

# GÜBELIN GEM LAB

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GÜBELIN

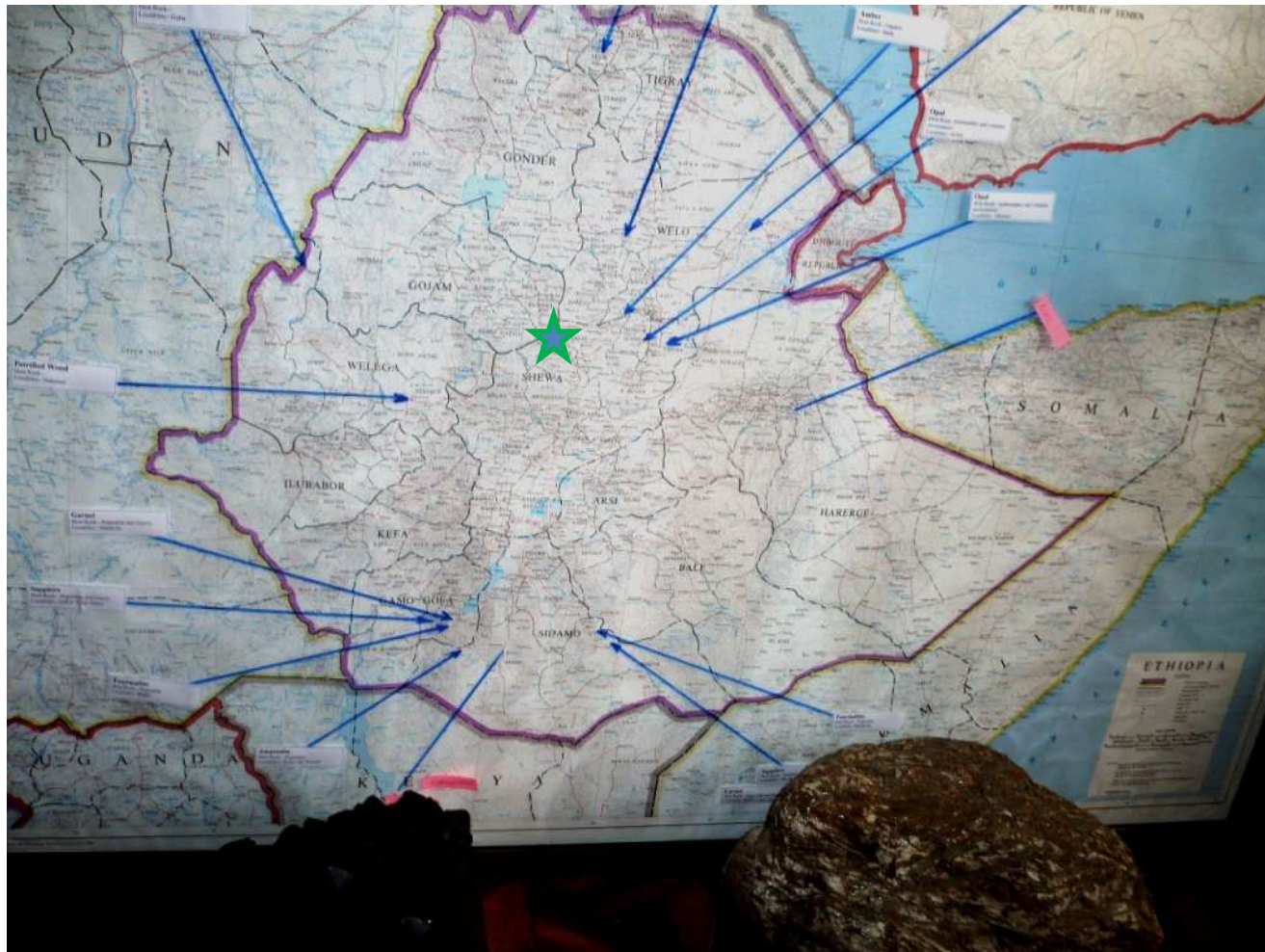
# GREEN AMBER FROM ETHIOPIA

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GUBELIN GEM LAB, LUZERN, SWITZERLAND

# CONTENTS

- Overview over Ethiopian gem mines
- Geology and Mining of Ethiopian green amber
- Properties and inclusions
- Inclusions of autoclave treated green amber
- FTIR spectra of some amber and comparison to the Ethiopian green amber
- Conclusions

# GEMSTONES OF ETHIOPIA



amethyst  
gold  
opal  
amber  
fire opal  
opal

- beryl
- tourmaline
- petrified wood
- peridot
- tourmaline
- aquamarine
- chrysocolla
- amazonite
- chrysoprase

Map of Ethiopia with various gemstone deposits. The green star marks the approximate location of the green amber deposit (Map: T. Sintayehu).

# ETHIOPIAN GREEN AMBER



# ETHIOPIAN GREEN AMBER





# ETHIOPIAN GREEN AMBER



Rough amber and polished beads

# ETHIOPIAN GREEN AMBER

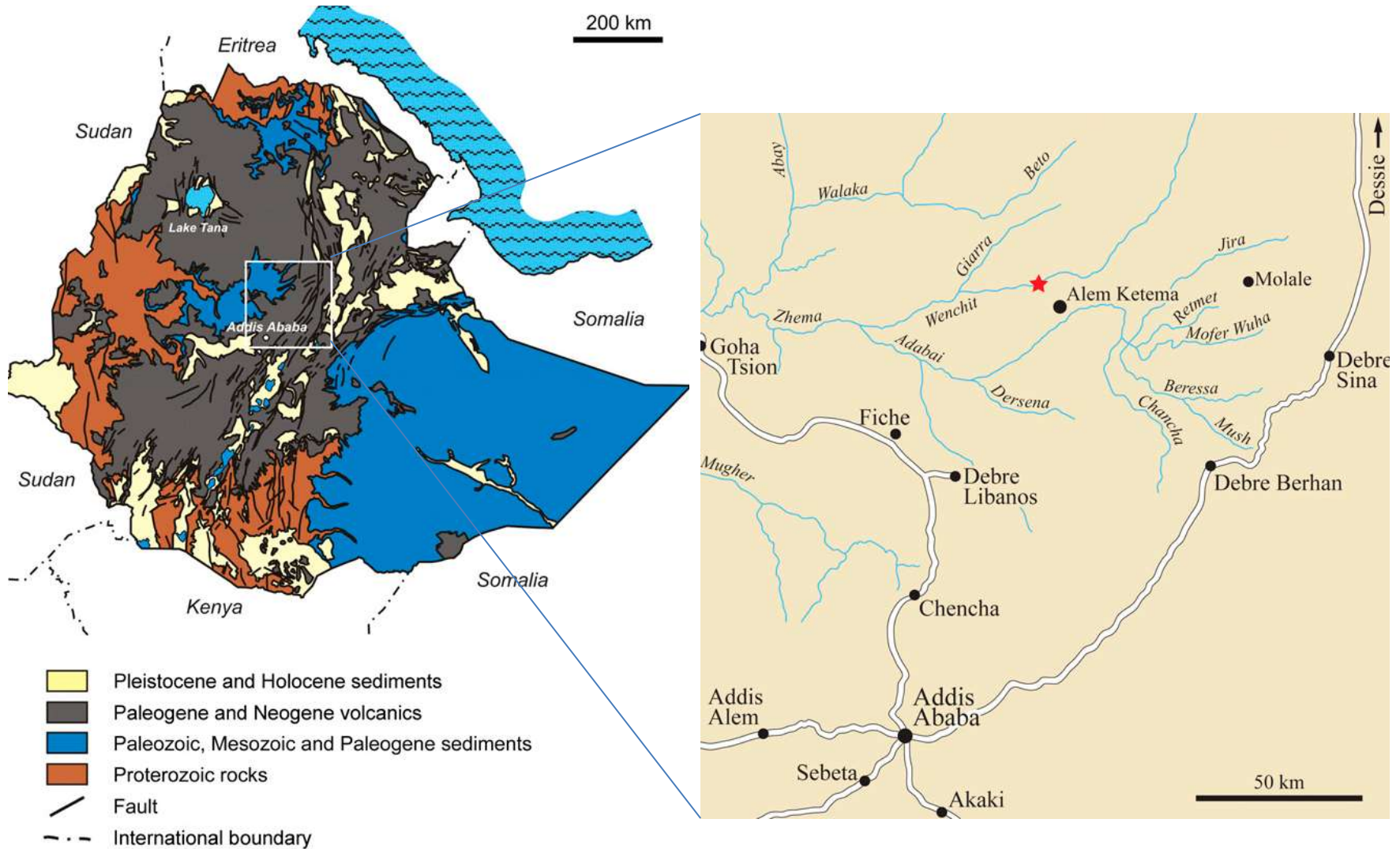
Questions:

