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# GIS Applications in Microbiology or The Beginning of the End

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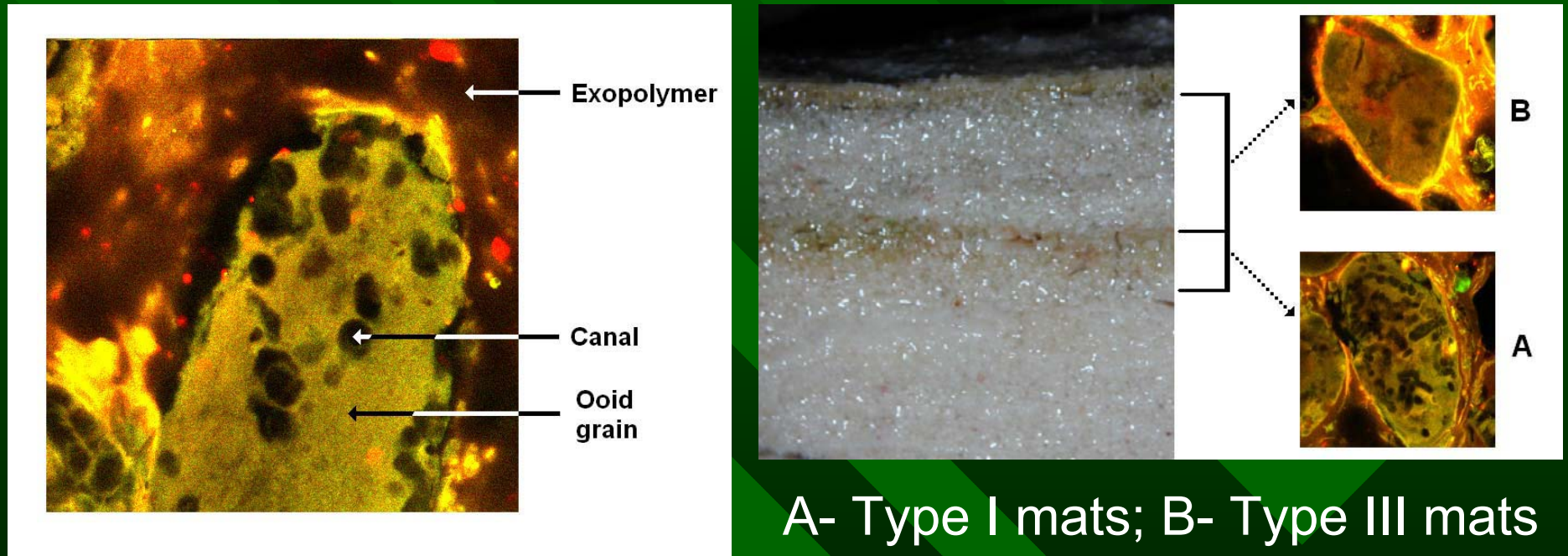
# Stromatolites

Picture courtesy of OAR/National Undersea Research Program

- Oldest macrofossils on Earth (3 billion years)
- Still formed in the Bahamas
- Built through bacterial activities, mainly  $\text{CaCO}_3$  precipitation and dissolution; influenced by environmental conditions such as pH, temperature etc.
- Laminated structure; there are three types of mat communities; two of which produce *micritic layers*
- Understanding their formation will facilitate understanding of prehistoric conditions



