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Micropaleontological Studies of Lunar and Terrestrial Precambrian Materials

by

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ABSTRACT

Optical microscopic and scanning electron microscopic studies of rock chips and dust returned by Apollo 14, 15, 16, and 17, and optical microscopic studies of petrographic thin sections of breccias and basalts returned by Apollo 14, 15, and 16, have yielded no evidence of modern or fossil lunar organisms. The lunar surface is now, and apparently has been throughout the geologic past, inimical to known biologic systems.

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INTRODUCTION

Studies of lunar samples funded by NASA Grant NGR 05-007-292 have been designed to detect evidence, if present, of extant or former (recently dead or fossil) life on the moon. Rationale underlying these investigations has been discussed elsewhere (SCHOPF, 1970).

In addition to studies of lunar samples, funds provided by NASA Grant NGR 05-007-292 have been used to support paleobiological investigations of terrestrial Precambrian materials. Results of these studies have been communicated in the 24 papers and abstracts listed in Appendix A. Funds provided by this grant have also contributed to costs connected with research resulting in the preparation of three doctoral dissertations (Appendix B).

SAMPLES STUDIED

As is summarized in Table 1, a total of 56 lunar samples, including lunar fines (26 samples), material from drill stems and from Surface Environmental Sample Containers (5 samples), and petrographic thin sections (16 sections) and interior and exterior chips of lunar rocks (9 samples) returned by Apollo 14, 15, 16, and 17 have been examined during the term of this grant.

TABLE 1
Samples Studied

Sample No.	Fines	Chips	Thin Sections	Other
Apollo 14:				
14003	X			
14047		X		
14063			X	
14066			X	
14148	X			
14156	X			
14162	X			
14240	X			
14258	X			
14298	X			
14301			X	
14310			X	
14313			X	
14318		X		
14321		X	X	
Apollo 15:				
15001				Drill Stem
15002				Drill Stem
15003				Drill Stem
15012				SESC-1
15013				SESC (blank)
15015		X		
15021	X			
15071	X			
15205			X	
15210	X			
15261	X			
15365		XX		
15271	X			
15285			X	
15298		X		
15421	X			
15426	X			
15455		X		
15465		X		
15471	X			
15498			X	
15505			X	
15556			X	

Table 1 (continued)

Sample No.	Fines	Chips	Thin Sections	Other
Apollo 16:				
60017			X	
60501	X			
61221	X			
63321	X			
64475			X	
65500	X			
67016			X	
67915			X	
68115			X	
68501	X			
69961	X			
Apollo 17:				
74220	X			
74240	X			
76240	X			
76260	X			
79261	X			

ANALYTICAL TECHNIQUES

Samples of the fines, placed on glass microscope slides either as free powder or dispersed in glycerine jelly, were studied with a light microscope at magnifications ranging from 4 to 1500 using normal and polarized transmitted light, phase-contrast optics, Smith-interference contrast optics, and reflected light. Similar optical microscopic studies were made of chips and petrographic thin sections. Other samples of the fines and selected particles and rock fragments were coated with a thin gold-palladium film and studied with a scanning electron microscope at magnifications ranging from 30 to 30,000. Previous studies have demonstrated that acid maceration of lunar material does not provide additional significant information (SCHOPF, 1970); this destructive technique was therefore here omitted.

RESULTS AND SUMMARY

These investigations have yielded no evidence of living, recently dead, or fossil microorganisms. In contrast with material returned by Apollo 11 and 12, which contained contaminants of terrestrial origin (e.g., cellulose fibers, Teflon fragments, aluminum foil, and gold-coated Mylar fabric; SCHOPF, 1970, 1971), the Apollo 14, 15, 16, and 17 samples

here studied were devoid of particular organic contaminants.

The present lunar environment is inimical to known biologic systems. Although only a small portion of the lunar surface has been sampled, and much remains to be learned regarding the early history of the moon and its evolution to the present, results of these studies seem to indicate that the moon is now, and has been throughout the geologic past, devoid of indigenous biologic activity.

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APPENDIX A

PUBLICATIONS OF THE PRINCIPAL INVESTIGATOR RESULTING FROM STUDIES SUPPORTED WHOLLY OR PARTIALLY BY NASA GRANT NGR 05-007-292

1. SCHOPF, J. W. & BLACIC, J. M. 1971. New microorganisms from the Bitter Springs Formation (late Precambrian) of the north-central Amadeus Basin, Australia. J. Paleontology, 45: 925-960.

