



Government of Western Australia  
Department of Mines, Industry Regulation and Safety  
Geological Survey of Western Australia



# Microbialites: an untapped resource

**Heidi Allen**

with contributions from **Kath Grey,**  
**Stanley Awramik, Peter Haines**  
**& David Martin**

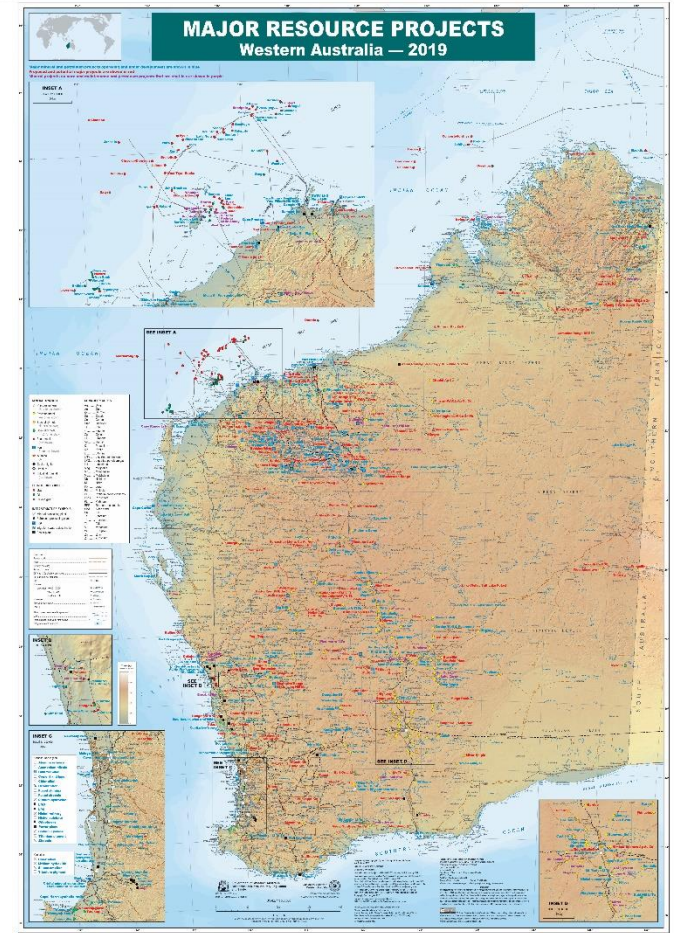


# Microbialites.....the next big thing?

- Iron ore
- Gold
- Nickel
- Lithium



.....microbialites?



# Talk outline

- Introduction
  - WA's wealth of stromatolites
- GSWA microbialite studies
  - Neoproterozoic Centralian Superbasin
  - Paleoproterozoic Turee Creek and Wyloo Groups
- New toolkit
  - Bulletin 147

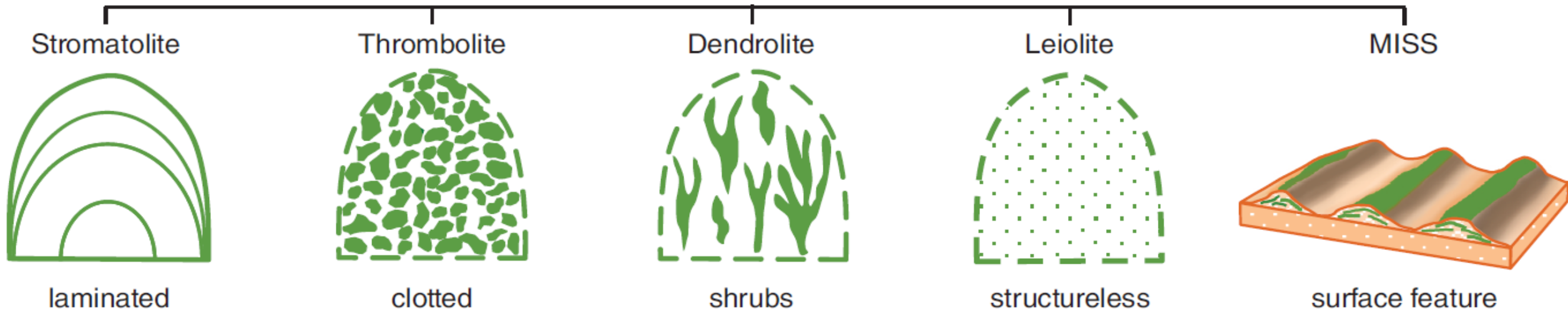


# What are microbialites?

‘organosedimentary deposits that have accreted as a result of a benthic microbial community trapping and binding detrital sediment and/or forming the locus of mineral precipitation’ (Burne and Moore, 1987)

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Stromatolite



laminated

Thrombolite



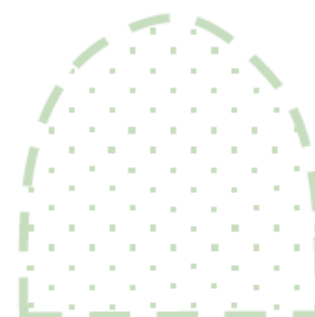
clotted

Dendrolite



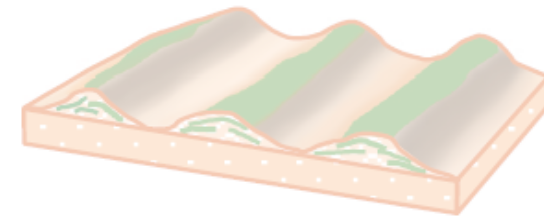
shrubs

Leiolite



structureless

MISS



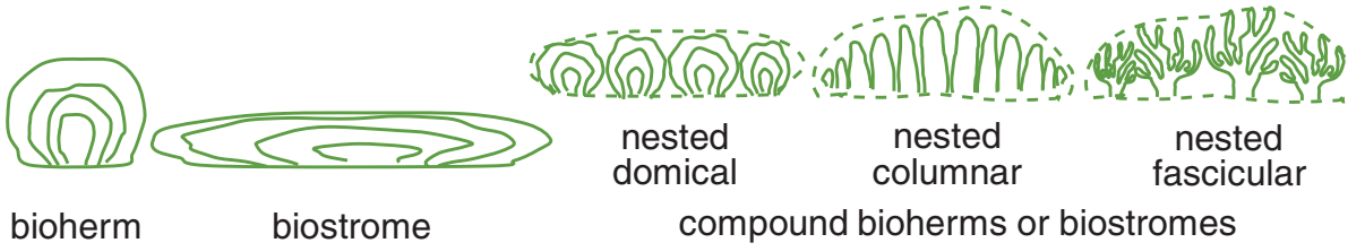
surface feature

Megastructure

Microbialite buildup (bed or reef)



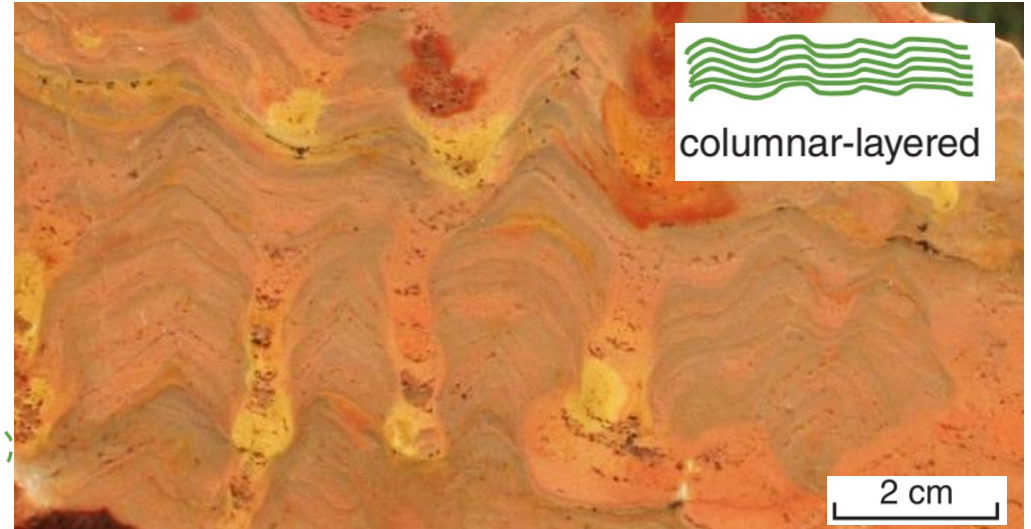
Bioherms and biostromes



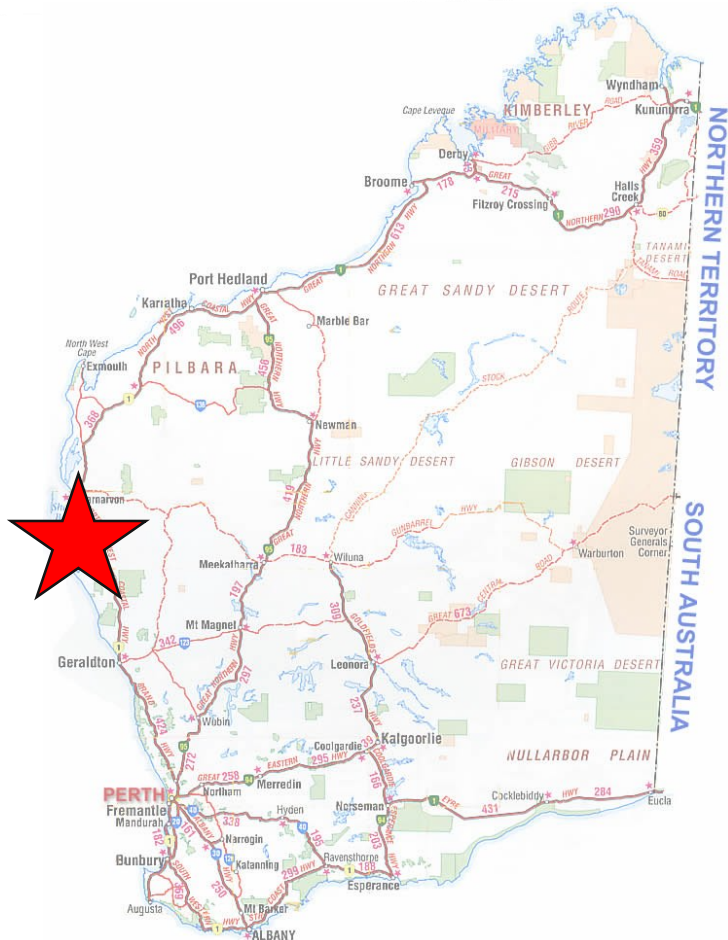
Head (or stromatoid: individual, coenoplas, calyptra)



