



GSA Annual Meeting 2016



Proliferation of **MISS-related** microbial mats following the **end-Permian mass extinction on LAND**: Evidence from the Lower Triassic of North China

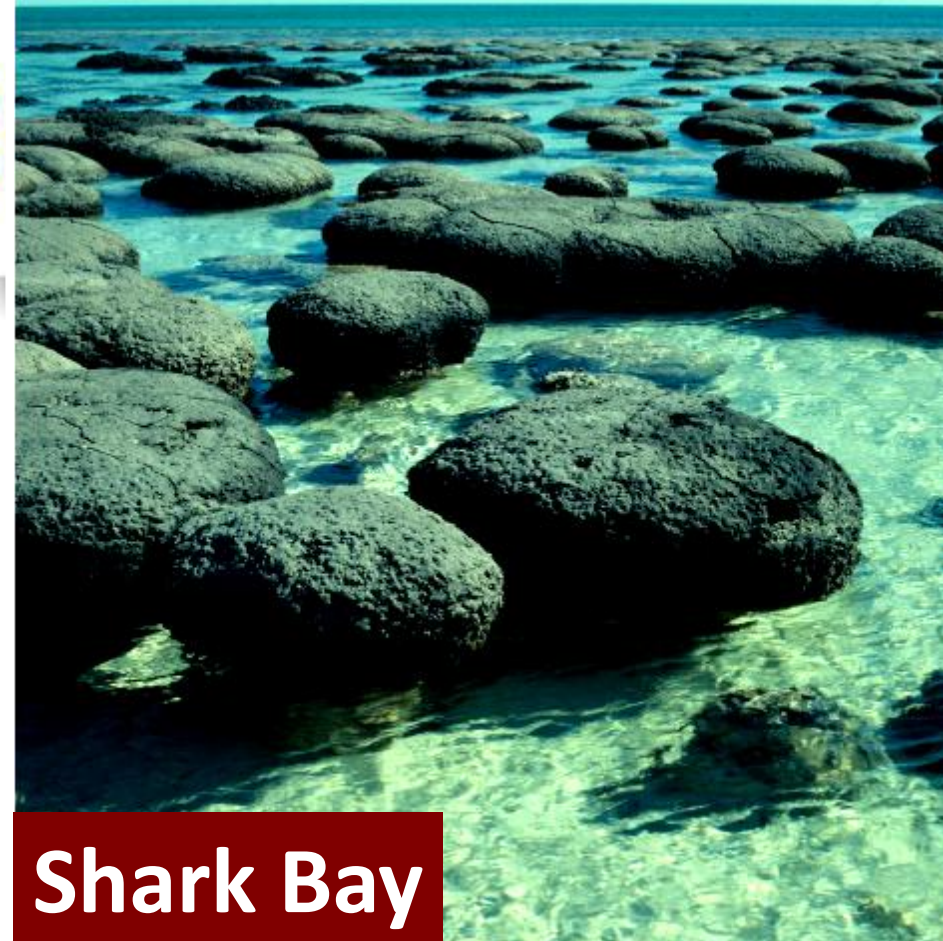
Chenyi Tu, Zhong-Qiang Chen, Gregory J. Retallack,
Yuangeng Huang, Yuheng Fang

China University of Geosciences
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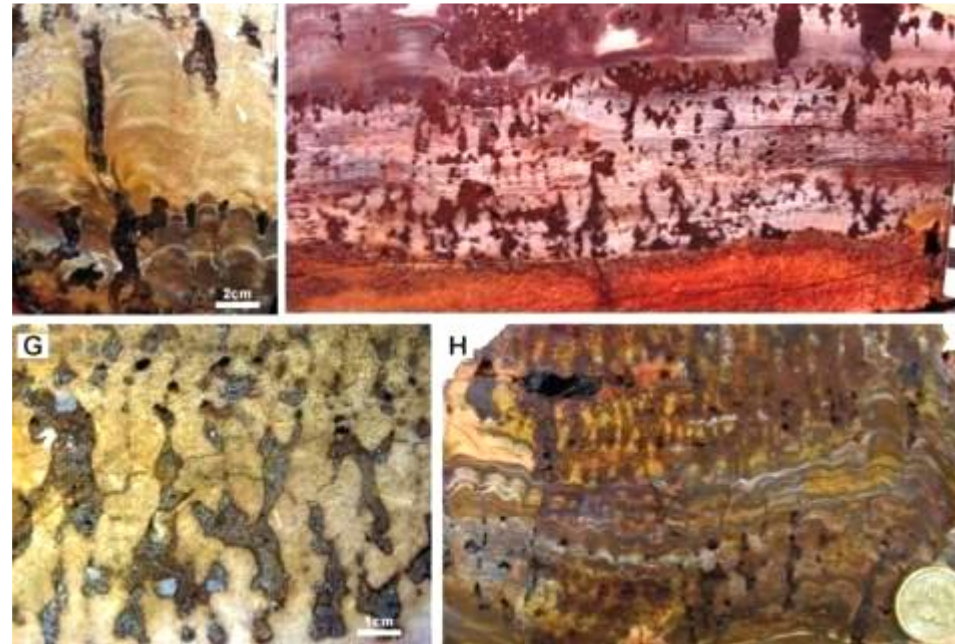
September 28, Denver

Stromatolite:

Carbonate \longleftrightarrow Microbe

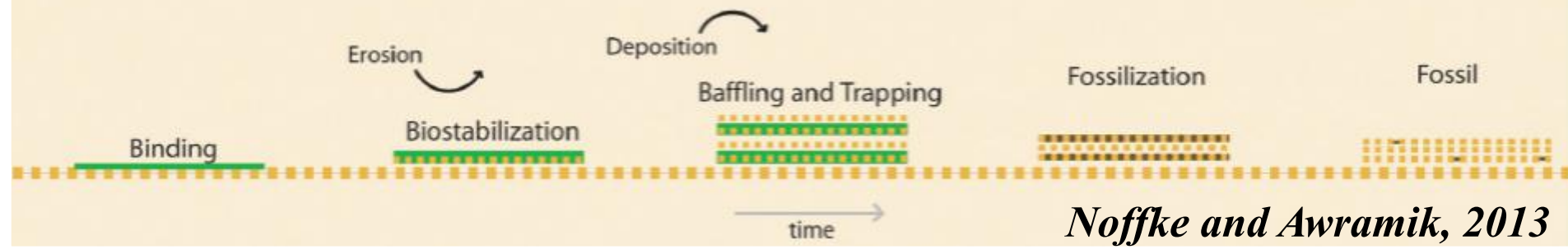


Shark Bay



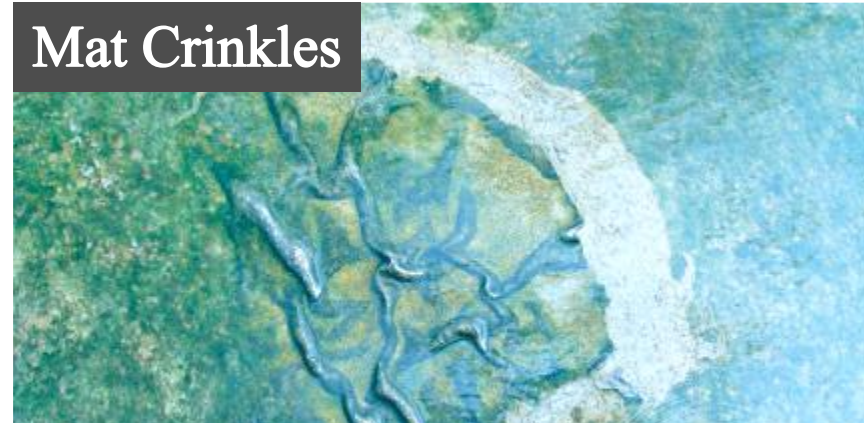
Chen et al., 2014





Noffke and Awramik, 2013

Mat Crinkles



Shrinkage Cracks



But how about MISS in Earth history

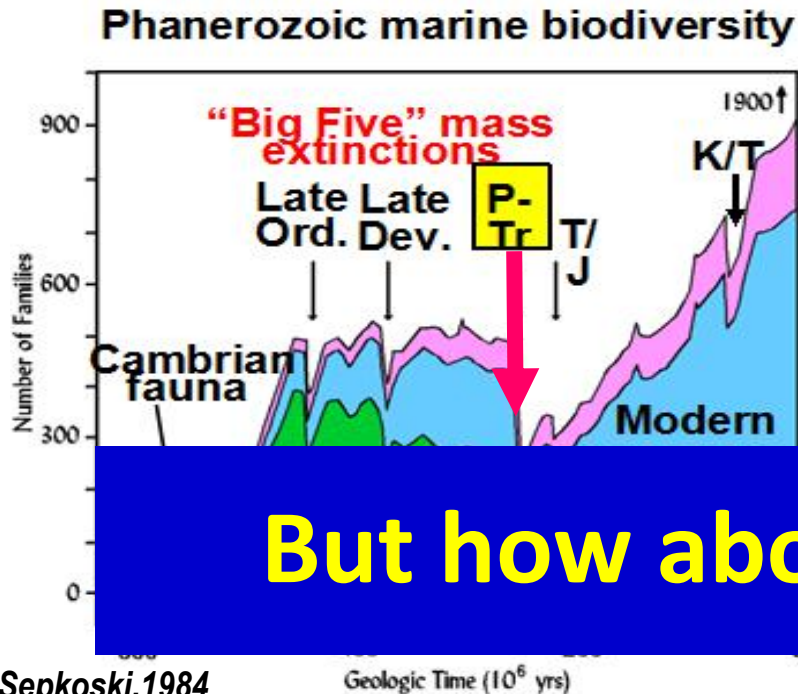
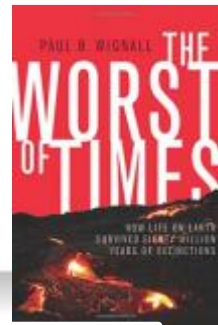


