (ed. by M. Shilo), Verlag Chemie, Berlin, pp. 125-135. (Dahlem Workshop Reports: Life Sciences Research Report 13)
- Lanyi\*, J.K.: 1979, 'Light-driven Solute Transport in Halobacterium halobium', in Microbiology - 1979 (ed. by D. Schlessinger), American Society for Microbiology, Washington, D.C., pp. 67-71.
- Lanyi\*, J.K.: 1979, 'Physicochemical Aspects of Salt-dependence in Halobacteria', in Strategies of Microbial Life in Extreme Environments (ed. by M. Shilo), Verlag Chemie, Berlin, pp. 93-107, (Dahlem Workshop Reports: Life Sciences Research Report 13)
- Lanyi\*, J.K.: 1979, 'The Role of Na<sup>+</sup> in Transport Processes of Bacterial Membranes', Biochim. Biophys. Acta 559, 377-397.
- Lanyi\*, J.K., Helgerson, S.L., and Silverman\*, M.P.: 1979, 'Relationship between Proton Motive Force and Potassium Ion Transport in Halobacterium halobium Envelope Vesicles', Arch. Biochem. Biophys. 193, 329-339.
- Lanyi\*, J.K. and MacDonald\*, R.E.: 1979, 'Light-induced Transport in Halobacterium halobium', in Methods in Enzymology, Vol. 56 (ed. by S. Fleischer and L. Packer), Academic Press, New York, pp. 398-407.
- Lanyi\*, J.K. and Silverman\*, M.P.: 1979, 'Gating Effects in Halobacterium halobium Membrane Transport', J. Biol. Chem. 254, 4750-4755.
- Lindley, E.V. and MacDonald\*, R.E.: 1979, 'A Second Mechanism for Sodium Extrusion in Halobacterium halobium: A Light-driven Pump', Biochem. Biophys. Res. Commun. 88, 491-499.
- Loew\*, G., Burt, S., Nomura, P., and MacElroy\*, R.D.: 1979, 'Interaction of Model Opiate Anionic Receptor Sites with Characteristic N-Substituents of Rigid Opiates: PCILO and Empirical Potential Energy Calculations', in Computer Assisted Drug Design (ed. by E.C. Olson and R.E. Christofferson), American Chemical Society, Washington, D.C., pp. 243-258. (ACS Symposium Series 112)
- MacDonald\*, R.E., Greene, R.V., Clark, R.D., and Lindley, E.V.: 1979, 'Characterization of the Light-driven Sodium Pump of Halobacterium halobium: Consequences of Sodium Efflux as the Primary Light-driven Event', J. Biol. Chem. 254, 11831-11838.

- MacKay, R.M., Zablen, L.B., Woese\*, C.R., and Doolittle, W.F.: 1979, 'Homologies in Processing and Sequence between 23S Ribosomal Ribonucleic Acids of Paracoccus denitrificans and Rhodopseudomonas sphaeroides', Arch. Microbiol. 123, 165-172.
- Margulis\*, L., Chase, D., and To, L.: 1979, 'Possible Evolutionary Significance of Spirochaetes', Proc. R. Soc. B 204, 189-198.
- McPherson, A., Journak, F.A., Wang, A., Molineux, I., and Rich\*, A.: 1979, 'Structure of 2.3 Å Resolution of the Gene 5 Product of Bacteriophage fd: A DNA Unwinding Protein', J. Mol. Biol. 134, 379-400.
- McPherson, A., Journak, F., Wang, A., Molineux, I., and Rich\*, A.: 1979, 'Structure of the DNA Binding Cleft of the Gene 5 Protein from Bacteriophage fd', J. Supramol. Structure 10, 457-465.
- Mirzabekov, A.D. and Rich\*, A.: 1979, 'Asymmetric Lateral Distribution of Unshielded Phosphate Groups in Nucleosomal DNA and Its Role in DNA Bending', Proc. Natl. Acad. Sci. USA 76, 1118-1121.
- Mowery, P.C., Lozier, R.H., Chae, Q., Tseng, Y.-W, Taylor, M., and Stoeckenius\*, W.: 1979, 'Effect of Acid pH on the Absorption Spectra and Photoreactions of Bacteriorhodopsin', Biochemistry 18, 4100-4107.
- Ornstein, R.L. and Rein\*, R.: 1979, 'Energetic and Structural Aspects of Ethidium Cation Intercalation into DNA Minihelices', Biopolymers 18, 2821-2847.
- Ornstein, R.L. and Rein\*, R.: 1979, 'Energetics of Intercalation Specificity. I. Backbone Unwinding', Biopolymers 18, 1277-1291.
- Ornstein, R.L. and Rein\*, R.: 1979, 'Nucleic Acid Base and Carcinogen Metabolite Specificities during Intercalative Interactions between DNA and 4-Nitroquinoline 1-Oxide', Chem.-Biol. Interactions 27, 291-311.
- Rambler, M. and Margulis\*, L.: 1979, 'An Ultraviolet Light Induced Bacteriophage in Beneckea gazogenes', Origins of Life 9, 235-240.
- Reimer, T.O., Barghoorn\*, E.S., and Margulis\*, L.: 1979, 'Primary Productivity in an Early Archean Microbial Ecosystem', Precambrian Res. 9, 93-104.
- Rein\*, R. and Kieber-Emmons, T.: 1979, 'Theory of Ionic Effects on Intermolecular Interactions in Polyions: Application to Ethidium Binding to DNA', Int. J. Quantum Chem.: Quantum Biol. Symp. 6, 481-489.

