Digital Worlds Institute

Department of Classics

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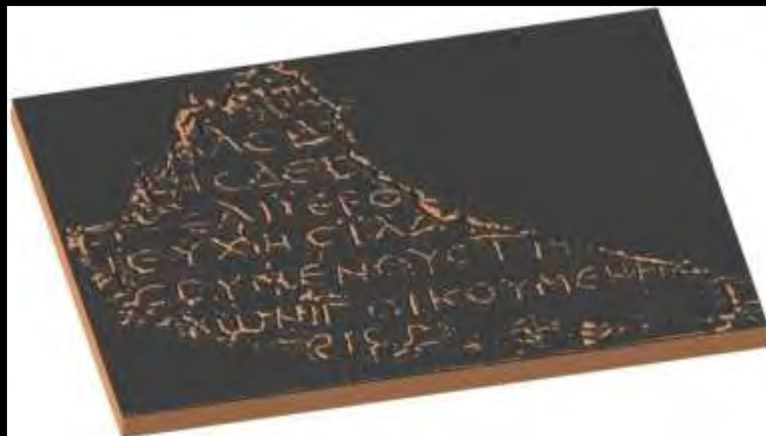
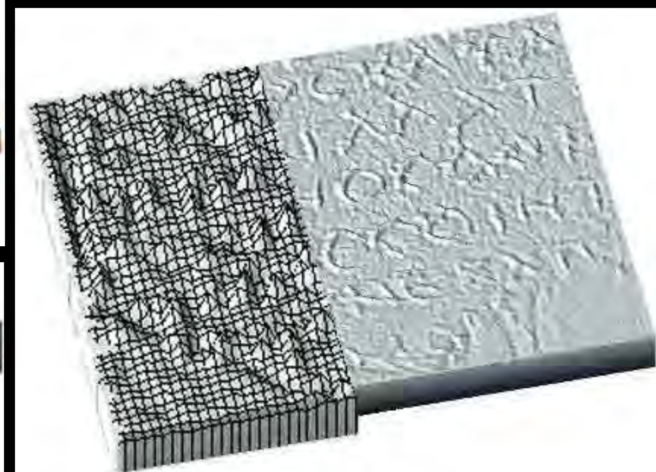




DIGITAL EPIGRAPHY TOOLBOX

A web-based application that facilitates the preservation, study, and dissemination of ancient inscriptions.

Funded by: NEH

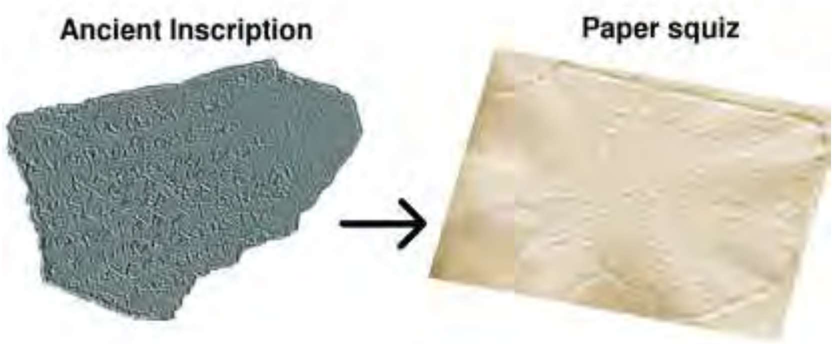
National Endowment for the Humanities

Angelos Barmpoutis, Eleni Bozia, Robert Wagman

Outline

- Motivation
- Computer Methods in Epigraphy
- Digitizing squeezes
- Automated epigraphic analysis
- DEMO – Experimental Results
- Conclusions

Motivation

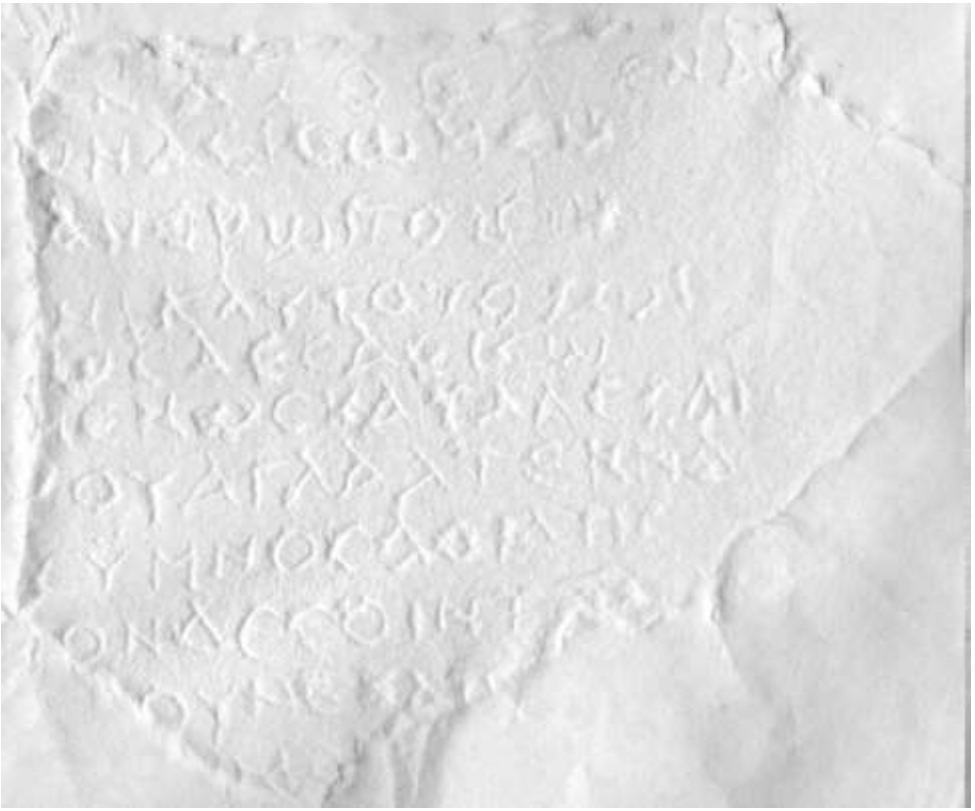


- There are several collections of squeezes in various institutions around the world
- Possible damage of squeezes
- Distribution difficulties
- Difficulties to read with naked eye
- ...

Challenges: How can we efficiently digitize squeezes? Computer assisted study?

Computer Methods

- Take pictures of squeezes.



- Easy and inexpensive
- 3D information is not depicted
- Problems

Computer Methods

- Take several pictures of an inscription using a device with different light sources.

- HP labs, Tom Malzbender, 2001
- Good relighting results.

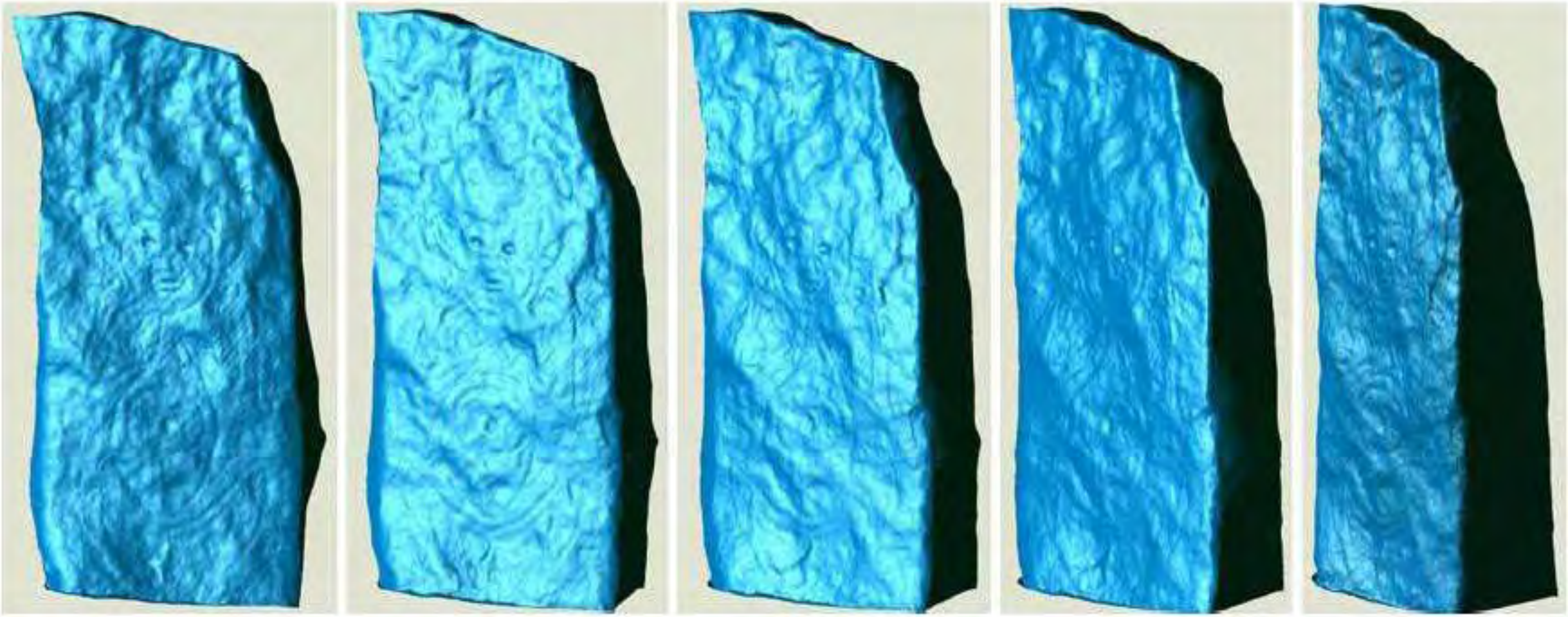
Computer Methods

- Take several pictures of an inscription using different light sources.

- An expensive device is needed.
- Must be carried to the site.

Computer Methods

- Petroglyph digitization using laser scanners
- George Landon et al., Machine Vision and Applications 2006



Computer Methods

- Petroglyph digitization using laser scanners
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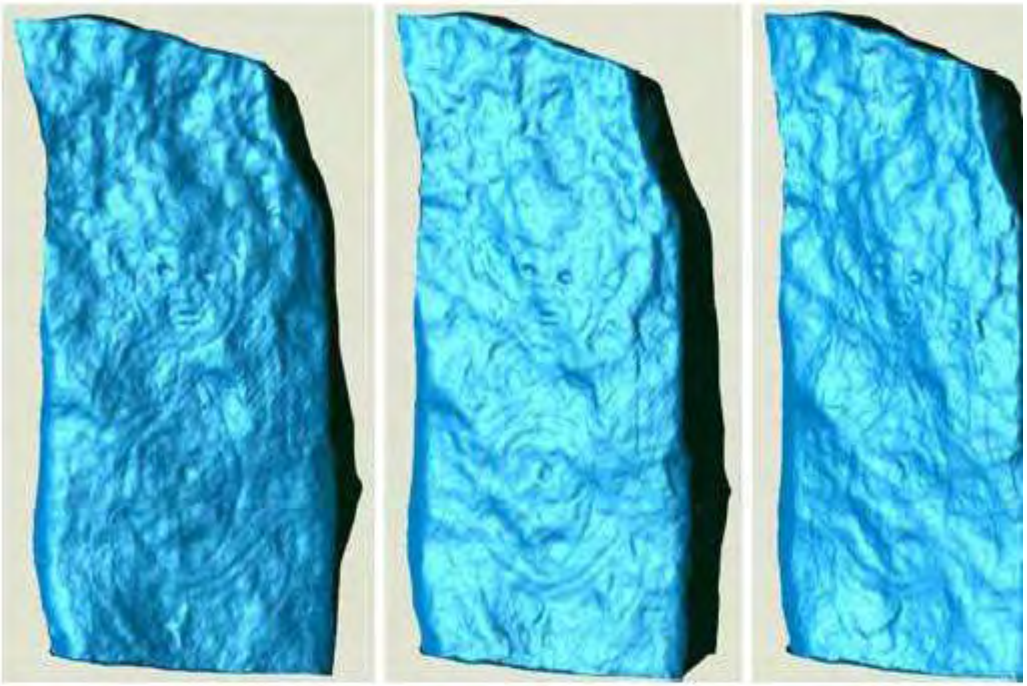
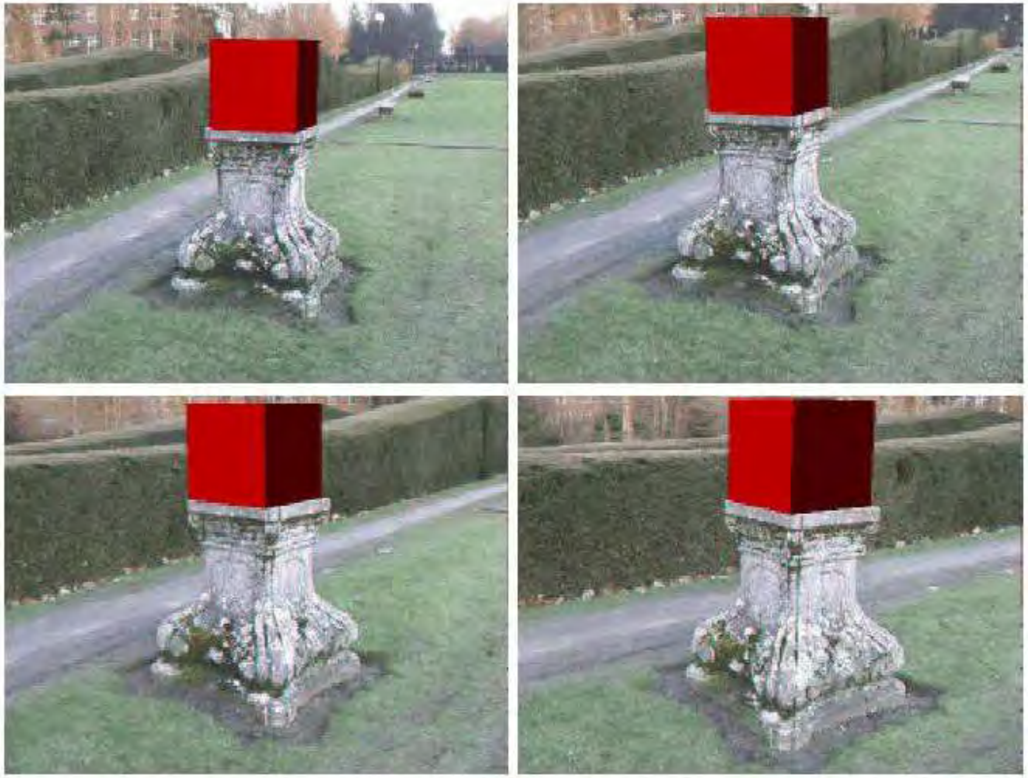