- \* Autoclaved amber?
- \* Autoclaved copal? But from where?
- \* If natural, where does it get its green colour from?



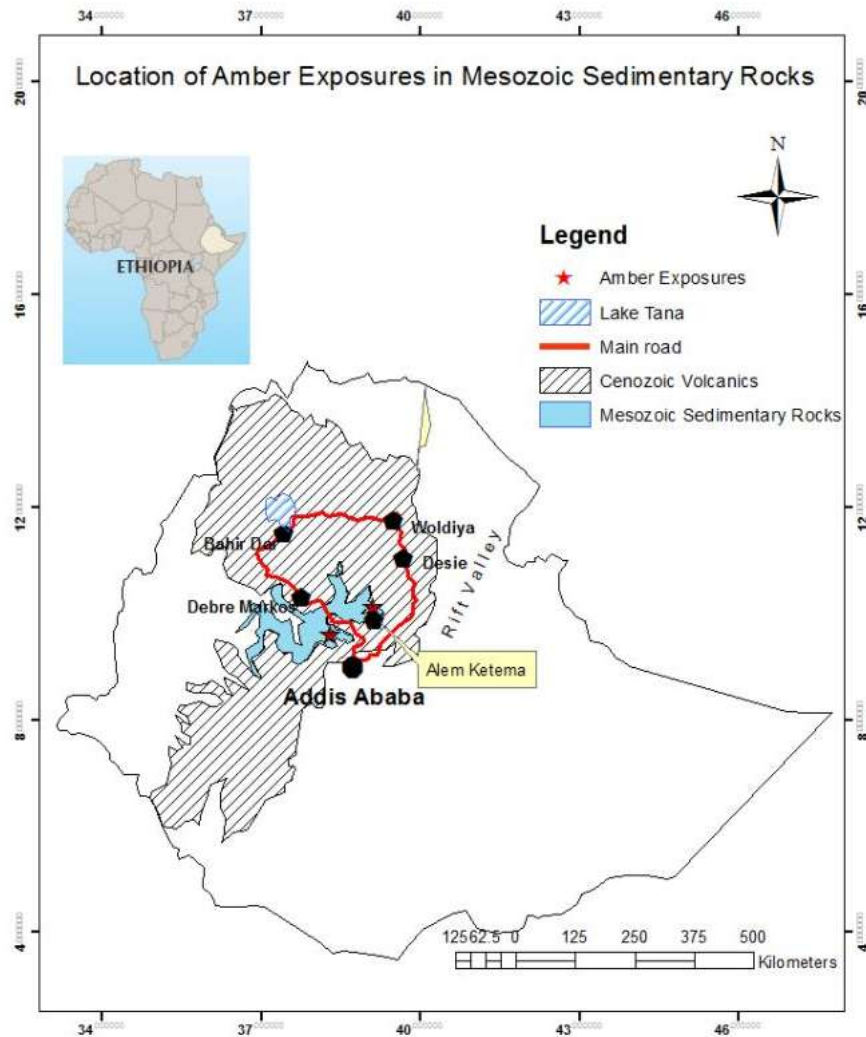


# ETHIOPIAN GREEN AMBER



After Schmidt et al. (2010)

# ETHIOPIAN GREEN AMBER



Map and photo: Begosew Abate



# ETHIOPIAN GREEN AMBER



Amber occurs within the sandy limestone just below the contact with Tertiary volcanic represented here by columnar basalts.