Microbialite shape

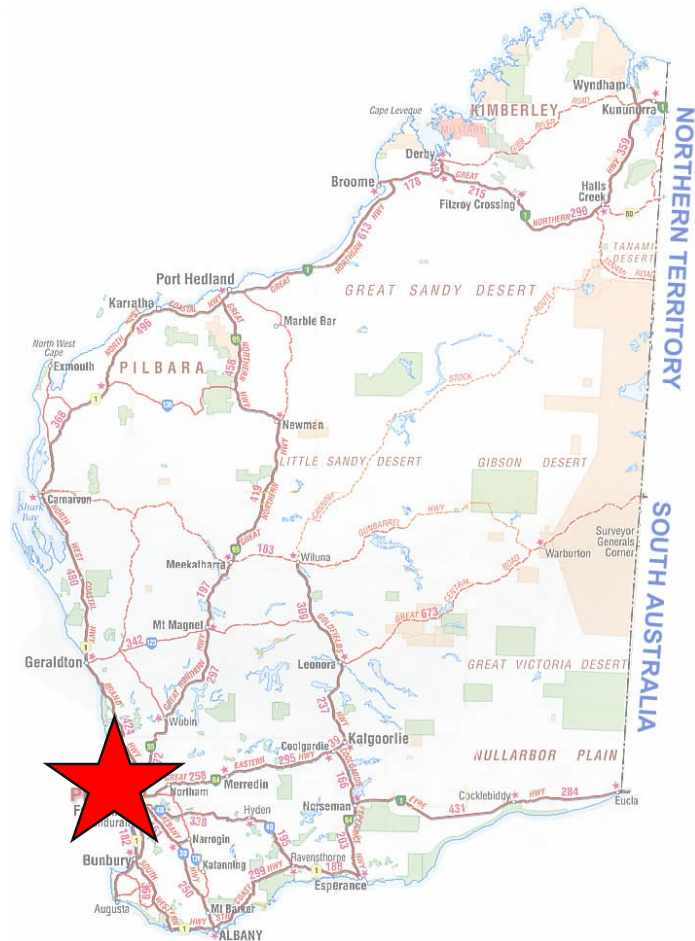


# WA's wealth of microbialites

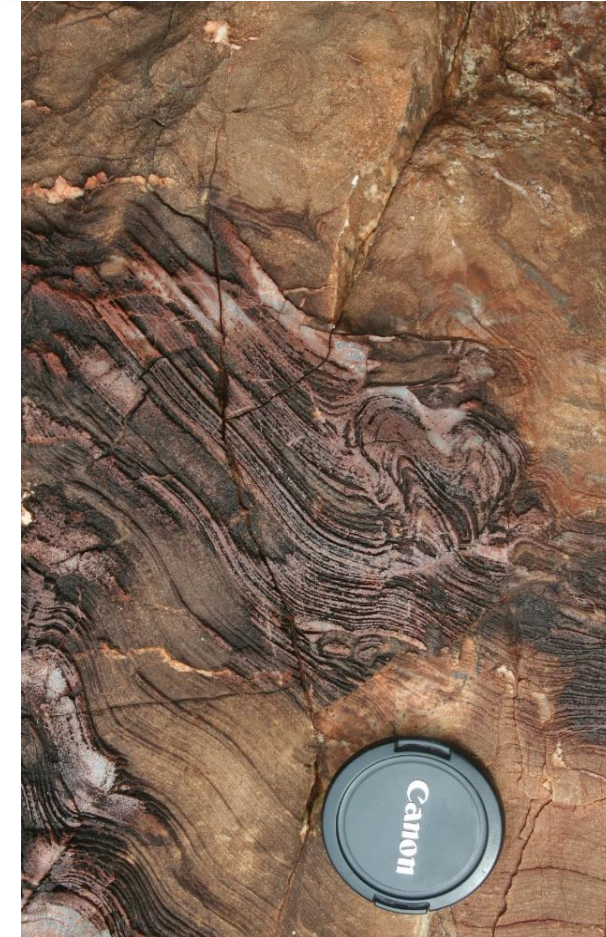
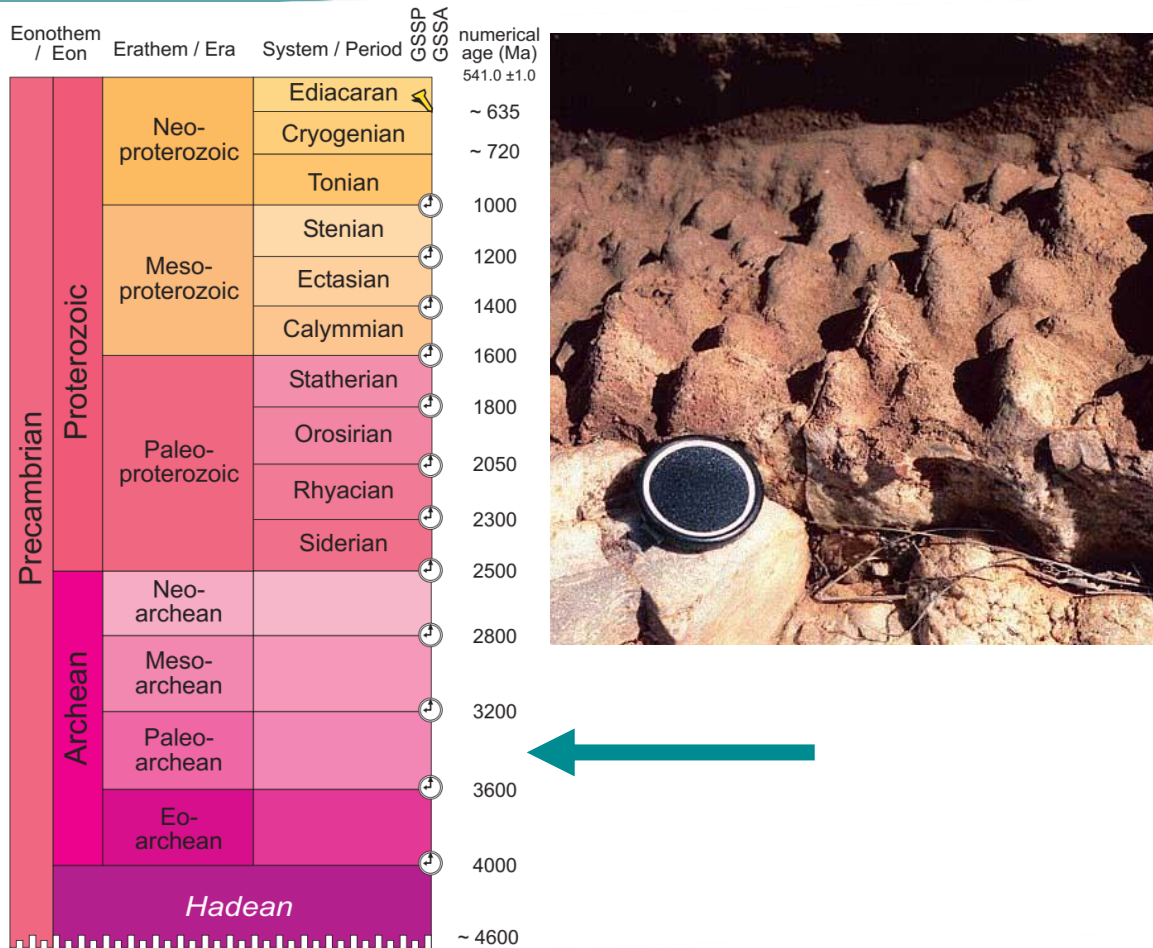


