Application of 3D Technologies for the Analysis of Ancient Inscriptions

Angelos Barmpoutis, Eleni Bozia, Robert S. Wagman
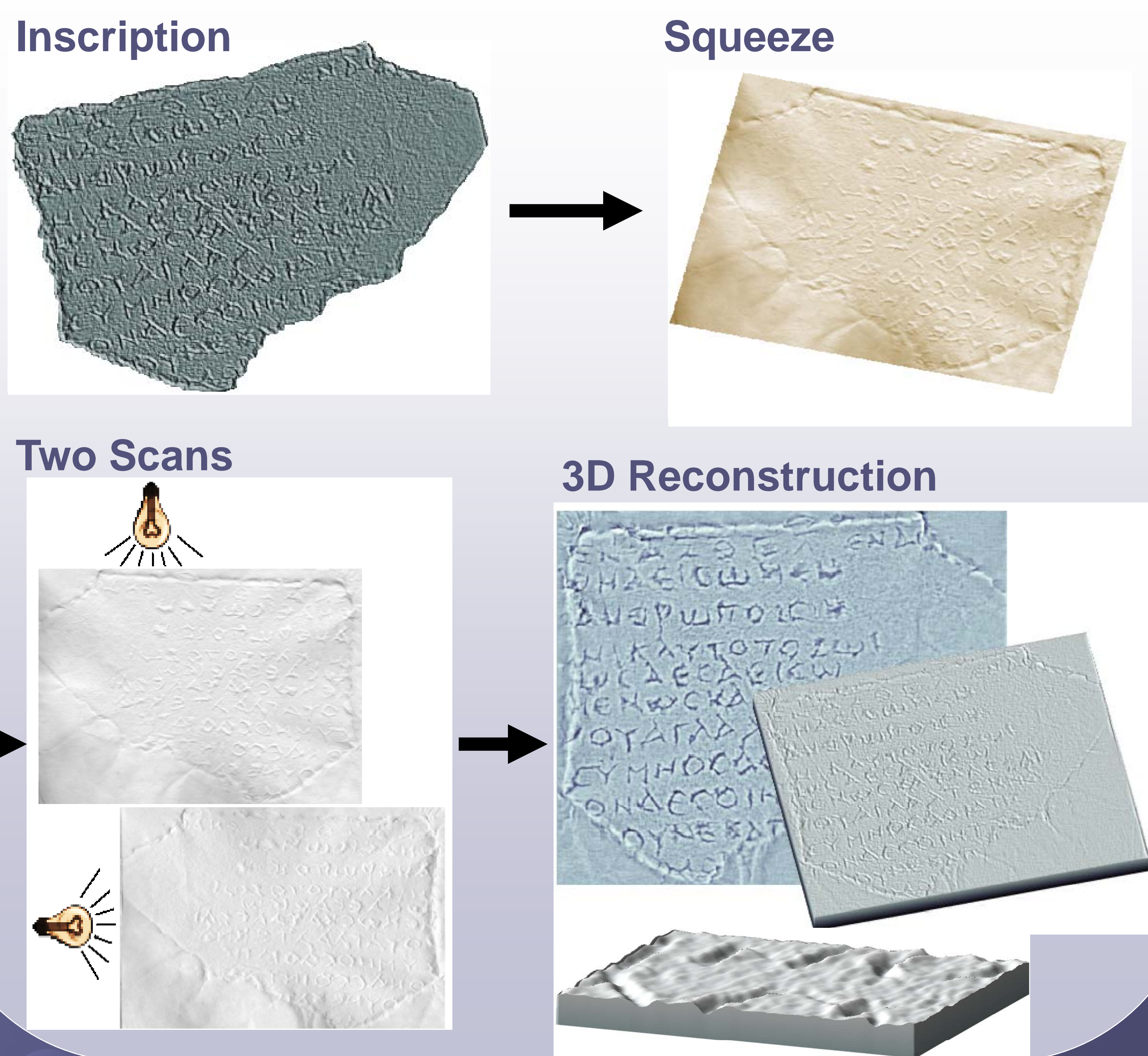
UF | UNIVERSITY of FLORIDA

Abstract In this paper we propose a novel method for 3D reconstruction of inscriptions using a shape-from-shading technique and for statistical analysis of their reconstructed surfaces using images of scanned squeezes.