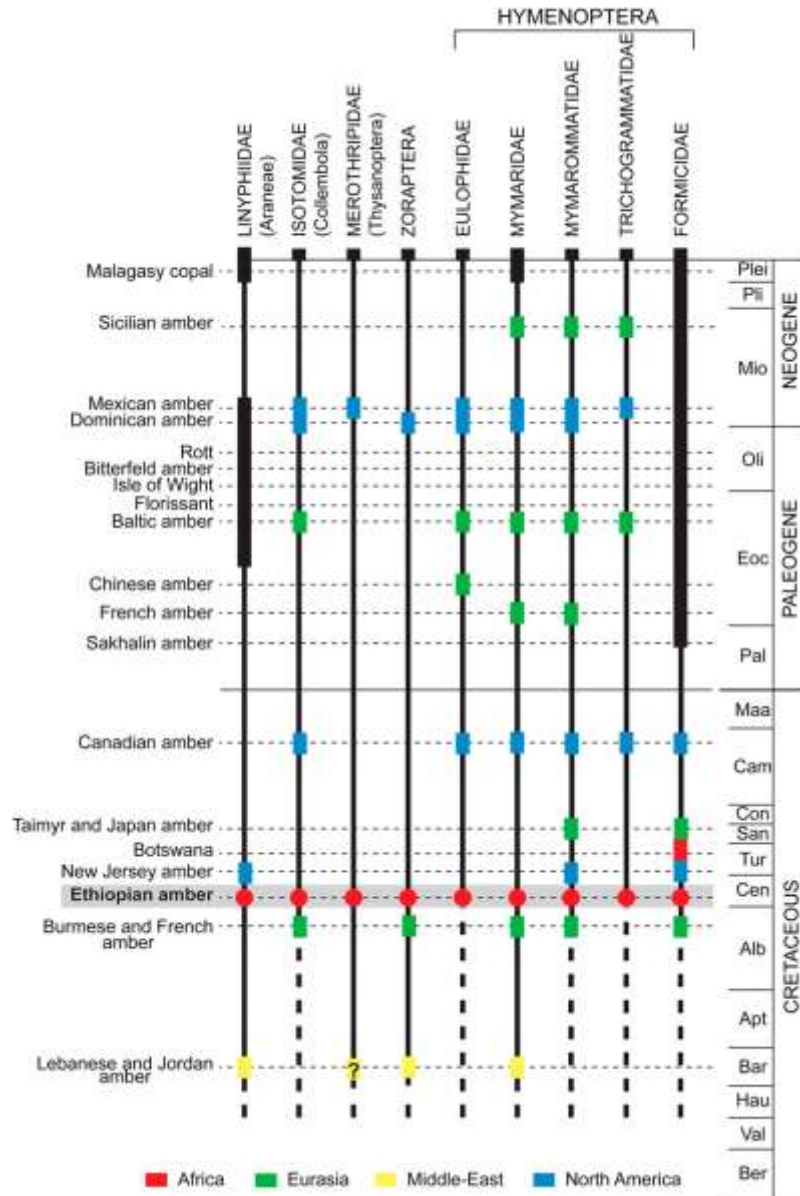
# ETHIOPIAN GREEN AMBER



Photo: Begosew Abate

Local miners

# EHTIOPIAN GREEN AMBER



From Schmidt et al. (2010): This group of researchers have studied the Ethiopian amber in detail and date it to the mid-Cretaceous, some 93-95 million years ago, which makes it older than the Baltic or the Japanese amber.

They point out the large variety of insects and their pristine state in which they could be found.