# Research on boring processes

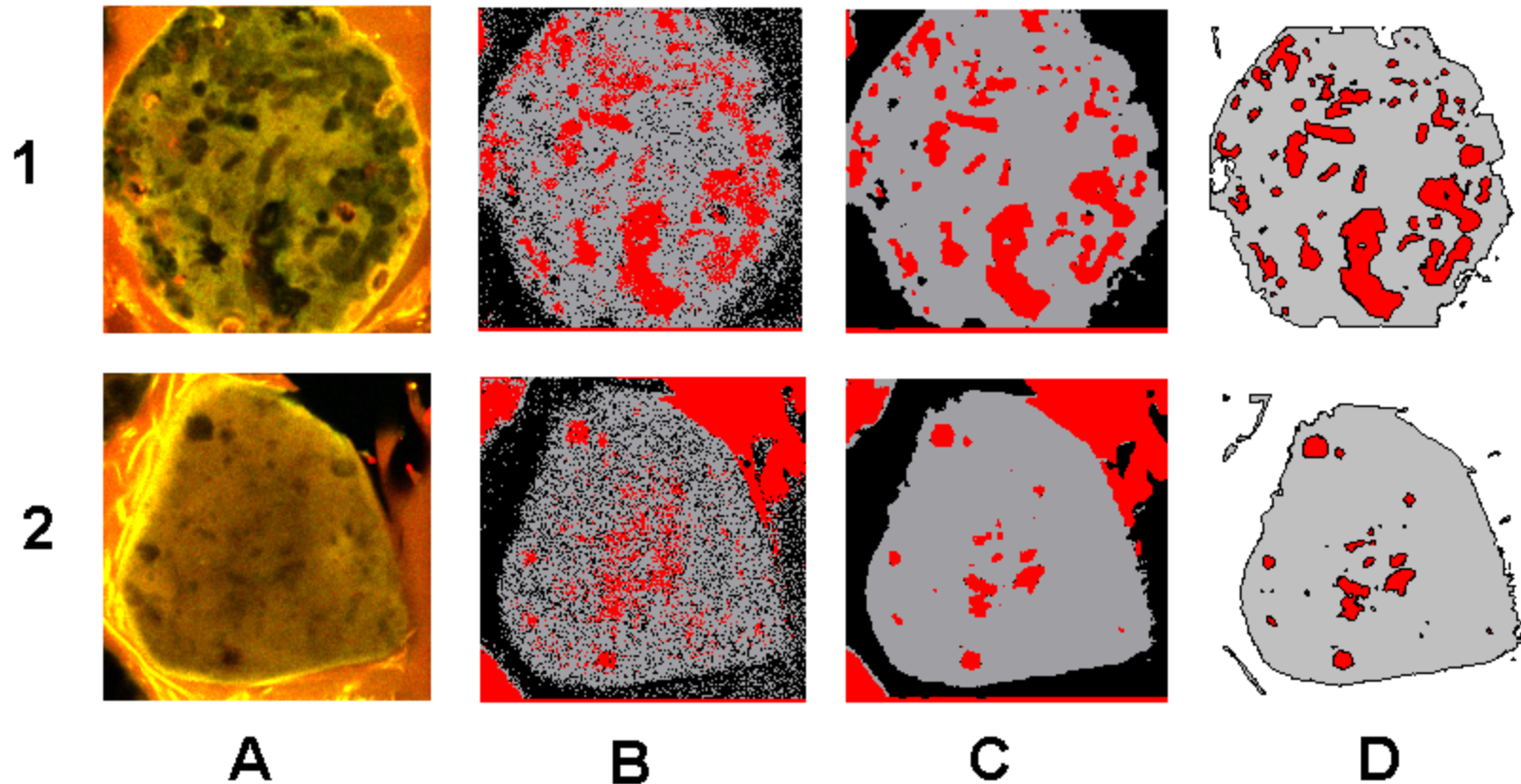


A- Type I mats; B- Type III mats

Boring processes, in ooid grains are due to endolithic species (*Solentia sp.*), and differentiates between "Type I" and "Type III" layers. Microbored "canals" are more abundant in Type III layers.

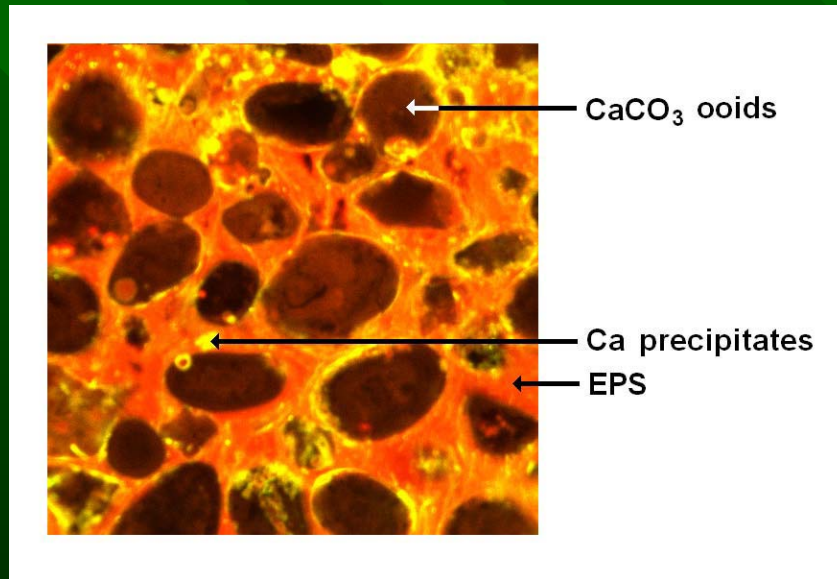
[A.I. Petrisor and A.W. Decho, Using geographical information techniques to quantify the spatial structure of endolithic boring processes within sediment grains of marine stromatolites, Journal of Microbiological Methods 56(2):173-180]

