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Geobiology

Microbial Mats in Sandy Deposits
from the Archean Era to Today



Springer



Preface



Sand is everywhere, and sandy deposits belong to the oldest sediments preserved in Earth's geological record. With the formation of the first continental crust, the first shorelines were created, tidal currents had the first opportunity to rework loose grains, and shallow shelves were the result of first transgressions. It is here, in sands, where life found one of its earliest habitats. And despite all evolutionary changes that took place in the worlds of Earth during its travel through time – the shorelines and the moving waters remained the same for at least 3 billion years.

Benthic prokaryotes, sea floor inhabiting bacterial microbes, are known as the constructors of the famous stromatolites, reef-like boulder heads that constitute the most valuable witnesses of the dawn of life. In recent years, research has wrenched open a new window that allows hopeful glances back in time. Stromatolites are beautiful geological features, laminated, branched, and full of preserved energy. It seemed therefore an odd idea that Robert Riding and I had in spring of 1993, when discussing in the stair well of the Geological-Paleontological Institute of the University of Tuebingen in Germany: to focus my future work on sandy deposits and prokaryotic build-ups therein. As student of Dolf Seilacher it was logical consequence to search for traces and trace fossils in sand and sandstones. Traces made by microorganisms.

Following Robert Riding's advice, I scratched my last savings together and participated the "Mini Mat Meeting MMM" in Oldenburg 1993. This meeting was organized by Wolfie Krumbein, and a short introduction by Robert opened the doors to a new approach. Working with Gisela Gerdes, pioneer in sandy microbial mat structures, I learned to understand modern shorelines and the study of cyanobacteria. The following two years were devoted to gather information for the ultimate goal: to have handy modern models that serve to explore Earth's most antique worlds. I investigated the famous tidal flats of the North Sea, detected MISS in Tunisia, and worked in Egypt.

My first postdoctoral research at the University in Frankfurt/Main let me back to my master thesis study area, the 480 Ma Ordovician of the Montagne Noire, France. After 4 days of looking for something I did not know what it would look like, the later afternoon sun illuminated wrinkled sandstone beds of a fossil tidal flat and shelf in the Gres et Schistes de la Cluse de l'Orb. Suddenly the structures seemed to pop out everywhere in the outcrop recording ancient microbial mats.

Like for so many successful young scientists in Germany, the doors for a continuing career in academia remained closed also for me. My note to Andy Knoll, however, was answered warmly. With Andy Knoll and John Grotzinger I had the opportunity to study 550 Ma Neoproterozoic tidal and shelf successions in Namibia. Containing the same



paleoenvironments like the Ordovician tidal flats and shelves, the Neoproterozoic Nama Group allowed the continuation of my walk into older Earth's history.

A year later, in 2001, as starting professor at Old Dominion University, I had funds for a ten day field trip to South Africa, the desperate task ahead of me to detect something as tiny as a bacterial fossil in an area as big as half of the country. In the afternoon of the last day (it was a very hot and dusty day) my already discouraged colleagues RC Kidd and Noah Nhleko and myself stumbled along a last road cut, when the light of the already sinking sun shone on a characteristically crinkled sandstone surface – a fossil microbial mat. Like the much younger sandstone successions I studied before, also the 2.9 Ga Mesoproterozoic Pongola and Witwatersrand Supergroups contained tidal flats and shelves, and showed the same facies-related distribution of photoautotrophic microbial mats. It was not a surprise to find the same situation two years later in the 3.2 Ga Paleoproterozoic Moodies Group, likewise in South Africa. The star of all study sites, however, was the Nhlazatse Section, a close to 3 Ga old tidal flat spotted with the most beautifully preserved MISS in Earth's record known so far.

It is this journey of mine through the career of a scientist, the migration from one continent to another, and from present times to most antique ones, which inspired me to summarize this book. This first text on MISS cannot be perfect and many issues will be resolved only in the future. I encourage the reader to contact me with suggestions, corrections and comments that may serve to improve this text for the future editions.

I am deeply grateful to my families on both sides of the Atlantic Ocean for their endurance to cope with my long absences, to my friends in Boston, Washington, and Norfolk for their warm welcome in the States, my colleagues all over the world for their support through my metamorphosis from a fossil-collecting kid to a scholar. I owe major thanks to Kurt Risser, who in long and persistent hours transformed the one or other Germanism in the manuscript into proper English. In stratigraphic order, most of the research on which this text is based has been supported by the Deutsche Forschungsgemeinschaft DFG, the Leopoldina Deutsche Akademie der Wissenschaften, the Sedimentary Geology and Paleobiology Program of the National Science Foundation NSF, and NASA's Exobiology and Mars Exploration Programs.