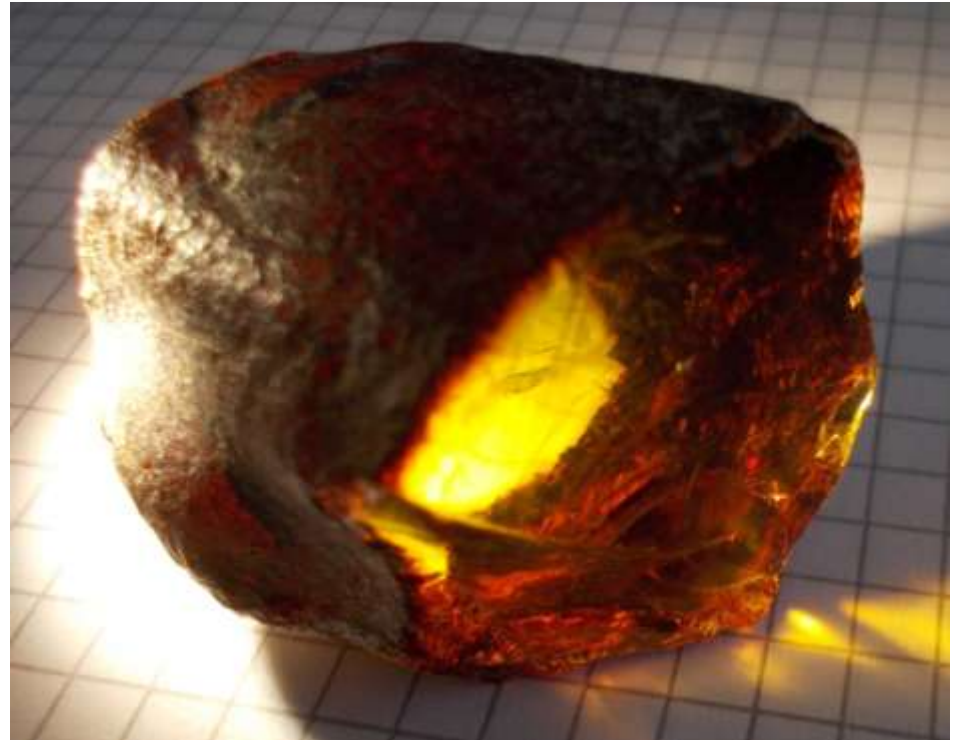


# THE WORKSHOP



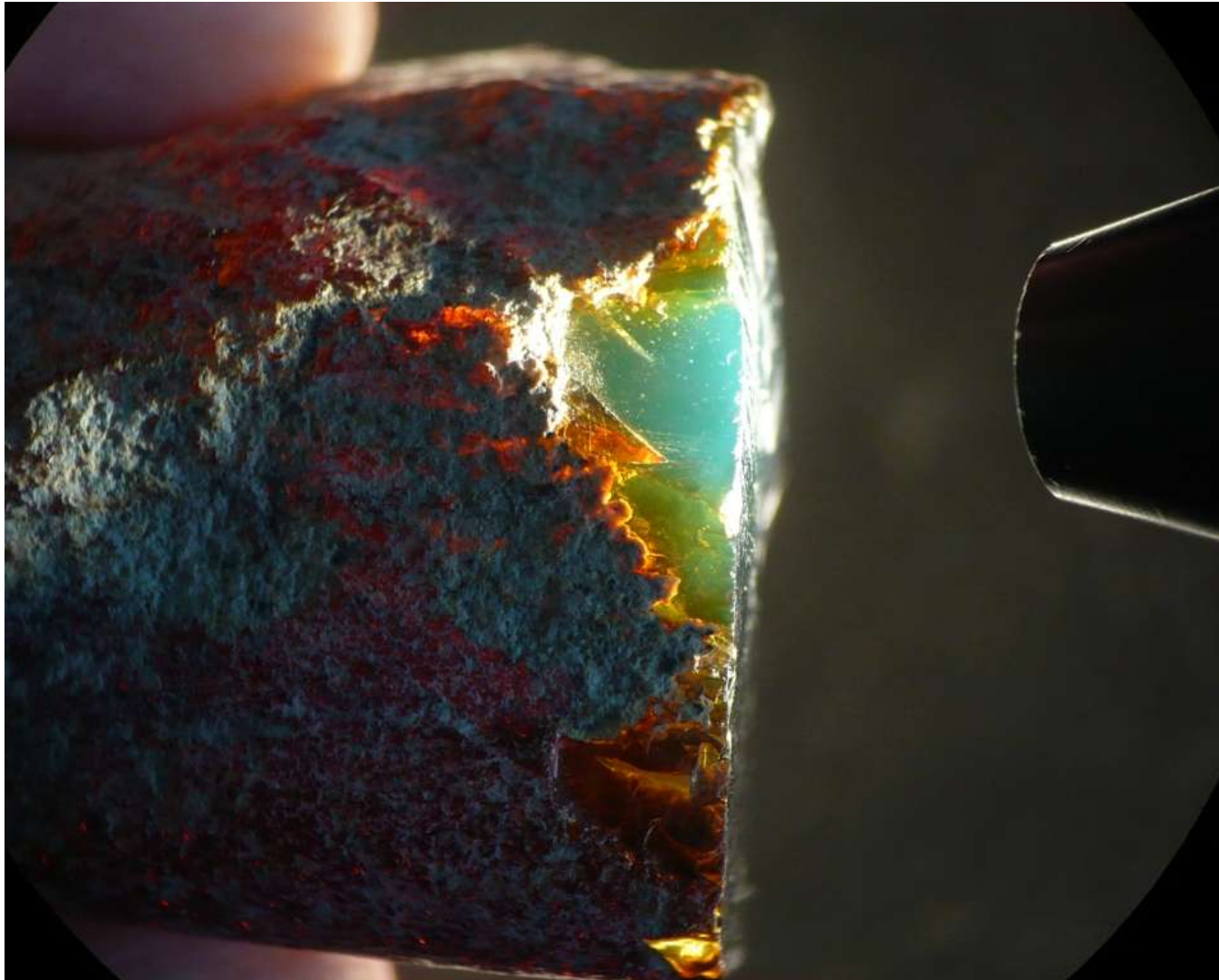


# PROPERTIES

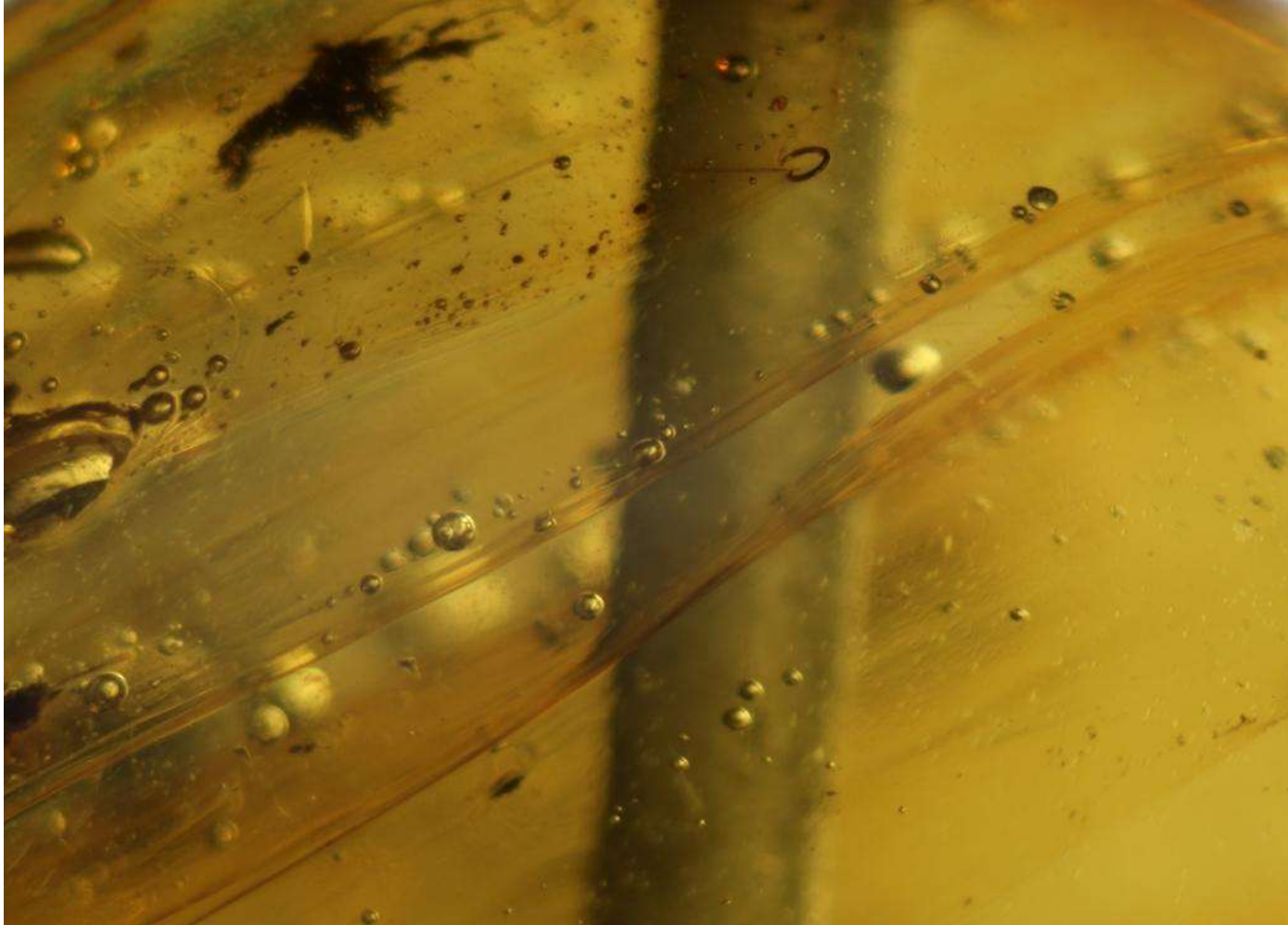


Colour change?