2. SCHOPF, J. W. 1971. Antiquity and evolution of the earliest plants. Abstracts, Palaeobotanical Conference, Birbal Sahni Inst. of Palaeobotany, Silver Jubilee, Lucknow, India: 52-53 (Abs.).

3. SCHOPF, J. W. 1971. Origin of Eukaryotic Cells, review of book by L. Margulis. American Scientist, 59: 765-766.

4. OEHLER, J. H. & SCHOPF, J. W. 1971. Artificial microfossils: experimental studies of permineralization of blue-green algae in silica. Science, 174: 1229-1231.

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8. SATTERTHWAIT, D. F. & SCHOPF, J. W. 1972. Structurally preserved phloem zone tissue in Rhynia. Am. J. Botany, 59: 373-376.

9. SCHOPF, J. W. 1972. Evolutionary significance of the Bitter Springs (late Precambrian) microflora. Abstracts, XXIV Internat. Geol. Cong., Montreal: 24-25 (Abs.).

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11. SCHOPF, J. W., HAUGH, B. N., MOLNAR, R. E. & SATTERTHWAIT, D. F. 1973. On the development of metaphytes and metazoans. J. Paleontology, 47: 1-9.

12. SCHOPF, J. W. 1973. Evolutionary status of the late Precambrian biota--new evidence from South Australia and the Grand Canyon. Abstracts, Symposium on Environmental Biogeochemistry, Utah State University, Logan, Utah: 2-3 (Abs.).

13. SCHOPF, J. W., FORD, T. D. & BREED, W. J. 1973. Microorganisms from the late Precambrian of the Grand Canyon, Arizona. Science, 179: 1319-1321.

14. SCHOPF, J. W. & FAIRCHILD, T. R. 1973. Late Precambrian microfossils: a new stromatolitic biota from Boorthanna, South Australia. Nature, 242: 537-538.

15. SCHOPF, J. W. 1973. The development and diversification of Precambrian life. Abstracts, 4th Internat. Conference on the Origin of Life, Colloquium II, Paper 12, Barcelona, Spain (Abs.).

16. FAIRCHILD, T. R., SCHOPF, J. W. & FOLK, R. L. 1973. Filamentous algal microfossils from the Caballos Novaculite, Devonian of Texas. J. Paleontology, 47: 946-952.

17. OEHLER, J. H., AIZENSHTAT, Z. & SCHOPF, J. W. 1974. Thermal degradation of blue-green algae and blue-green algal chlorophyll. Am. Assoc. Petrol. Geol. Bull., 58: 124-132.

18. WICANDER, E. R. & SCHOPF, J. W. 1974. Microorganisms from the Kalkberg Limestone (lower Devonian) of New York State. J. Paleontology, 48: 74-77.

IN PRESS

19. SCHOPF, J. W. In press. Paleobiology of the Precambrian: the age of blue-green algae. In: Dobzhansky, T., Hecht, M. K. & Steere, W. C., Eds., Evolutionary Biology, 7 (Appleton-Century-Crofts).

20. SCHOPF, J. W. In Press. The Development and Diversification of Precambrian Life. Origins of Life.

21. SCHOPF, J. W., HORODYSKI, R. J., FAIRCHILD, T. R. & DONALDSON, J. A. In Press. Late Precambrian microfossils: discovery of four new stromatolitic biotas. Amer. J. Botany (Abs.).

22. FAIRCHILD, T. R. & SCHOPF, J. W. In Press. A late Precambrian stromatolitic microflora from Boorthanna, South Australia. Amer. J. Botany (Abs.).

23. SCHOPF, J. W. In Press. Antiquity and evolution of the Precambrian biosphere. Abstracts, International Seminar on Problems of the Origin of Life, Moscow (Abs.).

24. SCHOPF. J. W. In Press. Major events in the evolution of the primitive (Precambrian) biota. Abstracts, International Symposium on the Taxonomy of Algae, Madras (Abs.).

APPENDIX B

DOCTORAL DISSERTATIONS SUPPORTED PARTIALLY BY NASA GRANT NGR 05-007-292

1. HORODYSKI, R. J. 1973. Stromatolites and paleoecology of parts of the Middle Proterozoic Belt Supergroup, Glacier National Park, Montana. Ph.D. Thesis, Department of Geology, UCLA.

2. OEHLER, D. Z. 1973. Carbon isotopic and electron microscopic studies of organic remains in Precambrian rocks. Ph.D. Thesis, Department of Geology, UCLA.

3. OEHLER, J. H. 1973. Morphological and biochemical changes in blue-green algae during simulated fossilization in synthetic chert. Ph.D. Thesis, Department of Geology, UCLA.