- Accurate results
- Very expensive.
- Must be carried to the site.

Computer Methods

- Reconstruct 3D scene from video.
- Kurt Cornelis et al. 2000

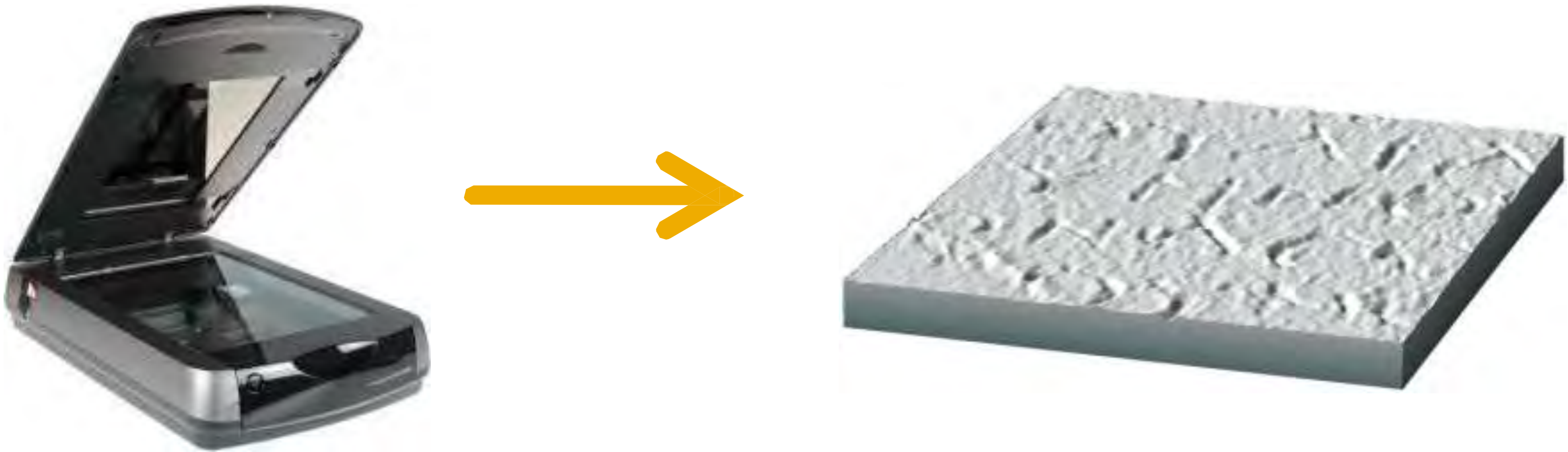


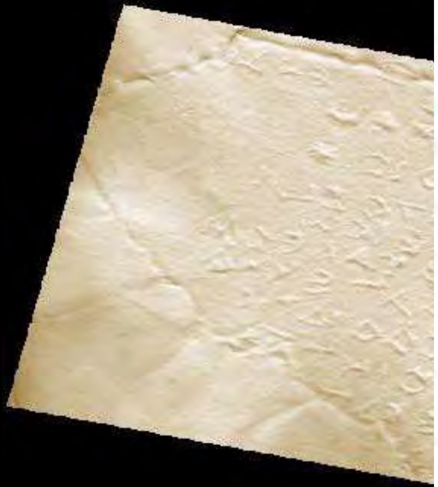
- Needs only a camera!
- Good for large objects
- Inaccurate for details
- Cannot recover inscribed details

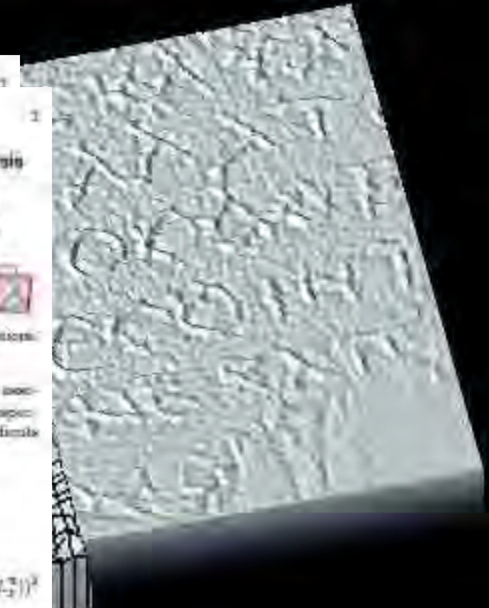
Computer Methods

Our proposed method:

- Makes use of squeezes
- Needs only a conventional scanner
- Inexpensive
- No need to transfer equipment in site.







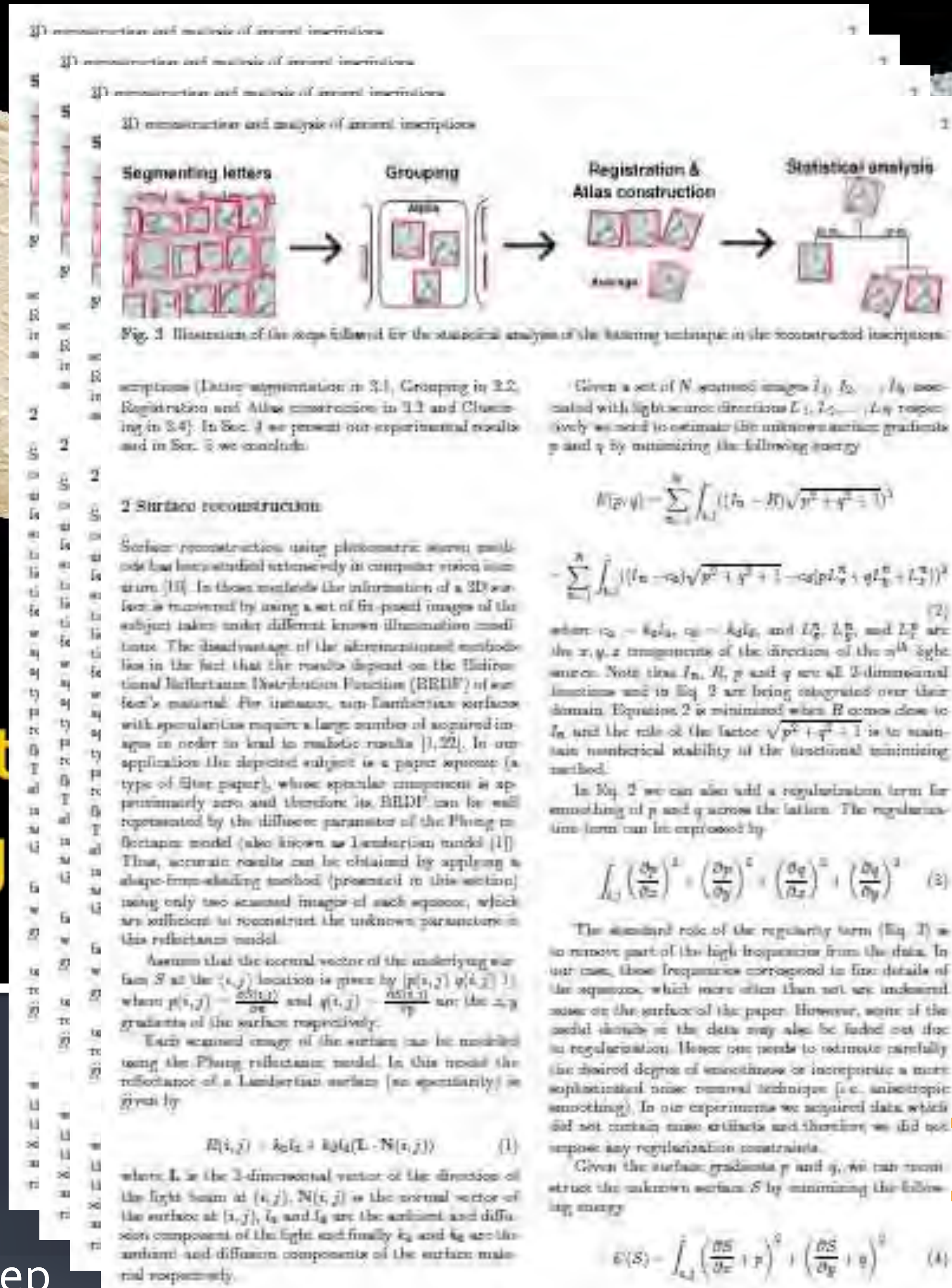

3D reconstruction and analysis of ancient inscriptions

Fig. 3 Illustration of the steps followed for the statistical analysis of the lettering technique in the reconstructed inscriptions

2 Surface reconstruction

An efficient … eezes and performing … lysis

), 2010, pp. 989-998

Eleni Bozia, Ang…

D…

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- Use a regular scanner
- Grayscale option
- Scan squeezes twice

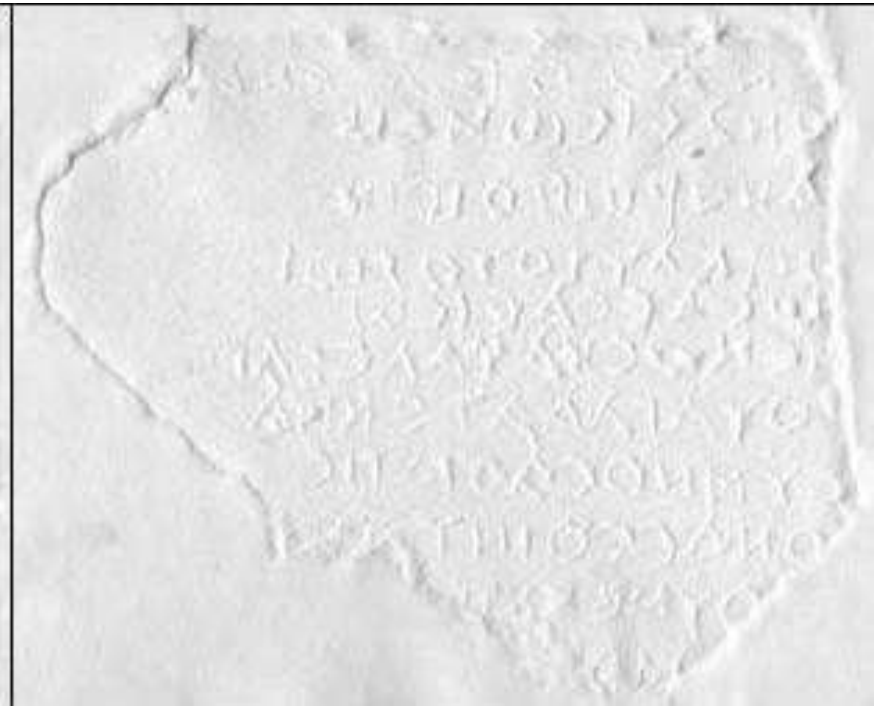
1.