The squeeze is scanned twice from two different directions. Using the shading information a 3D model of the original surface is reconstructed and parametrized as a height map. This map is automatically segmented into smaller regions containing single letters, which are divided into groups of same characters and are further employed for a statistical analysis of the inscribed letters. The results can be used for studying the variations of the lettering techniques within a set of inscriptions.
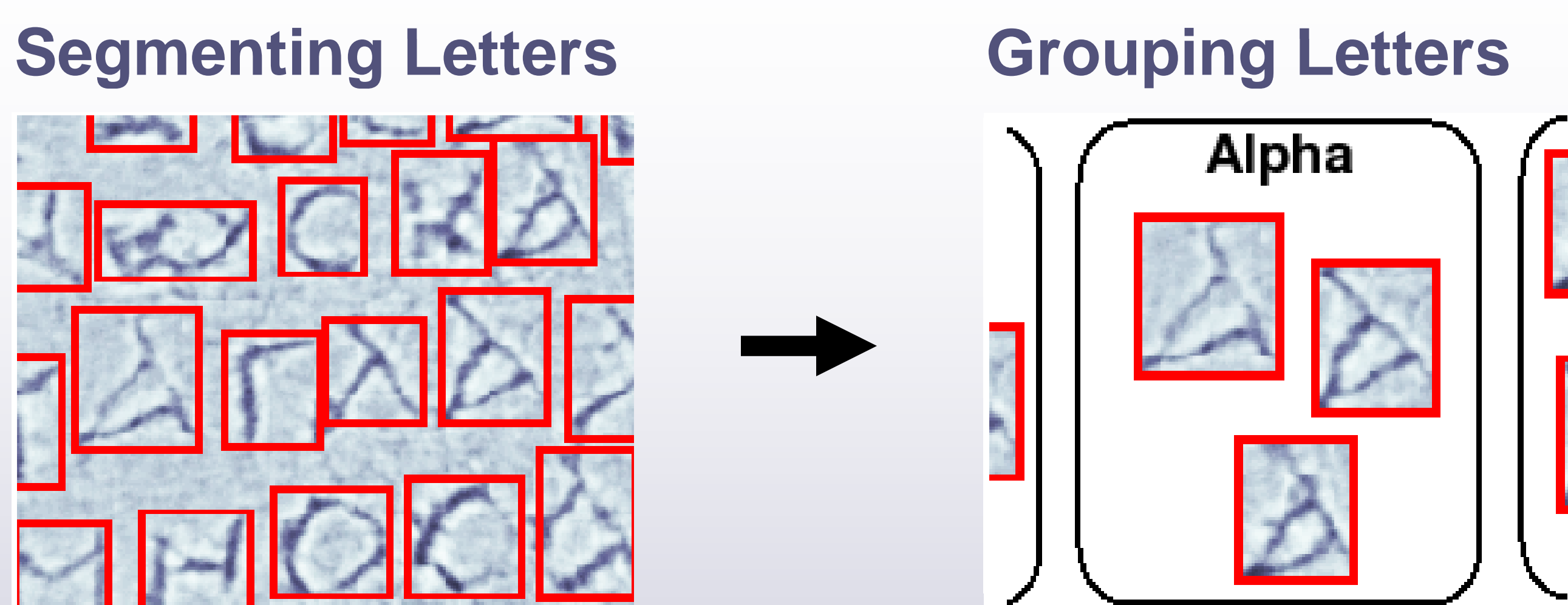
We have applied our framework to four inscribed fragments from the archaeological site of Epidauros, containing religious hymns for Asclepius and other deities (IG IV^2 I, 129-135; SEG 30, 390 = Robert Wagman, Inni di Epidauro, 1995). Although found in different locations, these inscriptions show close affinities in content (sacred poetry), material (red local limestone) and writing (uncial lettering of the third century CE).