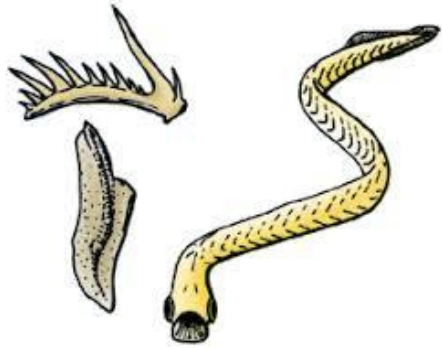


# WA's wealth of microbialites



# WA's wealth of microbialites



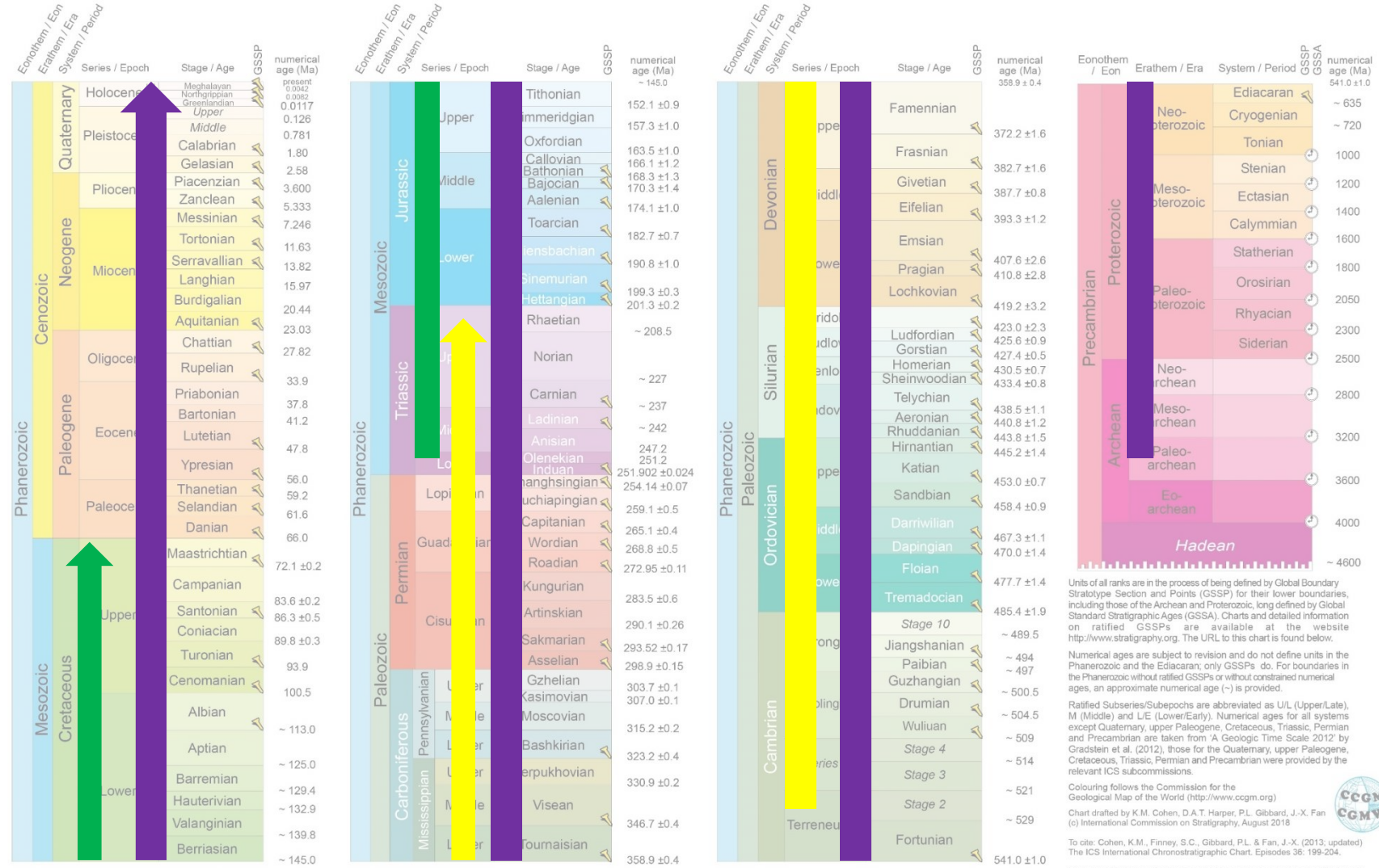


# INTERNATIONAL CHRONOSTRATIGRAPHIC CHART

www.stratigraphy.org

International Commission on Stratigraphy

v 2018/08



Units of all ranks are in the process of being defined by Global Boundary Stratotype Section and Points (GSSP) for their lower boundaries, including those of the Archean and Proterozoic, long defined by Global Standard Stratigraphic Ages (GSSA). Charts and detailed information on ratified GSSPs are available at the website <http://www.stratigraphy.org>. The URL to this chart is found below.

Numerical ages are subject to revision and do not define units in the Phanerozoic and the Ediacaran; only GSSPs do. For boundaries in the Phanerozoic without ratified GSSPs or without constrained numerical ages, an approximate numerical age (~) is provided.

Ratified Subseries/Subepochs are abbreviated as U/L (Upper/Late), M (Middle) and L/E (Lower/Early). Numerical ages for all systems except Quaternary, upper Paleogene, Cretaceous, Triassic, Permian and Precambrian are taken from 'A Geologic Time Scale 2012' by Gradstein et al. (2012), those for the Quaternary, upper Paleogene, Cretaceous, Triassic, Permian and Precambrian were provided by the relevant ICS subcommissions.

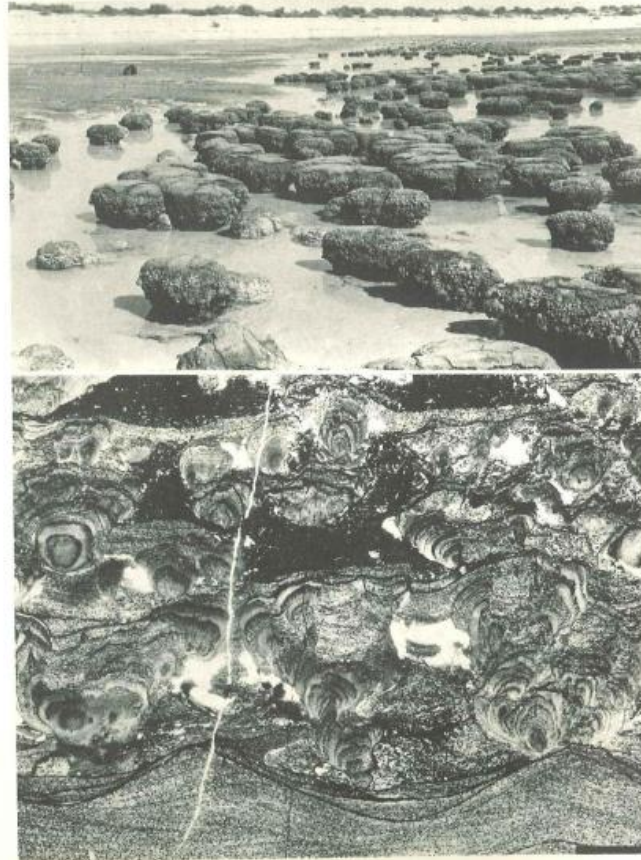
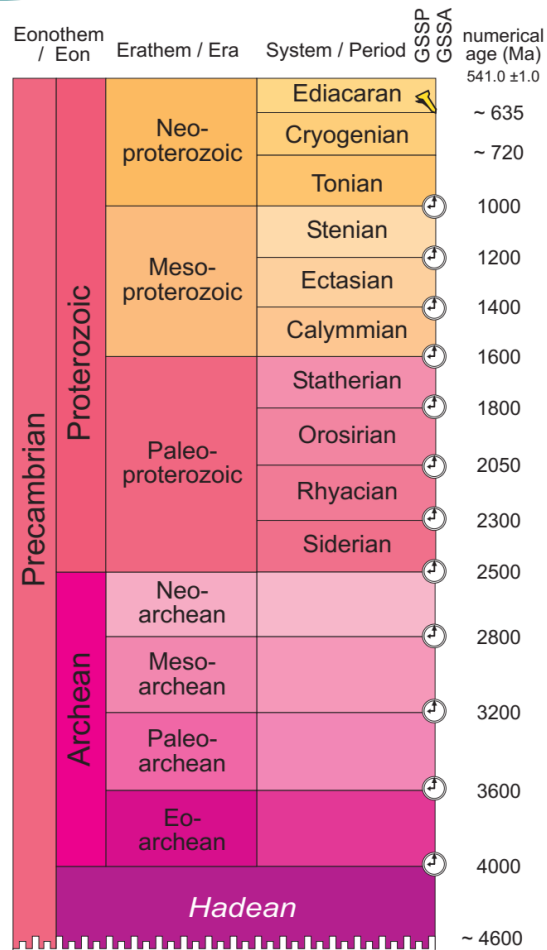
Colouring follows the Commission for the Geological Map of the World (<http://www.ccgmg.org>)

Chart drafted by K.M. Cohen, D.A.T. Harper, P.L. Gibbard, J.-X. Fan (c) International Commission on Stratigraphy, August 2018

To cite: Cohen, K.M., Finney, S.C., Gibbard, P.L. & Fan, J.-X. (2013, updated) The ICS International Chronostratigraphic Chart. Episodes 36: 199-204.

URL: <http://www.stratigraphy.org/ICSChart/ChronostratChart2018-08.pdf>

# Early microbialite research



SPECIAL PAPERS IN PALAEOONTOLOGY NO. 11

## STROMATOLITES AND THE BIOSTRATIGRAPHY OF THE AUSTRALIAN PRECAMBRIAN AND CAMBRIAN

BY  
M. R. WALTER

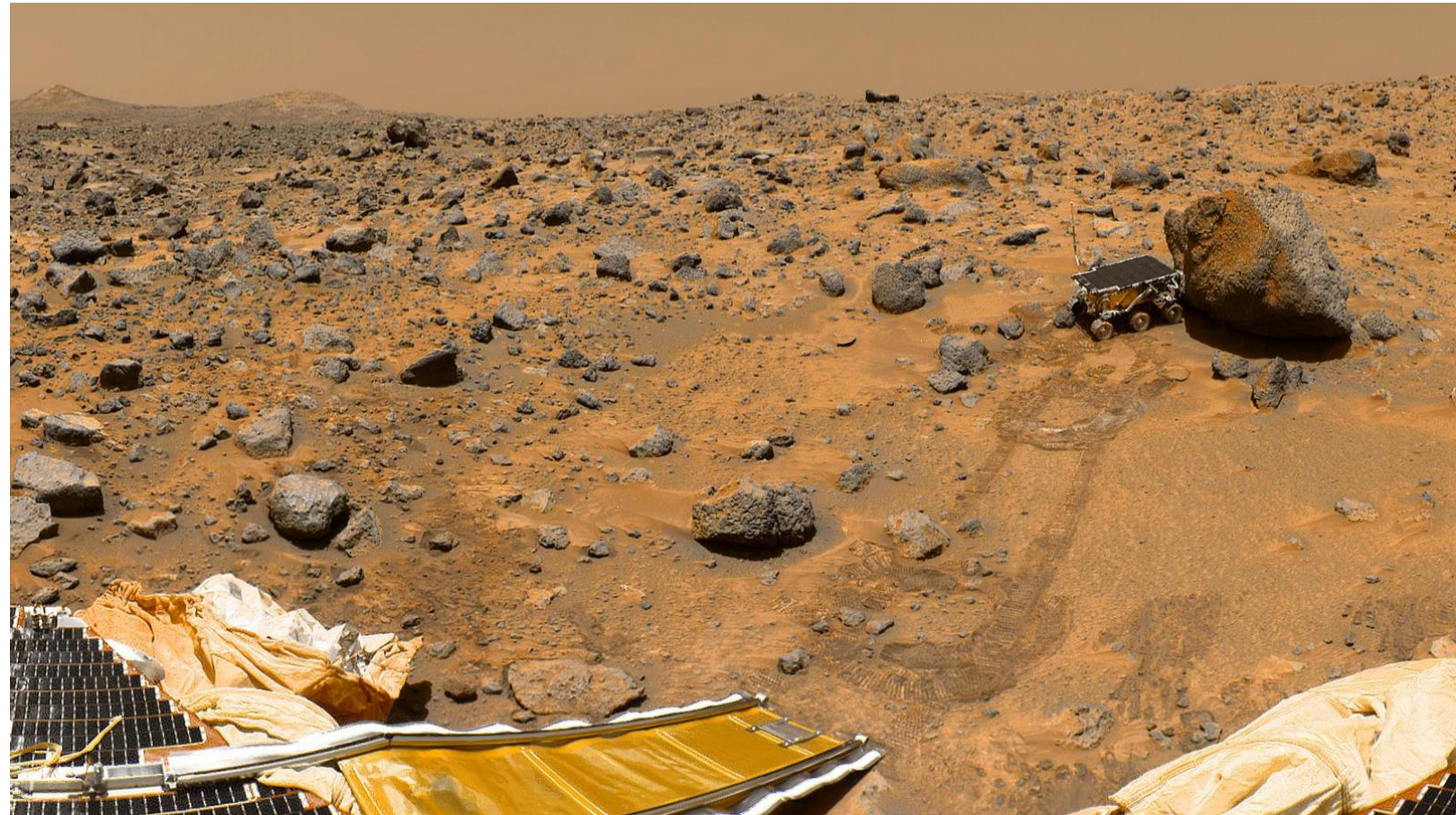
With 34 plates and 55 text-figures

The Centre for Precambrian Research, University of Adelaide,  
South Australia,  
provided a grant towards the cost of publishing  
this Special Paper