2.

- This will produce a set of images like that:

Light from the top

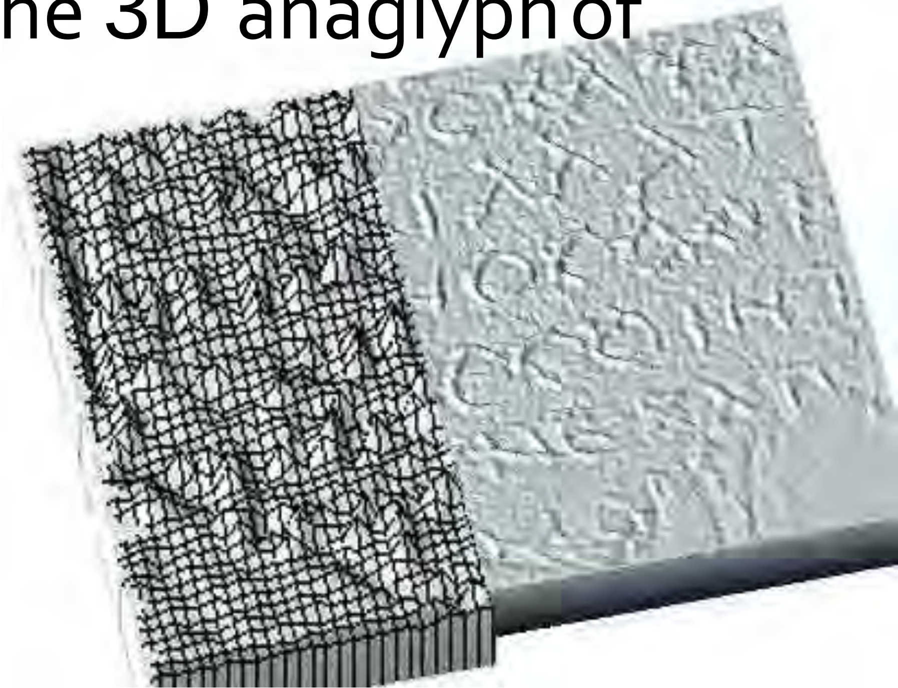
Light from the left



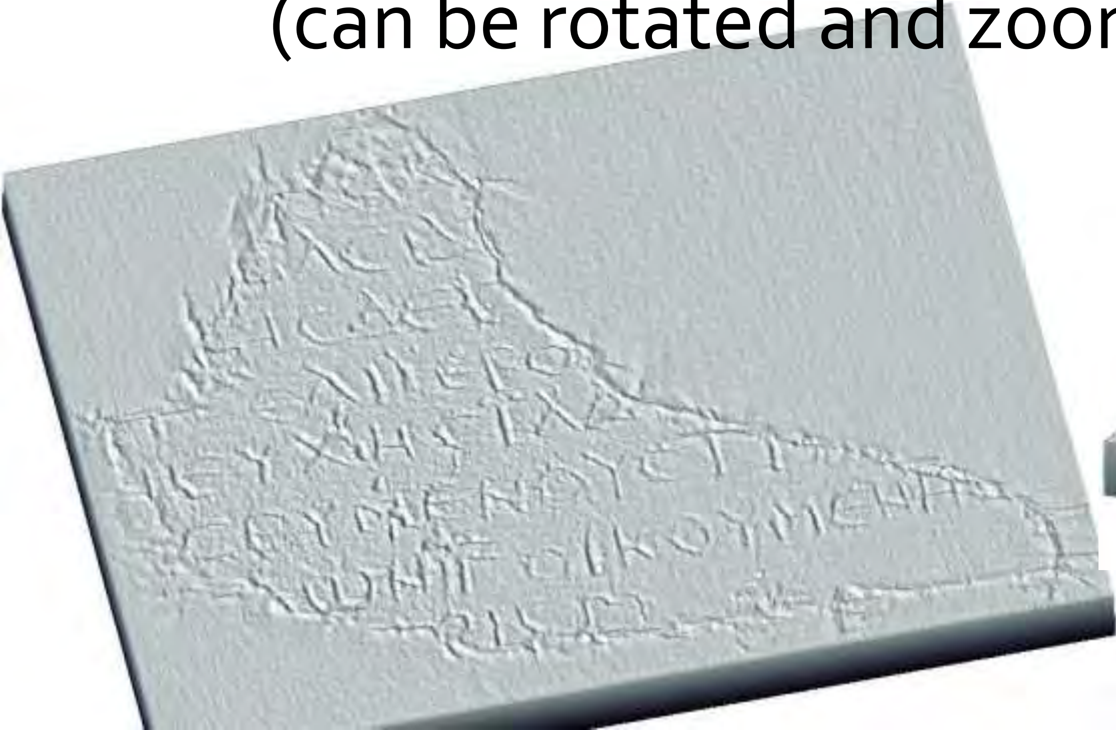
- These images contain all the shading information needed to understand the local curvature of the paper.

- By combining:
  - Knowledge about the reflectance model of a paper
  - The shading provided from the two scans
- A computer can recover the 3D anaglyph of the squeeze
  - This is known as

"shape from shading"

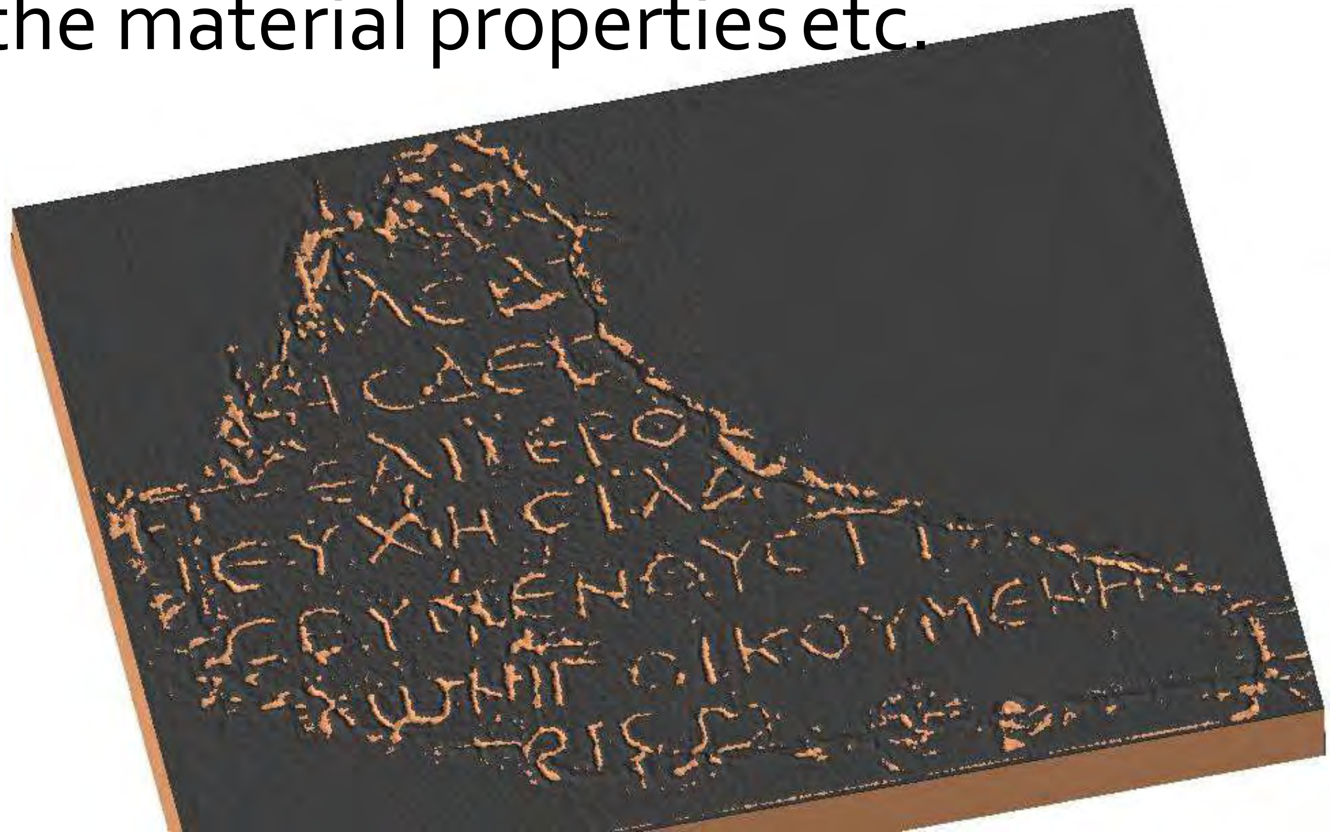


- There are several ways to visualize the reconstructed 3D surfaces
- 1) Plot the 3D surface
  (can be rotated and zoomed by the user)

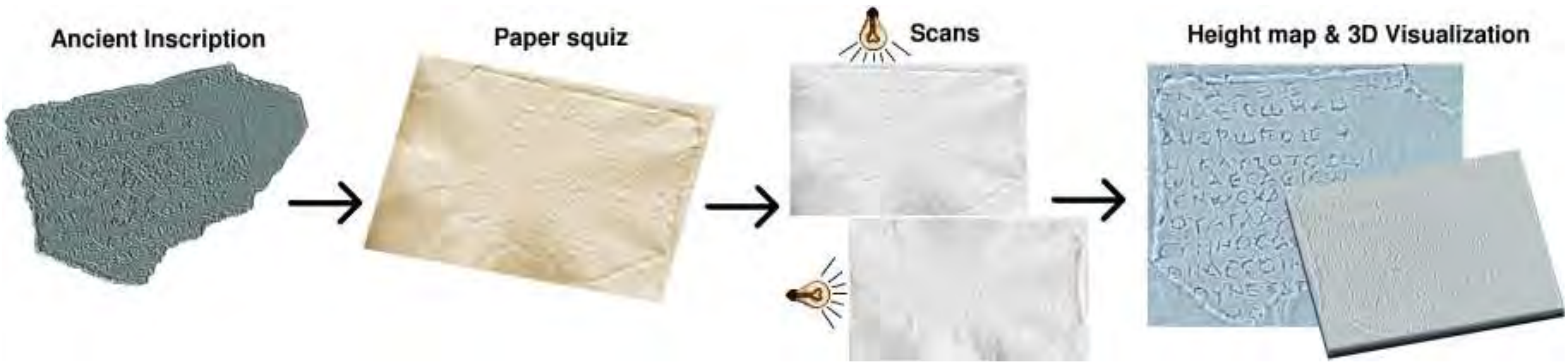


- There are several ways to visualize the reconstructed 3D surfaces
- 2) Plot the height-map
  (dark intensities=deeper locations)

- There are several ways to visualize the reconstructed 3D surfaces
- 3) Change the material properties etc.



- So far, the steps of our method:



- Then we can perform post-processing steps for automated analysis

- For each reconstructed inscription, we can automatically segment each letter or symbol

The process is fully automated.

A box is placed around each symbol.

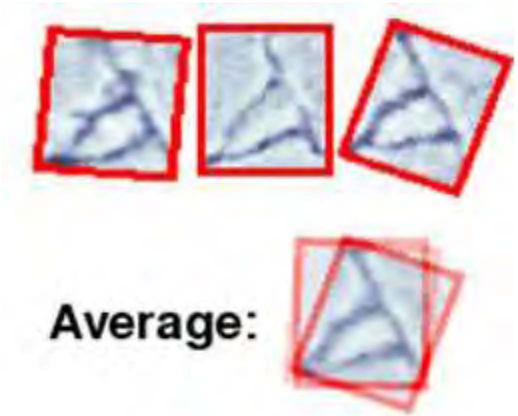
There may be few errors which can be discarded by the user.

- The segmented symbols can be automatically clustered into groups.
- Example:
all 'alpha' characters are grouped together

This process can be first done partly by the user.

Then the computer can continue automatically by finding letters similar to those chosen by the user.

- The symbols from each group are rotated and scaled automatically in order to overlap each other as much as possible.

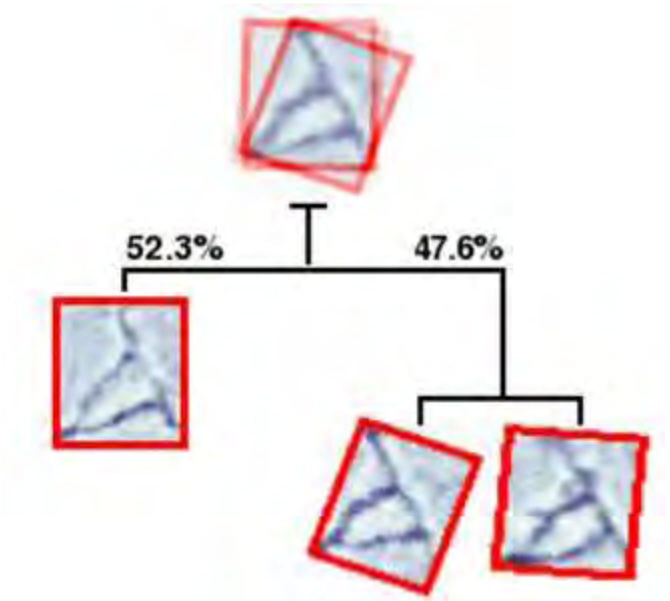


This process is fully automated and it is known as 'group-wise registration'.