The 3D reconstruction of the letterforms provides us with definite proof that all of them came from the same monument, possibly an inscribed wall from one of the buildings in the sanctuary's main area. A closer observation of the results reveals even some minor groups of letters with similar construction, which validates the accuracy of the proposed method. The advantages of 3D reconstruction in epigraphical research are especially obvious in the case of badly weathered or damaged inscribed surfaces, where the lettering is difficult to discern with the naked eye.

3 Statistical analysis

Registration & Atlas construction

Statistical Analysis

52.3%   47.6%

Average:
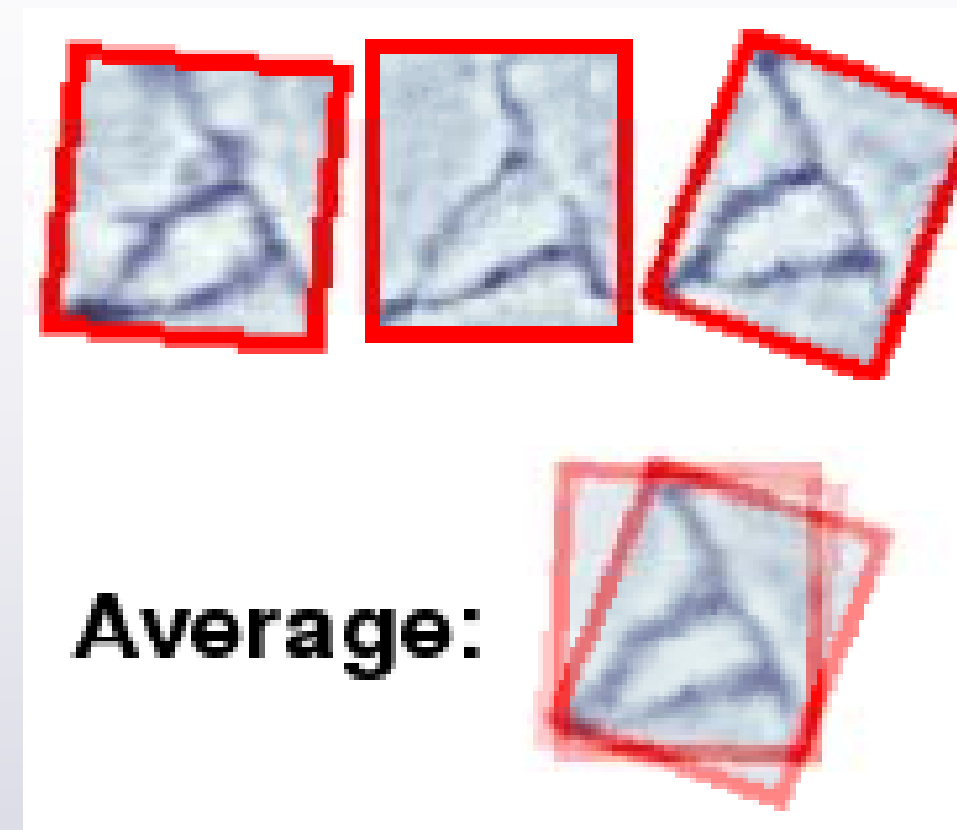
➢ In order to compare the letters of a group, all letters are registered (each letter is automatically rotated until all of them overlap each other as much as possible).

➢ The registered letters are then statistically analyzed. Such an analysis provides us with information concerning the average letter, as well as the affinities between letters and lettering techniques.

1 3D Surface reconstruction

Inscription → **Squeeze**

Two Scans   **3D Reconstruction**

2 Letter Segmentation & Grouping

Segmenting Letters   **Grouping Letters**

Alpha

➢ From the 3D reconstructed surface we compute the 'height map' which is an image where the darker colour depicts deeper parts of the originally inscribed surface.