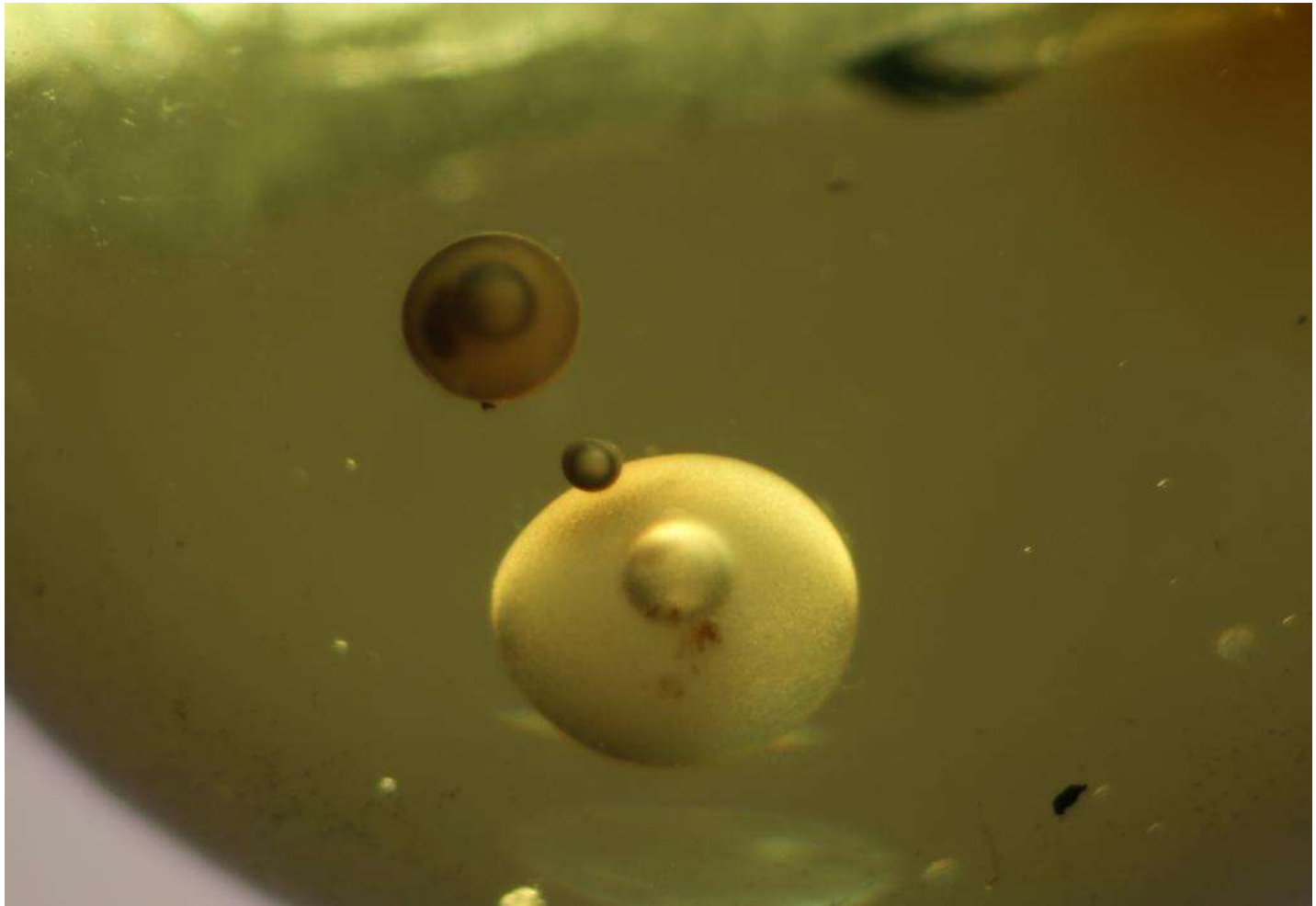
# PROPERTIES



# GREEN AMBER - INCLUSIONS



# GREEN AMBER - INCLUSIONS



Bubble or pollen?