The average character is also computed during this process.

The average depicts useful information about the letterforms.

- Finally, the registered characters can be compared to each other by measuring the affinity between them.



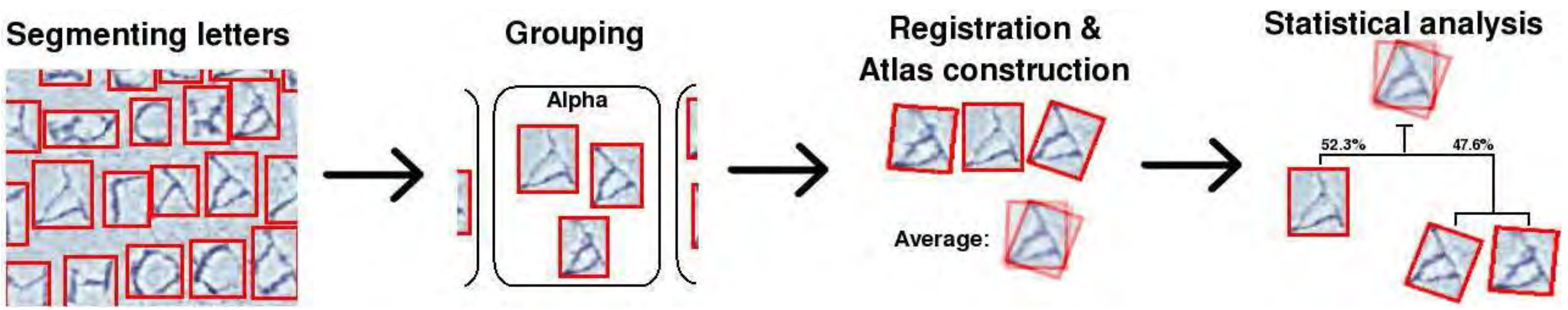
The computed affinities can be further used to construct a dendrogram.

The method is known as:
Agglomerative hierarchical clustering

The computed dendrogram shows groups of letters with similar characteristics.

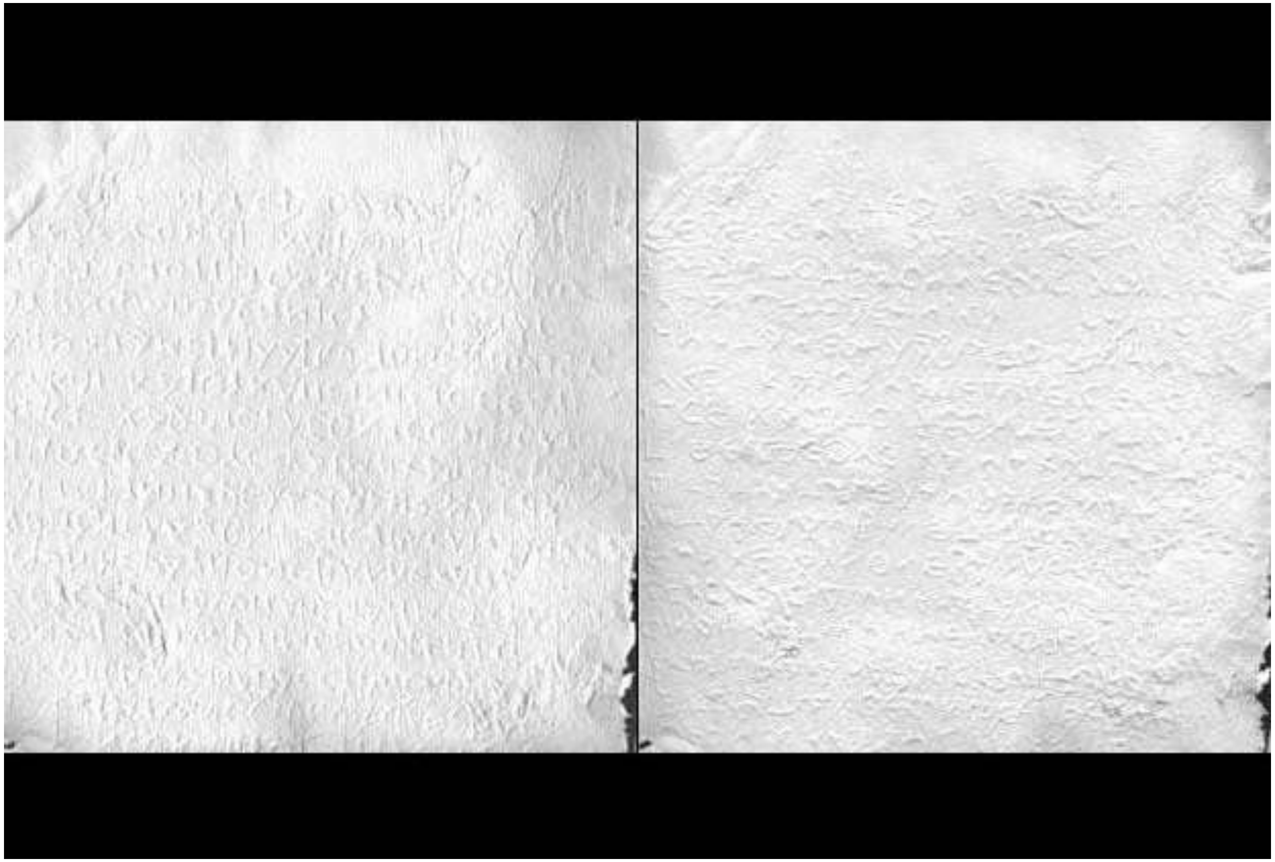
Useful for automated analysis.

- The post-processing steps of our method:



- We applied the proposed framework to:
- 5 squeezes from five inscribed fragments (archaeological site of Epidauros)
- contain religious hymns for Asclepius and other deities
- IG IV I 2, 129-135; SEG 30, 390 in R. S.Wagman. *Inni di Epidauro. Biblioteca di Studi Antichi,* Pisa, 1995

- Example of the two scanned images:



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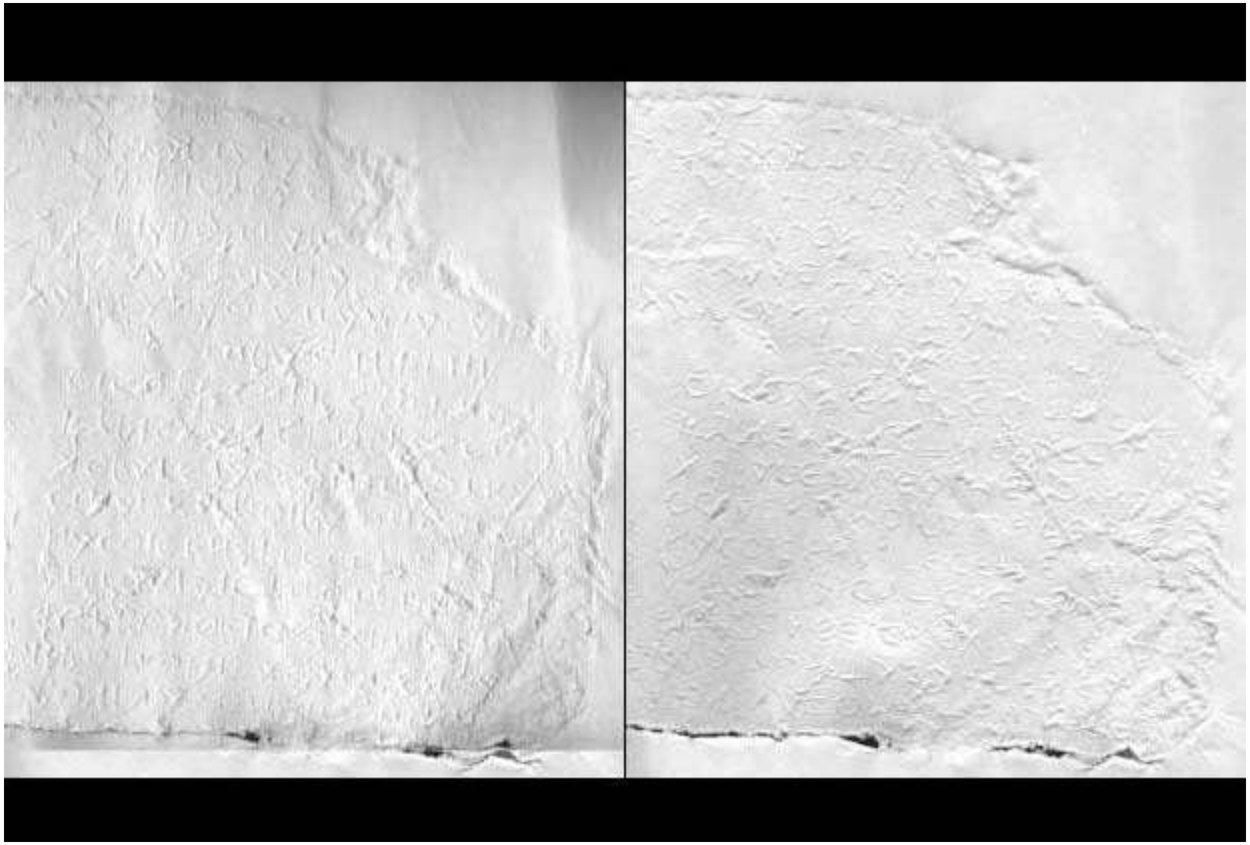

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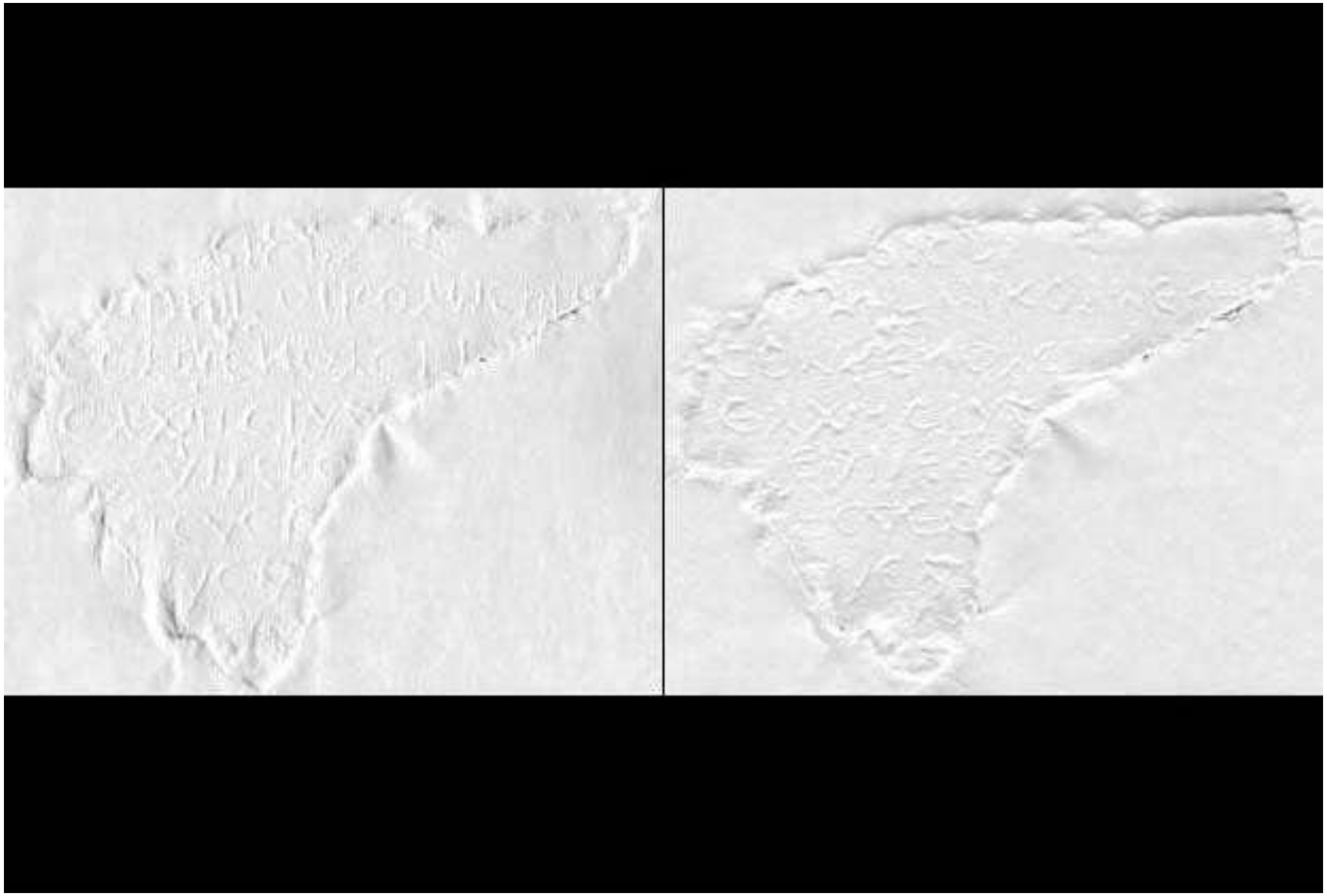