- Rich\*, A., Quigley, G.J., and Wang, A.H.-J.: 1979, 'Conformational Flexibility of the Polynucleotide Chain', in Stereodynamics of Molecular Systems, Proceedings of a Symposium, State University of New York, Albany, April 23-24, 1979 (ed. by R.H. Sarma), Pergamon Press, New York, pp. 315-330.
- Rohlfing\*, D.L.: 1979, Evolving Models for Primordial Polypeptides', Polymer Preprints 20, 4.
- Schwartz, R.M. and Dayhoff\*, M.O.: 1979, 'Protein and Nucleic Acid Sequence Data and Phylogeny', Science 205, 1036-1039.
- Silverman\*, M.P.: 1979, 'Biological and Organic Chemical Decomposition of Silicates', in Biogeochemical Cycling of Mineral-Forming Elements (ed. by P.A. Trudinger and D.J. Swaine), Elsevier, New York, pp. 445-465.. (Studies in Environmental Science, Vol. 3)
- Stackebrandt, E. and Woese\*, C.R.: 1979, 'Primärstruktur der Ribosomalen 16S RNA - ein Marker der Evolution der Prokaryonten', Forum Mikrobiol. 4, 183-190.
- Stoeckenius\*, W.: 1979, 'A Model for the Function of Bacteriorhodopsin', in Membrane Transduction Mechanisms (ed. by R.A. Cone and J.E. Dowling), Raven Press, New York, pp. 39-47.
- Stoeckenius\*, W. and Casadio, R.: 1979, 'Dissociation and Reconstitution of Purple Membrane', in Membrane Bioenergetics (ed. by C.P. Lee, G. Schatz, and L. Ernster), Addison-Wesley, Reading, Massachusetts, pp. 229-254.
- Stoeckenius\*, W., Lozier, R.H., and Bogomolni, R.A.: 1979, 'Bacteriorhodopsin and the Purple Membrane of Halobacteria', Biochim. Biophys. Acta 505, 215-278.
- Thorington, G., Berger, B., and Margulis\*, L.: 1979, 'Transmission of Symbionts through the Sexual Cycle of Hydra viridis. I. Observations on Living Organisms', Trans. Am. Microscop. Soc. 98, 401-413.
- Wang, A.H.J., Quigley, G.J., Kolpak, F.J., Crawford, J.L., van Boom, J.H., van der Marel, G., and Rich\*, A.: 1979, 'Molecular Structure of a Left-Handed Double Helical DNA Fragment at Atomic Resolution', Nature 282, 680-686.
- Woese\*, C.R.: 1979, 'A Proposal Concerning the Origin of Life on the Planet Earth', J. Mol. Evol. 13, 95-101.

- Wrede, P. and Rich\*, A.: 1979, 'Stability of the Unique Anticodon Loop Conformation of E. Coli tRNA<sup>Met</sup>', Nucleic Acids Res. 7, 1457-1467.
- Wrede, P., Woo, N.H., and Rich\*, A.: 1979, 'Initiator tRNAs Have a Unique Anticodon Loop Conformation', Proc. Natl. Acad. Sci. USA 76, 3289-3293.
- Wrede, P., Wurst, R., Vournakis, J., and Rich\*, A.: 1979, 'Conformational Changes of Yeast tRNA<sup>Phe</sup> and E. coli tRNA<sub>2</sub><sup>Glu</sup> as Indicated by Different Nuclease Digestion Patterns', J. Biol. Chem. 254, 9608-9615.
- Zielinski, T.J., Shibata, M., and Rein\*, R.: 1979, 'Ab initio STO-3G Energy of Tautomerism for Uracil', Int. J. Quantum Chem.: Quantum Biol. Symp. 6, 475-480.