# Classification and quantification

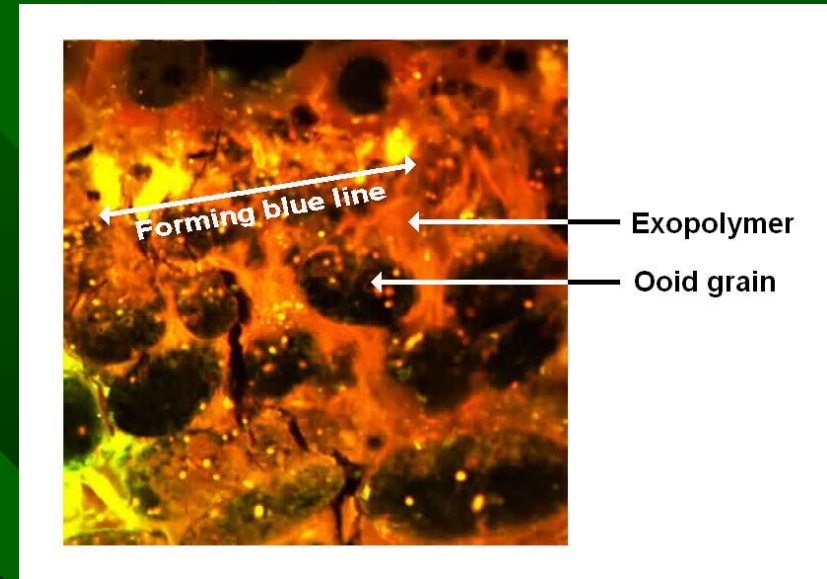


1- abundant canals; 2- fewer canals; A- initial images, B- classified images, C- filtered images, D- reclassified images with canals selected within the ooids