THE PALAEOONTOLOGICAL ASSOCIATION  
LONDON  
DECEMBER 1972

# A changing focus

- Biogenicity of older (and older) structures
- Early life
- Extraterrestrial life
- Modern biological studies of microbialites



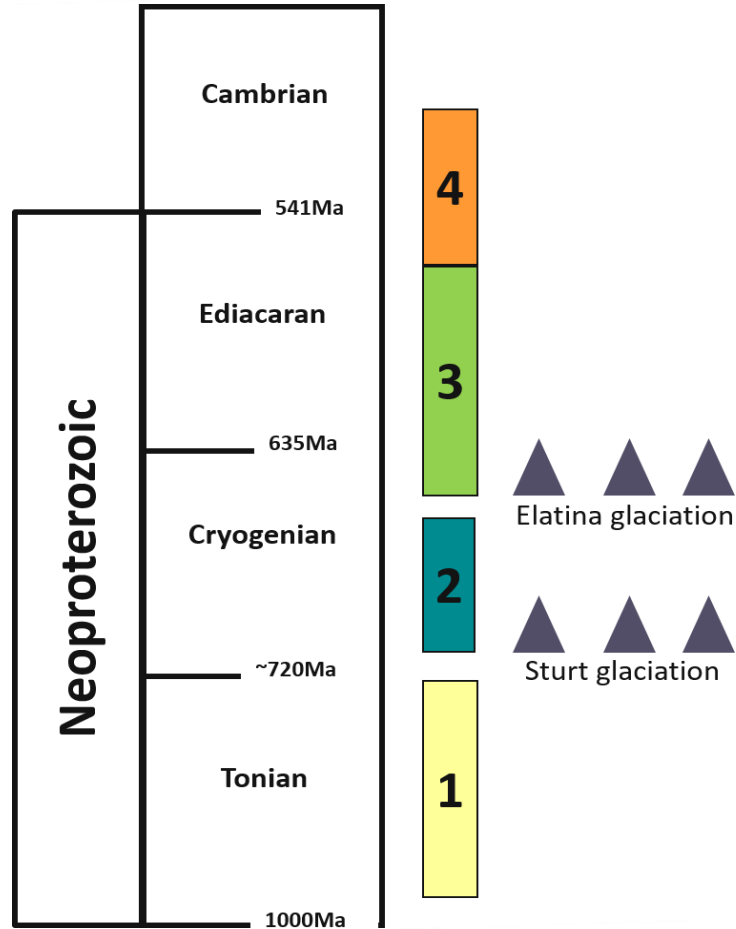
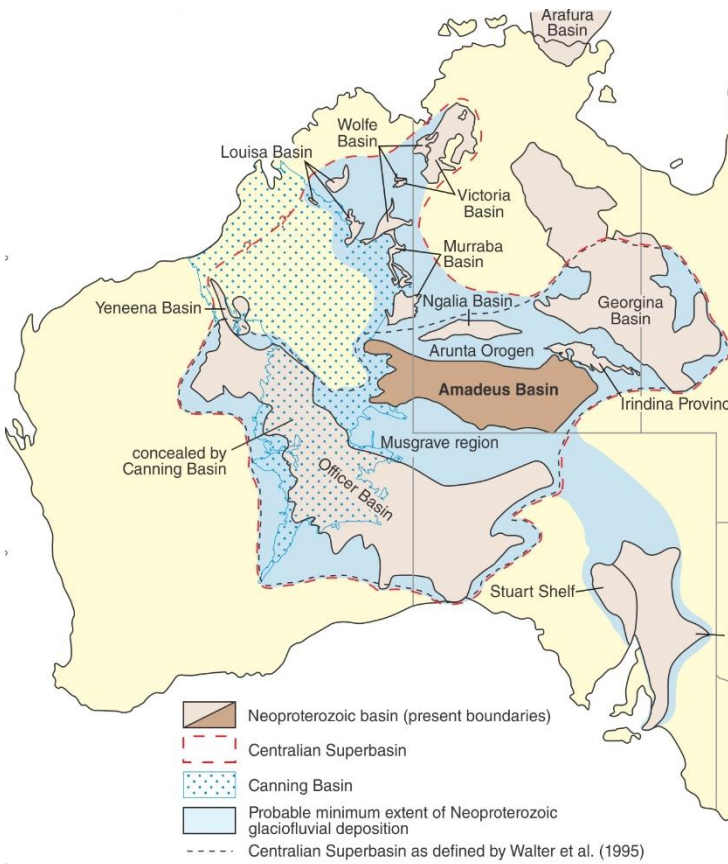
<https://www.jpl.nasa.gov/news>

# GSWA microbialite work

- 100s of microbialite localities documented in WA and Australia-wide
  - Systematic description
- ➔ Biostratigraphic application



# Amadeus Basin

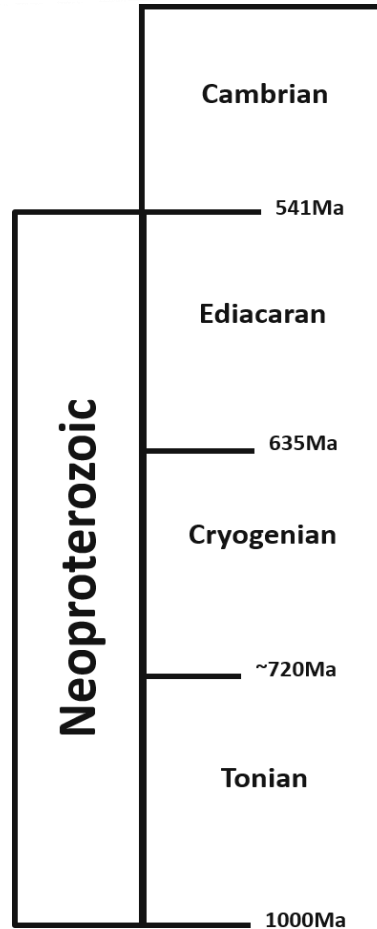
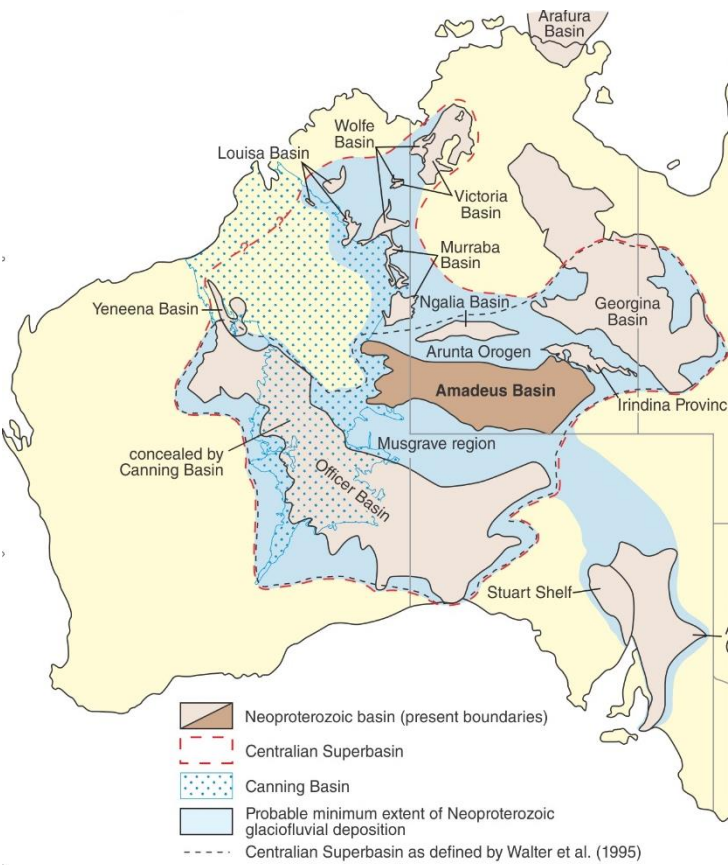