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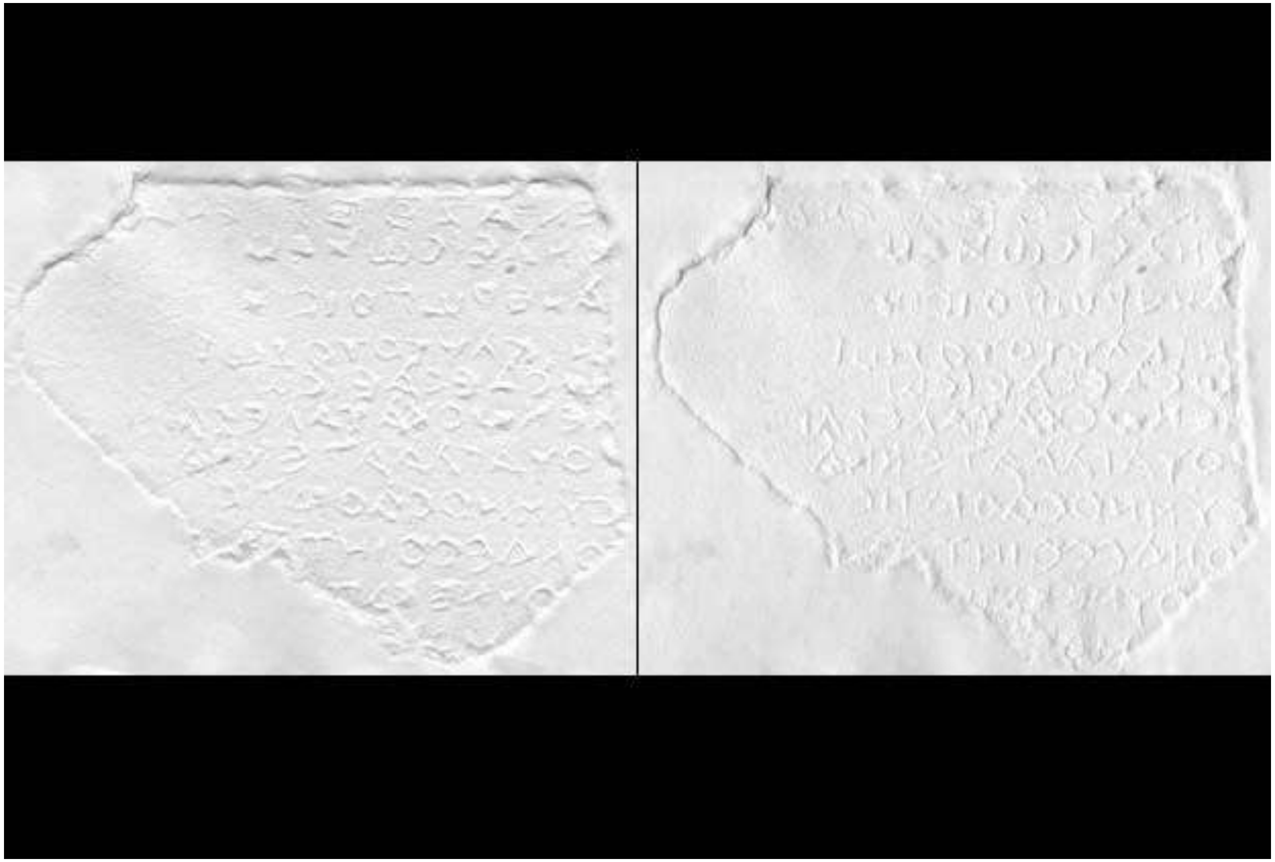
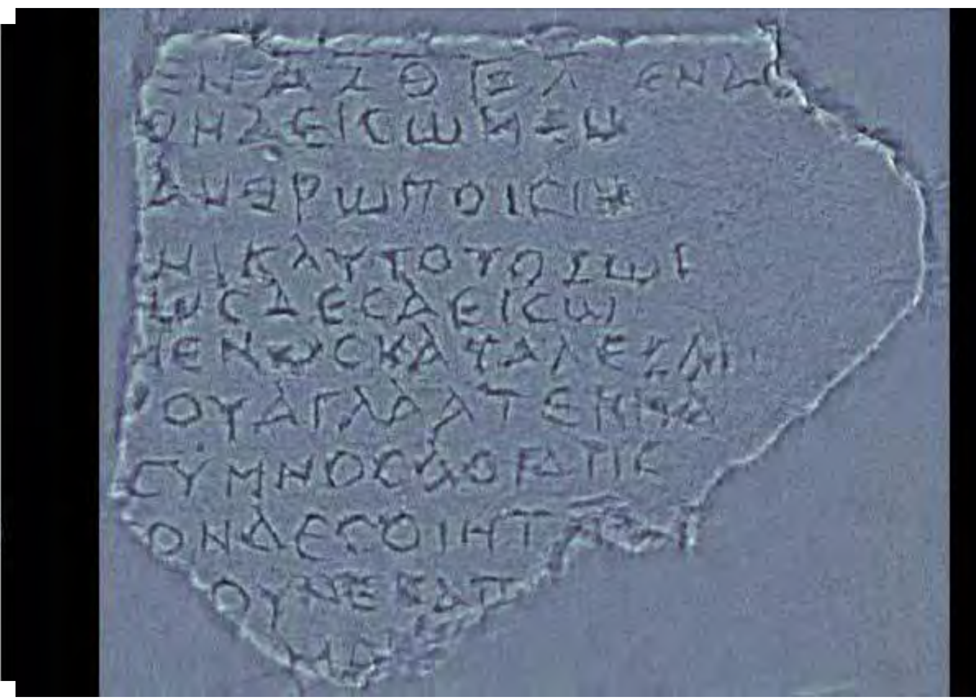


- Example of the 3D reconstruction

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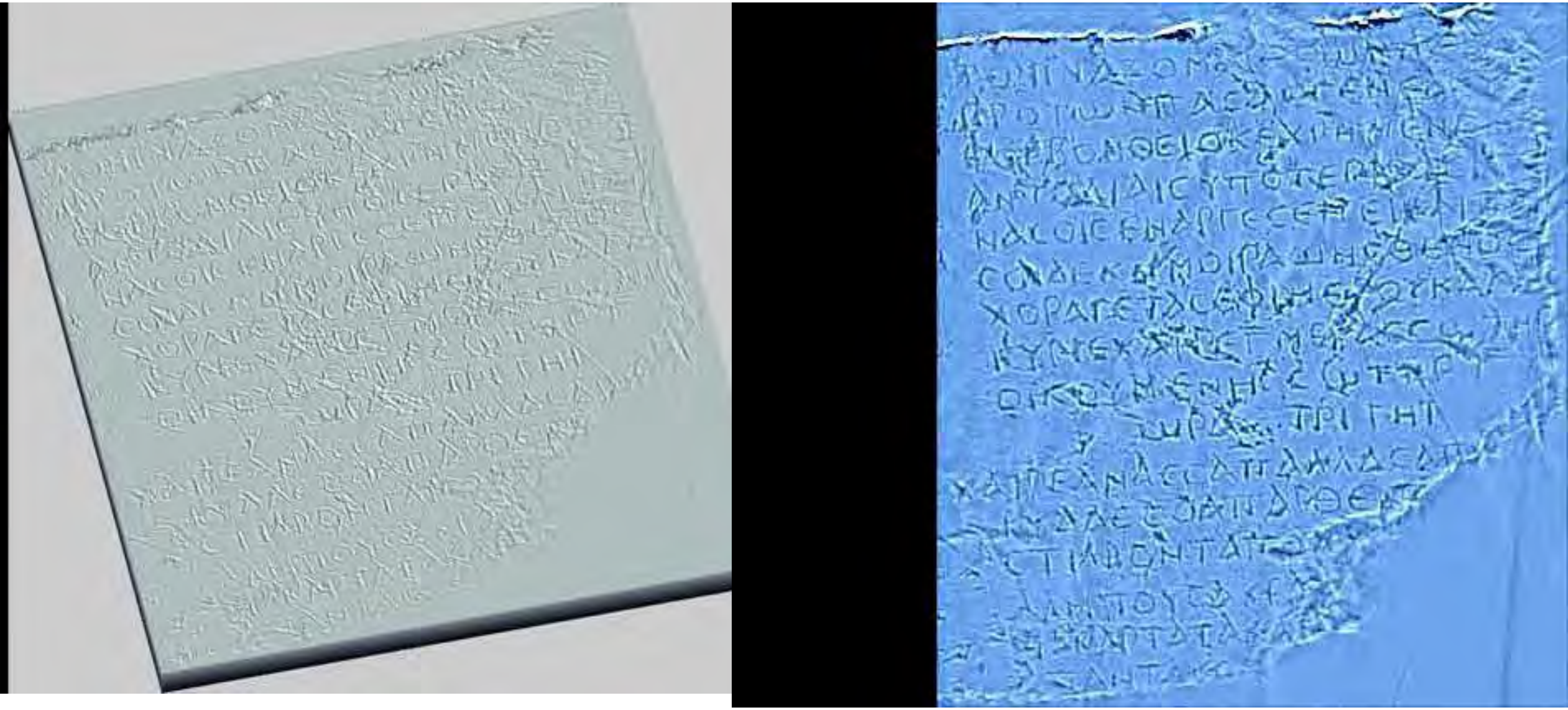

