

Confocal microscopy for 3D surface texture characterization of diverse Paleolithic artifacts.

A. Queffelec, L. Bassel, S. Caux, F. d'Errico, A. Galland, L. Geis, S. Rigaud

Artifact's surface characterization in archaeology, a lack of quantification

- High variability of quotation systems
- High variability of inter-observer quantification
- Difficulty to go back to causes

General methodology

1. Establishment of problematics
2. Creation of a reference collection
3. Multi-scalar observation
4. Creation of a protocol of confocal microscopy measurement
5. Creation of 3D measurements treatment
6. Measurement of reference collection
7. Selection of rugosimetric parameters from the reference collection
8. Application of the same protocol on archaeological artifacts

Methodology

confocal measurement



Sensofar S NEOX

Column for big objects

Diverse set of objectives (5x, 20x, 50x ELWD, 100x, 150x)

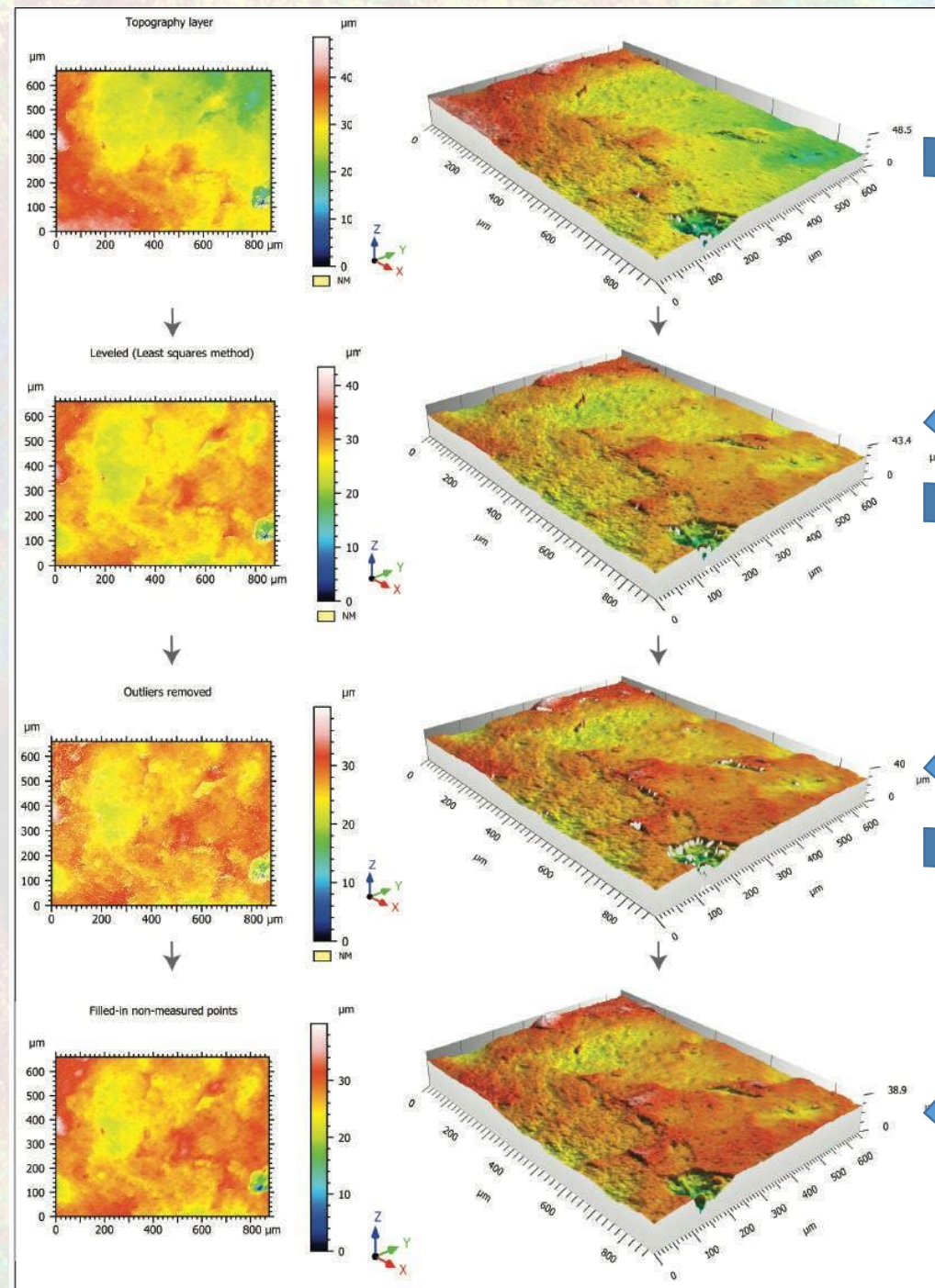
Fully motorised

Anti-vibration table

Up-to-date softwares

Methodology

3D treatment



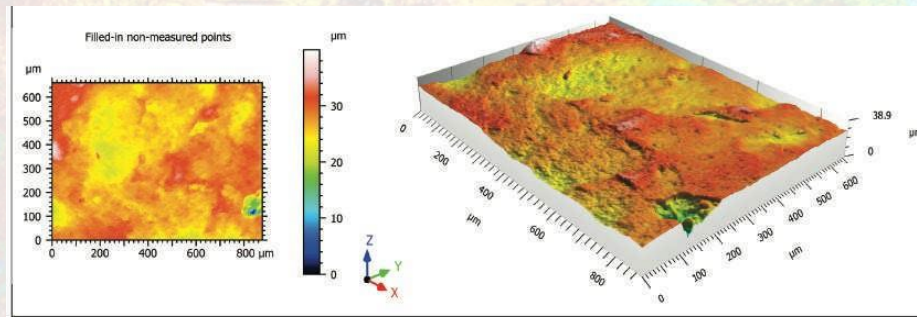
Leveling

Outliers removal

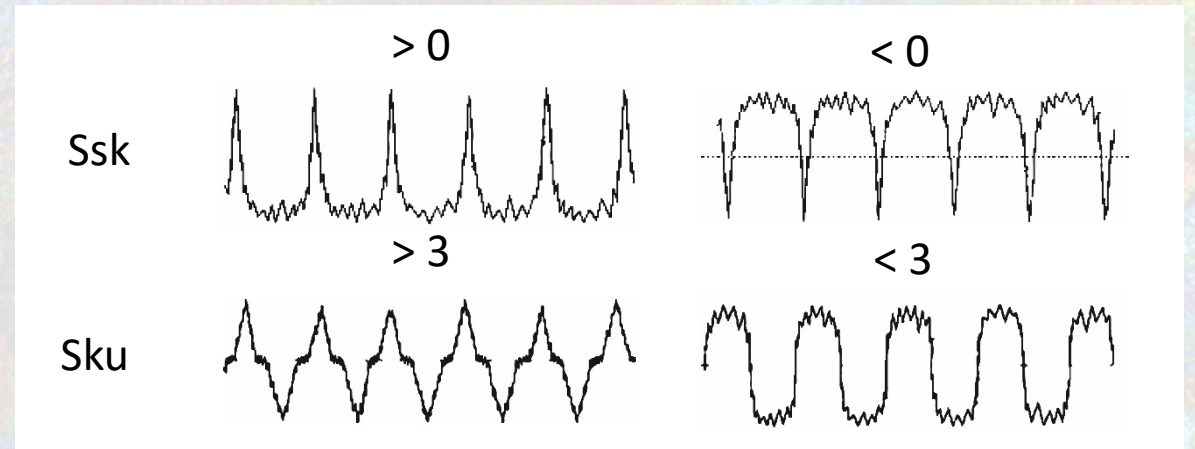
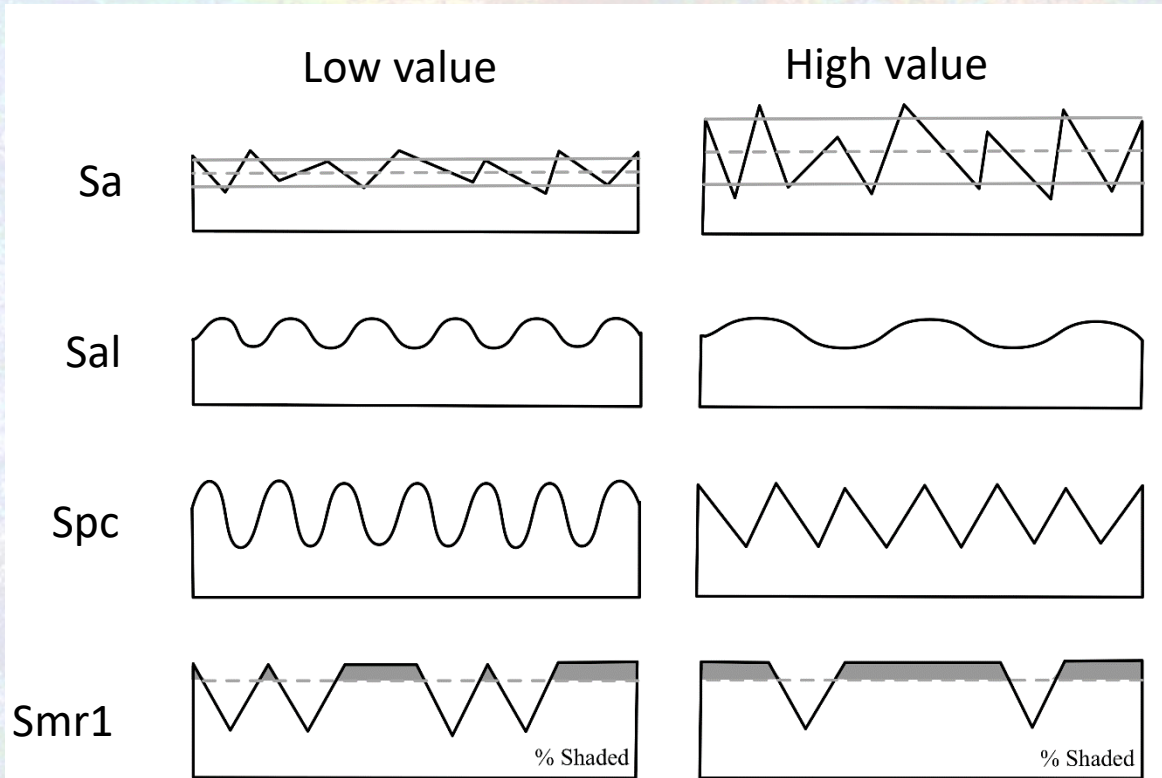
Non-measured points filling

Methodology

3D treatment



Rugosimetric surface parameters calculation
ISO 25178 norm



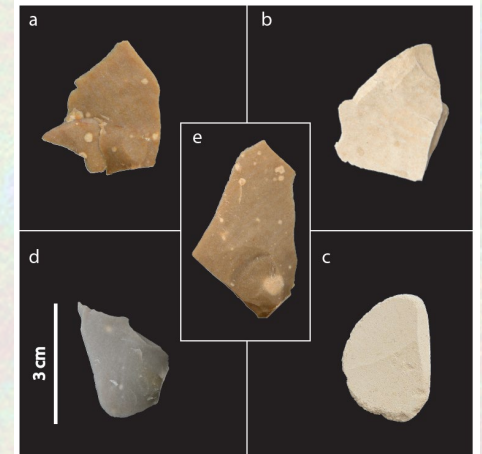
Case studies

- Flint taphonomy
 - White patine and luster phenomena
 - Archaeological case study
- Lustered gravels in Solutrean sites
- Middle Stone Age ochre use
 - Production of powder (Rosso *et al.* in a few tens of minutes)
 - Preparation (?) of silcrete surface
- Intra-artifact surfaces comparison on Tolbor pendant

Flint taphonomy

- White patina, a poorly understood phenomena which can lead to problematic raw material identification.