# Calcification in stromatolites



Typical image from Type I layers

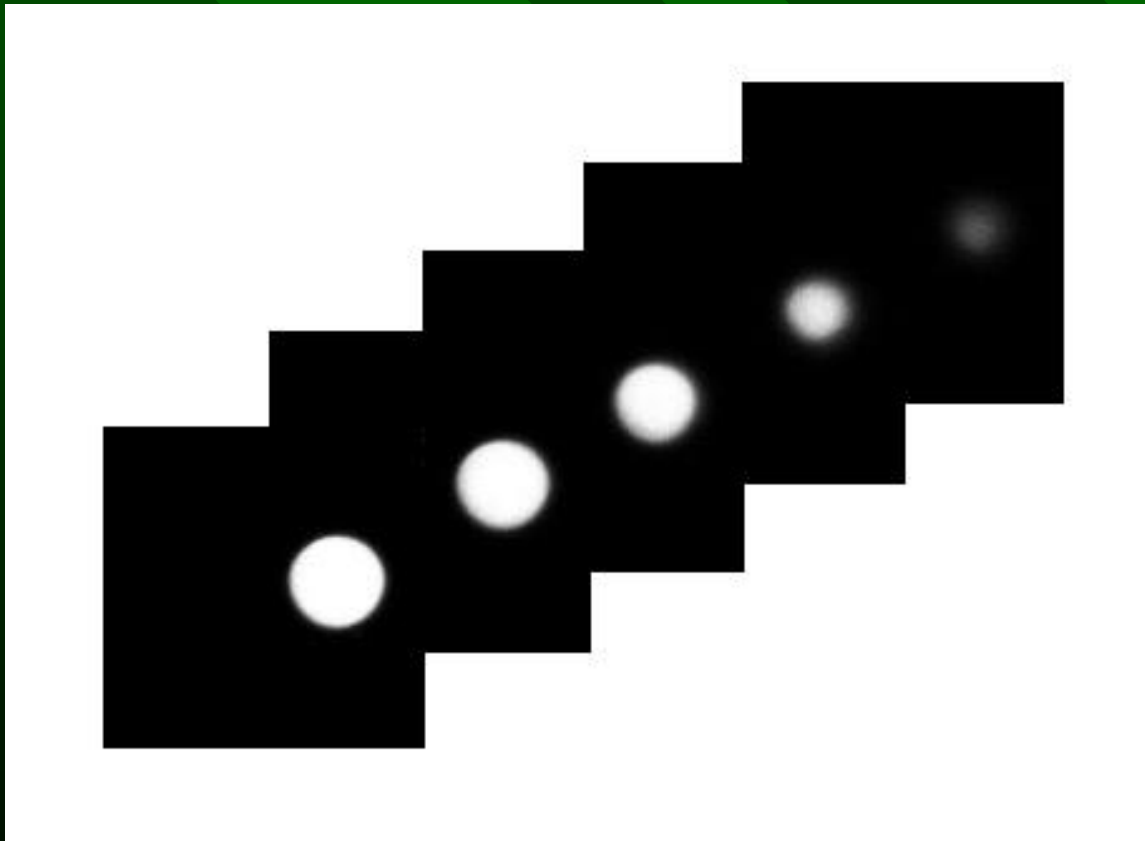


Natural break between the two types of mats: the blue line

This ongoing research is quantifying the amount of CaCO<sub>3</sub> precipitates in Type I and Type II layers. The results indicate significantly larger amounts in Type II layers. This is related to the activities of sulfate-reducing bacteria.

[A.I. Petrisor, T. Kawaguchi, and A.W. Decho, Manuscript in preparation]

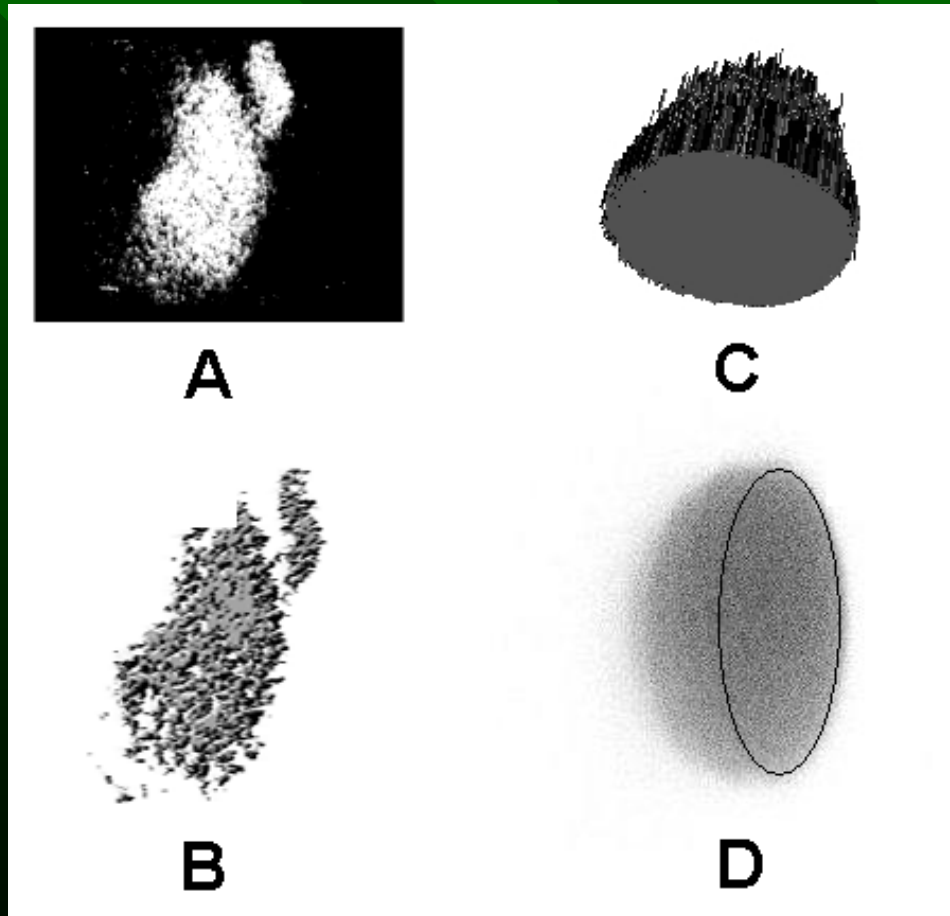
# Reconstruction and estimation of biovolumes