Noffke, 2010



End-Permian Mass Extinction

MISS in marine ecosystem



Mata and Bottjer, 2009

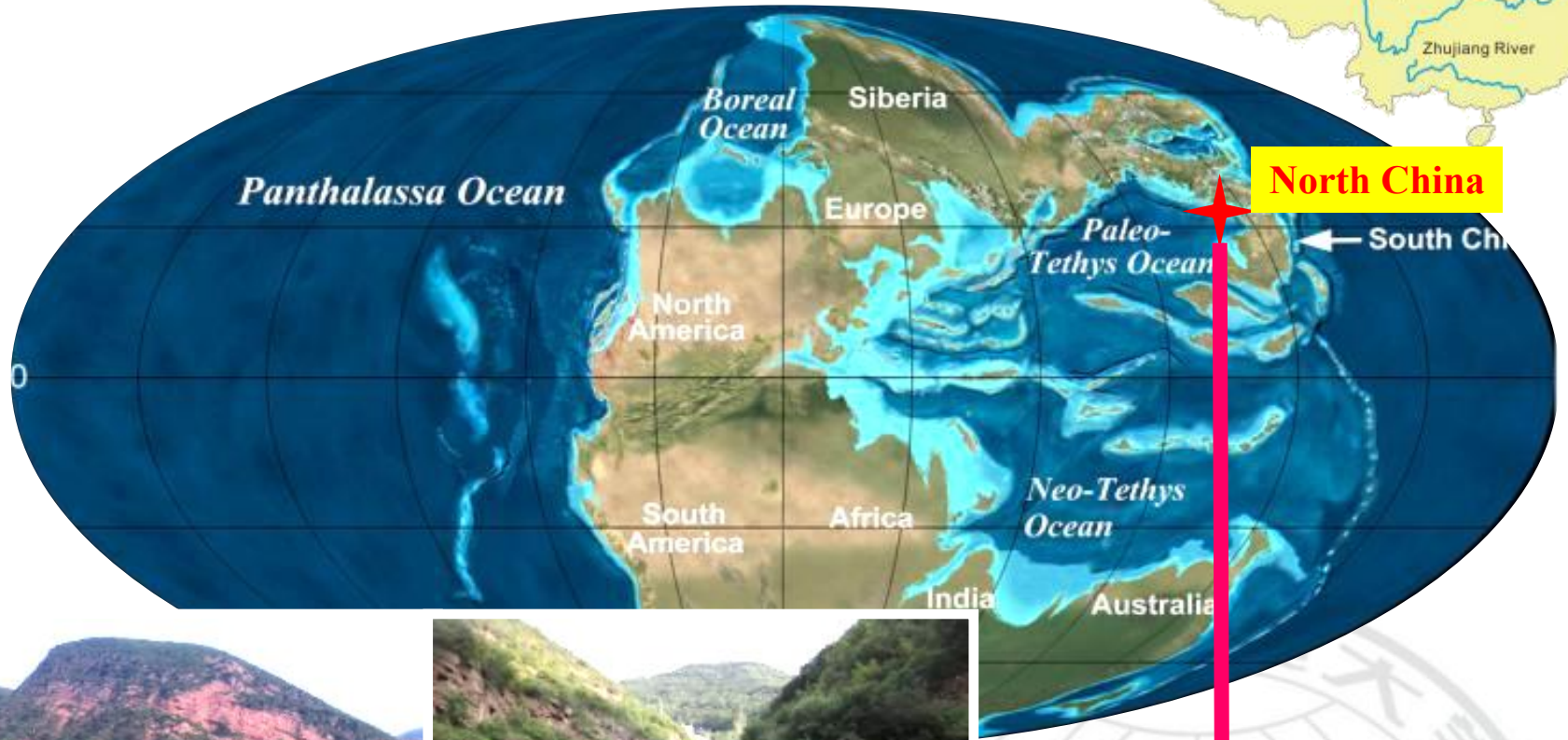
But how about MISS on land



Pruss et al., 2004



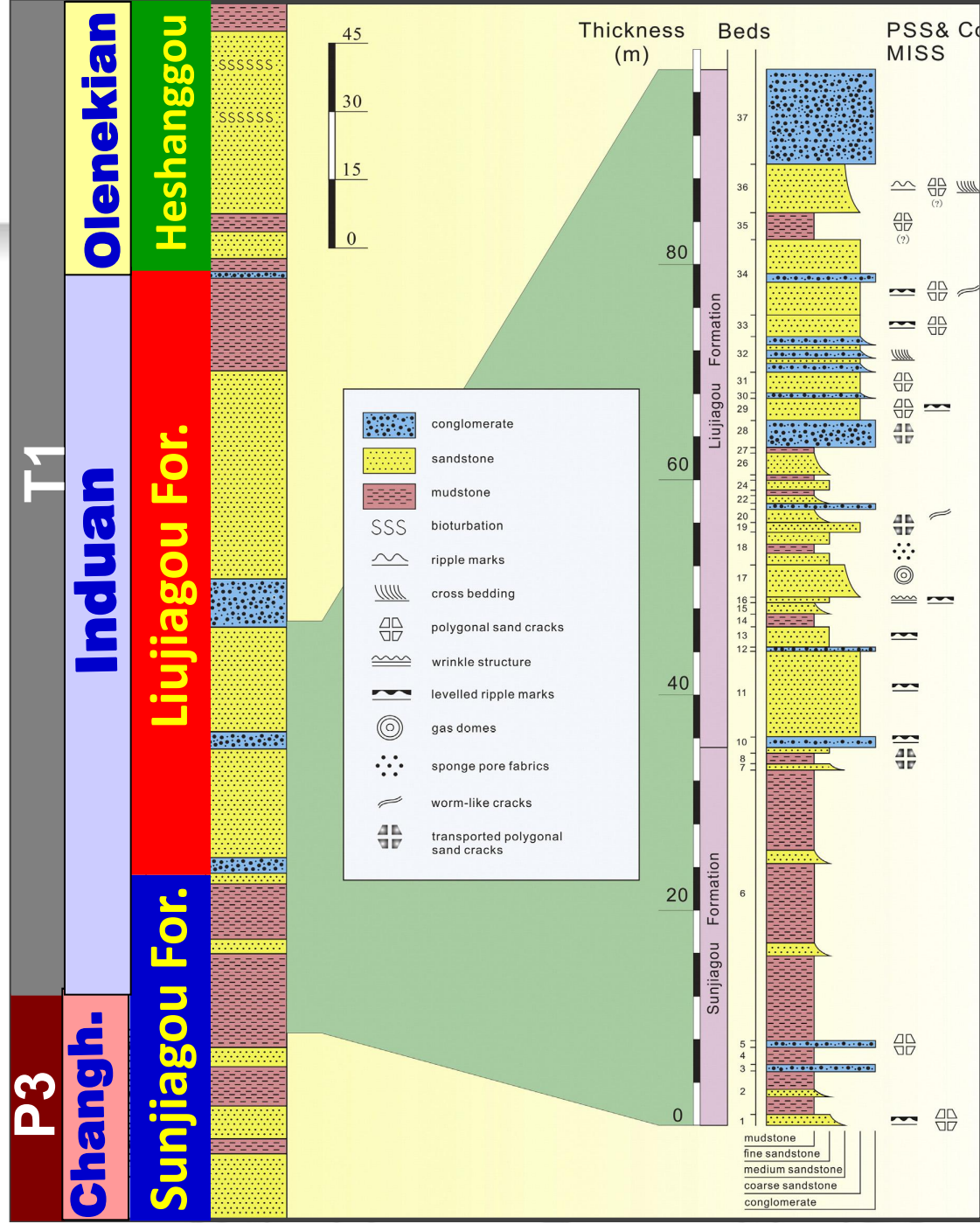
Early Triassic, Yiyang Section

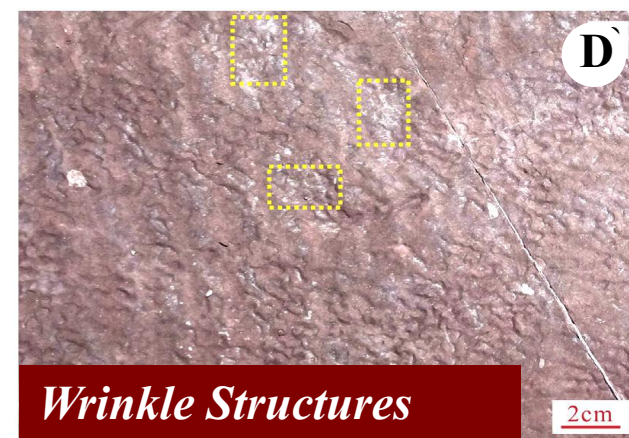
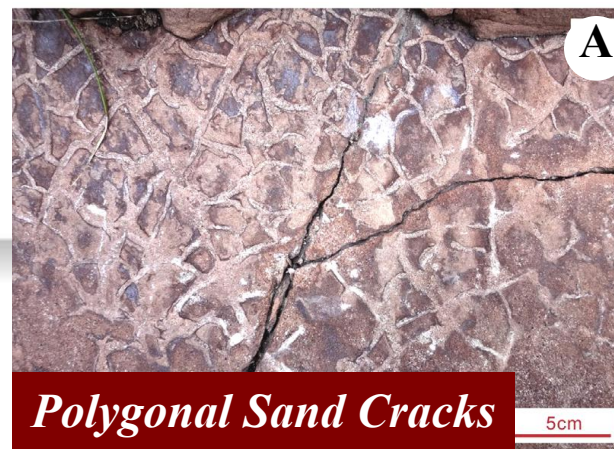
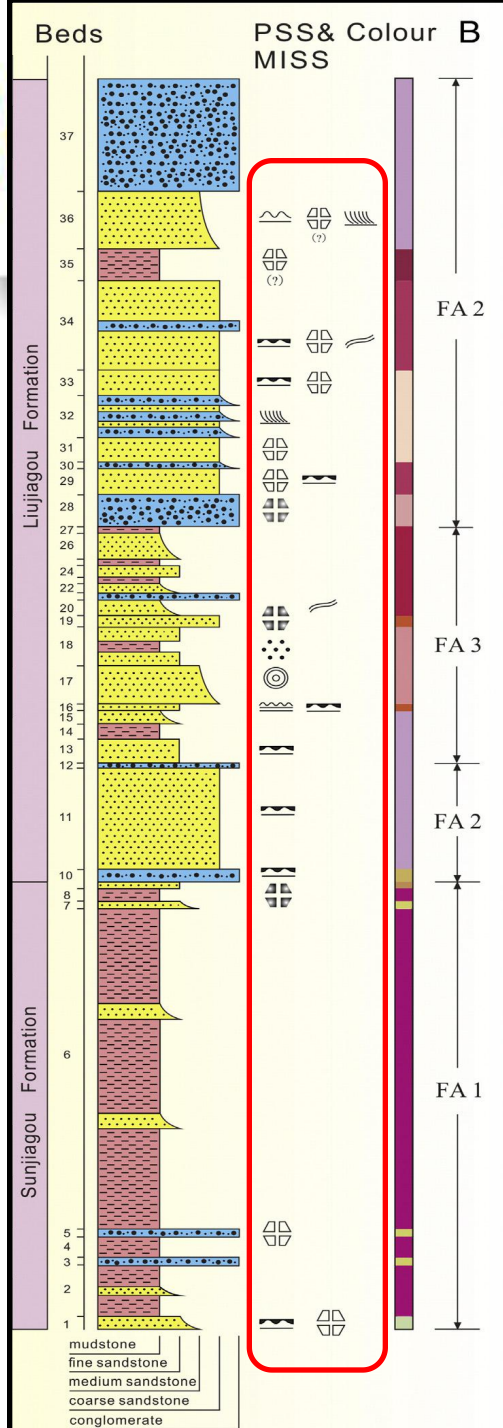