CAUX S., GALLAND A., QUEFFELEC A., BORDES J.-G. (2018) – Aspects and characterization of chert alteration in an archaeological context: A qualitative to quantitative pilot study, *Journal of Archaeological Science: Reports*, 20, p. 210-219.

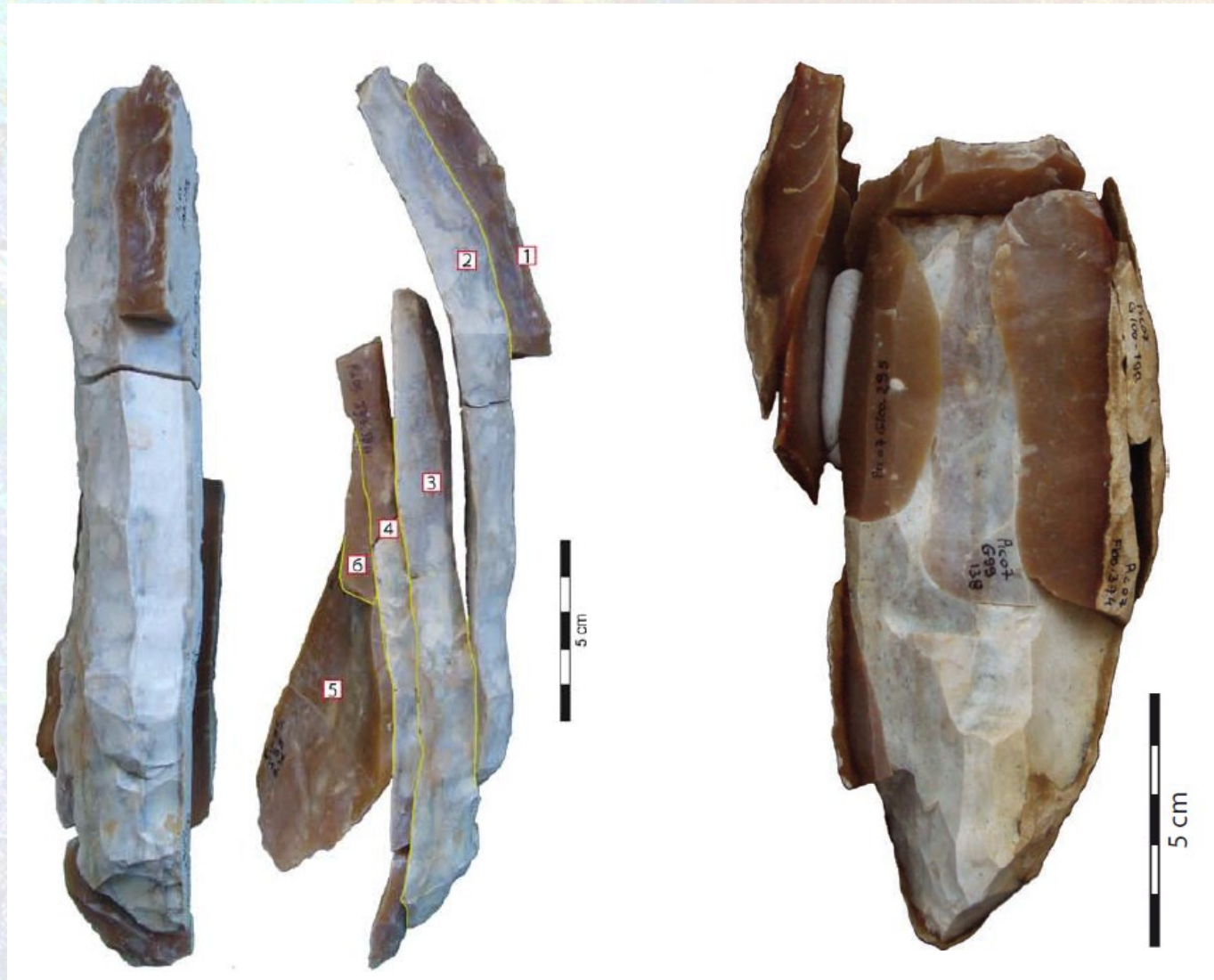


- Lithics surface alteration study at St. Césaire for taphonomic assessment.

GALLAND A., QUEFFELEC A., CAUX S., BORDES J.-G. (2019) – Quantifying lithic surface alterations using confocal microscopy and its relevance for exploring the Châtelperronian at La Roche-à-Pierrot (Saint-Césaire, France), *Journal of Archaeological Science*, 104, p. 45-55.



White Patina



refitting from the La Picardie site (Indre et Loire, excavation L. Klaric)