Fluorescent microspheres of known sizes ( $1\ \mu\text{m}$  diameter) were used to build an approach to the computation of biovolumes. For each microsphere, images of five parallel sections were taken at equal distances.

[A.I. Petrisor, A. Cuc, and A.W. Decho, Reconstruction and Computation of Microscale Biovolumes Using Geographical Information Systems: Potential Difficulties, Research in Microbiology, *in press*]

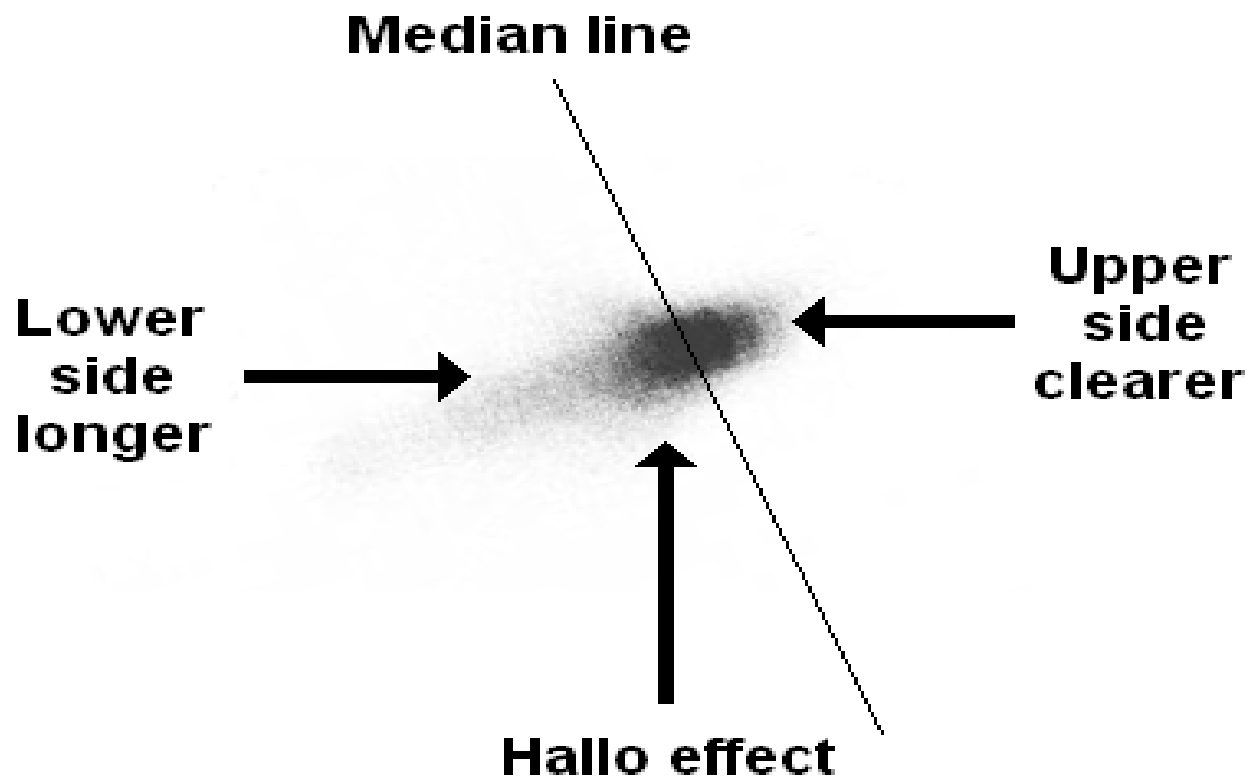
# Reconstruction of biovolumes



A and B- two, respectively three-dimensional reconstruction of a portion of a biofilm, using five parallel sections