## Planetary Environments

- Balkwill, D.L. and Casida\*, L.E., Jr.: 1979, 'Attachment to Autoclaved Soil of Bacterial Cells from Pure Cultures of Soil Isolates', Appl. Environ. Microbiol. 37, 1031-1037.
- Biemann\*, K.: 1979, 'The Implications and Limitations of the Findings of the Viking Organic Analysis Experiment', J. Mol. Evol. 14, 65-70.
- Casida\*, L.E., Jr. and Liu, K.-C.: 1979, 'Minute Tubular Forms in Soil', Can. J. Microbiol. 25, 722-729.
- Horowitz\*, N.H.: 1979, 'Biological Water Requirements', in Strategies of Microbial Life in Extreme Environments (ed. by M. Shilo), Verlag Chemie, Berlin, pp. 15-28. (Dahlem Workshop Reports: Life Sciences Research Report 13)
- Kuhn\*, W.R., Rogers, S.R., and MacElroy\*, R.D.: 1979, 'The Response of Selected Terrestrial Organisms to the Martian Environment: A Modeling Study', Icarus 37, 336-346.
- Margulis\*, L., Mazur, P., Barghoorn\*, E.S., Halvorson\*, H.O., Jukes\*, T.H., and Kaplan\*, I.R.: 1979, 'The Viking Mission: Implications for Life on Mars', J. Mol. Evol. 14, 223-232.
- Oyama\*, V.I., Carle\*, G.C., Woeller\*, F., and Pollack, J.B.: 1979, 'Laboratory Corroboration of the Pioneer Venus Gas Chromatograph Analyses', Science 205, 52-54.
- Oyama\*, V.I., Carle\*, G.C., Woeller\*, F., and Pollack, J.B.: 1979, 'Venus Lower Atmospheric Composition: Analysis by Gas Chromatography', Science 203, 802-805.
- Oyama\*, V.I., Lehwalt, M.E., and Berdahl, B.J.: 1979, 'Implications of the Hypohydrous History of Mars', in Life Sciences and Space Research, Vol. XVII, Proceedings of the Open Meeting of the Working Group on Space Biology of the 21st Plenary Meeting of COSPAR, Innsbruck, Austria, May 29-June 10, 1978 and Symposium on Gravitational Physiology, Innsbruck, Austria, June 2-3, 1978 (ed. by R. Holmquist), Pergamon Press, New York, pp. 53-58.
- Pollock\*, G.E. and Heiderer, R.: 1979, 'Aldocyanoin Microspheres: Partial Amino Acid Analysis of the Microparticulates Formed from Simple Reactants under Various Conditions', J. Mol. Evol. 13, 253-264.

Radmer\*, R.J. and Kok, B.: 1979, 'Rate-Temperature Curves as an Unambiguous Indicator of Biological Activity in Soil', Appl. Environ. Microbiol. 38, 224-228.

## Extraterrestrial Life

Billingham\*, J., Oliver, B.M., and Wolfe, J.H.: 1979, 'A Review of the Theory of Interstellar Communication', Acta Astronaut. 6(1-2), 47-57.

Billingham\*, J. and Pesek, R. (eds.): 1979, 'Communication with Extraterrestrial Intelligence', Acta Astronaut. 6(1-2), Special Edition.

Machol<sup>1</sup>, R.E.: 1979, 'Two Systems Analyses of SETI', Acta Astronaut. 6(1-2), 163-173.

Seeger\*, C.L.: 1979, 'Strategic Considerations in SETI, and a Microwave Approach', Acta Astronaut. 6(1-2), 105-127.

Tarter\*, J. and Zuckerman, B.: 1979, 'Is There Anyone Out There?', Nature 281, 528-529.