Same flint, different alteration rate

White patina

Experimental approach

Grand-Pressigny



Grain de mil

White patina

Experimental approach

Grand-Pressigny



Chemicals + warm temperature



Grain de mil



White patina

Experimental approach

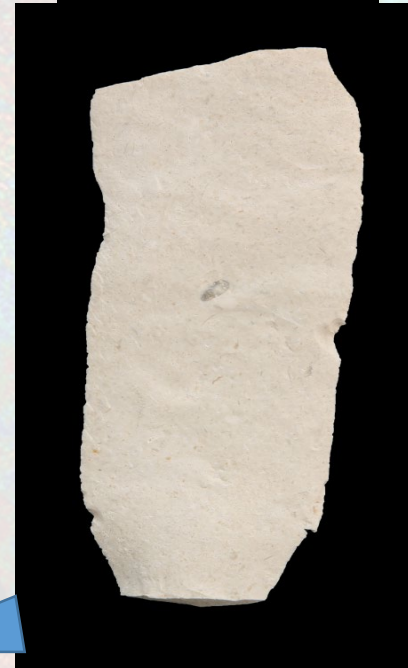
Grand-Pressigny



Grain de mil



Grand-Pressigny, NaOH, t9



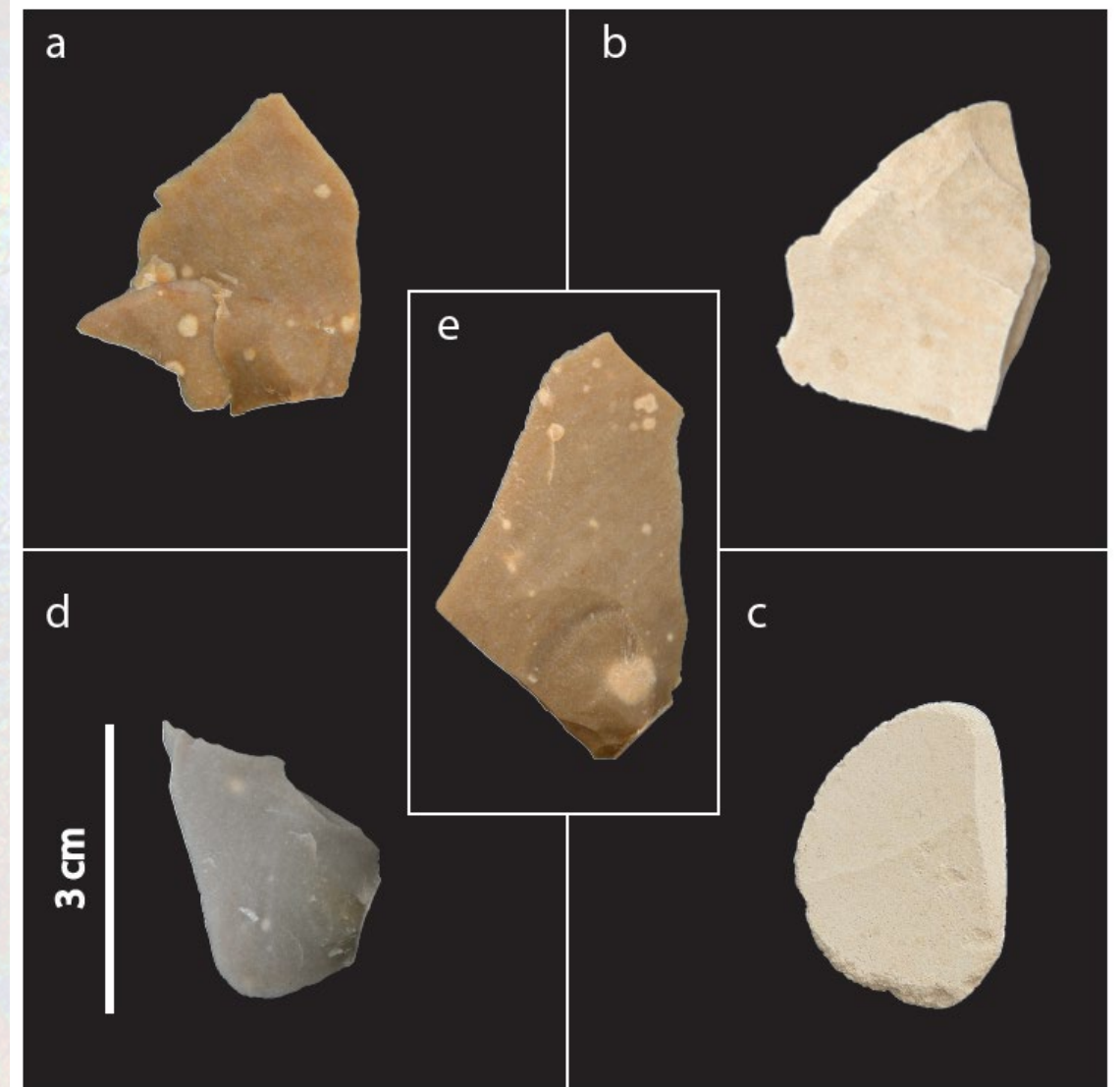
Grain de mil, NaOH, t5

White patina

Results

White patina forms under
basic conditions

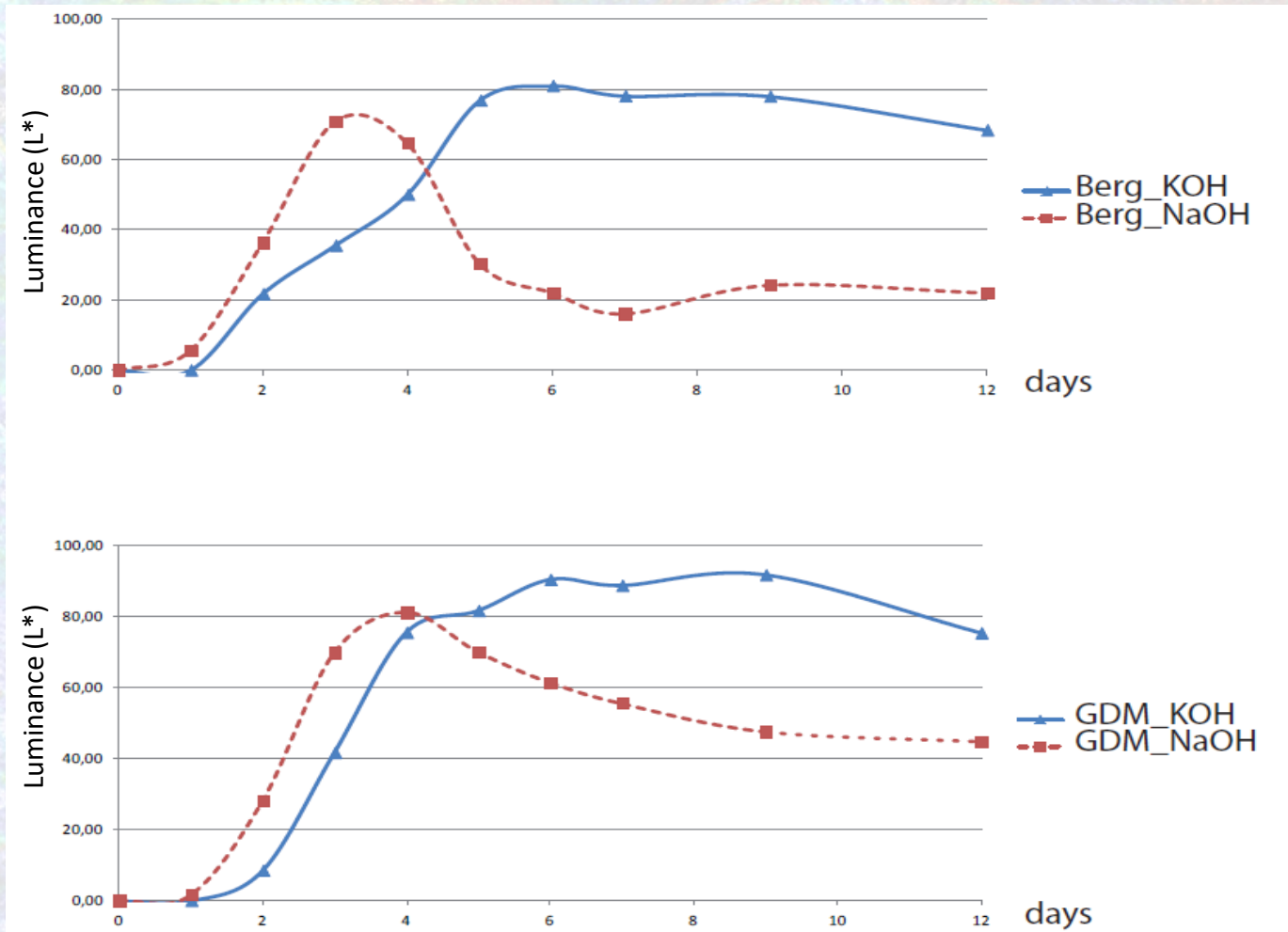
- a. Distilled water
- b. Potassium hydroxide (KOH)
- c. Sodium hydroxide (NaOH)
- d. Hydrochloric acid (HCl)
- e. Witness sample