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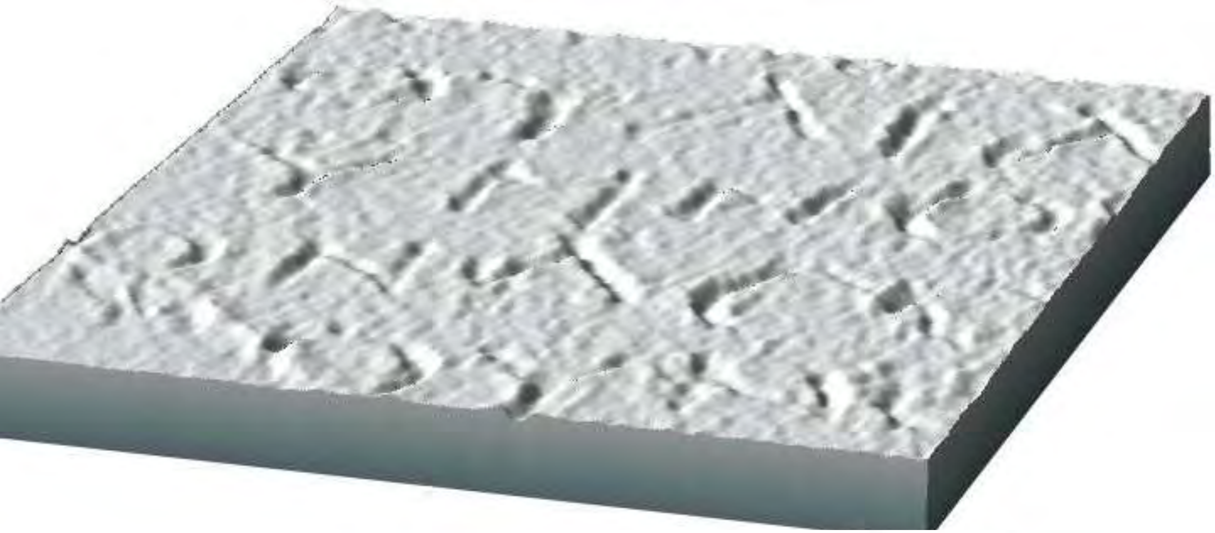
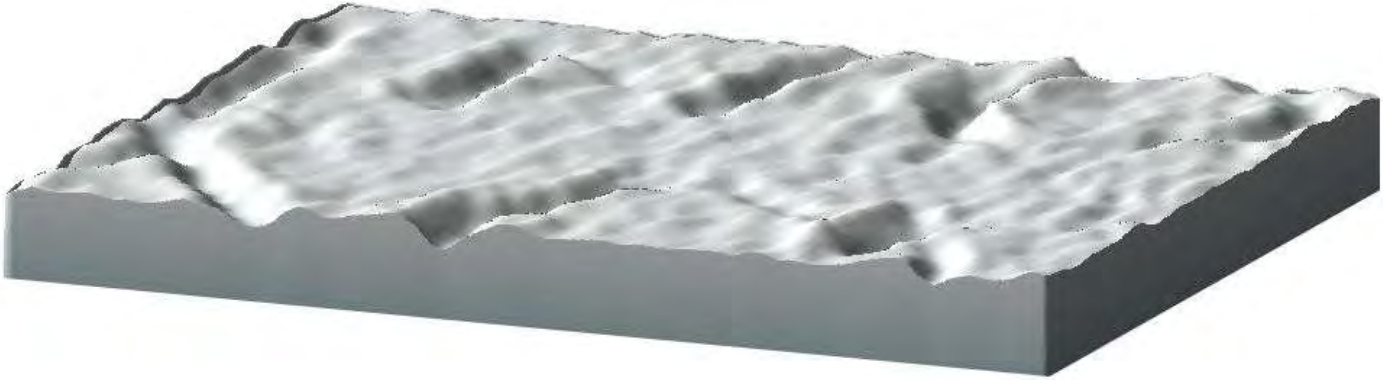
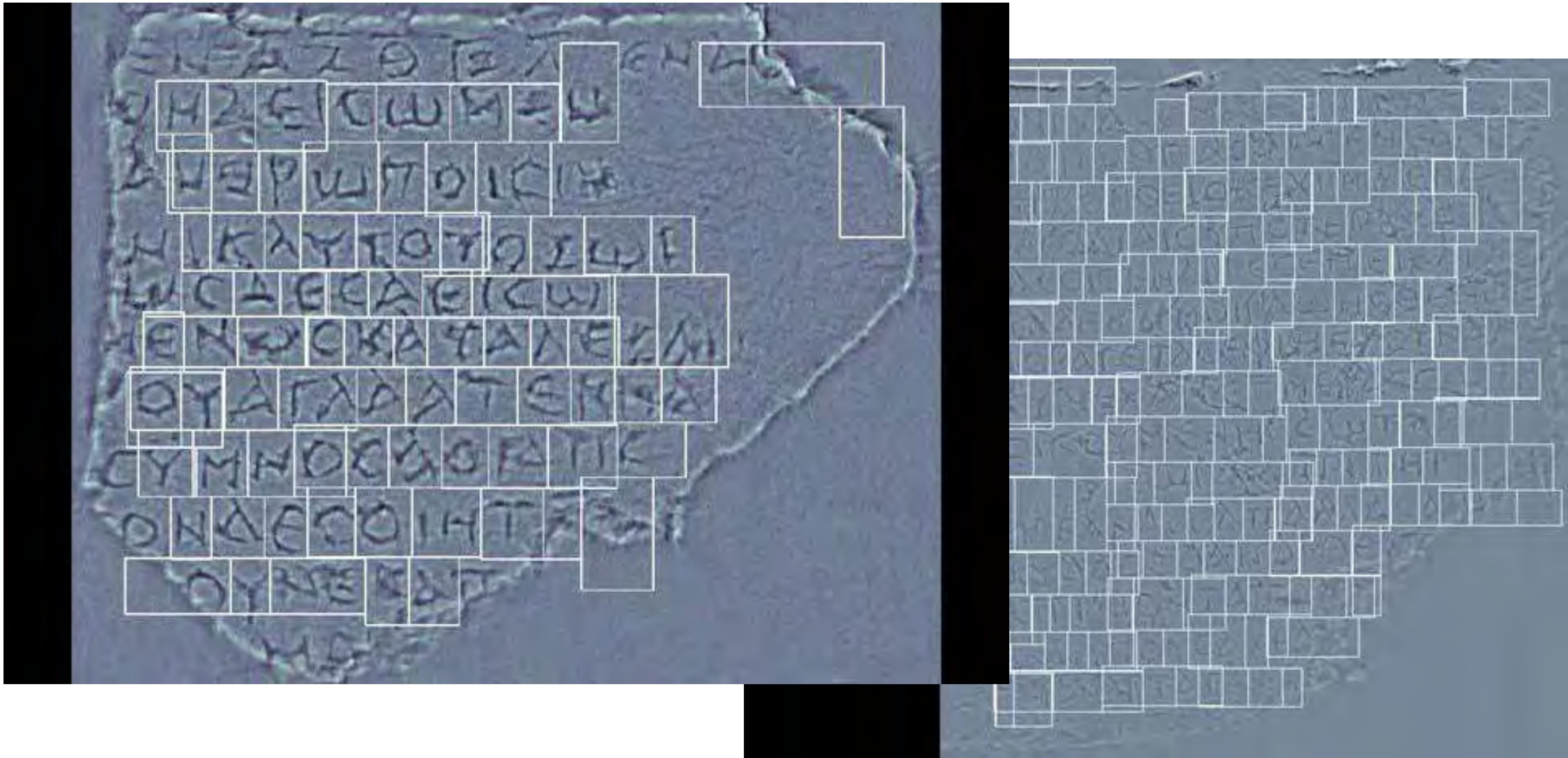


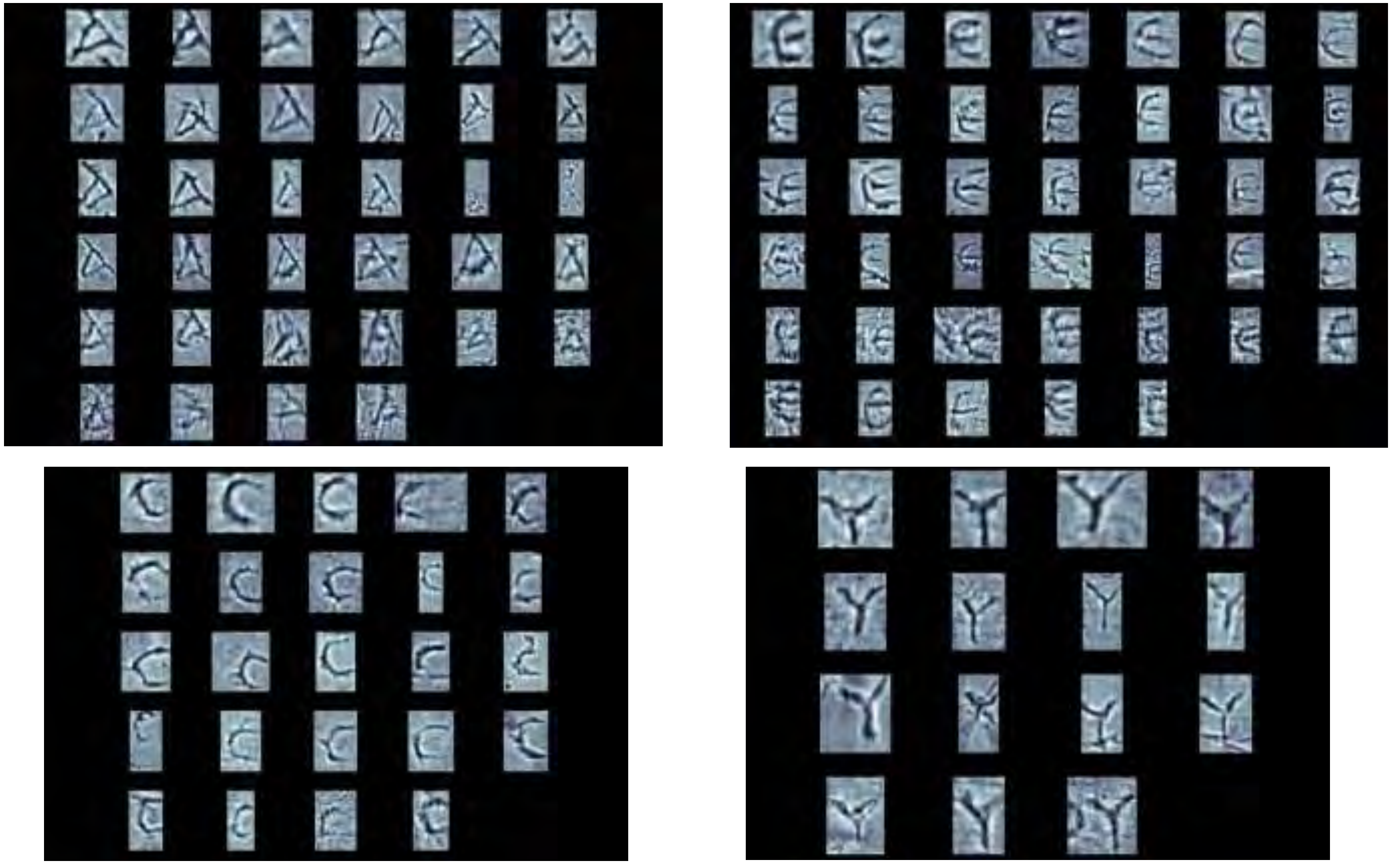
Details from the reconstructed surfaces



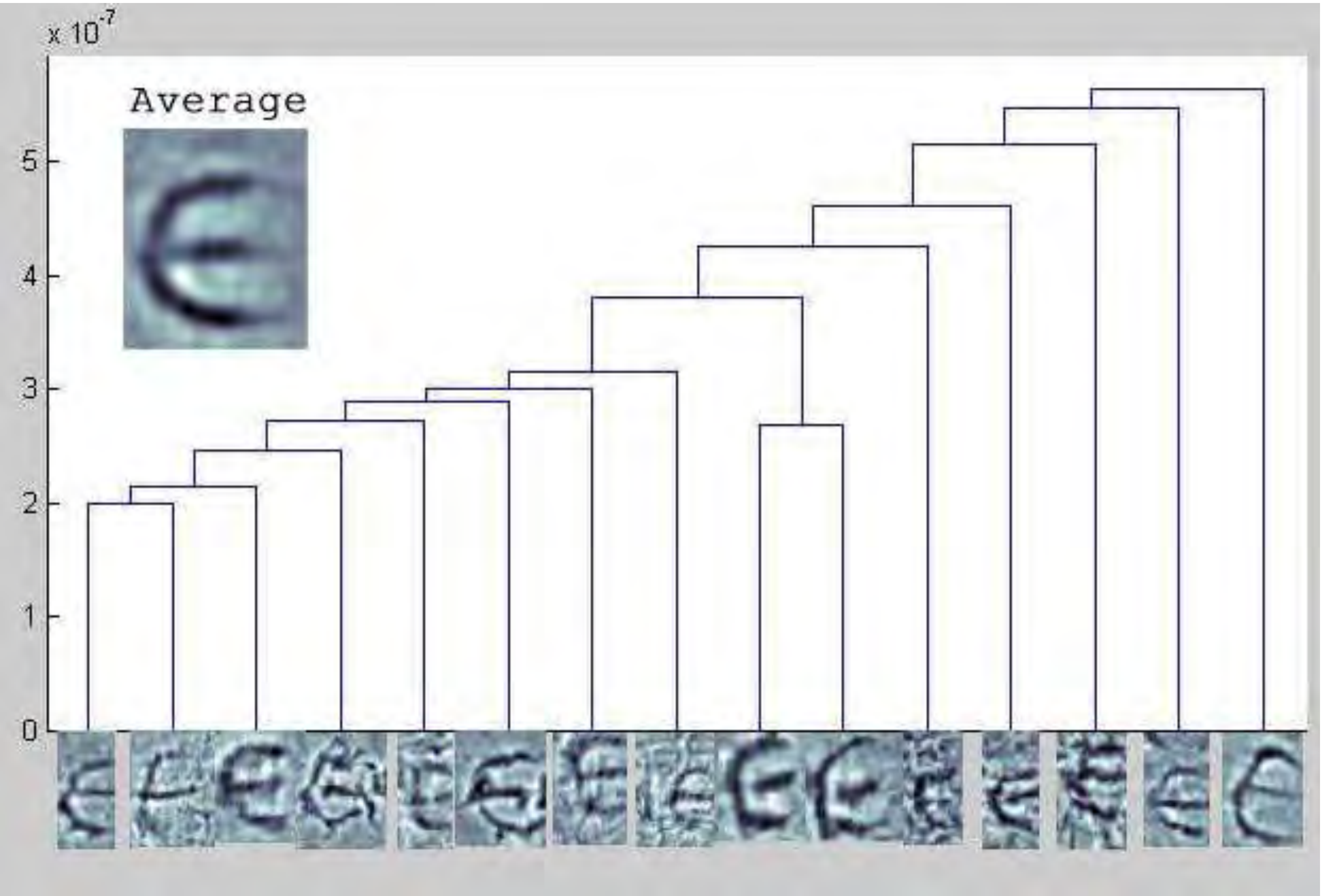
- Examples of letter segmentation



- Examples of letter grouping



- Dendrogram of ‘epsilon’