---

<sup>1</sup>J. Billingham, Principal Investigator

Planetary Protection

No publications in 1979



## Mars Data Analysis

- Banin<sup>1</sup>, A. and Navrot, J.: 1979, 'Chemical Fingerprints of Life in Terrestrial Soils and Their Possible Use for the Detection of Life on Mars and Other Planets', Icarus 37, 347-350.
- Banin<sup>1</sup>, A. and Rishpon, J.: 1979, 'Smectite Clays in Mars Soil: Evidence for Their Presence and Role in Viking Biology Experimental Results', J. Mol. Evol. 14, 133-152.
- Banin<sup>1</sup>, A. and Rishpon, J.: 1979, 'Experimental Simulation of the Viking Labeled Release (LR) Results with Iron-Adsorbed Smectite Clay Minerals', in Life Sciences and Space Research, Vol. XVII, Proceedings of the Open Meeting of the Working Group on Space Biology of the 21st Plenary Meeting of COSPAR, Innsbruck, Austria, May 29-June 10, 1978 and Symposium on Gravitational Physiology, Innsbruck, Austria, June 2-3, 1978 (ed. by R. Holmquist), Pergamon Press, New York, pp. 59-64.
- Hubbard\*, J.S.: 1979, 'Laboratory Simulations of the Pyrolytic Release Experiments: An Interim Report', J. Mol. Evol. 14, 211-221.
- Huguenin\*, R.L., Miller, K.J., and Harwood, W.S.: 1979, 'Frost-Weathering on Mars: Experimental Evidence for Peroxide Formation', J. Mol. Evol. 14, 103-132.
- Levin\*, G.V. and Straat\*, P.A.: 1979, 'Completion of the Viking Labeled Release Experiment on Mars', J. Mol. Evol. 14, 167-183.
- Levin\*, G.V. and Straat\*, P.A.: 1979, 'Laboratory Simulations of the Viking Labeled Release Experiment: Kinetics Following Second Nutrient Injection and the Nature of the Gaseous End Product', J. Mol. Evol. 14, 185-197.
- Oro\*, J. and Holzer, G.: 1979, 'The Effects of Ultraviolet Light on the Degradation of Organic Compounds: A Possible Explanation for the Absence of Organic Matter on Mars', in Life Sciences and Space Research, Vol. XVII, Proceedings of the Open Meeting of the Working Group on Space Biology of the 21st Plenary Meeting of COSPAR, Innsbruck, Austria, May 29-June 10, 1978 and Symposium on Gravitational Physiology, Innsbruck, Austria, June 2-3, 1978 (ed. by R. Holmquist), Pergamon Press, New York, pp. 77-86.

---

<sup>1</sup>J.B. Orenberg, Principal Investigator

- Oro\*, J. and Holzer, G.: 1979, 'The Photolytic Degradation and Oxidation of Organic Compounds under Simulated Martian Conditions', J. Mol. Evol. 14, 152-160.
- Oyama\*, V.I. and Berdahl, B.J.: 1979, 'A Model of Martian Surface Chemistry', J. Mol. Evol. 14, 199-210.
- Oyama\*, V.I., Berdahl, B.J., and Woeller\*, F.: 1979, 'Carbon Suboxide Polymer: An Explanation for the Wave of Darkening on Mars', in Life Sciences and Space Research, Vol. XVII, Proceedings of the Open Meeting of the Working Group on Space Biology of the 21st Plenary Meeting of COSPAR, Innsbruck, Austria, May 29-June 10, 1978 and Symposium on Gravitational Physiology, Innsbruck, Austria, June 2-3, 1978 (ed. by R. Holmquist), Pergamon Press, New York, pp. 47-51.
- Singer, R.B., McCord, T.B., Clark, R.N., Adams, J.B., and Huguenin\*, R.L.: 1979, 'Mars Surface Composition from Reflectance Spectroscopy: A Summary', J. Geophys. Res. 84, 8415-8426.
- Zill\*, L.P., Mack, R., and DeVincenzi\*, D.L.: 1979, 'Mars Ultraviolet Simulation Facility', J. Mol. Evol. 14, 79-89.

APPENDIX: PROGRAM PARTICIPANTS

Amos Banin  
Department of Soil and Water Sciences  
The Hebrew University  
P.O. Box 12  
Rehovot, Israel

Els0 E. Barghoorn  
The Biological Laboratories  
Harvard University  
16 Divinity Avenue  
Cambridge, Massachusetts 02138

Ralph S. Becker  
Department of Chemistry  
University of Houston  
Houston, Texas 77004

Klaus Biemann  
Department of Chemistry  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139

John Billingham, M.D.  
Code LX  
Ames Research Center  
Moffett Field, California 94035

William A. Bonner  
Department of Chemistry  
Stanford University  
Stanford, California 94305

A.L. Burlingame  
Space Sciences Laboratory  
University of California  
Berkeley, California 94720

Melvin Calvin  
Space Sciences Laboratory  
University of California  
Berkeley, California 94720

Glenn C. Carle  
Code LXE  
Ames Research Center  
Moffett Field, California 94035

L.E. Casida, Jr.  
Department of Microbiology and  
Cell Biology  
College of Science  
The Pennsylvania State University  
University Park, Pennsylvania 16802

Sherwood Chang  
Code LX  
Ames Research Center  
Moffett Field, California 94035

M.R. Christensen  
Jet Propulsion Laboratory  
4800 Oak Grove Drive  
Pasadena, California 91103

John R. Cronin  
Department of Chemistry  
Arizona State University  
Tempe, Arizona 85281