White patina

Results

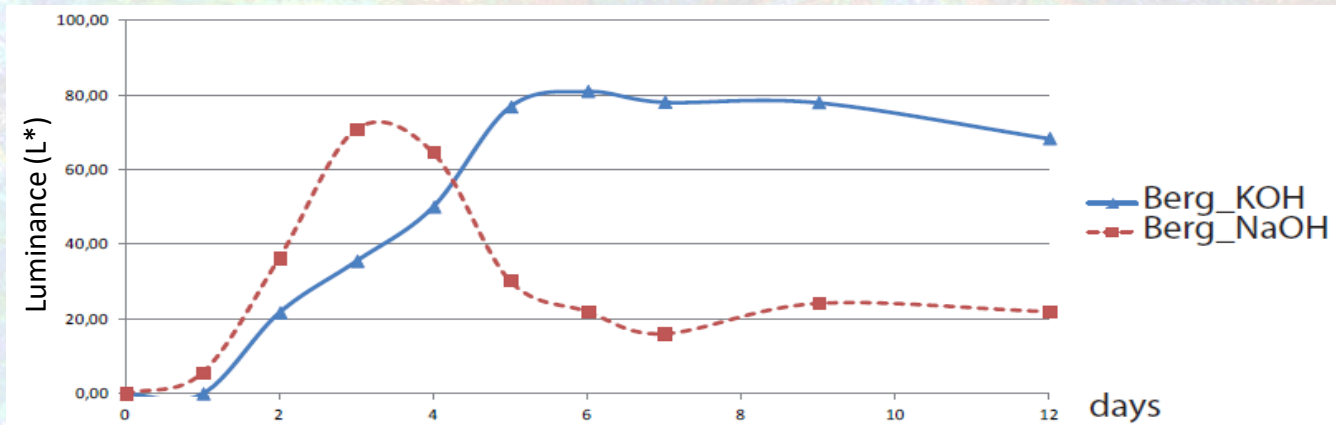
Luminance (L^*) measurement



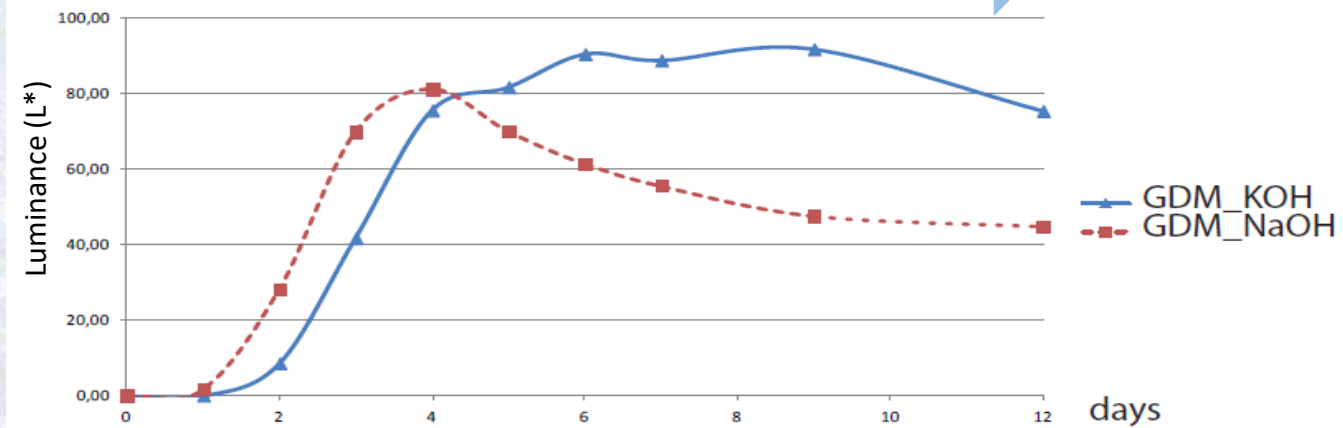
White patina

Results

Luminance (L^*) measurement



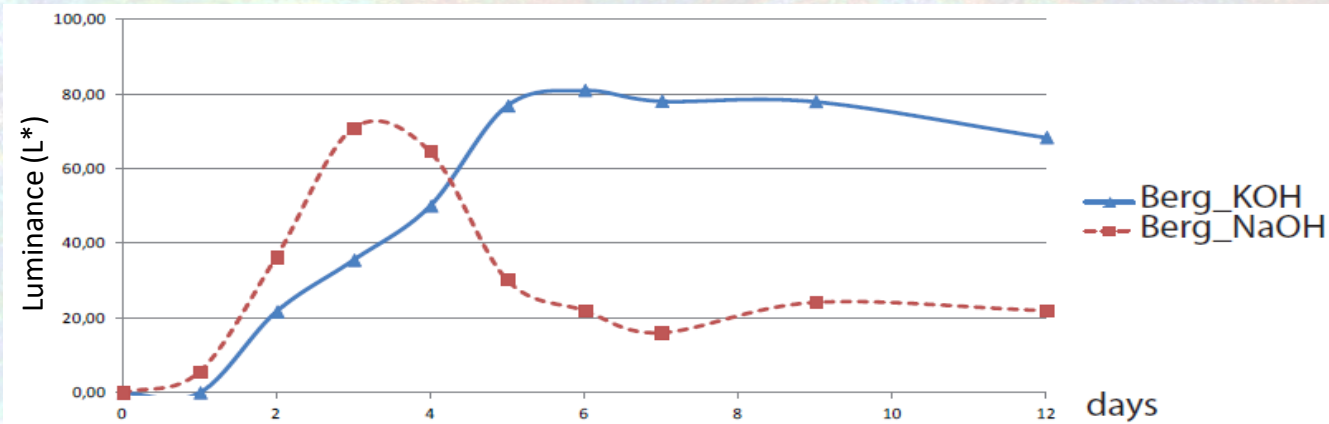
Meanwhile, a^* and b^* remain quite constant