Shore Lake

Riverbed

Flood Plain







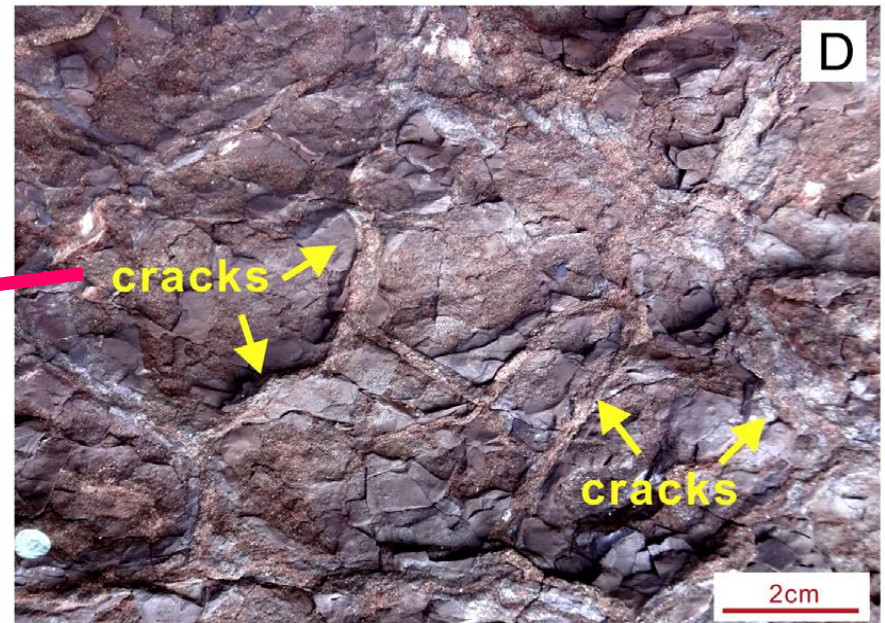
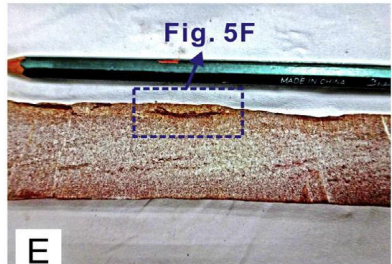
How did the MISSs form?

Two Interpretations

Purely Sedimentary Structures **VS** Biogenecity

Take a closer look at field features:

① 'U' shaped cracks → ~~Mud cracks~~





How did the MISSs form?

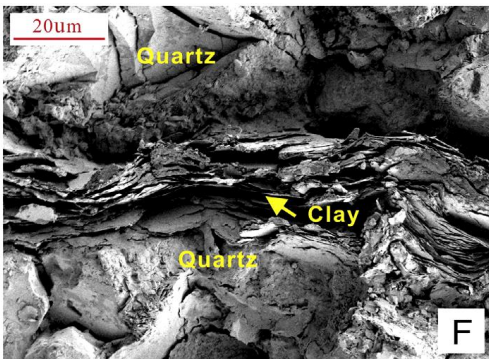
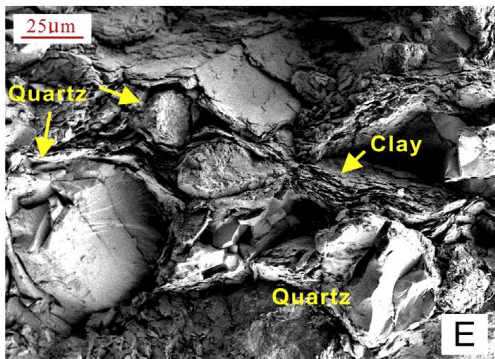
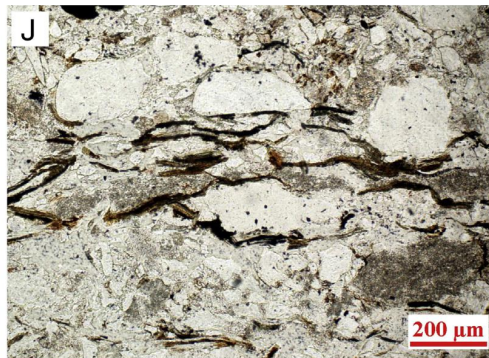
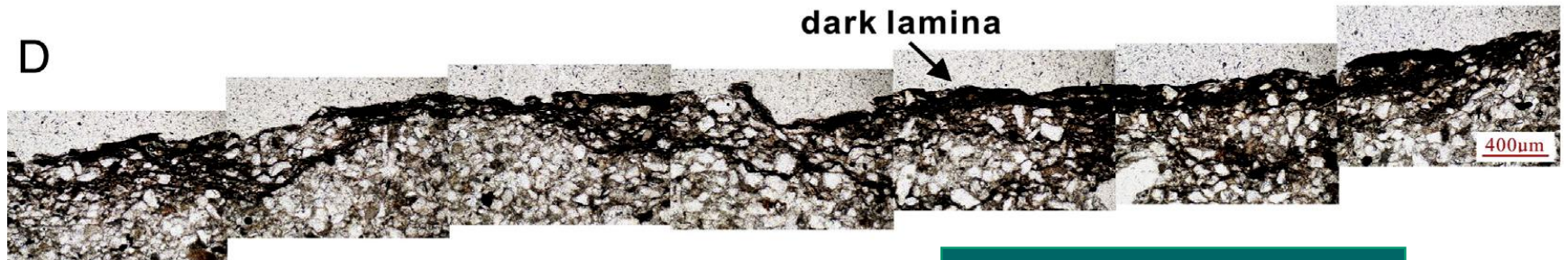
② Most MISS-bearing rocks (**coarse sandstone**) are covered by a very thin **MUD-RICH** layer on the surfaces



The involvement of microbes played an important role into the formation of the Yiyang MISSs