➢ We automatically segment the height map into small rectangular regions containing each inscribed letter.
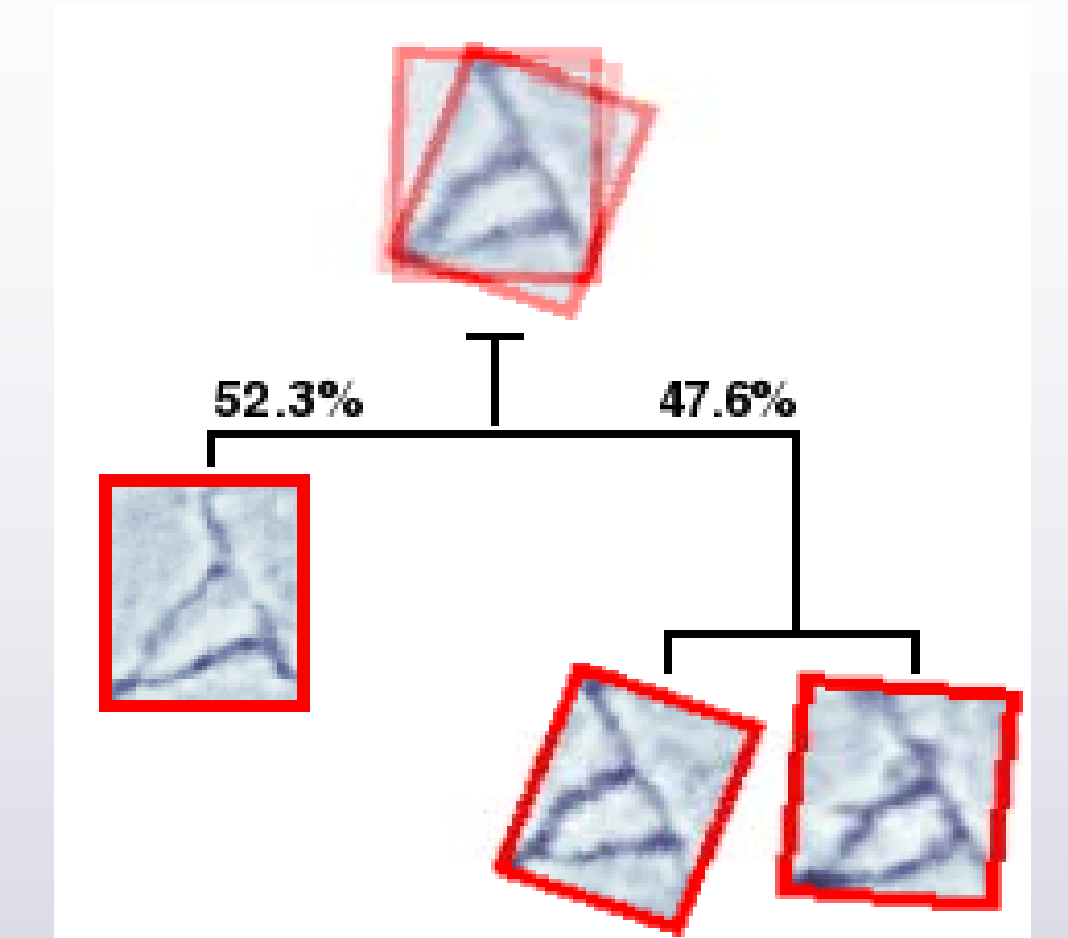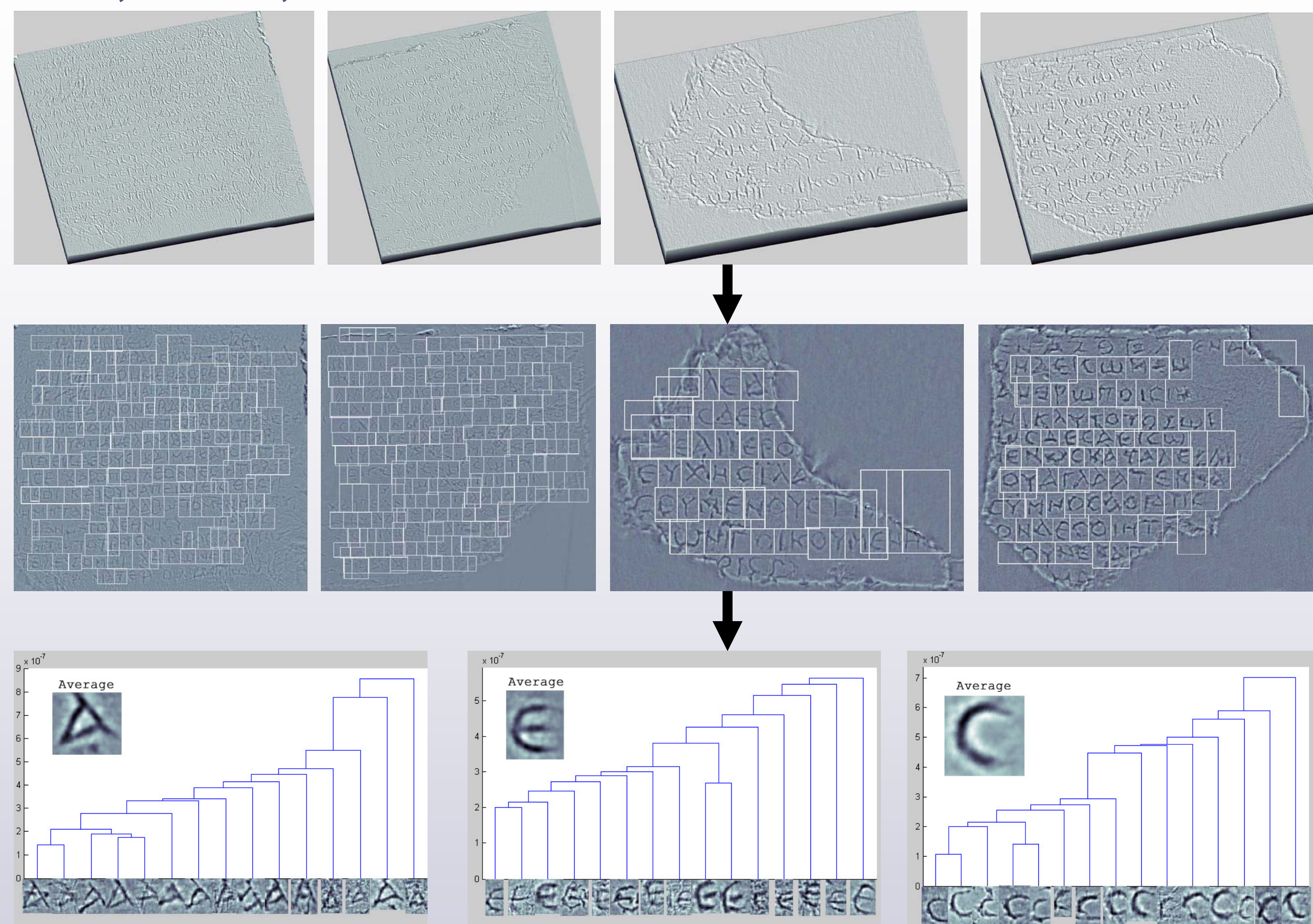
➢ The segmented letters are then divided into groups of same characters.

4 Experimental results

➢ Test sample, showing from left to right: IG IV^2 I, 131; 133-134; 135; SEG 30, 390

Average   Average   Average

➢ The affinities of the letters are presented in the form of a dendrogram.

➢ Study of the above dendrograms shows for instance that a small group of Epsilon differs structurally from the rest.

➢ The overall analysis shows a common lettering technique with very few variations which suggests that the above fragments probably come from the same inscription.

➢ The execution time of our algorithm was just a few minutes.

5 Contributions

✓ Reconstruction of badly weathered or damaged inscribed surfaces.

✓ Efficient way to compare and categorize automatically ancient inscriptions.

✓ Advantageous way to store squeezes digitally.