James F. Danielli  
Department of Life Sciences  
Worcester Polytechnic Institute  
Worcester, Massachusetts 01609

R. Day  
TRW Systems, Incorporated  
One Space Park  
Redondo Beach, California 90278

Margaret O. Dayhoff  
National Biomedical Research Foundation  
Georgetown University Medical Center  
3900 Reservoir Road, N.W.  
Washington, D.C. 20007

David J. Des Marais  
Code LX  
Ames Research Center  
Moffett Field, California 94035

Donald L. DeVincenzi  
Program Manager, Exobiology  
Code SBL-3  
National Aeronautics and Space Administration  
Washington, D.C. 20546

Frederick R. Eirich  
Department of Chemistry  
Polytechnic Institute of New York  
333 Jay Street  
Brooklyn, New York 11201

James P. Ferris  
Department of Chemistry  
School of Science  
Rensselaer Polytechnic Institute  
Troy, New York 12181

Walter M. Fitch  
Department of Physiological Chemistry  
University of Wisconsin  
Madison, Wisconsin 53706

Clair E. Folsome  
Laboratory for Primordial Biology  
University of Hawaii at Manoa  
Honolulu, Hawaii 96822

Terry L. Foster  
Science Research Center  
Hardin-Simmons University  
P.O. Box 812  
Abilene, Texas 79698

George E. Fox  
Department of Biophysical Sciences  
University of Houston  
Houston, Texas 77004

Sidney W. Fox  
Institute for Molecular and Cellular  
Evolution  
University of Miami  
521 Anastasia  
Coral Gables, Florida 33134

E. Imre Friedmann  
Department of Biological Science  
Florida State University  
Tallahassee, Florida 32306

Jane Gibson  
Section of Biochemistry, Molecular  
and Cell Biology  
Division of Biological Sciences  
Wing Hall  
Cornell University  
Ithaca, New York 14853

Stjepko Golubic  
Department of Biology  
Boston University  
Boston, Massachusetts 02215

William A. Guillory  
Department of Chemistry  
University of Utah  
Salt Lake City, Utah 84112

Harlyn O. Halvorson  
Rosenstiel Basic Medical Sciences  
Research Center  
Brandeis University  
Waltham, Massachusetts 02154

Hyman Hartman  
Department of Earth and Planetary  
Sciences  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139

John M. Hayes  
Department of Chemistry  
Indiana University  
Bloomington, Indiana 47405

Lawrence I. Hochstein  
Code LXL  
Ames Research Center  
Moffett Field, California 94035

Norman H. Horowitz  
Department of Biology  
California Institute of Technology  
Pasadena, California 91109

Jerry Hubbard  
School of Biology  
Georgia Institute of Technology  
Atlanta, Georgia 30332

Robert L. Huguenin  
Department of Physics/Astronomy-Hasbrouck  
University of Massachusetts  
Amherst, Massachusetts 01003

Linda Jahnke  
Code LX  
Ames Research Center  
Moffett Field, California 94035

Richard D. Johnson  
Code LB  
Ames Research Center  
Moffett Field, California 94035

Thomas H. Jukes  
Division of Biophysics and Medical  
Physics  
University of California  
Berkeley, California 94720

Isaac R. Kaplan  
Institute of Geophysics and Planetary  
Physics  
University of California  
Los Angeles, California 90024

Harold P. Klein  
Code L  
Ames Research Center  
Moffett Field, California 94035

William R. Kuhn  
Department of Atmospheric and Oceanic  
Science  
College of Engineering  
University of Michigan  
Ann Arbor, Michigan 48109

James C. Lacey, Jr.  
Laboratory of Molecular Biology  
University of Alabama School of Medicine  
University Station  
Birmingham, Alabama 35294

Janos K. Lanyi  
Code LX  
Ames Research Center  
Moffett Field, California 94035

James G. Lawless  
Code LX  
Ames Research Center  
Moffett Field, California 94035

Edward R. Leadbetter  
Department of Biology  
University of Connecticut  
Storrs, Connecticut 06268

Gilbert V. Levin  
Biospherics Incorporated  
4928 Wyaconda Road  
Rockville, Maryland 20852

John S. Lewis  
Department of Earth and Planetary Sciences  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139

Gilda H. Loew  
Molecular Research Institute  
Atherton, California 94035

Russell E. MacDonald  
Section of Biochemistry, Molecular and  
Cell Biology  
Division of Biological Sciences  
Wing Hall  
Cornell University  
Ithaca, New York 14853

Robert D. MacElroy  
Code LX  
Ames Research Center  
Moffett Field, California 94035

Lynn Margulis  
Department of Biology  
Boston University  
2 Cummington Street  
Boston, Massachusetts 02215