# Tonian Aa Assemblage





# Amadeus Basin



← *Tungussia julia* Assemblage

← *Atilanya fennensis* Assemblage

← *Baicalia burra* Assemblage

← *Acaciella australica* Assemblage

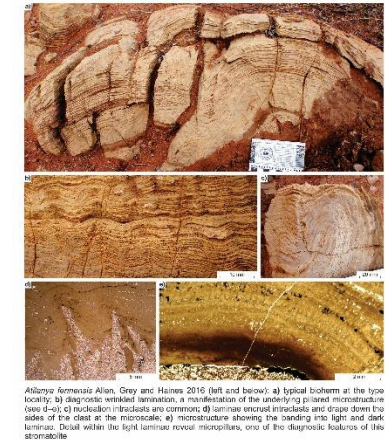
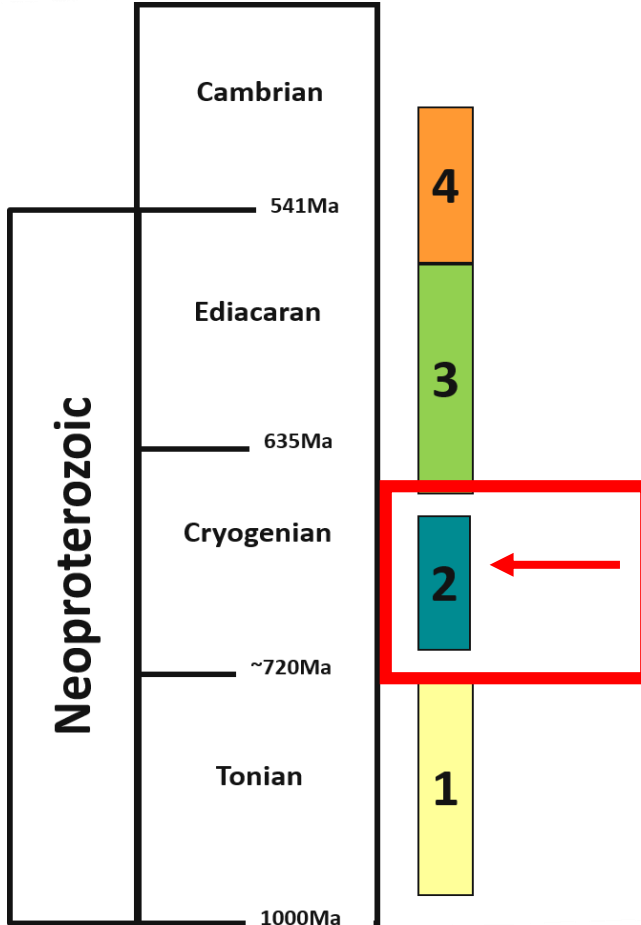
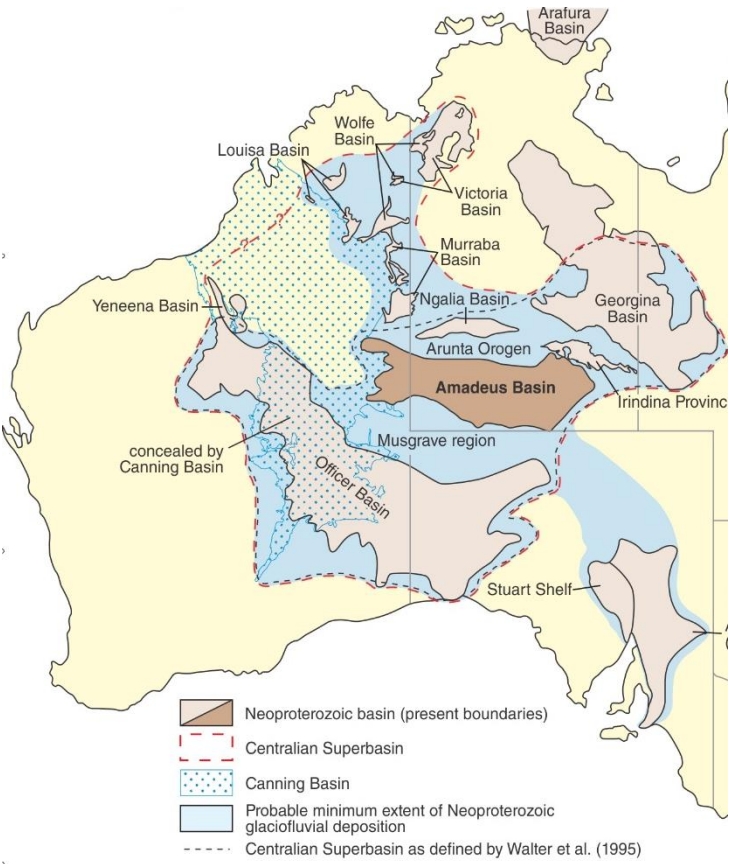
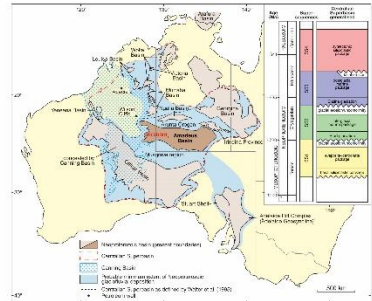
← *Tungussia erecta*

# Amadeus Basin

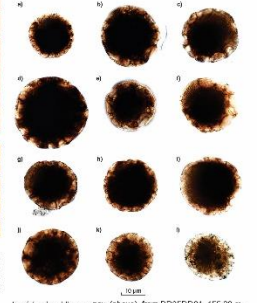
## BIOSTRATIGRAPHIC REVIEW OF THE CRYOGENIAN ARAKA FORMATION, AMADEUS BASIN

The Cryogenian Araka Formation, deposited during the interglacial period flanked by the Sturt and Elatina glaciations, is a unique interval for the Earth's biosphere. The formation is predominantly recessive siltstone but includes minor stromatolitic carbonates. It has been included in recent revisions of Neoproterozoic-Cambrian stratigraphy and is now recognised across much of the Amadeus Basin. The discovery of new outcrop and drillhole intersections prompted systematic revision of stromatolites in the Araka Formation and analysis of their distribution.

A distinct stromatolite assemblage, characterised by the presence of *Tangussia inna* and *Atharya fernensis*, has been recognised from outcrop and drillhole intersections across the Amadeus Basin. The assemblage also contains other stromatolites, not yet systematically described, that are similar to stromatolites in the Cryogenian Umberatana Group of the Adelaide Rift Complex.



The interglacial Araka Formation is commonly barren of organic-walled microfossils, but a new species, *Vandakoplacium* sp. nov., has been documented from Northern Territory Geological Survey stratigraphic drillhole BR05DD01. The species is abundant in a single sample and, combined with stromatolite data, could prove to be a valuable stratigraphic marker if encountered elsewhere in the basin.



For more information, contact: [dmirs@dmirs.wa.gov.au](mailto:dmirs@dmirs.wa.gov.au)

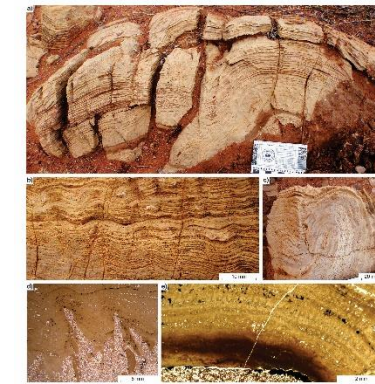
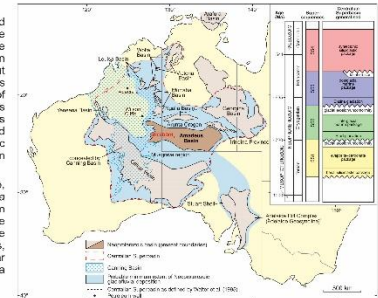
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[www.dmirs.wa.gov.au](http://www.dmirs.wa.gov.au)

Geological Survey of Western Australia

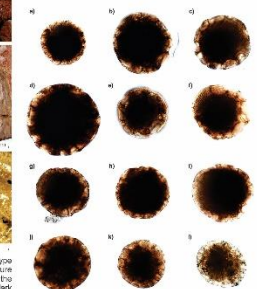
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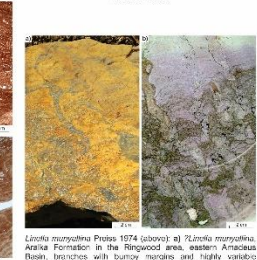
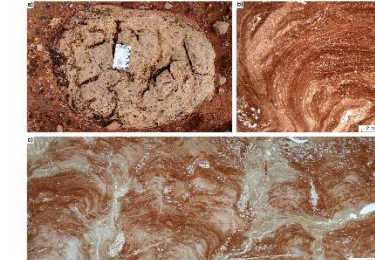
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The interglacial Aralka Formation is commonly barren of organic-walled microfossils, but a new species, *Vandobryoceras* sp. nov., has been documented from Northern Territory Geological Survey stratigraphic drillhole BR05DD01. The species is abundant in a single sample and, combined with stromatolite data, could prove to be a valuable stratigraphic marker if encountered elsewhere in the basin.