# GREEN AMBER - INCLUSIONS



"Donut" and flattened bubbles

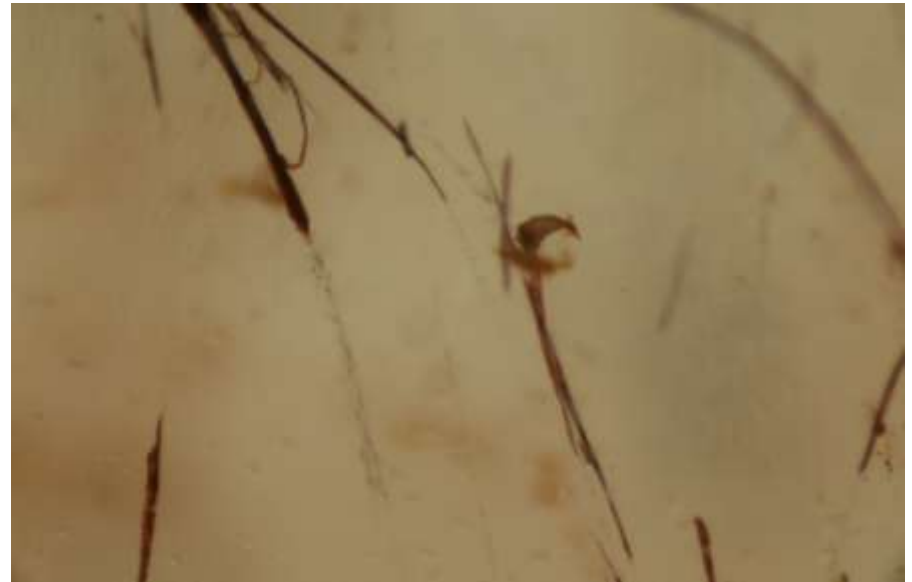
# GREEN AMBER - INCLUSIONS



Irregular bubble

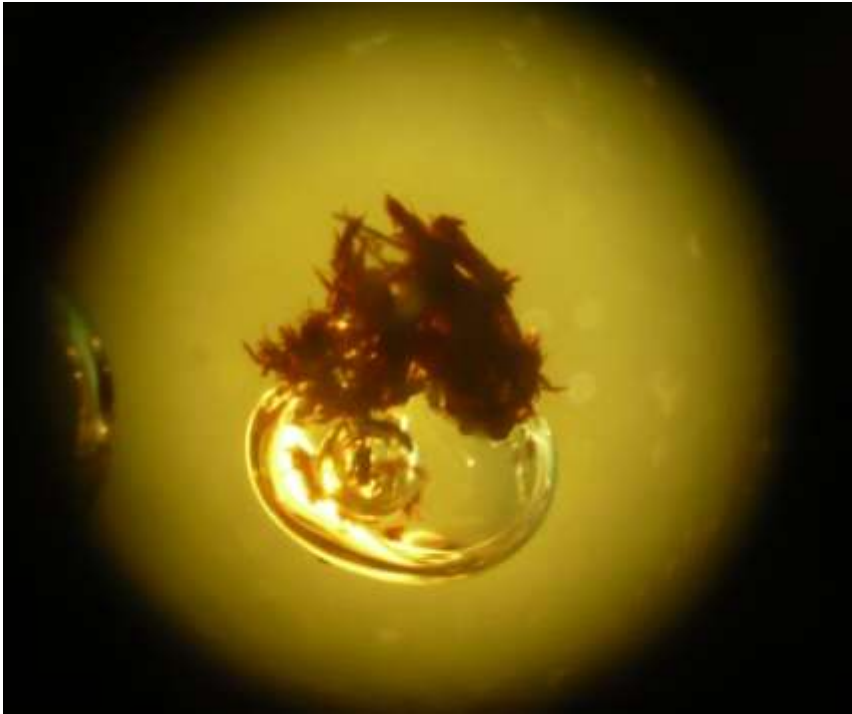


# GREEN AMBER - INCLUSIONS



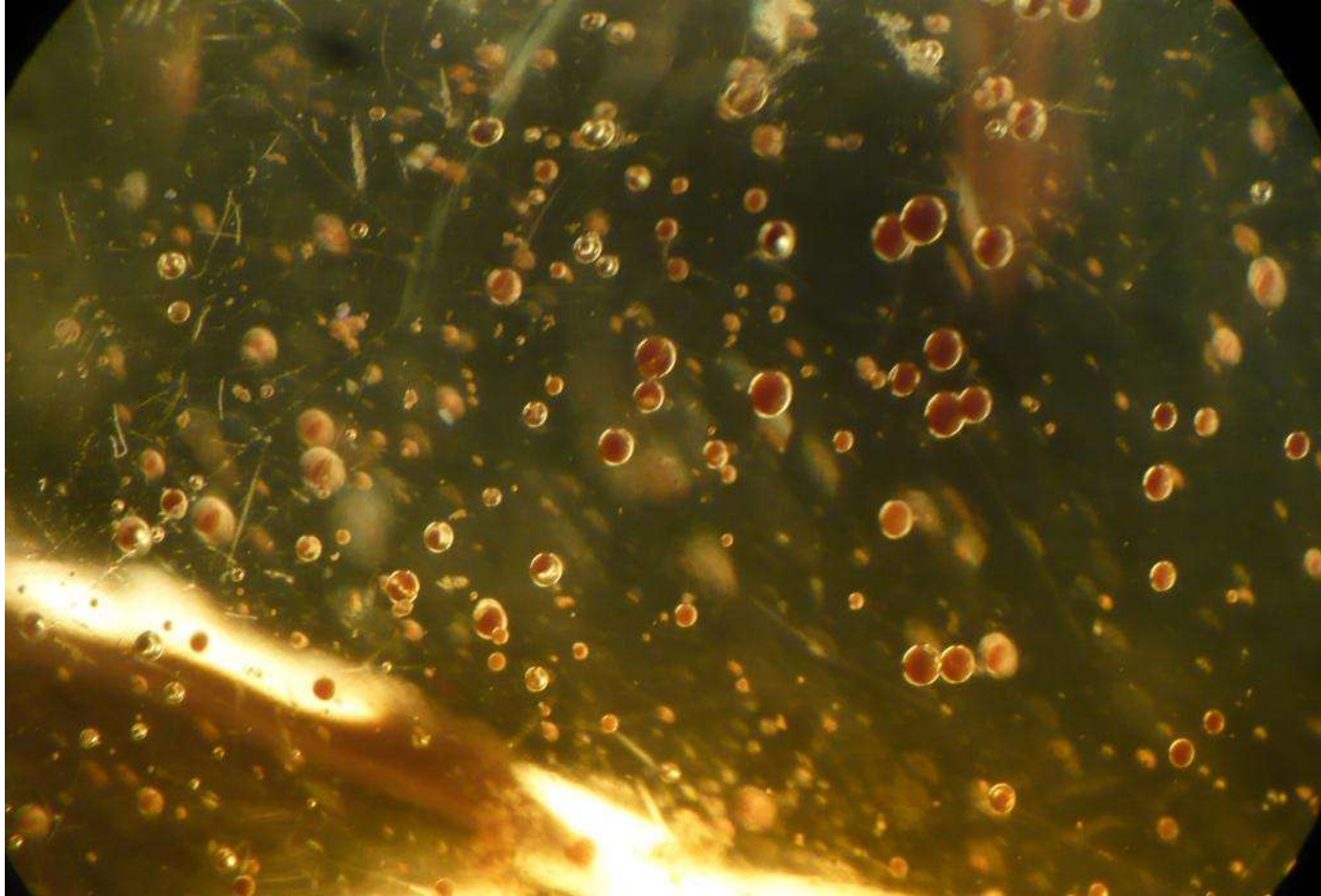
Fibrous plant material

# GREEN AMBER - INCLUSIONS



Bubbles with attached plant material

# GREEN AMBER - INCLUSIONS



Pollen and bubbles

# GREEN AMBER - INCLUSIONS



Nematode

# GREEN AMBER - INCLUSIONS



Unknown insect

# GREEN AMBER - INCLUSIONS



Insect leg



# GREEN AMBER - INCLUSIONS



Insect parts cut on surface. The facet eye in the center is actually only the print, the eye itself is gone.

# GREEN AMBER - INCLUSIONS



Ticks (spider animals)

# GREEN AMBER - INCLUSIONS



# GREEN AMBER - INCLUSIONS





# GREEN AMBER - INCLUSIONS



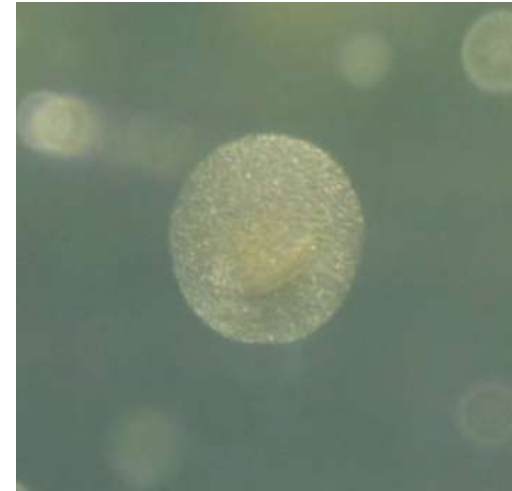
# GREEN AMBER - INCLUSIONS



# GREEN AMBER - INCLUSIONS



# AUTOCLAVED GREEN AMBER - INCLUSIONS



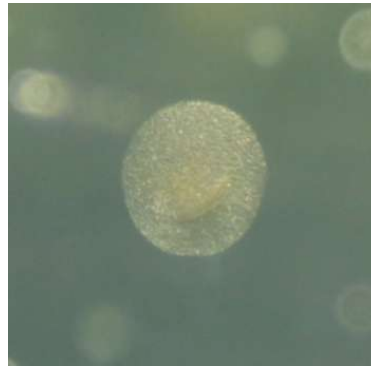
Collapsed pollen?

The brownish particles in the left earring showed the above and right inclusions. They remind of modern pollen in dust.



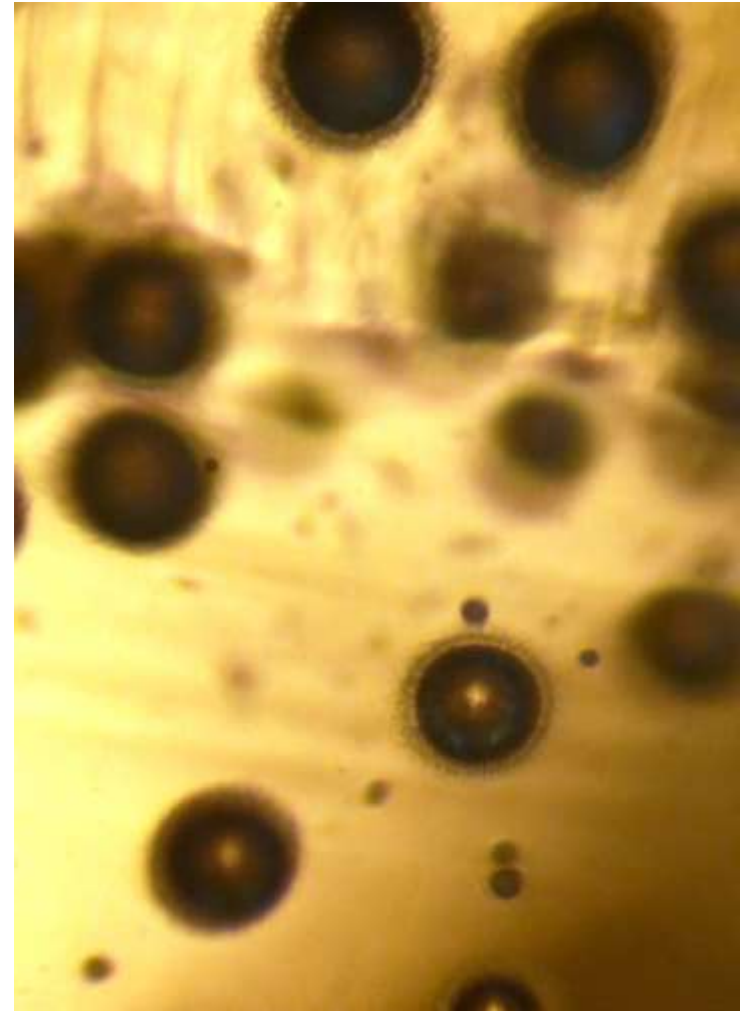


# AUTOCLAVED GREEN AMBER - INCLUSIONS



Collapsed pollen?