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Contents

I	Introduction	1
I.1	Microbial Mats, Stromatolites and MISS – an Overview	3
I.2	The Geobiological Concept	7
I.3	Microbially Induced Sedimentary Structures	11
I.3.1	The Scholarly Definition	11
I.3.2	Taxonomic Relation of MISS to Stromatolites	11
I.3.3	Etymology of the Term	12
I.3.4	History of MISS Research	12
I.3.5	Distribution of MISS in Space and through Time	13
I.3.5.1	Temporal Distribution	13
I.3.5.2	Spatial Distribution	14
I.4	Significance of Microbially Induced Sedimentary Structures – Status and Perspectives	15
I.4.1	Sedimentology	15
I.4.1.1	Biotic-Physical Sediment Dynamics Versus Physical Sediment Dynamics	15
I.4.1.2	A New Group of Primary Sedimentary Structures	15
I.4.1.3	Indicators for Sequence Stratigraphy and Basin Analysis	15
I.4.2	Paleontology and Microbiology	16
I.4.2.1	First Cyanobacteria	16
I.4.2.2	First Photoautotrophic Microbiota	16
I.4.3	Astrobiology	16
I.4.3.1	Earthly Analogues	16
I.4.3.2	Biosignatures	17
I.4.4	Oceanography and Climatology	17
I.5	Collection of MISS	18
	19
II.1	MISS – Products of Life and Environment	21
II.1.1	The Sedimentary Surface – an Interface	21
II.1.1.1	The Three Main Types of Sedimentary Systems	22
II.1.2	Life at the Interface	23
II.1.2.1	Biofilm	24
II.1.2.2	Microbial Mat	29
II.1.2.3	Cyanobacteria for Beginners	31

II.2	Formation and Preservation of MISS	32
II.2.1	Development and Preservation of Microbial Mats: the Ecological and the Taphonomic Window	32
II.2.1.1	The Ecological Window: Primary Processes of MISS-Formation	32
II.2.1.2	The Taphonomic Window: Primary and Secondary Processes of MISS-Preservation	56
II.2.2	Bringing the Ecological and Taphonomic Window into Alignment: the Search for Biofilms and Microbial Mats in Siliciclastic Settings	62
II.2.2.1	Search	63
II.2.2.2	Detection	64
II.2.2.3	Identification	65
II.2.2.4	Confirmation	66
II.2.2.5	Differentiation	67
II.2.3	The Criteria for Biogenicity of MISS	68
II.2.3.1	List of Criteria	69
II.2.3.2	The Criteria for the Biogenicity of MISS in the Context of the Criteria for Stromatolites	71
	75
III.1	The Classification Diagram of MISS	77
III.2	The Five Categories of MISS	79
III.2.1	Structures Arising from Microbial Growth	79
III.2.1.1	Oriented Grains	79
III.2.1.2	Laminated Leveling Structure	83
III.2.2	Structures Arising from Microbial Binding	85
III.2.2.1	Mat Microfabrics	86
III.2.2.2	Sinoidal Structure	92
III.2.3	Structures Arising from Biostabilization	94
III.2.3.1	Mat Chips	95
III.2.3.2	Roll-up Structure (Mat Curl)	99
III.2.3.3	Shrinkage Cracks	102
III.2.3.4	Petees	104
III.2.3.5	Gas Domes	106
III.2.3.6	Sponge Pore Fabrics	109
III.2.4	Structures Arising from Baffling and Trapping	111
III.2.4.1	Mat Layer-Bound Small Grains	112
III.2.4.2	Mat Layer-Bound Heavy Minerals	113
III.2.5	Structures Arising from the Interference of All Microbial Activities Interacting with Physical Sediment Dynamics	114
III.2.5.1	Erosional Remnants and Pockets	114
III.2.5.2	Multidirected Ripple Marks	122
III.2.5.3	Microsequences	127
III.2.5.4	Wrinkle Structures	130
III.2.5.5	Polygonal Oscillation Cracks	137

	141
IV.1 Ancient Biofilm- and Microbial Mat-Forming Prokaryotes	143
IV.2 Geobiological Field Trip Sites	145
IV.2.1 Modern and Pleistocene Catena of Benthic Cyanobacteria in the Bahar Alouane, Southern Tunisia, Africa	145
IV.2.2 Earth's Possibly Oldest Fossil Cyanobacteria Preserved in the Nhlazatse Section, 2.9 Ga Pongola Supergroup, South Africa	147
IV.2.2.1 Location of the Outcrop	148
IV.2.2.2 Stratigraphy	148
IV.2.2.3 Tectonic Overprint	149
IV.2.2.4 Biofilm-Catena	149
IV.2.2.5 Exceptionally Preserved Structures in the Nhlazatse Outcrop	150
	169
	177