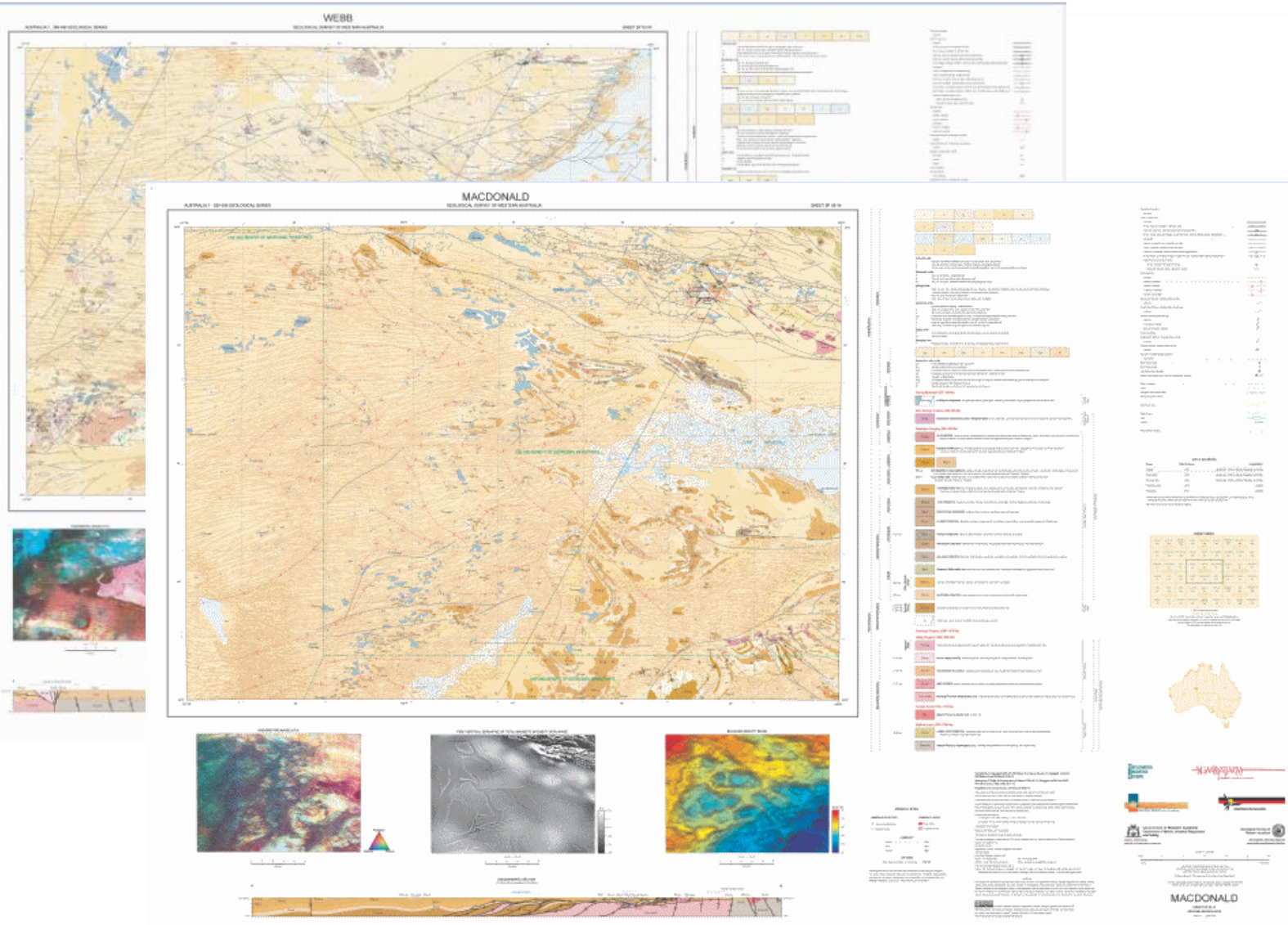


*Vandobryoceras* sp. nov. (above), from BR05DD01, 155.28 m, Aralka Formation

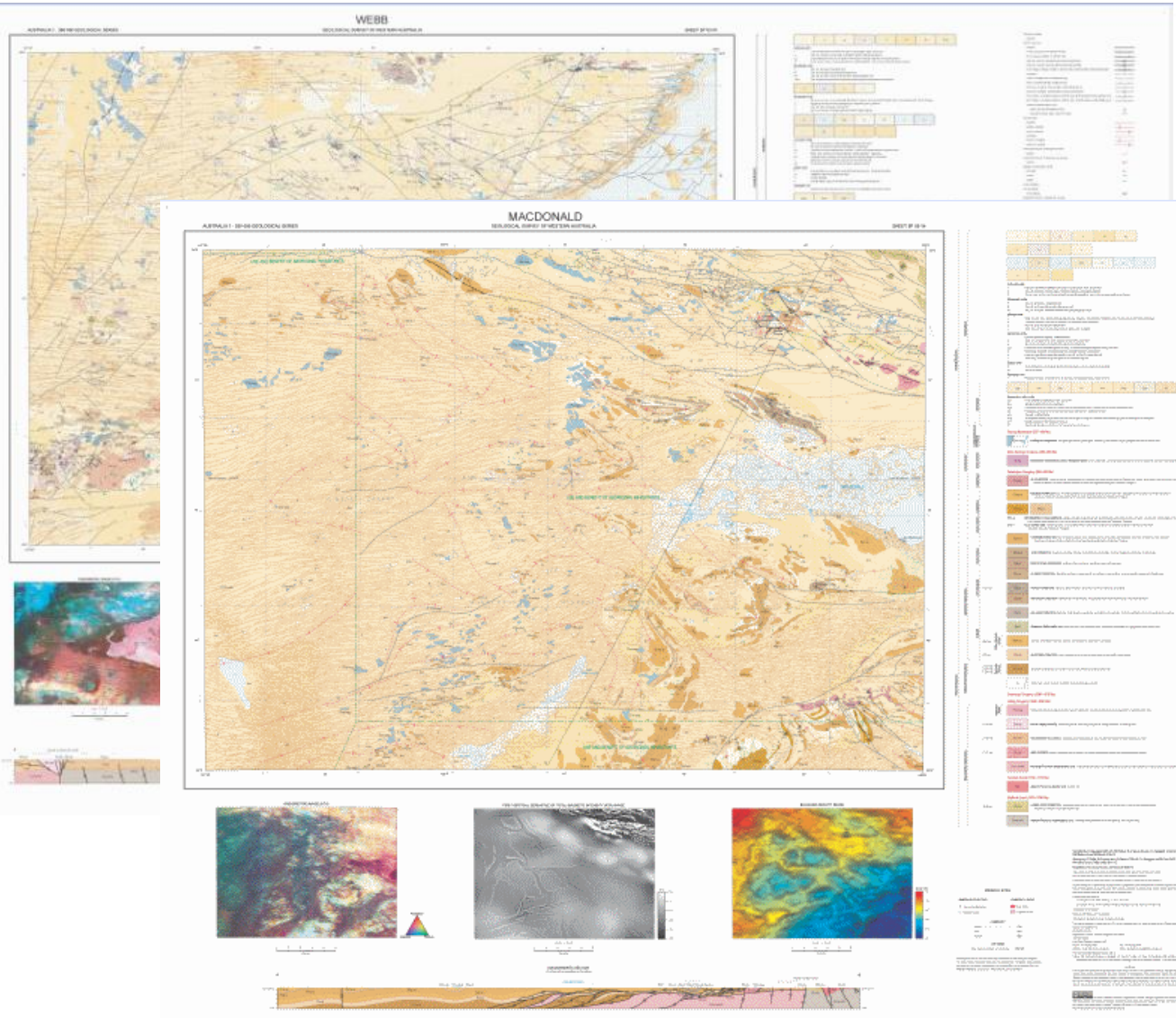


*Lizetta murphyana* Probst, 1974 (above): a) *Lizetta murphyana* Aralka Formation in the Ringwood area, eastern Amadeus Basin: b) showing comparison with ST1, Adelaide University Collection; *Lizetta murphyana* bioherm

*Tangussia inna* Walter, 1977 (above) from the Board Ridges western Amadeus Basin: a) bioherm in plan view displaying typical pink coloration of *T. inna* at this location; b-d) typical microstructures of *T. inna* in outcrop showing banded lamination with commonly incorporated clastic material



# BIOSTRATIGRAPHIC REVIEW OF THE CRYOGENIAN ARALKA FORMATION, AMADEUS BASIN



Government of Western Australia  
Department of Mines and Petroleum

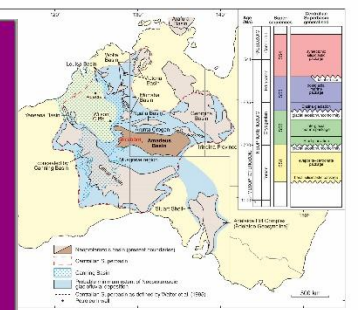
RECORD 2014/11

**GEOLOGY OF THE BOORD RIDGES AND GORDON HILLS: KEY STRATIGRAPHIC SECTION IN THE WESTERN AMADEUS BASIN, WESTERN AUSTRALIA**

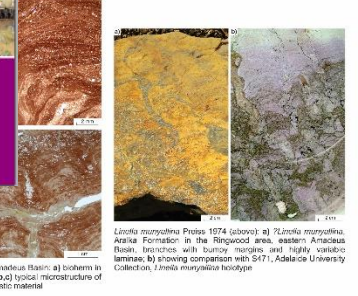
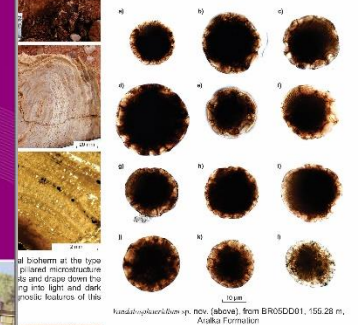
by  
PW Haines and HJ Allen

MACDONALD

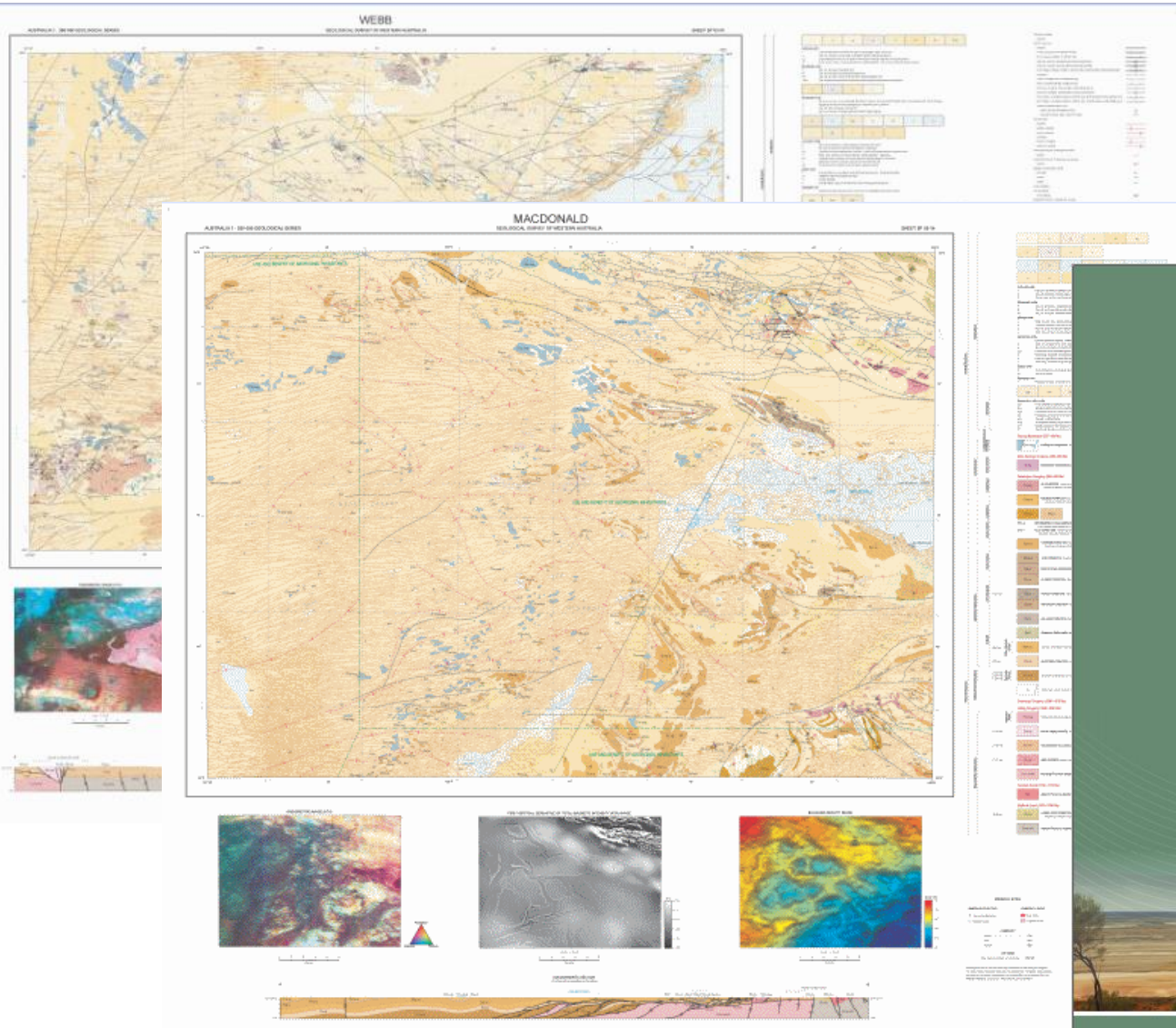
Geological Survey of Western Australia



The interglacial Aralka Formation is commonly barren of organic-walled microfossils, but a new species, *Vandakoplacarium* sp. nov., has been documented from Northern Territory Geological Survey stratigraphic drillhole BR05DD01. The species is abundant in a single sample and, combined with stromatolite data, could prove to be a valuable stratigraphic marker if encountered elsewhere in the basin.