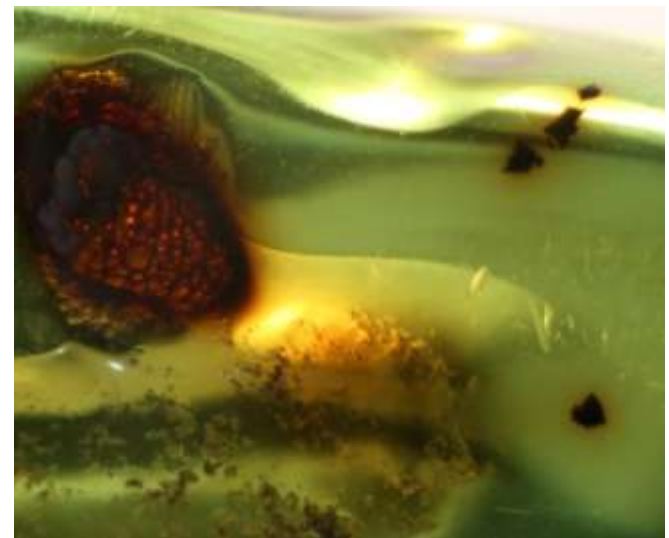
The right image shows bubbles with a hairy surface or possibly also a type of pollen, in an untreated copal.



# AUTOCLAVED GREEN AMBER - INCLUSIONS



Another autoclave treated amber sample showed very weak bluish dispersion compared to the Ethiopian green amber. It had some melted features on the surface, and a typical brownish rim around the organic inclusions. Both autoclaved samples showed no bubbles inside.



# AUTOCLAVED AMBER INCLUSIONS



From C. Hoffeins (2012): On Baltic amber inclusions treated in an autoclave. Polish Journal of Entomology, Vol. 81, 165-183.

The effect on insects when autoclaved typically shows a brownish rim (left), or broken wings and other parts (right). Interesting are the bubbles in the right image, which were not observed in our autoclaved samples.

# DIFFERENCE ETHIOPIAN AND AUTOCLAVED AMBER

Colour

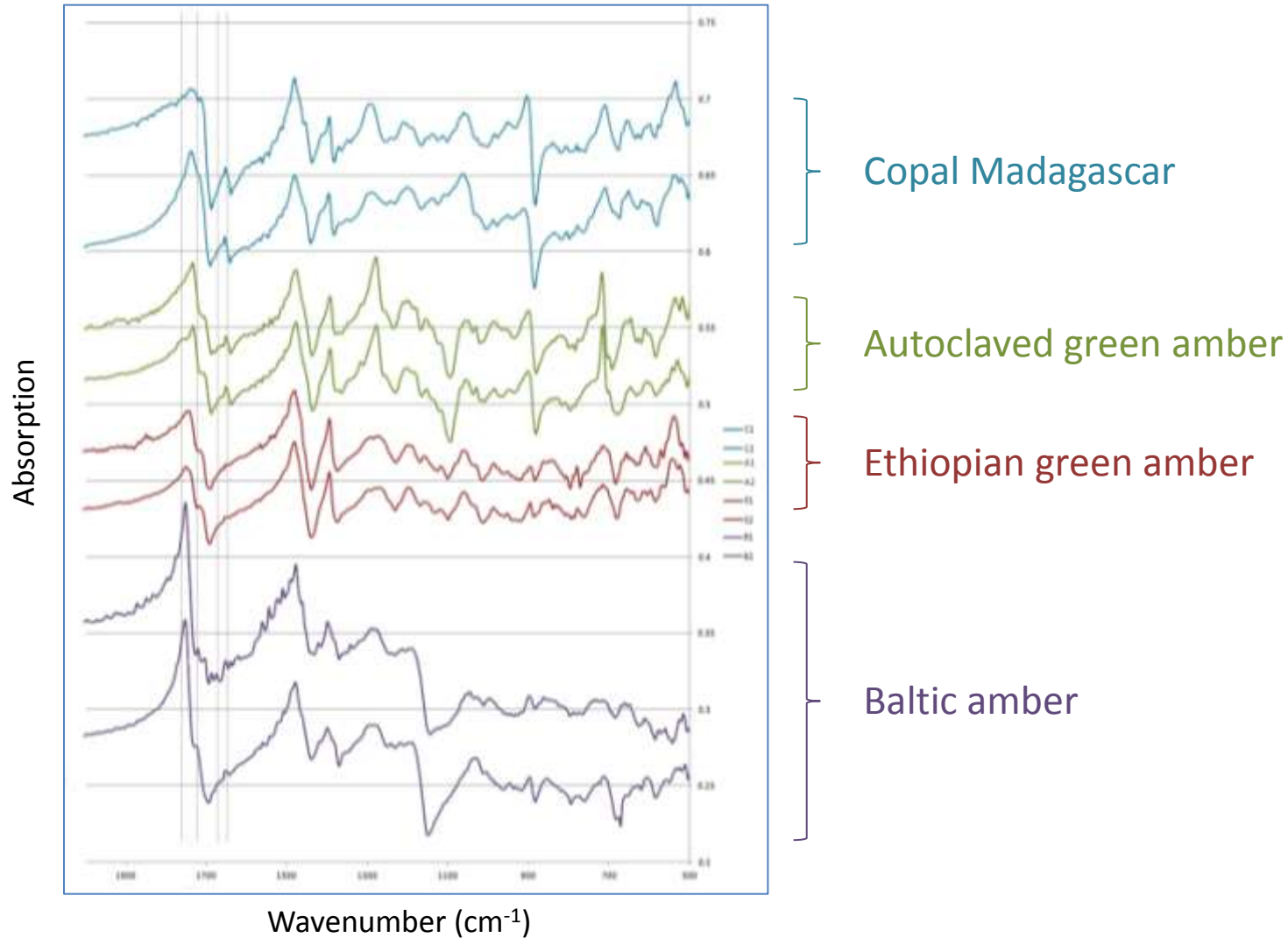


In general, autoclaved amber appears to be less included than the Ethiopian green amber.