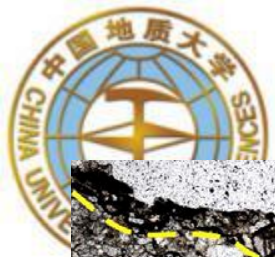


Further examinations via microscope and SEM

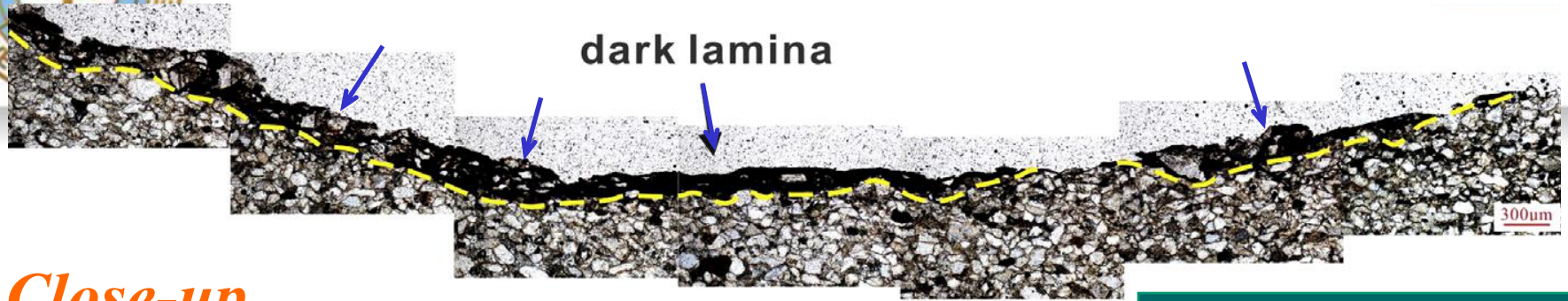


Evidence 1

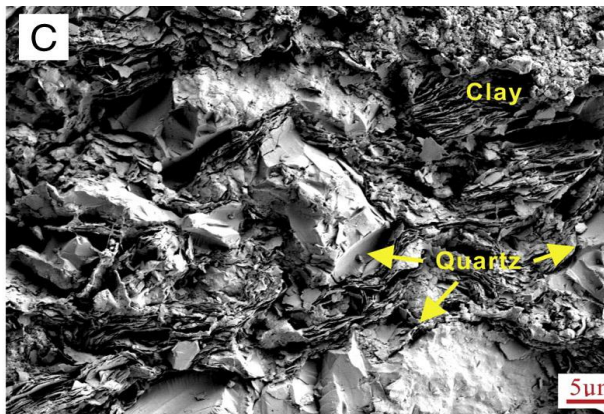
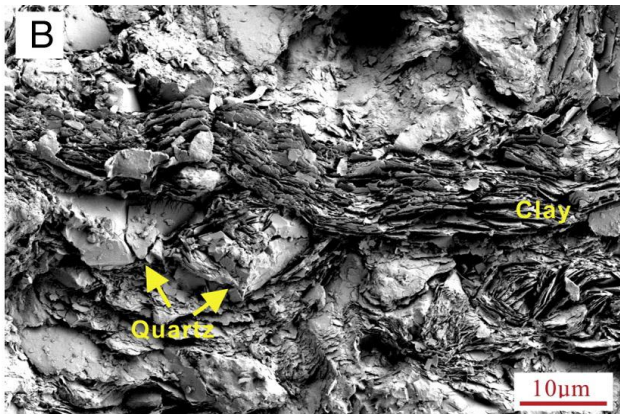
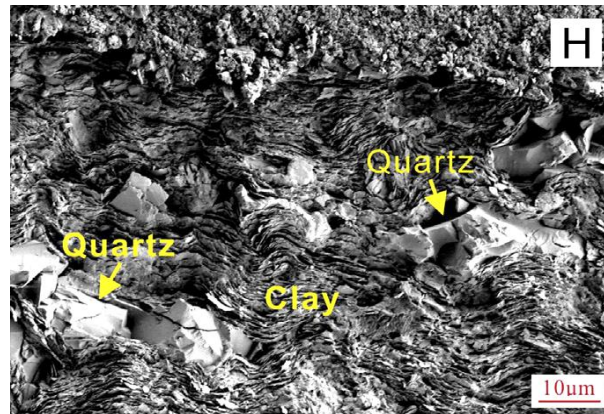
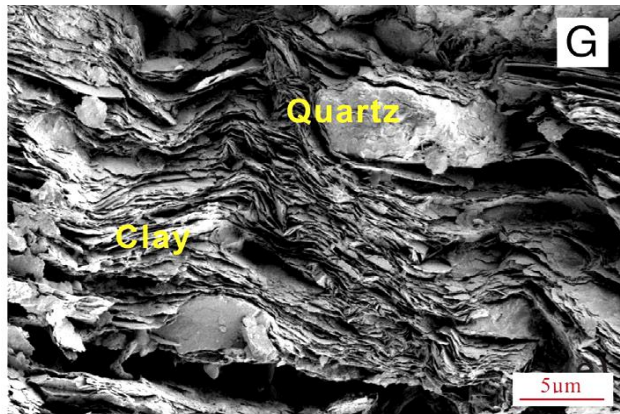
Sinuuous, thin and dark laminae, arranged **parallel** to the bedding plane, composed of **clay minerals** (O, Si, Al), **surrounding quartz grains**



Futher examinations via microscope and SEM



Close-up



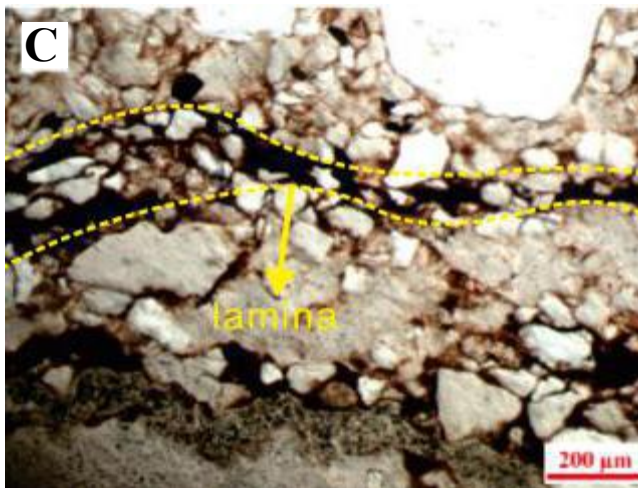
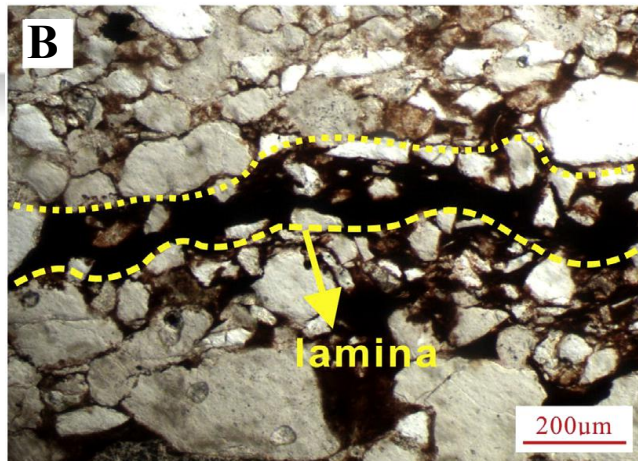
Evidence 2

Quartz grains
float in the
laminae with the
long axes **parallel**
oriented

The grains were
pushed upward and
separated by the
growth of biomass

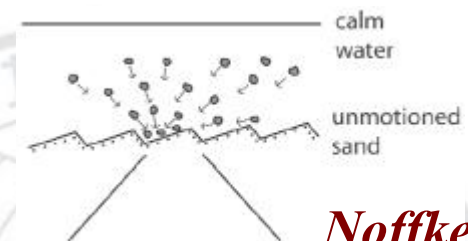


Further examinations via microscope and SEM



Evidence 3

Quartz grains trapped within laminae are **significantly smaller** than those in non-laminated horizons