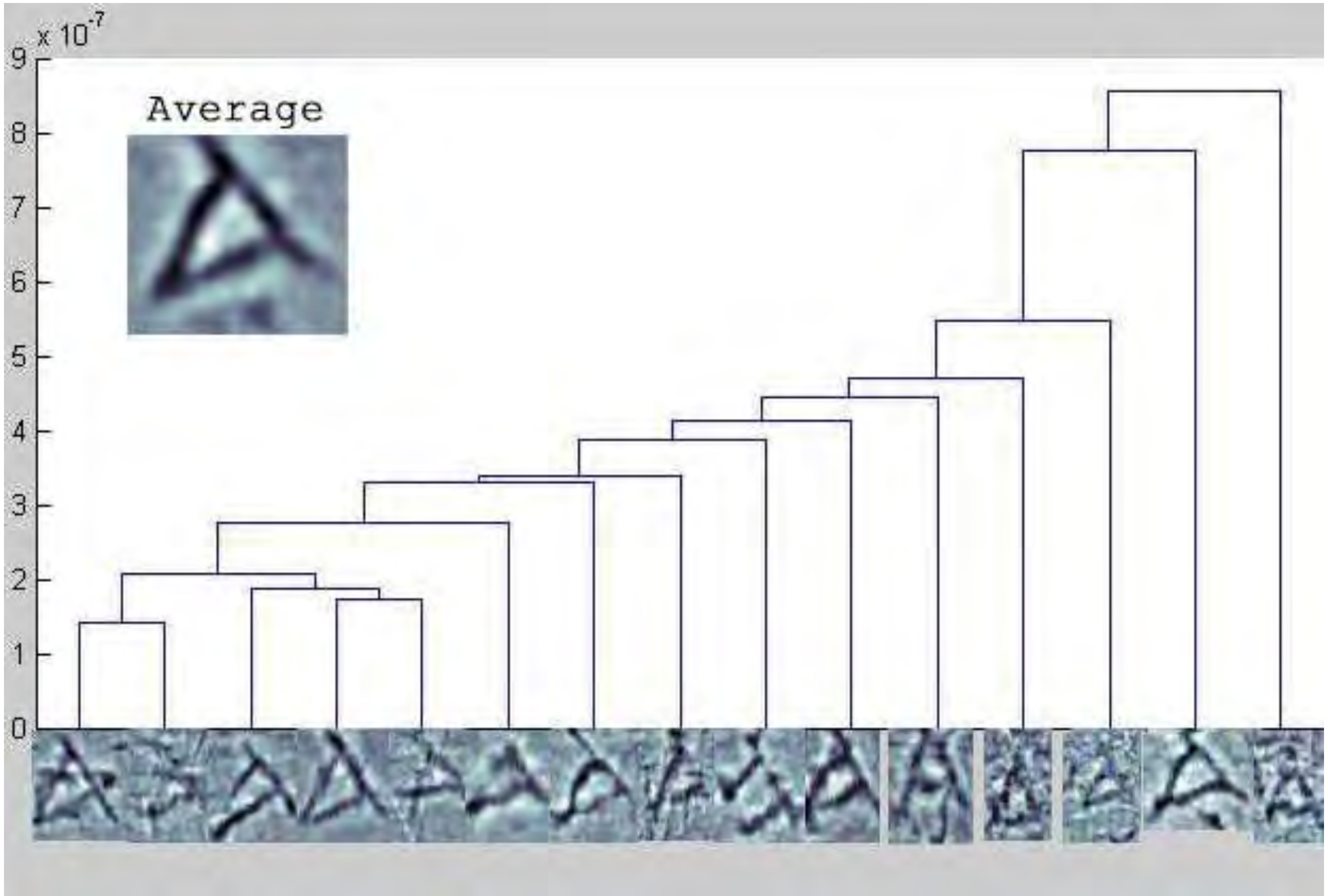


Notice line extensions in the average image.

Notice a small group in the dendrogram with two ‘epsilons’ whose middle line is not touching the vertical one.

No other significant sub-groups were formed.

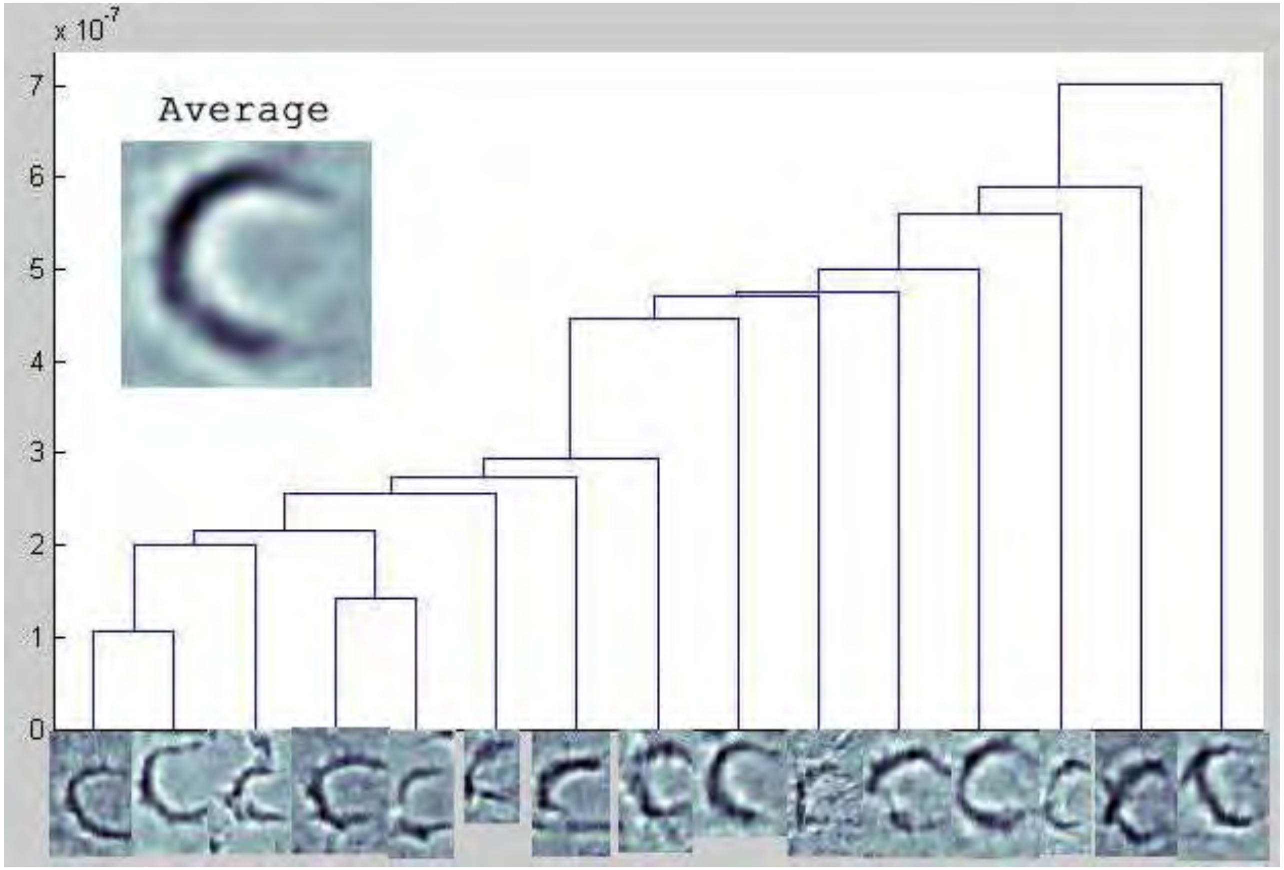
- Dendrogram of ‘alpha’



Look at the shape of the computed average.

No significant sub-groups were formed.

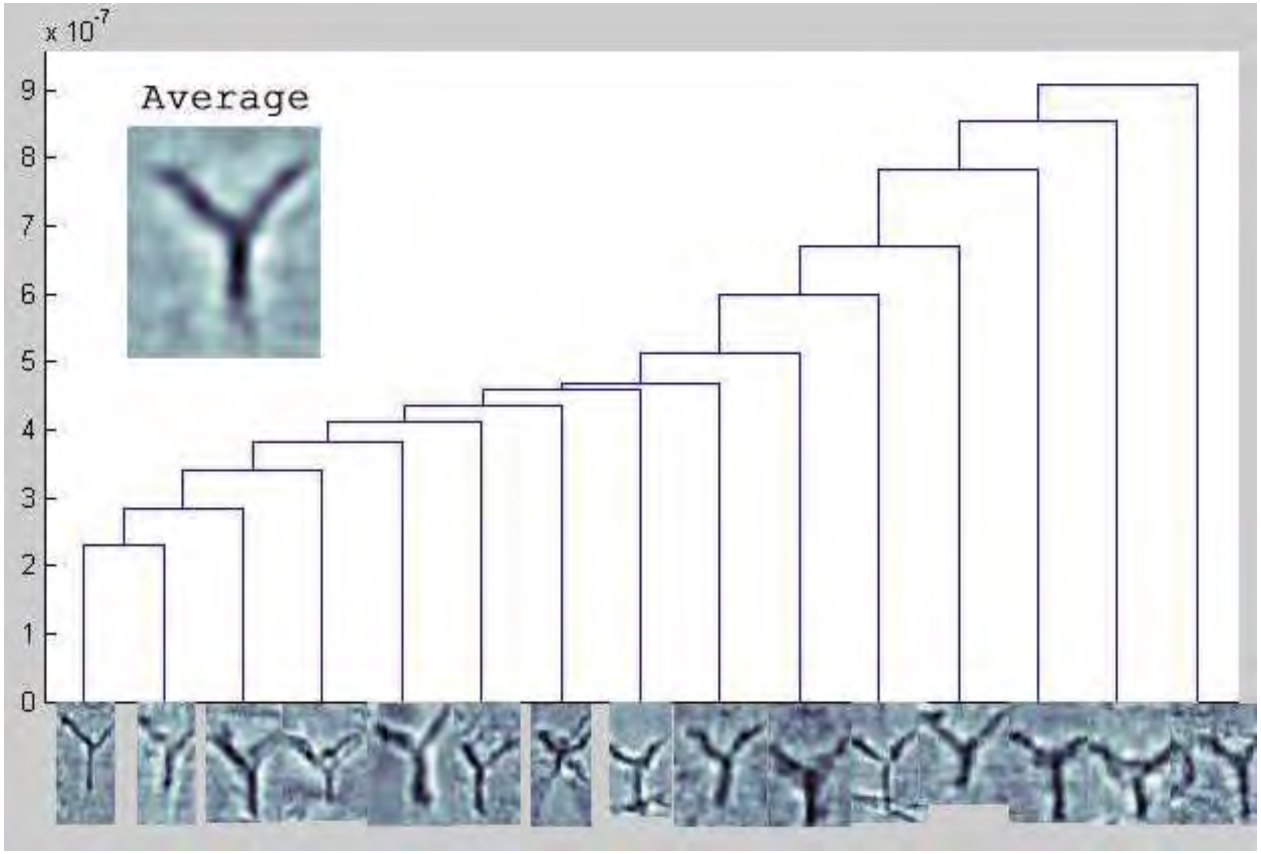
- Dendrogram of ‘sigma’



Look at the shape of the computed average.

No significant sub-groups were formed.