Joe Martin  
Martin Marietta Corporation  
Denver Division  
P.O. Box 179  
Denver, Colorado 80201

Stanley L. Miller  
Chemistry Department  
University of California  
La Jolla, California 92037

Bartholomew Nagy  
Laboratory of Organic Geochemistry  
Department of Geosciences  
University of Arizona  
Tucson, Arizona 85721



James B. Orenberg  
Frederic Burk Foundation for Education  
San Francisco State University  
1640 Holloway Avenue  
San Francisco, California 94132

Leslie E. Orgel  
Salk Institute for Biological Studies  
P.O. Box 85800  
San Diego, California 92138

John Oro  
Laboratory of Biomolecular Analysis  
Department of Biophysical Sciences  
University of Houston  
Houston, Texas 77004

Vance I. Oyama  
Code LXE  
Ames Research Center  
Moffett Field, California 94035

Robert C. Plumb  
Department of Chemistry  
Worcester Polytechnic Institute  
Worcester, Massachusetts 01609

Glenn E. Pollock  
Code LX  
Ames Research Center  
Moffett Field, California 94035

Cyril Ponnampereuma  
Laboratory of Chemical Evolution  
Department of Chemistry  
University of Maryland  
College Park, Maryland 20742

Richard Radmer  
Martin Marietta Laboratories  
Martin Marietta Corporation  
1450 South Rolling Road  
Baltimore, Maryland 21227

Robert Rein  
Health Research, Incorporated  
Roswell Park Division  
666 Elm Street  
Buffalo, New York 14263

Alexander Rich  
Department of Biology  
Massachusetts Institute of Technology  
Cambridge, Massachusetts 02139

Arthur Rich  
Department of Physics  
University of Michigan  
Ann Arbor, Michigan 48109

Edward M. Ripley  
Department of Geology  
Indiana University  
1005 East Tenth Street  
Bloomington, Indiana 47401

Duane L. Rohlifing  
Department of Biology  
University of South Carolina  
Columbia, South Carolina 29208

Carl E. Sagan  
Laboratory for Planetary Studies  
Center for Radiophysics and Space  
Research  
Cornell University  
Ithaca, New York 14853

J. William Schopf  
Department of Earth and Space Sciences  
3806 Geology Building  
University of California  
Los Angeles, California 90024

Charles L. Seeger  
Department of Physics and Astronomy  
San Francisco State University  
San Francisco, California 94132

Melvin P. Silverman  
Code LX  
Ames Research Center  
Moffett Field, California 94035

Grant Gill Smith  
Department of Chemistry and Biochemistry  
UMC 03  
Utah State University  
Logan, Utah 84322

Perry D. Stabekis  
Exotech Research and Analysis,  
Incorporated  
1200 Quince Orchard Boulevard  
Gaithersburg, Maryland 20760

Walther Stoeckenius, M.D.  
Cardiovascular Research Institute  
School of Medicine  
University of California  
San Francisco, California 94143

Patricia A. Straat  
Biospherics Incorporated  
4928 Wyaconda Road  
Rockville, Maryland 20852

Bernard Strehler  
Department of Biology  
University of Southern California  
University Park  
Los Angeles, California 90027

Jill Tarter  
Code SSL  
Ames Research Center  
Moffett Field, California 94035

Helen S. Vishniac  
Department of Cellular, Molecular  
and Developmental Biology  
Oklahoma State University  
Stillwater, Oklahoma 74074

Arthur L. Weber  
The Salk Institute for Biological Studies  
P.O. Box 85800  
San Diego, California 92138

Frederick C. Wedler  
Department of Biochemistry and  
Biophysics  
Althouse Lab  
Pennsylvania State University  
University Park, Pennsylvania 16802