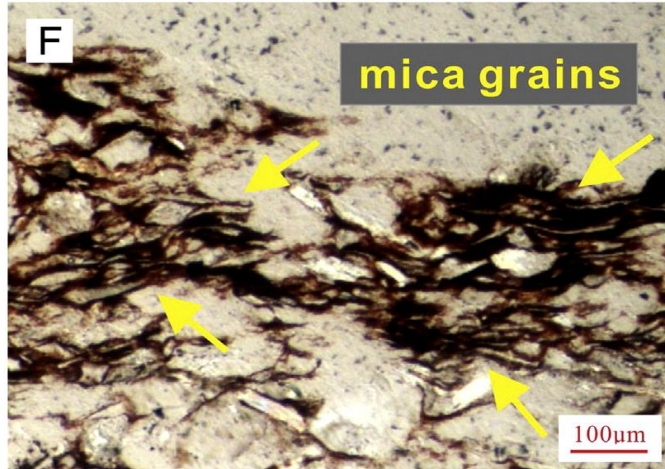
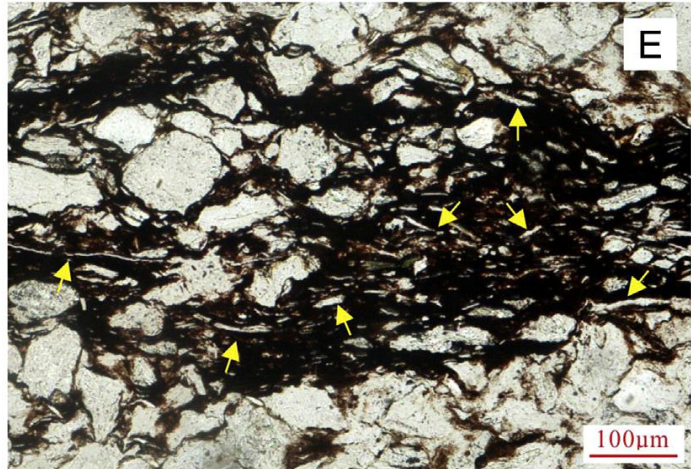


Noffke, 2010

Microbial organisms might colonize in low-energy settings

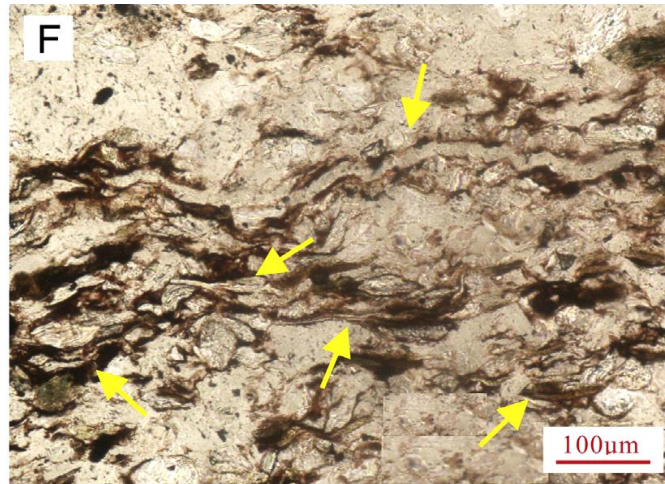
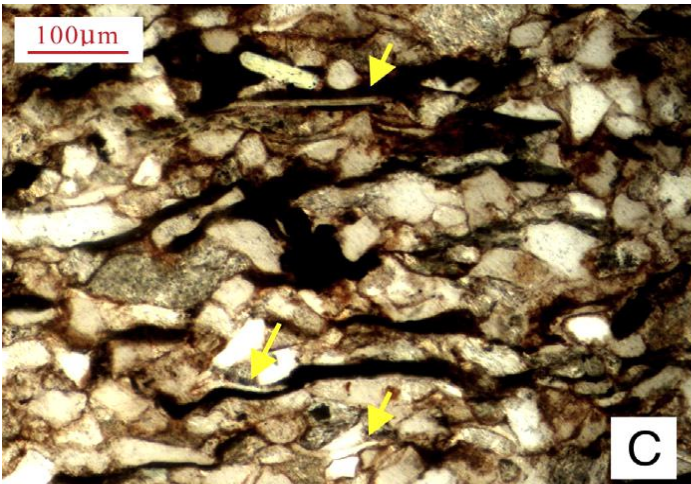


Further examinations via microscope and SEM



Evidence 4

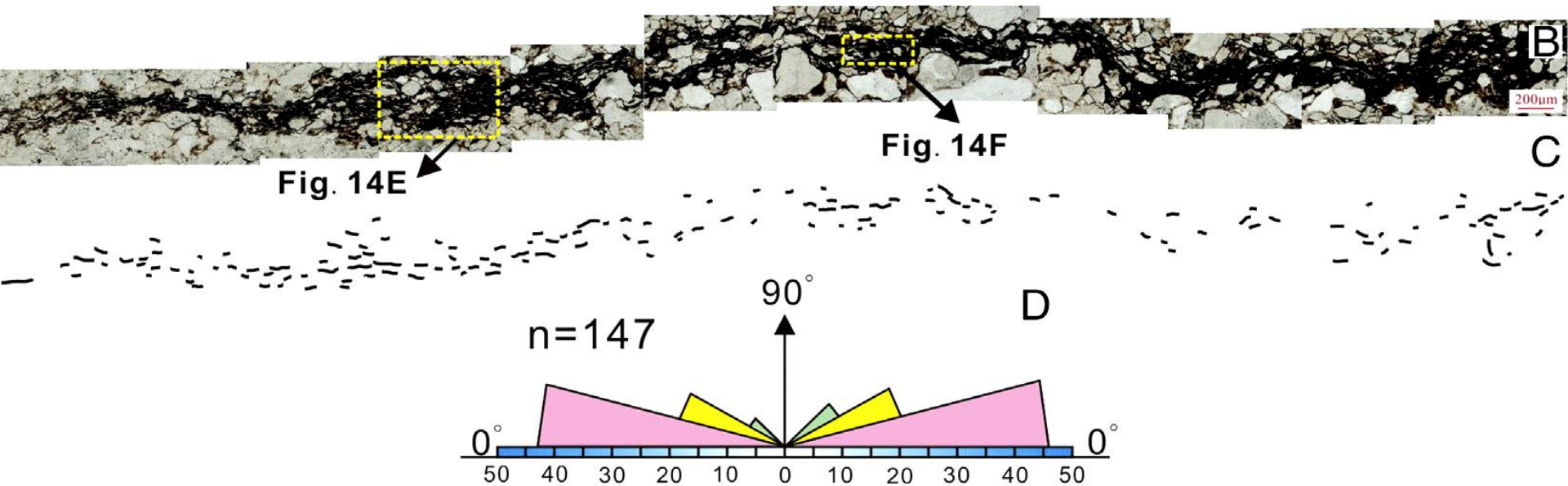
Mica grains:
euhrdal and
filamentous
embedded
within the
laminae



And...