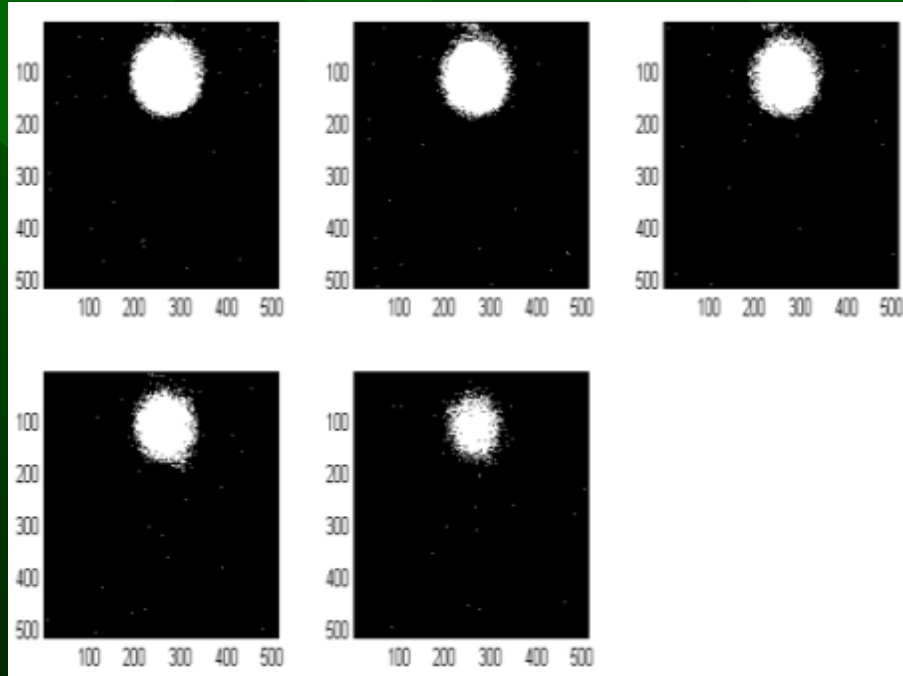
C, D- reconstruction of the upper portion of a 1 μ-diameter microsphere using five parallel sections