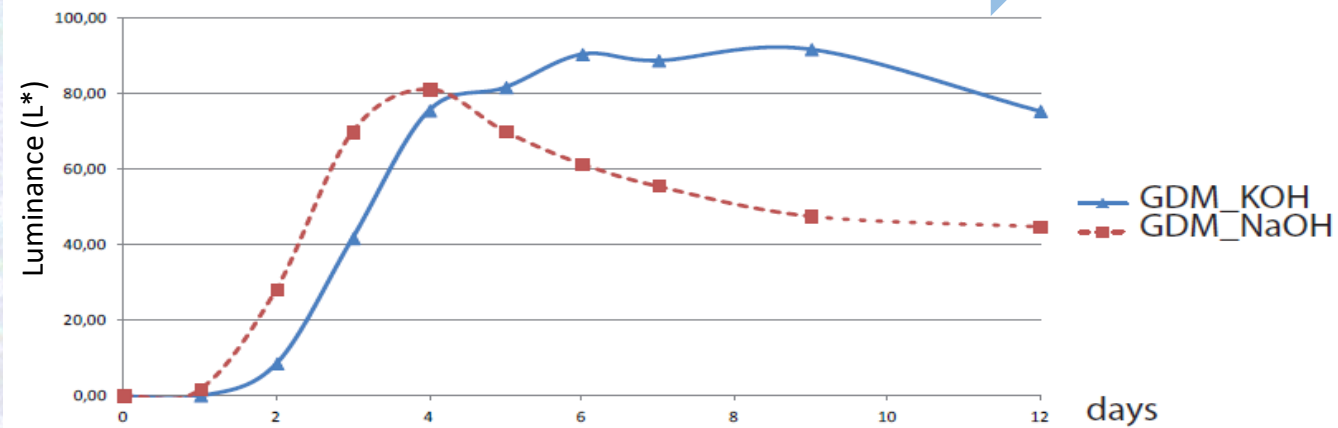
White patina

Results

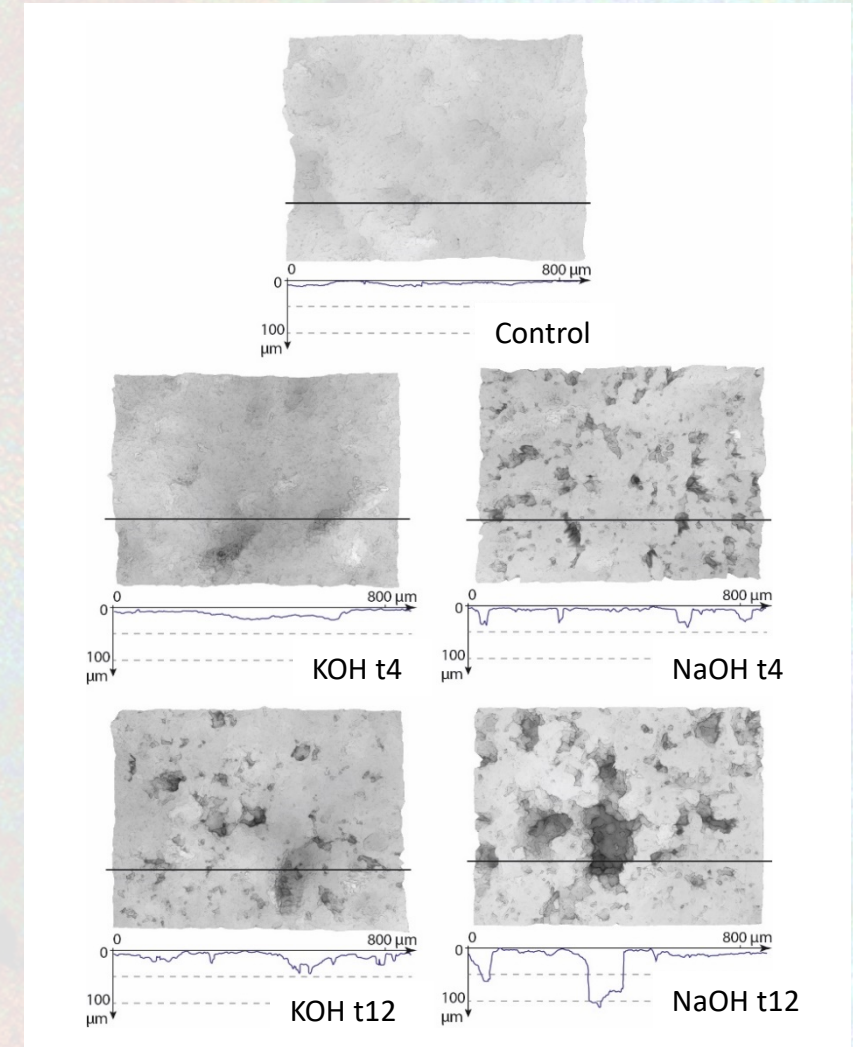
Luminance (L^*) measurement