Further examinations via microscope and SEM

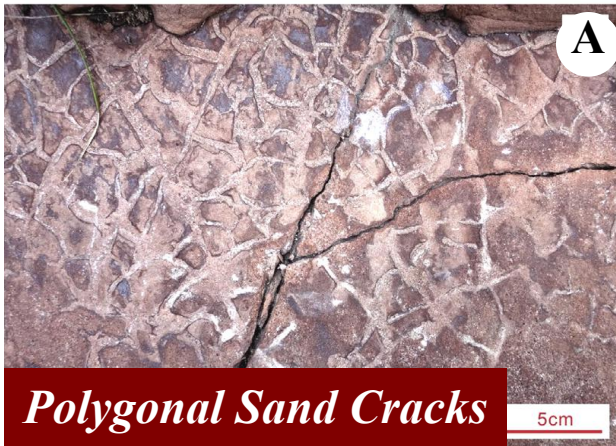


Mica grains are parallel oriented → 'flypaper' effect

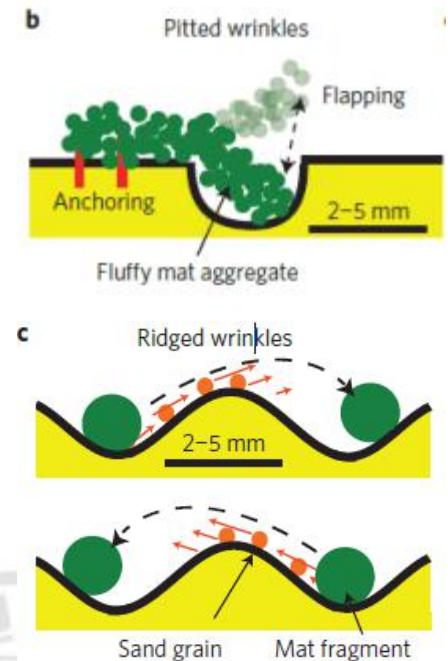
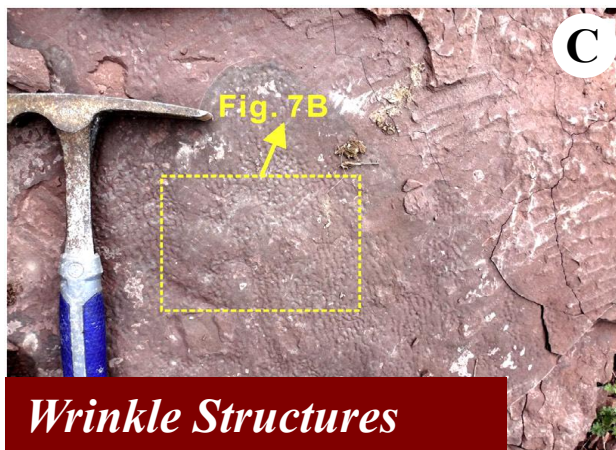
All lines of evidence suggest that the Yiyang MISSs are biogenetic in origin

What about the formation mechanisms?

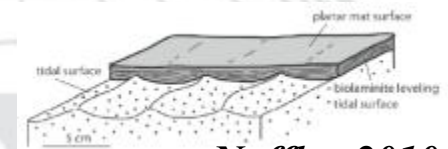
➤ Subaerial exposure, desiccation and shrinkage



➤ Hydraulic related



Mariotti et al., 2014



Noffke, 2010



What about the formation mechanisms?

➤ Gas related



Gas (H_2S , CH_4 , NH_3 et al.) accumulated in microbial **metabolic activities** and **decay processes**

However, the role played by diagenesis cannot be completely ruled out...



Co-occurrence of different types of MISS Sand Cracks & Leveled Ripple Marks



How did the enigmatic structures form

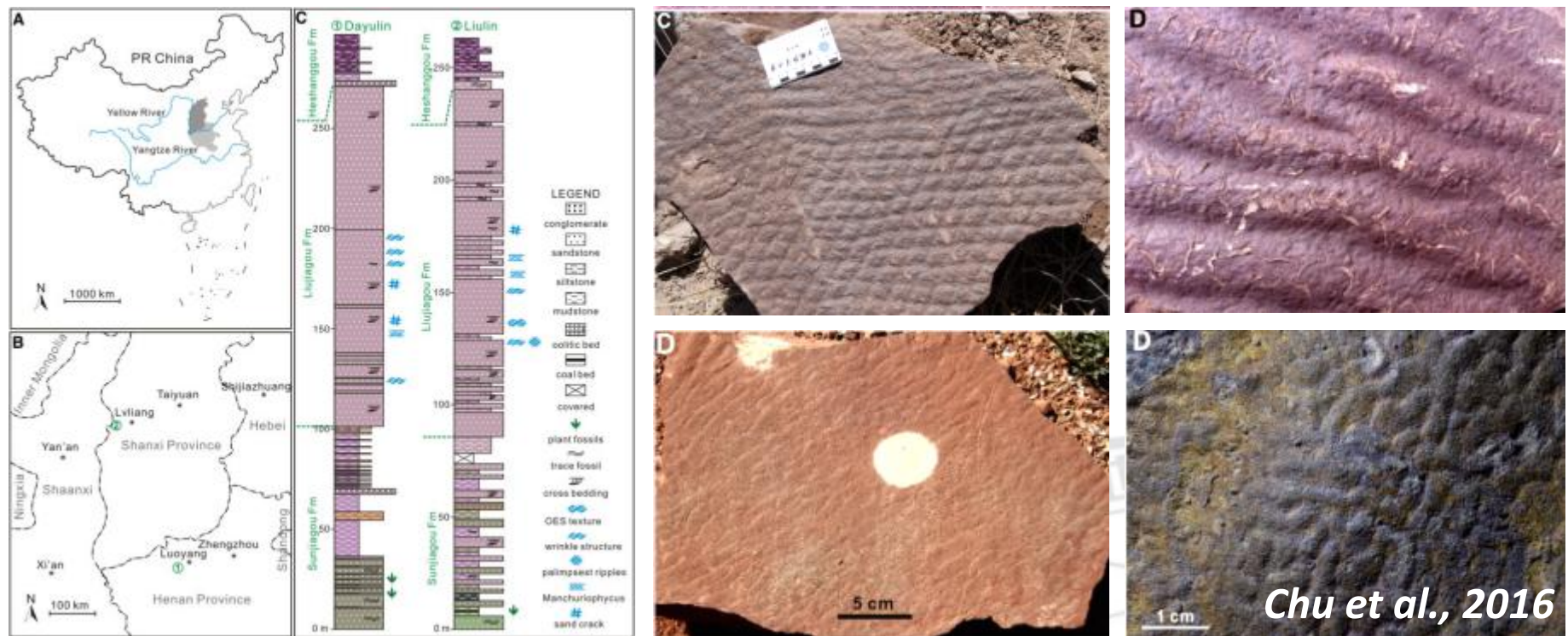


- **Ripple marks** formed due to hydraulic reworking
- **Colonization** of microbial organisms
- **Dehydration** of microbial products



FIRST record in *terrestrial ecosystem* in the aftermath of end Permian mass extinction

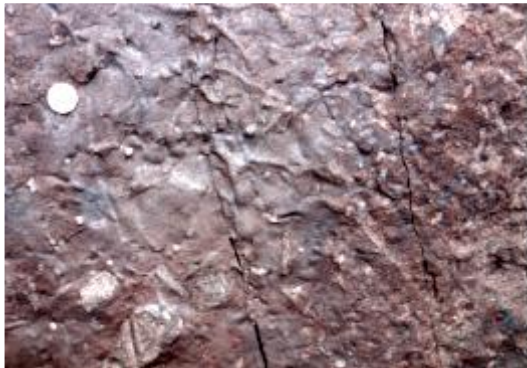
More records of microbial mats (North China) were reported



Regional **or** global **control?** More work remains to be done...