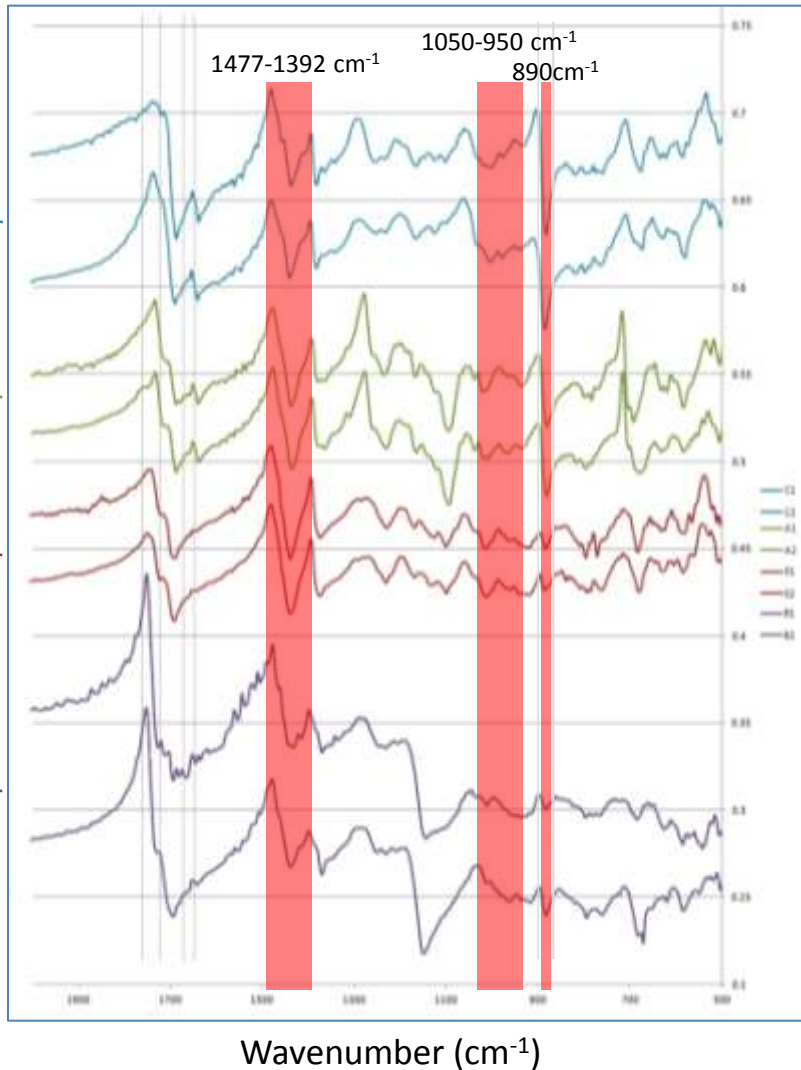
# GREEN AMBER FROM ETHIOPIA

## FTIR SPECTRA - COMPARISON



# GREEN AMBER FROM ETHIOPIA

## FTIR SPECTRA - COMPARISON



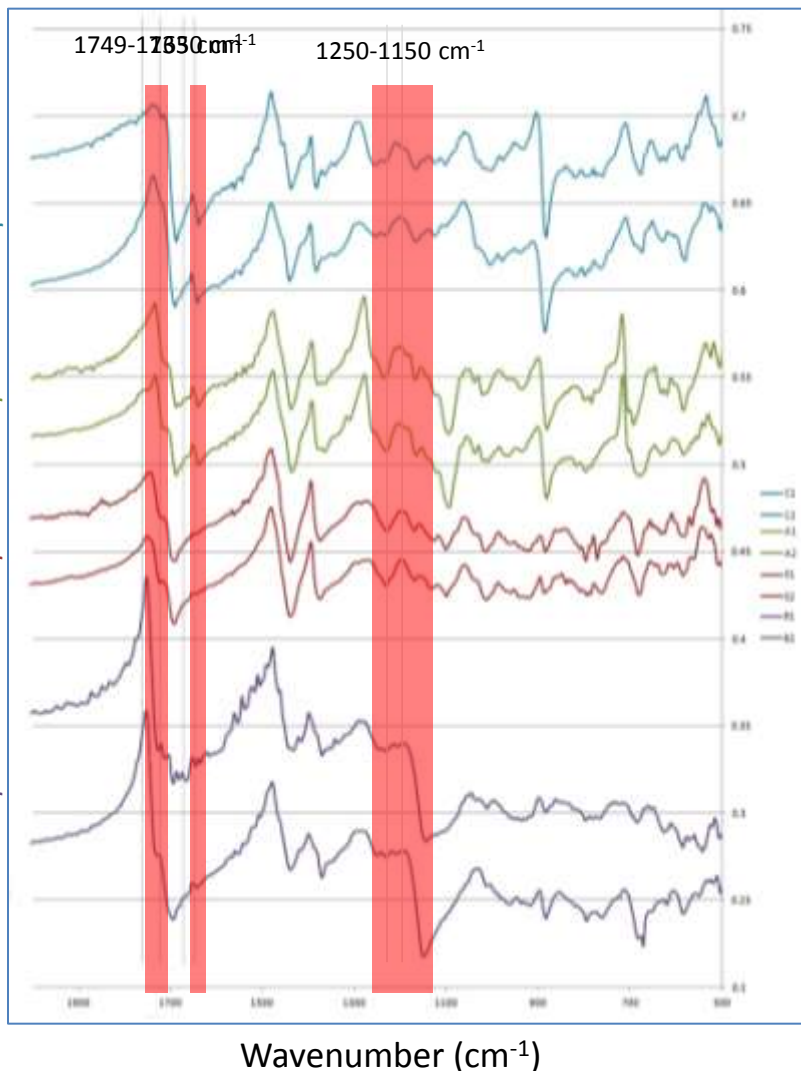
FTIR spectroscopy was carried out with a Varian 640 IR Fourier Transform Spectrometer between 500 and 7000  $\text{cm}^{-1}$ , however, the area of interest is between 1000 and 1800  $\text{cm}^{-1}$ .

Absorptions in the range of 1477 and 1392  $\text{cm}^{-1}$  plus the band from 1050-950  $\text{cm}^{-1}$  were observed in all samples and are correlated to single bonds between carbon and hydrogen in the exocyclic group.

Absorption bands in the range of 890  $\text{cm}^{-1}$ , correlated to C=C double bonding, are strongest in copal, and appear to correlate with the age of the amber. The autoclaved sample shows a band that correlates much more closely to copal than to amber.

# GREEN AMBER FROM ETHIOPIA

## FTIR SPECTRA - COMPARISON



Left absorption bands: Double bonds of carbon C=C-oxygen, which is around 1733-1736 cm<sup>-1</sup> for copal and the autoclaved amber, but between 1745 and 1749 cm<sup>-1</sup> for the Ethiopian and Baltic amber.

Absorption band at 1650 cm<sup>-1</sup> belongs to double bonds between carbons C=C in the exocyclic group. This band was only observed in copal and the autoclaved amber.

The "Baltic Shoulder" between 1250 and 1150 cm<sup>-1</sup>, which correlates to Carbon-oxygen single bonds C-O, is only observed in the Baltic amber sample.  
(See also Schollenbruch, 2012 and Abduriyim et al., 2009).

# CONCLUSIONS

- \* Ethiopian green amber contains a multitude of inclusions: Bubbles in various shape, plant matter, insect parts and well preserved insects.
- \* The green colour resembles the colour of autoclave treated amber, however, it is darker and uneven.
- \* The FTIR spectrum indicates that it is an amber rather than a copal, possibly more aged than the Baltic amber.

Work in progress:

- \* Comparison with more autoclave treated and natural samples from other origins
- \* Age determination?





# THANK YOU!





**QUESTION TIME**

# THE TEAM



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