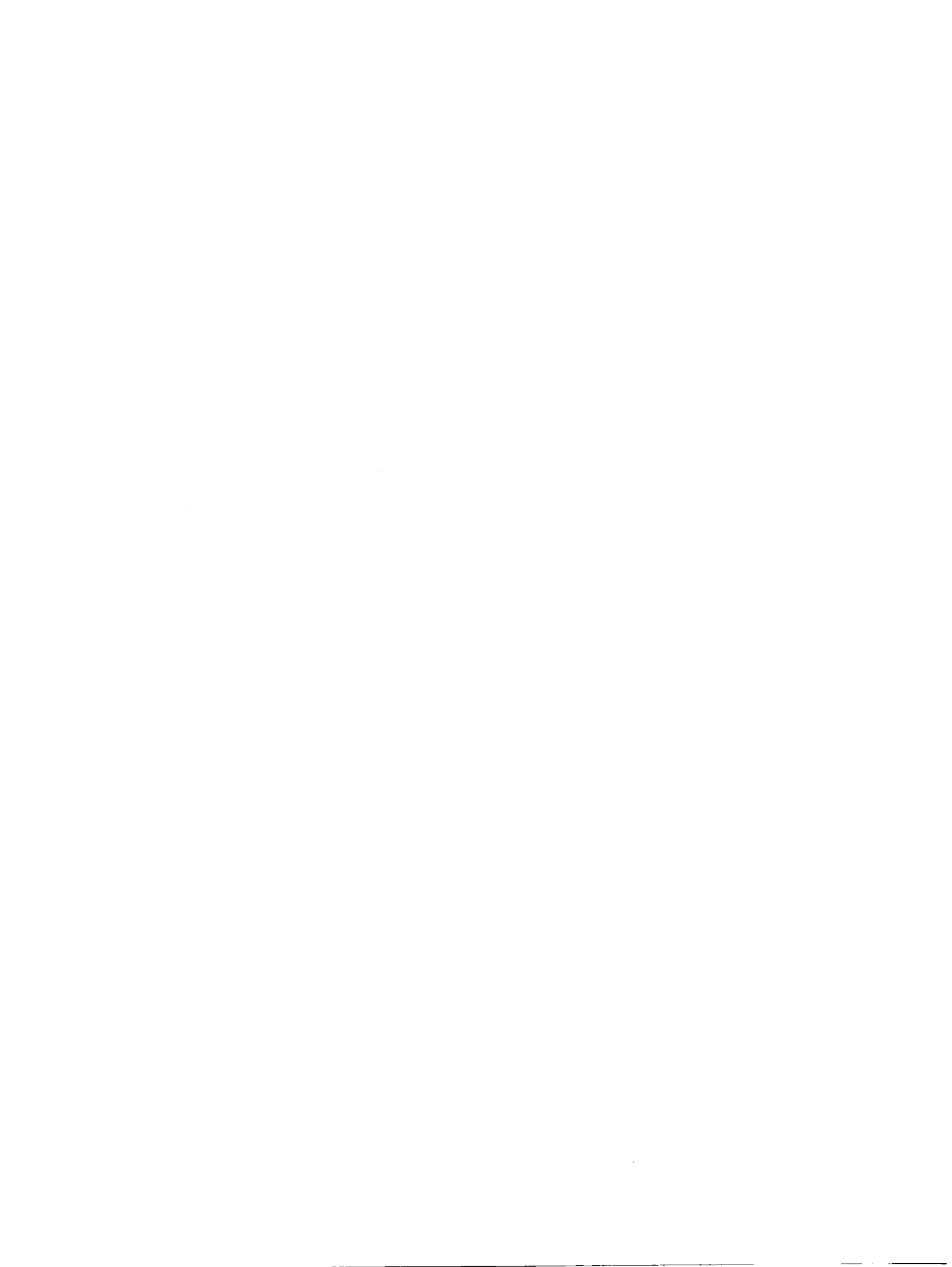
Fritz H. Woeller  
Code LXE  
Ames Research Center  
Moffett Field, California 94035

Carl R. Woese  
Department of Genetics and Development  
University of Illinois  
Urbana, Illinois 61801

Richard S. Young  
Vice President  
Rockefeller University  
1230 York Avenue  
New York, New York 10021

G.U. Yuen  
Department of Chemistry  
Arizona State University  
Tempe, Arizona 85281