Implications for **TERRESTRIAL** ecosystem

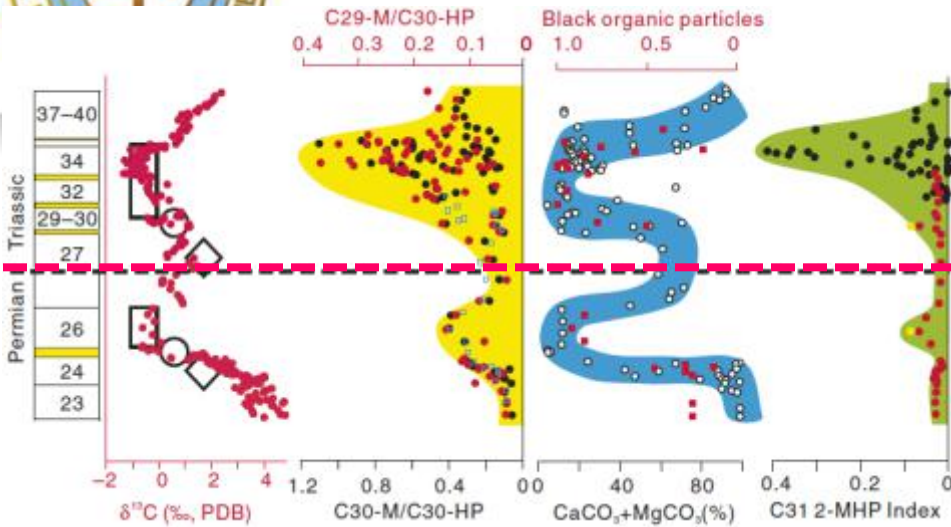


- **No** trace fossil has been found in the **MISS-bearing sediments**
- **Abundant** trace fossils occur in the upper portion of the Liujiagou Formation where **mat-related structures disappear**

Environmental deterioration **within TERRESTRIAL ecosystem**
in the aftermath of end-Permian mass extinction

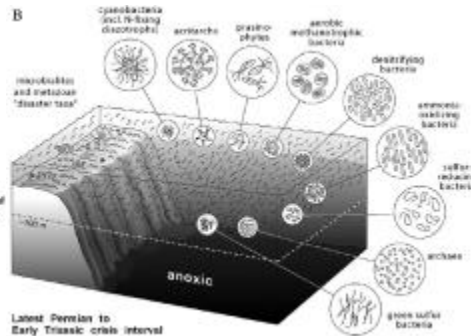
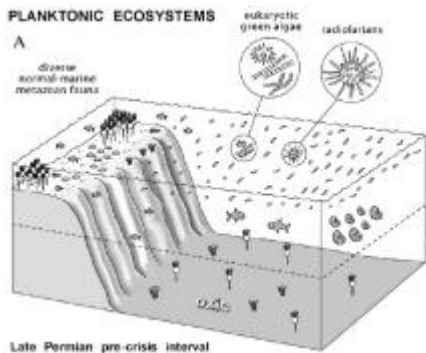


Microbial records in MARINE ecosystem

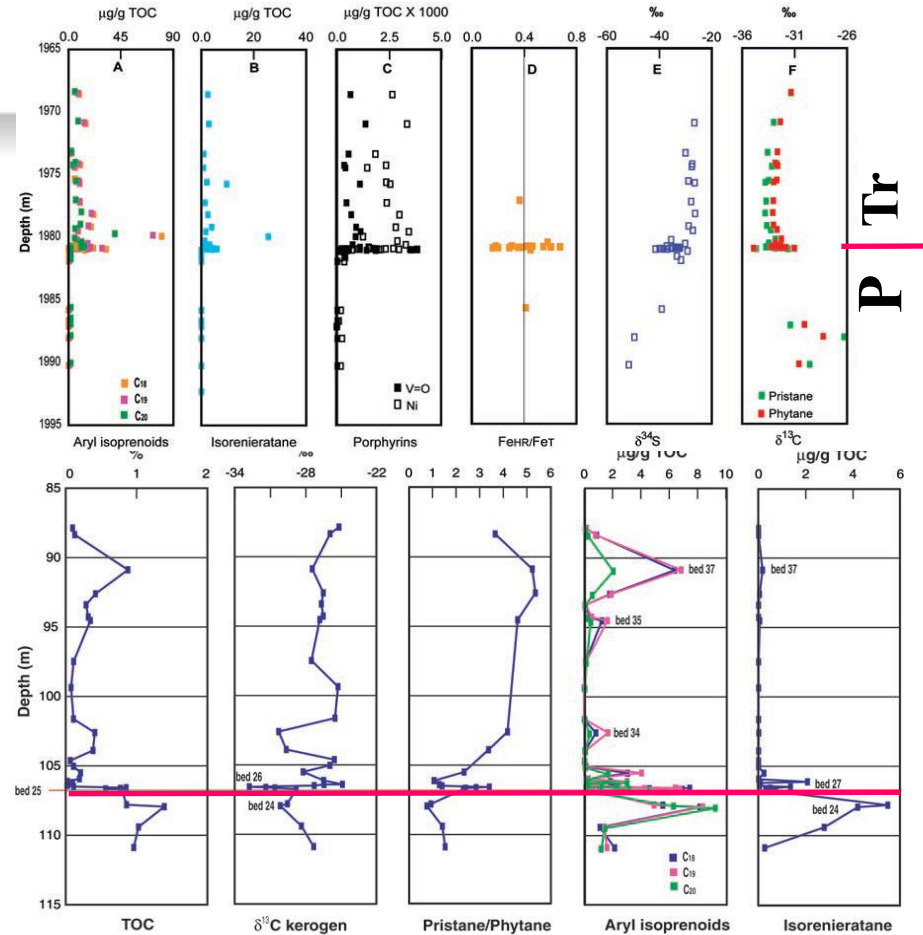


Cyanobacteria

Xie et al., 2007



Luo et al., 2013



Chlorobiaceae

Grice et al., 2005

The bloom of microbes **may indicate the COLLAPSE of** marine & terrestrial ecosystem during the EPME and its aftermath



Thanks for your attention!

Thanks for your attention!

Rocky Mountains