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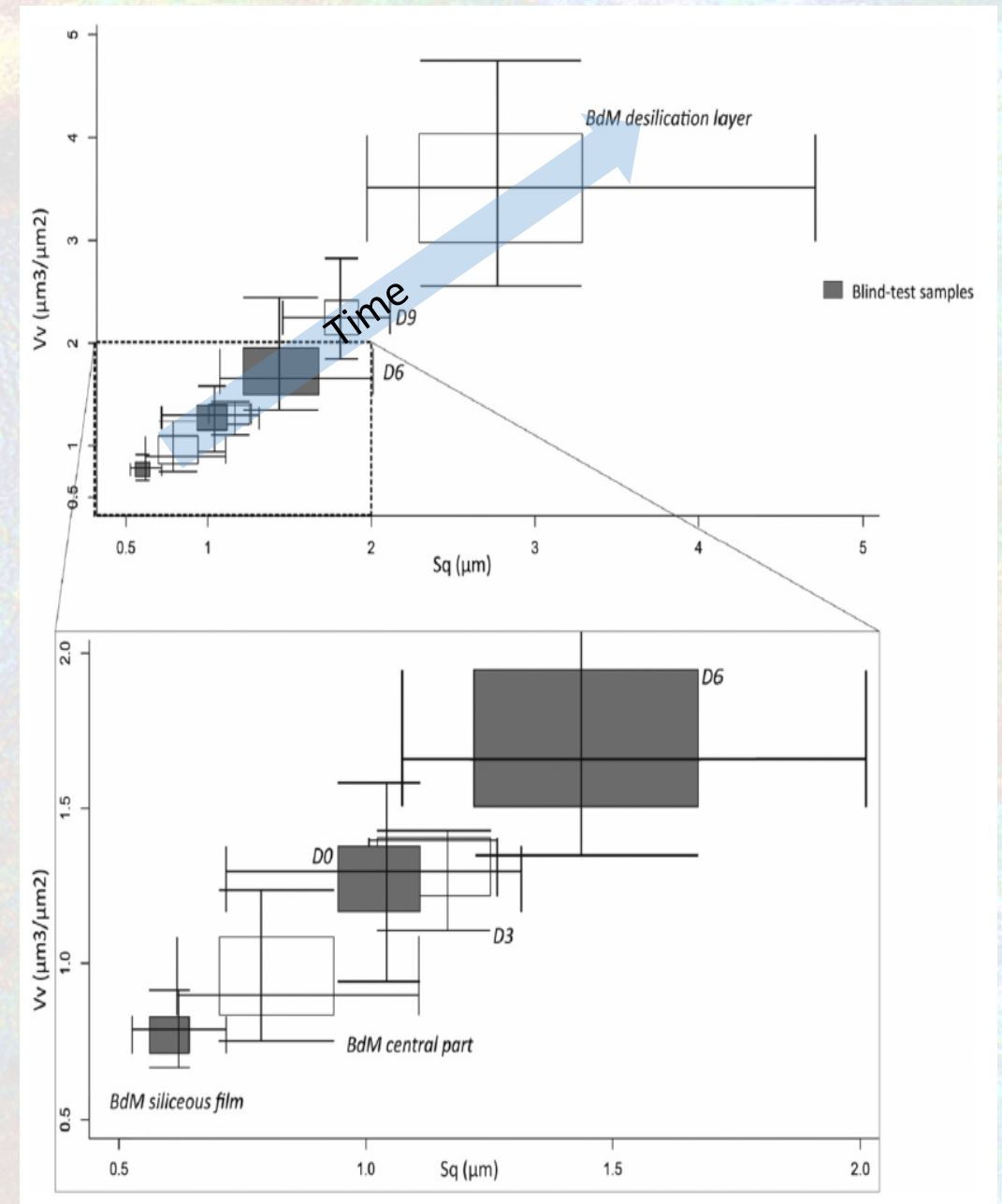
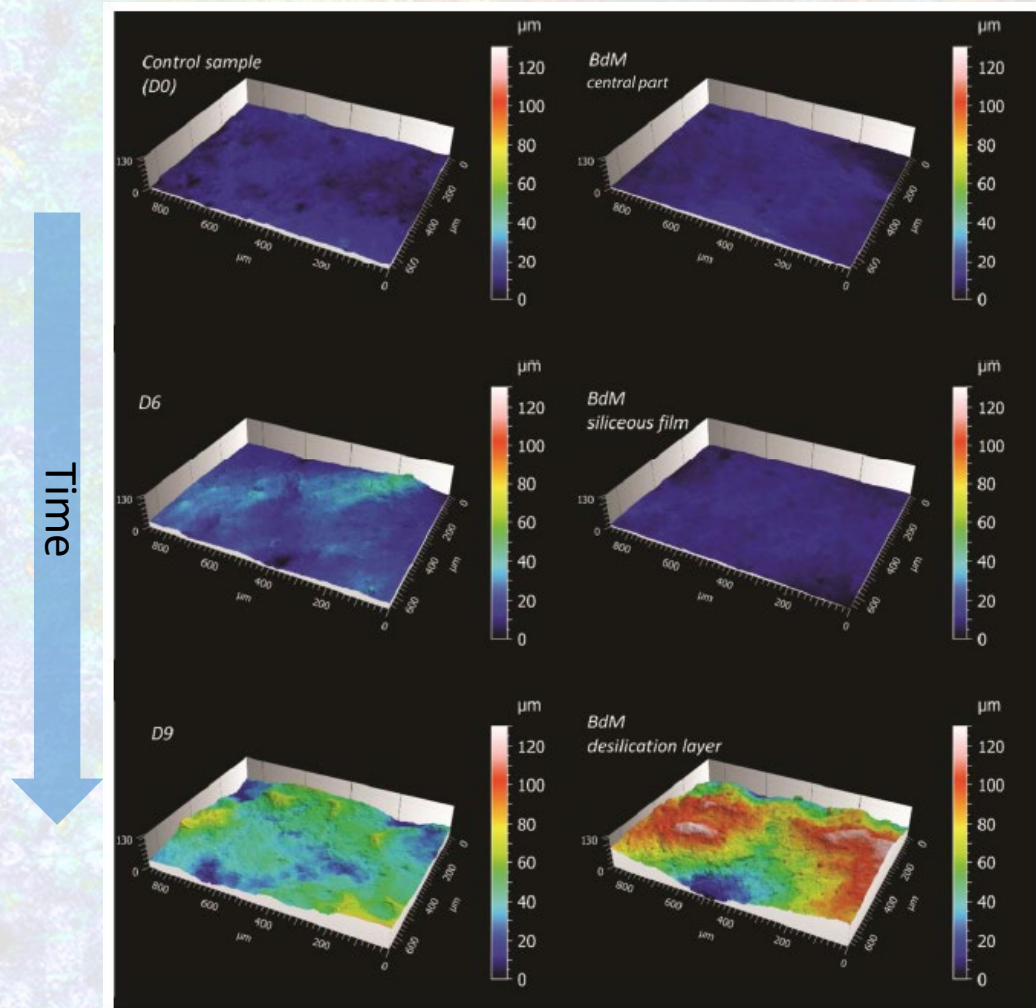
Confocal microscope images and profiles