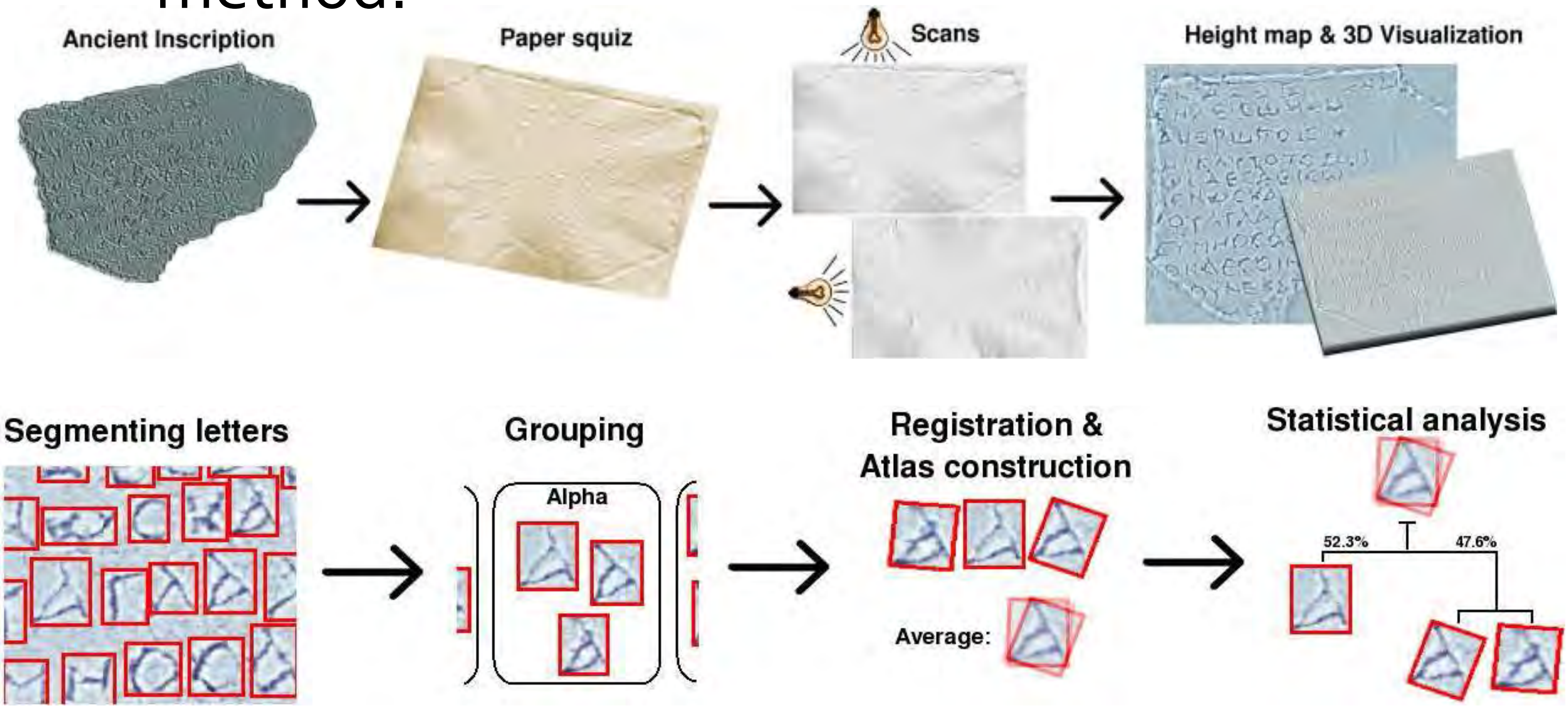
- Dendrogram of 'ypsilon'



Look at the shape of the computed average.

No significant sub-groups were formed.

- To conclude, here is a diagram of our method.



Advantages:

- Convert paper squeezes into a digital format
- Easy copy and distribution of the squeezes
- Create libraries of 3D squeezes
- Use different viewing angles and shadings
- Compare letters and compute statistics

Drawbacks:

- Some details of the inscriptions are not captured by the squeezes, such as depth.
- Very large squeezes are hard to be scanned.

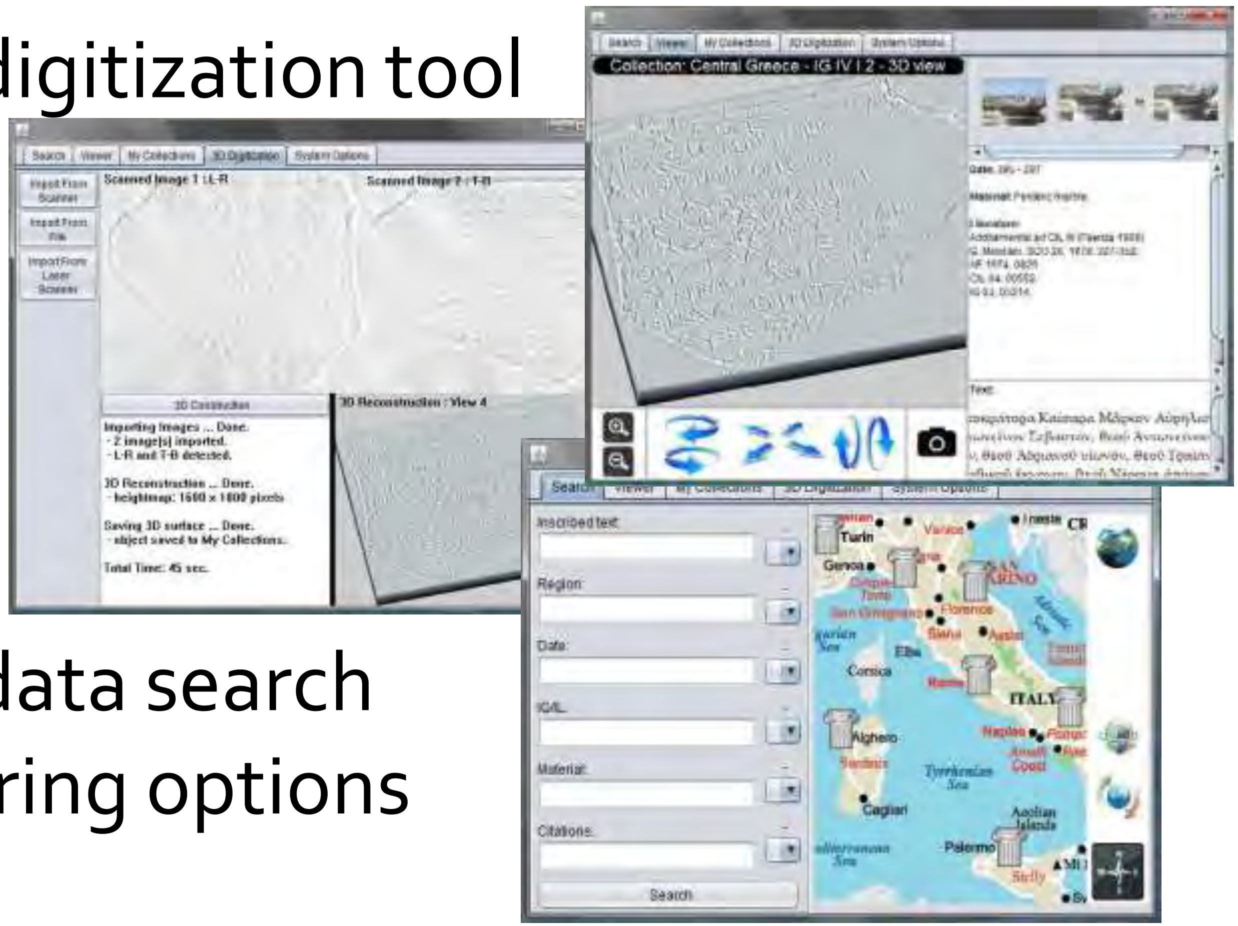
Future uses:

- Build an on-line library of 3D squeezes
- Other uses e.g. Create fonts from inscriptions

Other challenges:

- Automated dating
- Automated classification of inscriptions made from the same workshop

- 3D digitization tool



- 3D data search
- Sharing options

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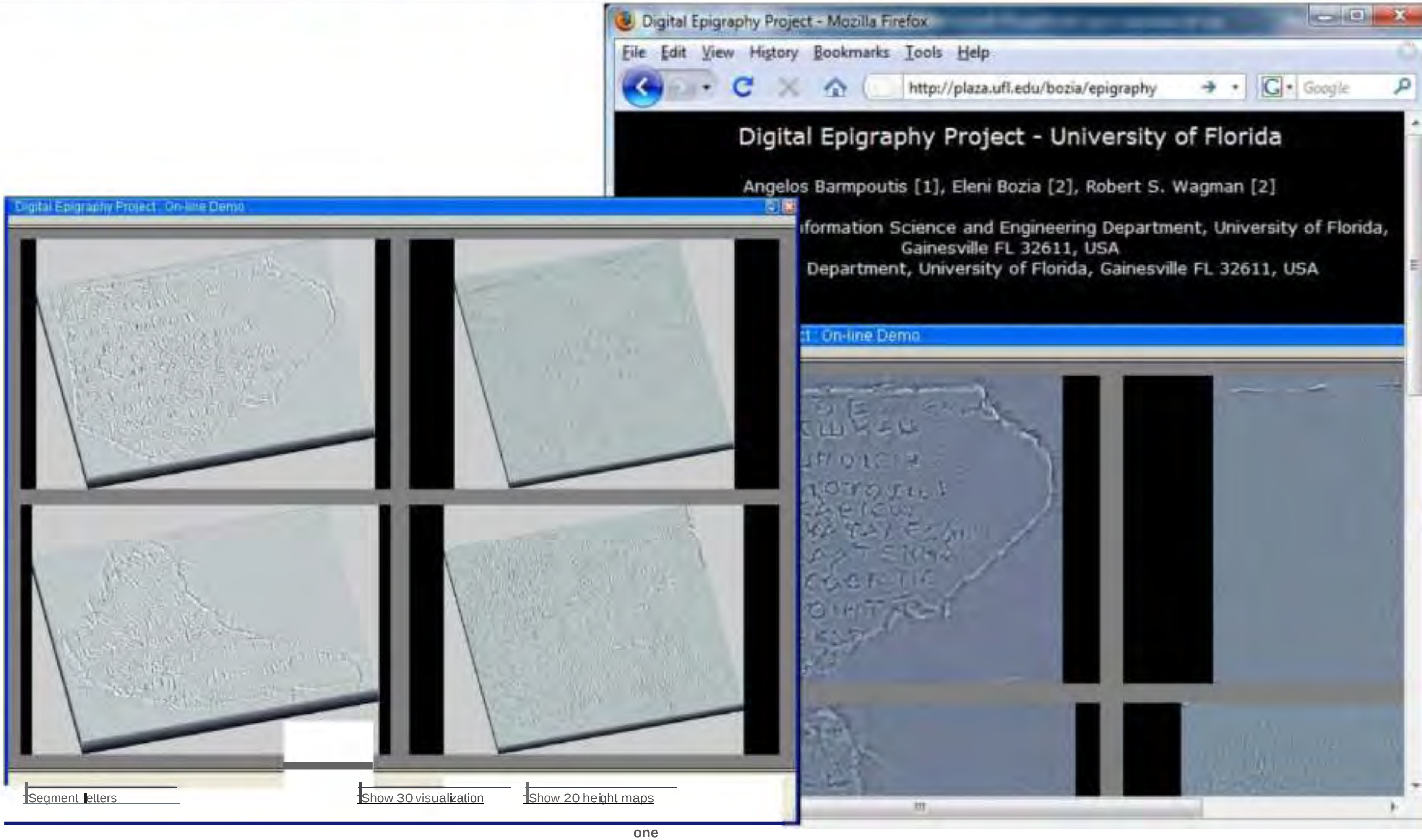
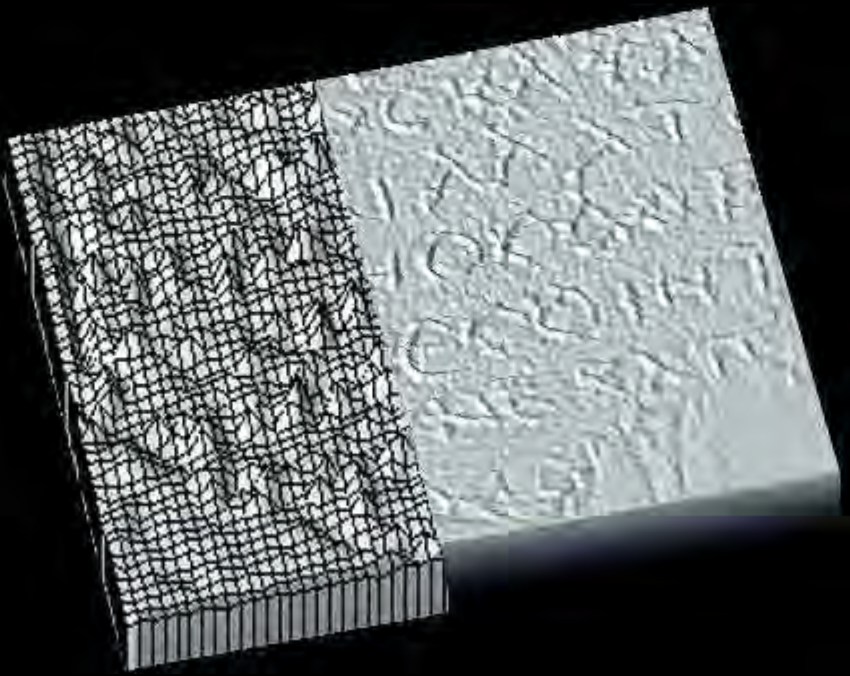
On-line Demo http://plaza.ufl.edu/bozia/epigraphy





Thank you