# Potential problems



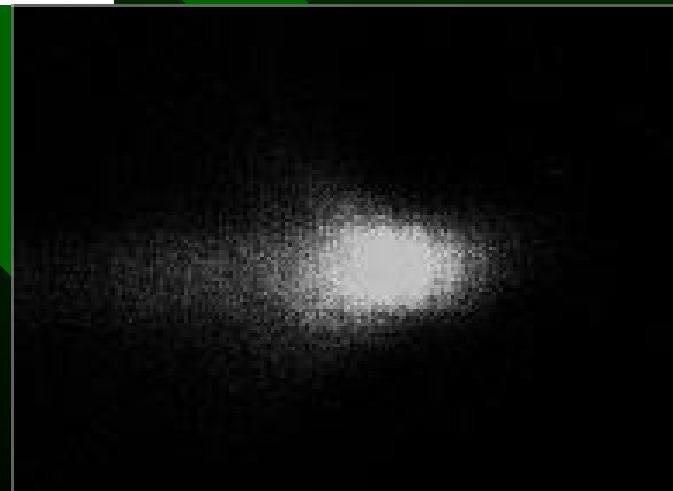


# The halo effect

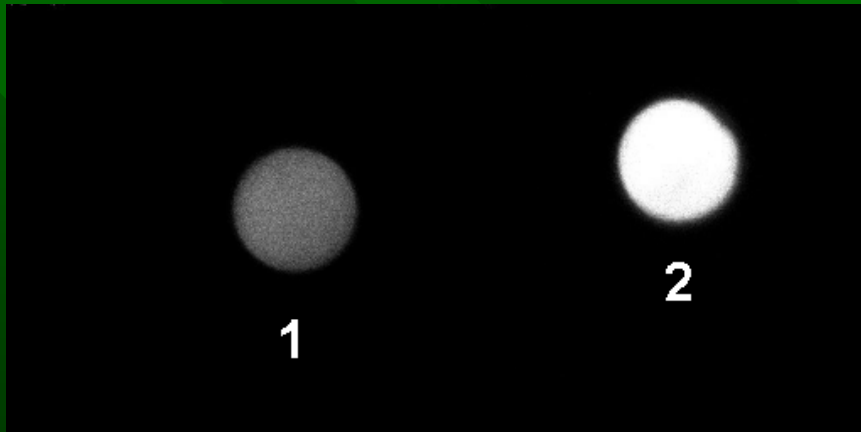


2-D analysis:  
areas of upper  
sections appear  
larger than they  
should be

3-D analysis:  
actual view of  
the halo

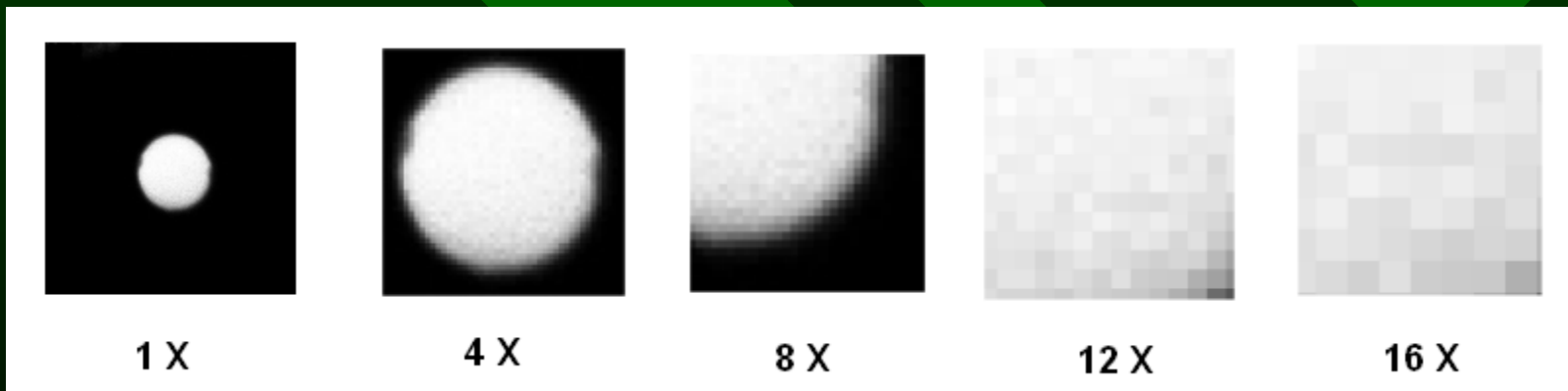


# Differences in color intensity



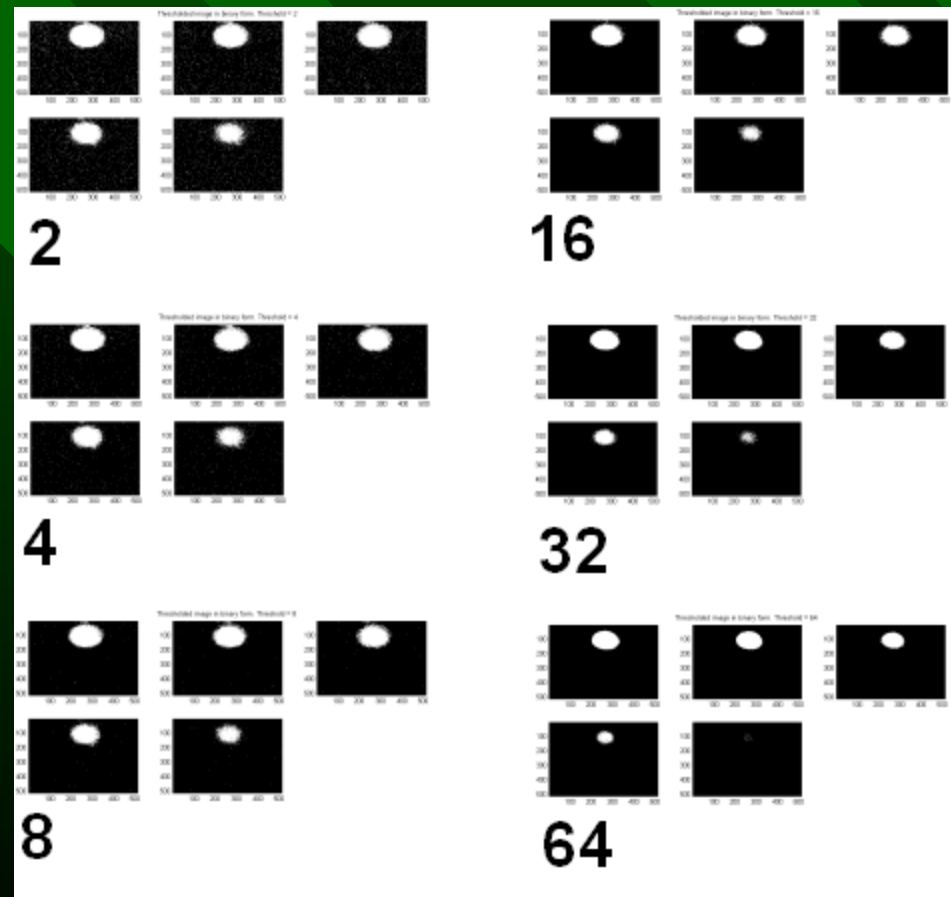
1- pale appearance;  