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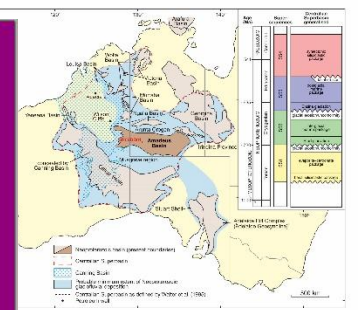
RECORD 2018/11

## THE CRYOGENIAN ARALKA FORMATION, AMADEUS BASIN: A BASINWIDE BIOSTRATIGRAPHIC CORRELATION

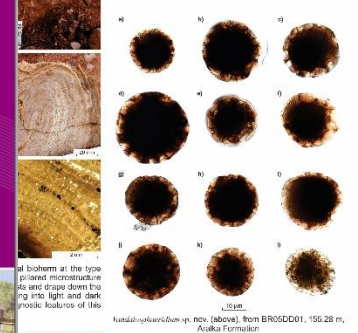
by  
HJ Allen, K Grey, PW Haines, CJ Edgoose and VJ Normington

Geological Survey of Western Australia

NORTHERN TERRITORY GOVERNMENT



The interglacial Aralka Formation is commonly barren of organic-walled microfossils, but a new species, *Vandolobosarcium* sp. nov., has been documented from Northern Territory Geological Survey stratigraphic drillhole BR05DD01. The species is abundant in a single sample and, combined with stromatolite data, could prove to be a valuable stratigraphic marker if encountered elsewhere in the basin.



*Vandolobosarcium* sp. nov. (above) from BR05DD01, 155.28 m, Aralka Formation

*Lenticula murphyana* Probst 1974 (above) a) *Lenticula murphyana* Aralka Formation in the Ringwood area, eastern Amadeus Basin, b) showing comparison with SK71, Adelaide University Collection, *Lenticula murphyana* holotype

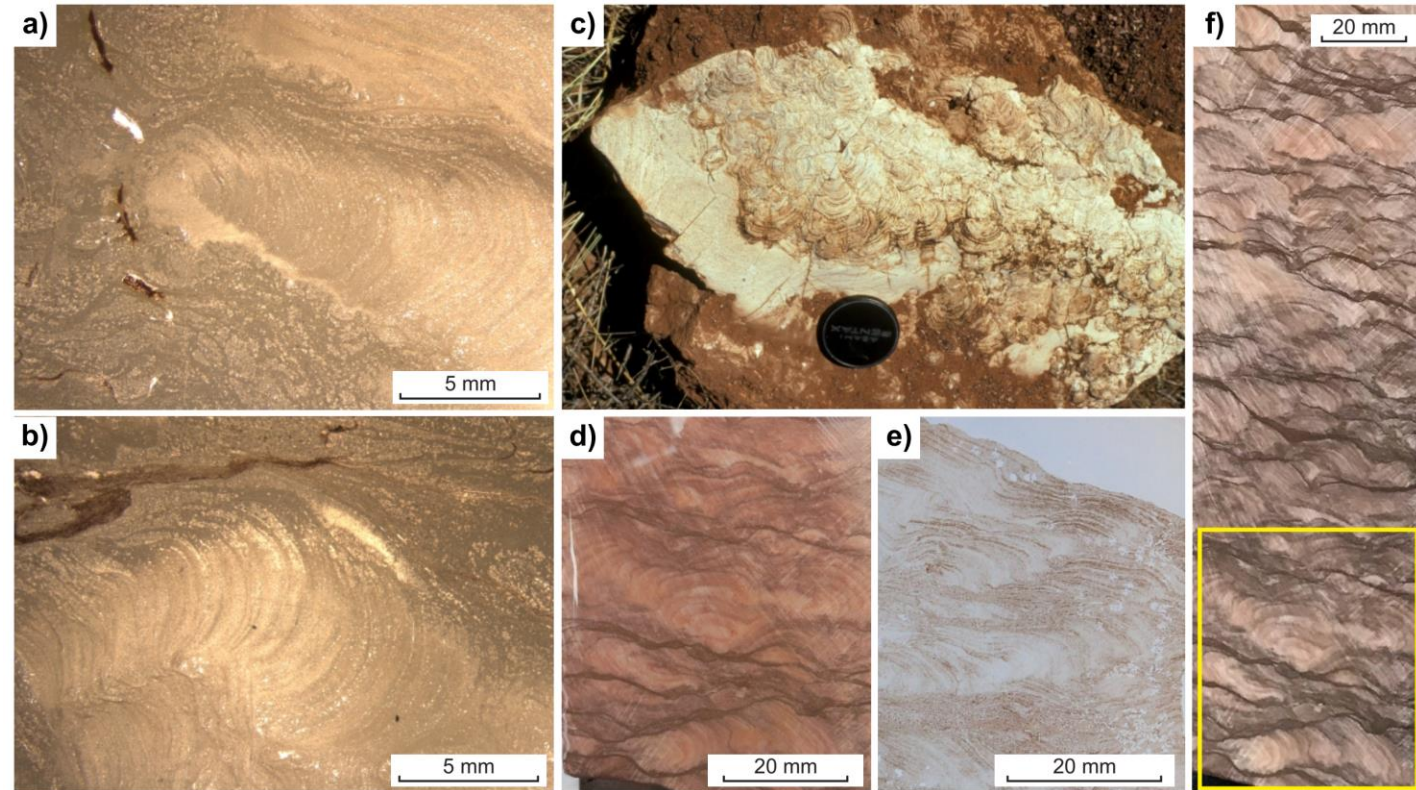
# Officer Basin

## A stromatolite assemblage, including *Eleonora boondawarica* Grey and Walter, 1994 and *Acaciella savoryensis* Grey and Walter, 1994, from mineral drillhole AusQuest Table Hill 07THD003

by

HJ Allen and PW Haines

- Paleontology Report 2018/1
- New stromatolite work will revise and refine older biostratigraphic schemes

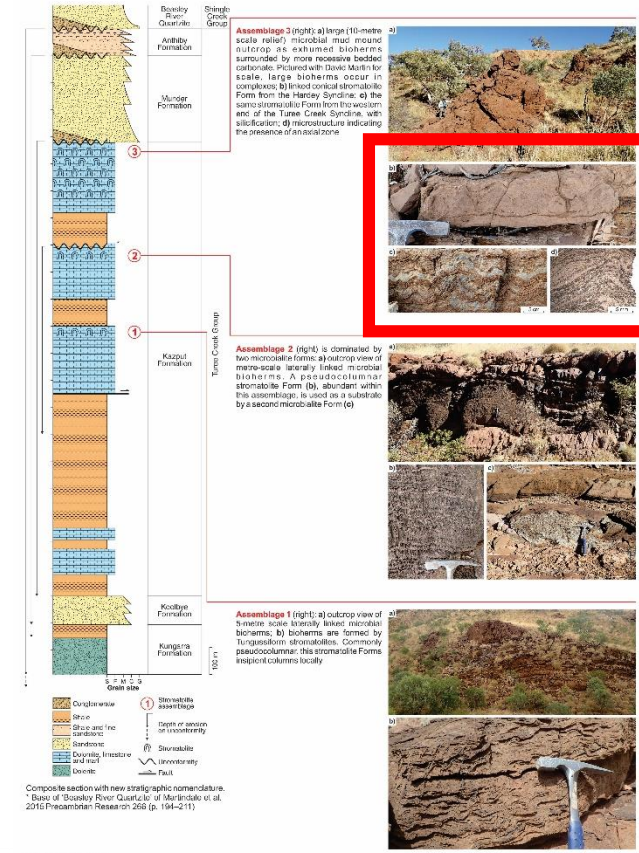
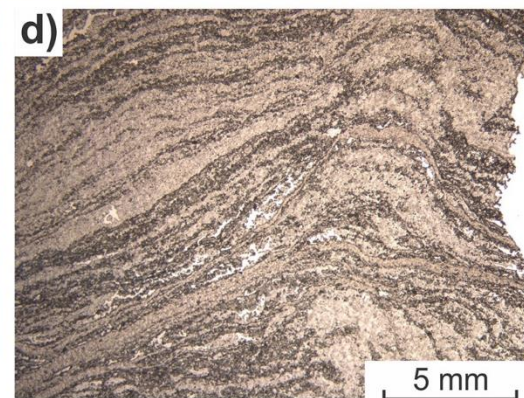
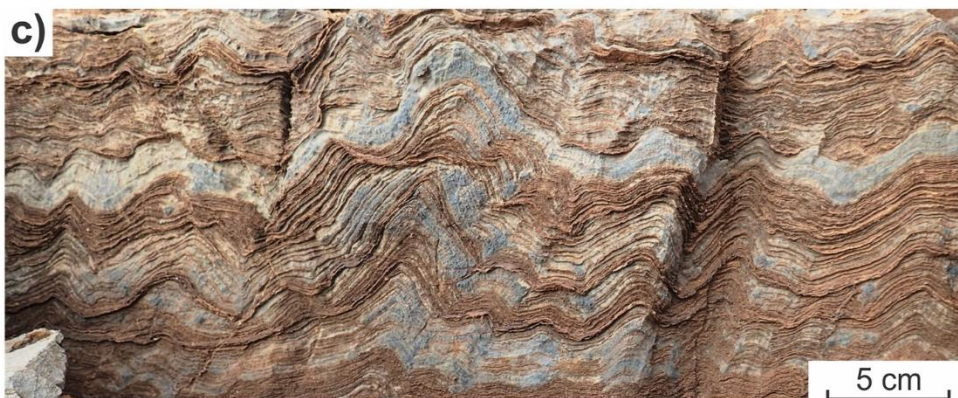
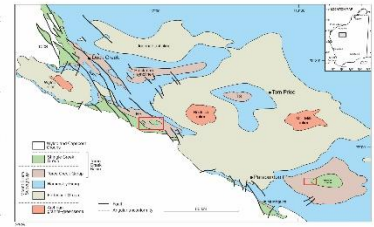


# Hamersley province

## PILBARA/HAMERSLEY PROJECT REGIONALLY PERSISTENT STROMATOLITE ASSEMBLAGES OF THE TUREE CREEK GROUP

Systematic description of microbialites from the Turee Creek Group, deposited in the aftermath of the Great Oxidation Event, provides an opportunity to understand links between the atmosphere and biosphere during this important period of Earth history. Recent field investigation of a revised Kazput Formation has revealed previously undescribed microbialites from the western end of the Turee Creek Syncline (TCS), a marked expansion of microbialites known from the Hardey Syncline (HS), and chronologically rapid changes in microbialite Forms within the Turee Creek Group. Microbialite assemblages of the Kazput Formation are distinct and regionally persistent. These assemblages include new microbialite Forms that have proven valuable as temporal markers during a targeted regional mapping program of the Hamersley province.