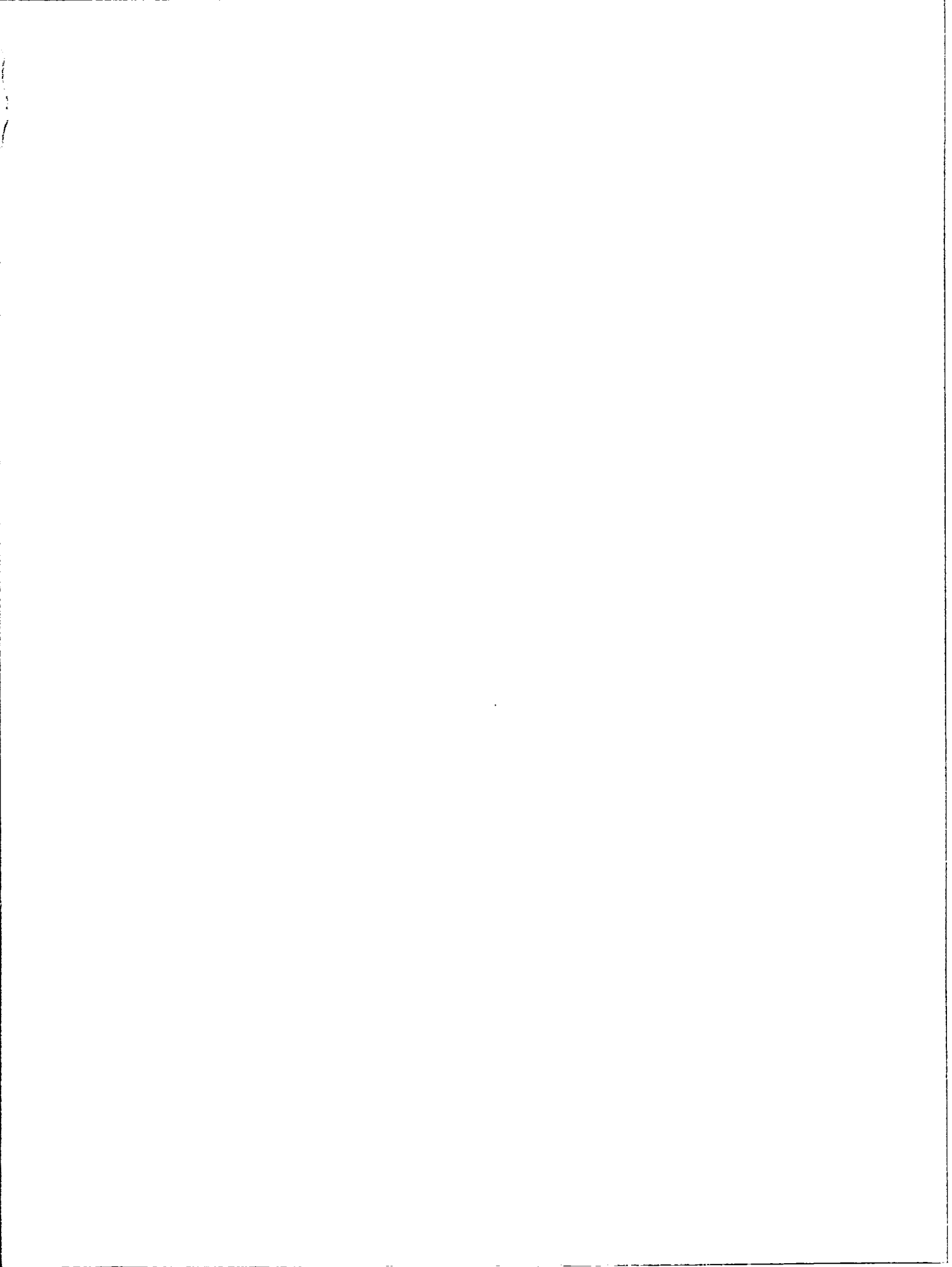
Leonard P. Zill  
Code LXL  
Ames Research Center  
Moffett Field, California 94035



1. Report No. NASA TM-82182		2. Government Accession No.		3. Recipient's Catalog No.	
4. Title and Subtitle Publications of the Exobiology Program for 1979: A Special Bibliography				5. Report Date October 1980	
				6. Performing Organization Code	
7. Author(s) Linda G. Pleasant and Donald L. DeVincenzi				8. Performing Organization Report No.	
9. Performing Organization Name and Address National Aeronautics and Space Administration Washington, D.C. 20546				10. Work Unit No.	
				11. Contract or Grant No.	
12. Sponsoring Agency Name and Address Office of Space Science National Aeronautics and Space Administration Washington, D.C. 20546				13. Type of Report and Period Covered Technical Memorandum	
				14. Sponsoring Agency Code SBL	
15. Supplementary Notes For previous bibliography in this series, see NASA TM-80745.					
16. Abstract  List of 1979 publications resulting from research pursued under the auspices of NASA's Exobiology Program.					
17. Key Words (Suggested by Author(s)) Chemical Evolution Organic Geochemistry, Life Detection, Origin of Life Exobiology, Extraterrestrial Life				18. Distribution Statement  Unclassified - Unlimited  Subject Category 55	
19. Security Classif. (of this report) Unclassified		20. Security Classif. (of this page) Unclassified		21. No. of Pages 30	22. Price* A03

\* For sale by the National Technical Information Service, Springfield, Virginia 22161

NASA-Langley, 1980



National Aeronautics and  
Space Administration

THIRD-CLASS BULK RATE

Postage and Fees Paid  
National Aeronautics and  
Space Administration  
NASA-451



Washington, D.C.  
20546

Official Business

Penalty for Private Use, \$300

**NASA**

POSTMASTER: If Undeliverable (Section 158  
Postal Manual) Do Not Return

---