2- bright appearance

# Differences at the pixel level

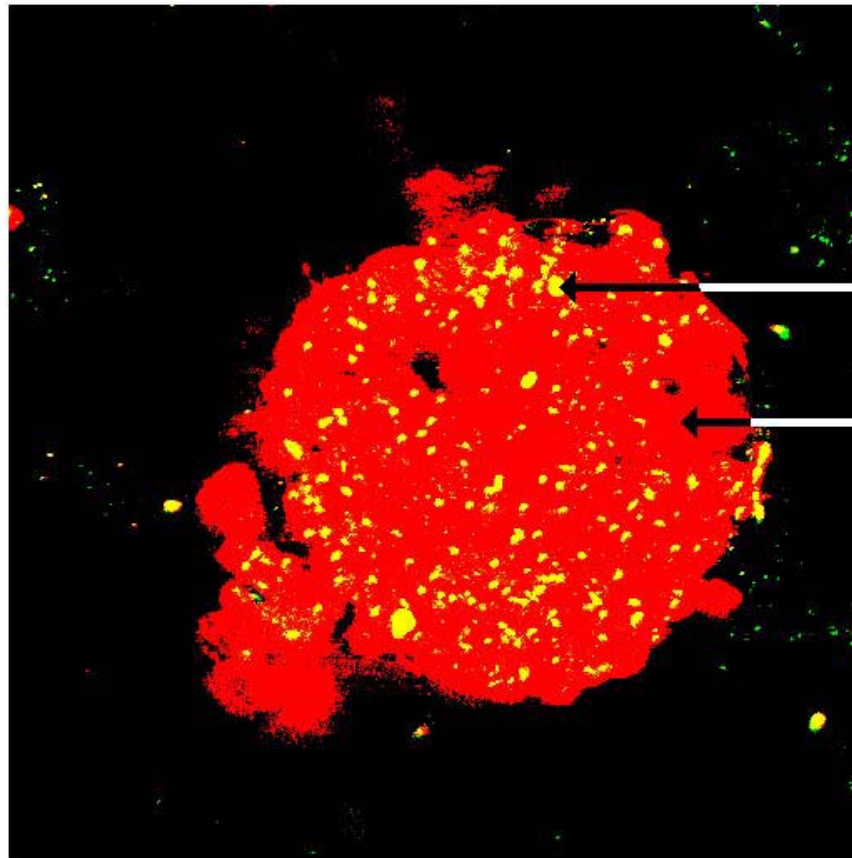


Even though images appear homogeneous, they represent collections of pixels having different colors or intensities of the same color

# Effect of the threshold value used in unsupervised classification



# Embedding microspheres in gel capsules: simulation of complex environments



Microsphere

Gel capsule