Three stromatolite assemblages have been recognised during regional mapping of the Kazput Formation in the eastern Hamersley province. Microbialite assemblages 2 and 3 share Forms in common between the Turee Creek Syncline (TCS) and Hardey Syncline (HS) localities (see map to right).





# HANDBOOK FOR THE STUDY AND DESCRIPTION OF MICROBIALITES

**Bulletin 147  
coming in  
2019**



Small columns developing on broader columns overlain by climbing ripples; stromatolite, Meentheena Member, Tumbiana

There has long been a need for a more balanced and consistent approach to how stromatolites and other microbialites are described and recorded in the literature.

GSWA Bulletin 147, due for release in 2019, has consolidated definitions and useful terminology from global literature into a rational and systematic manual to address many of the existing problems that have historically prevented effective comparative studies.



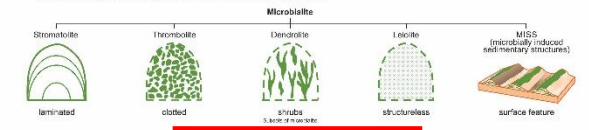
# Bulletin 147: Microbialite handbook

## HANDBOOK FOR THE STUDY AND DESCRIPTION OF MICROBIALITES

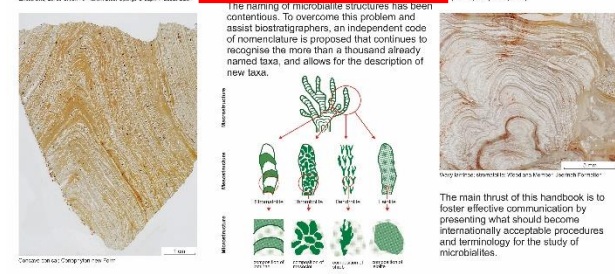
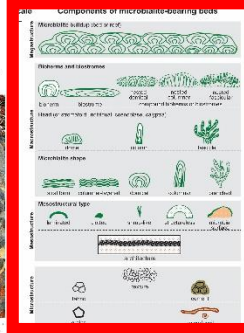
Bulletin 147 coming in 2019



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This handbook is a practical guide extensively complemented with illustrative examples. It deals with the description of microbialites from the regional and outcrop scale down to the macroscopic and microscopic scale.



The main thrust of this handbook is to foster effective communication by presenting what should become internationally acceptable procedures and terminology for the study of microbialites.

### ABOUT THE AUTHORS

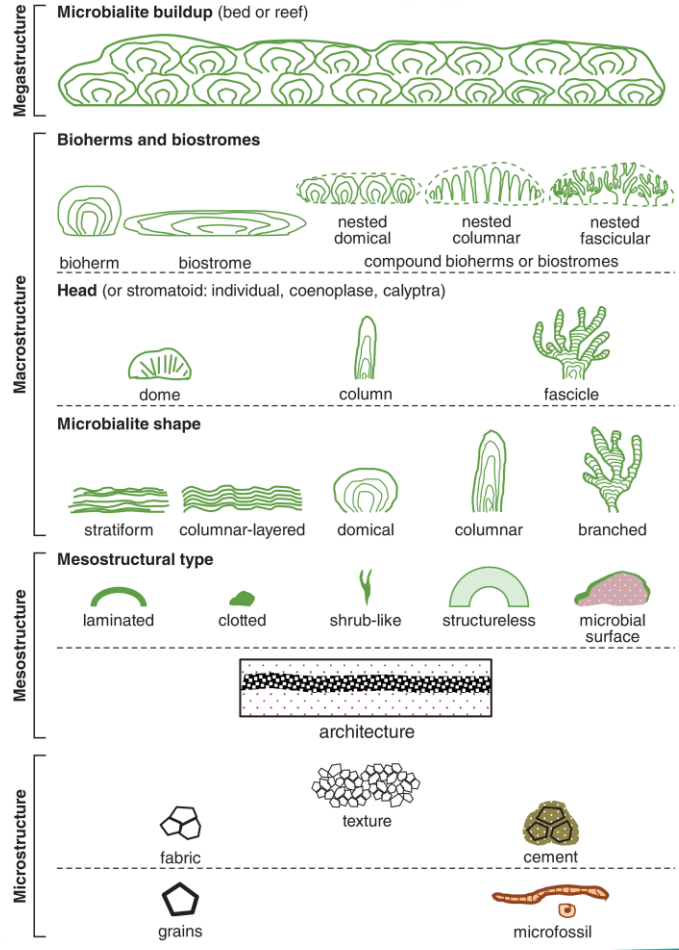
For more information about the release of Bulletin 147, contact: [kathleen.gre@dmirs.wa.gov.au](mailto:kathleen.gre@dmirs.wa.gov.au) or [stanley.awramik@dmirs.wa.gov.au](mailto:stanley.awramik@dmirs.wa.gov.au)



**Dr. Kathleen Grey** is a retired State paleontologist. During her career, Kath worked at Geological Survey of Western Australia (GSWA) for 40 years. Her large volume of work on Proterozoic paleontology resulted in the creation of a biostratigraphic framework for countless publications and traps published by the Department.



**Professor Stanley Awramik** is a researcher in the Department of Earth Sciences, University of California, Santa Barbara. He has been studying microbialites for over 45 years from both marine and non-marine environments, and from the early Archean to living examples of the Holocene.



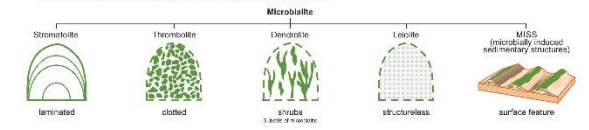
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The naming of microbialite structures has been contentious. To overcome this problem and assist biostratigraphers, an independent code of nomenclature is proposed that continues to recognise the more than a thousand already named taxa, and allows for the description of new taxa.

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**Dr Kathleen Grey** is a retired State geoscientist. During her career, Kath worked at Geological Survey of Western Australia (GSWA) for 40 years. Her large volume of work on Proterozoic paleontology resulted in the creation of a biostratigraphic framework for countless publications and traps published by the Department.

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For more information about the release of Bulletin 147, contact: [kath.awramik@dmirs.wa.gov.au](mailto:kath.awramik@dmirs.wa.gov.au) or [kath.awramik@gsa.wa.gov.au](mailto:kath.awramik@gsa.wa.gov.au)

Government of Western Australia  
Department of Mines, Industry Regulation and Safety

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Geological Survey of Western Australia

### Microbialite buildup (bed or reef)

### Bioherms and biostromes

### Head (or stromatoid: individual, coenoplas, calyptra)

### Microbialite shape

### Mesostructural type

### Architecture

### Texture

### fabric

### grains

### cement

### microfossil

### BRANCHING STYLE

Bifurcate     Trifurcate     Dichotomous     Lateral     Coalesced     Anastomosed

### BRANCHING MODE

Alpha     Beta     Gamma

### ANGLE OF DIVERGENCE

Parallel     Moderate     Marked Divergence     Horizontal

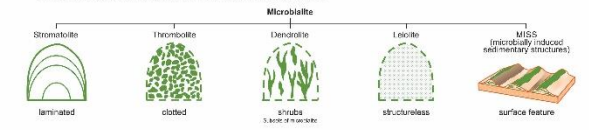
# Bulletin 147: Microbialite handbook

## HANDBOOK FOR THE STUDY AND DESCRIPTION OF MICROBIALITES

Bulletin 147 coming in 2019



There has long been a need for a more balanced and consistent approach to how stromatolites and other microbialites are described and recorded in the literature. GSWA Bulletin 147, due for release in 2019, has consolidated definitions and useful terminology from global literature into a rational and systematic manual to address many of the existing problems that have historically prevented effective comparative studies.



This handbook is a practical guide extensively complemented with illustrative examples. It deals with the description of microbialites from the regional and outcrop scale down to the macroscopic and microscopic scale.

The naming of microbialite structures has been contentious. To overcome this problem and assist biotrologists, an independent code of nomenclature is proposed that continues to recognise the more than a thousand already named taxa, and allows for the description of new taxa.

The main thrust of this handbook is to foster effective communication by presenting what should become internationally acceptable procedures and terminology for the study of microbialites.

### ABOUT THE AUTHORS

**Dr Kathleen Grey** is a retired State geologist. During her career, Kathleen worked at Geological Survey of Western Australia (GSWA) for 40 years. Her large volume of work on Proterozoic paleogeology resulted in the creation of a biostratigraphic framework for countless publications and maps published by the Department.

**Professor Stanley Awramik** is a researcher in the Department of Earth Sciences, University of California, Santa Barbara. He has been studying microbialites for over 45 years from both marine and non-marine environments, and from the early Archean to living examples of the Holocene.

For more information about the release of Bulletin 147, contact: [kathy.gre@dmirs.wa.gov.au](mailto:kathy.gre@dmirs.wa.gov.au) or [stan.awramik@ucsb.edu](mailto:stan.awramik@ucsb.edu)

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### Megastructure

**Microbialite buildup (bed or reef)**

**Bioherms and biostromes**

bioherm    biostrome

nested domical    nested columnar    nested fascicular

compound bioherms or biostromes

### Macrostructure

**Head (or stromatoid: individual, coenoplas, calyptra)**

dome    column    fascicle

**Microbialite shape**

stratiform    columnar-layered    domical    columnar    branched

### Mesostructure

**Mesostructural type**

laminated    clotted    shrub-like    structureless    microbial surface

architecture

### Microstructure

fabric    texture    cement    grains    microfossil