White patina

Results

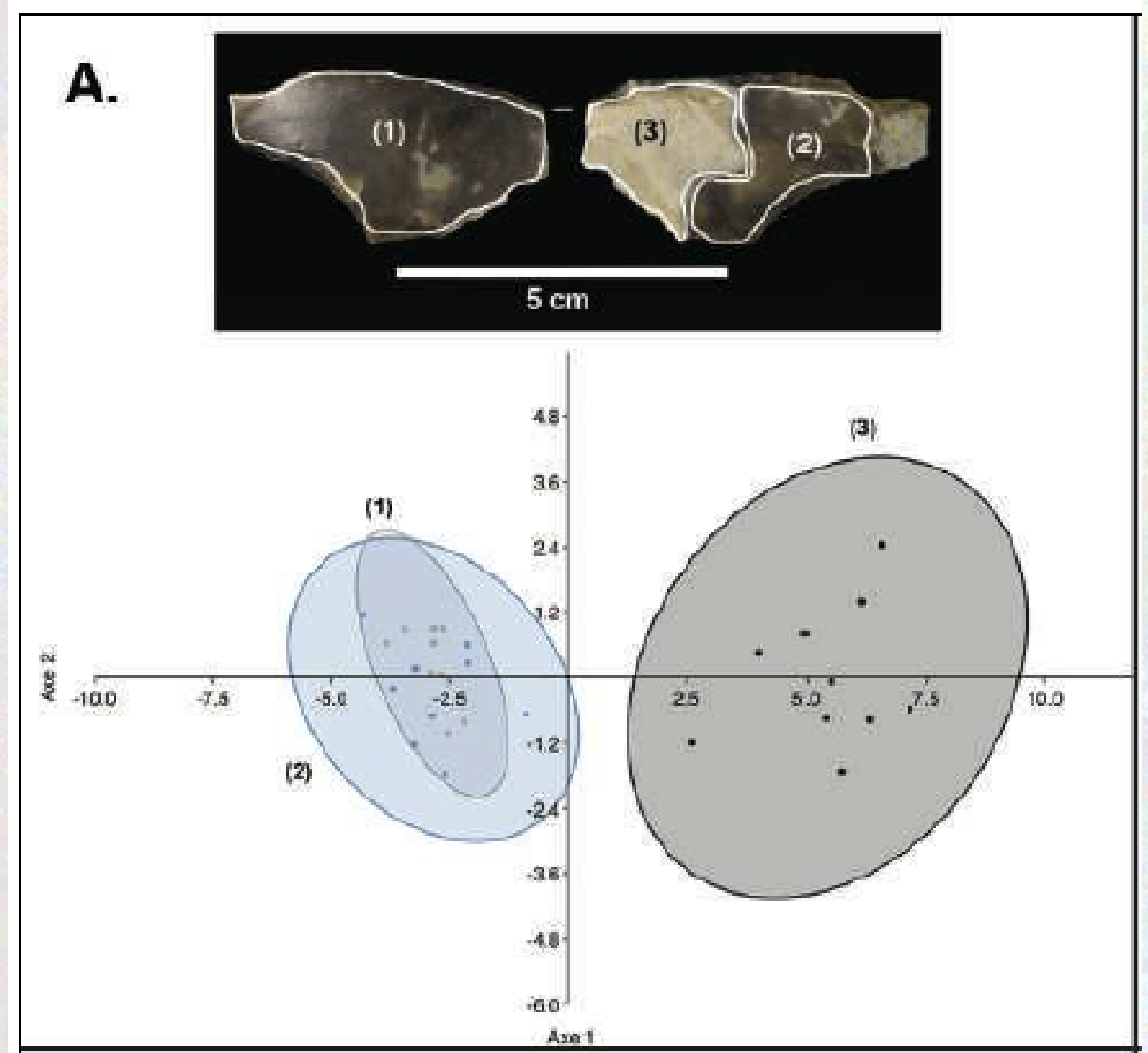
Confocal microscopy quantification



Lithics surface at St. Césaire

Application of the methods to extreme case

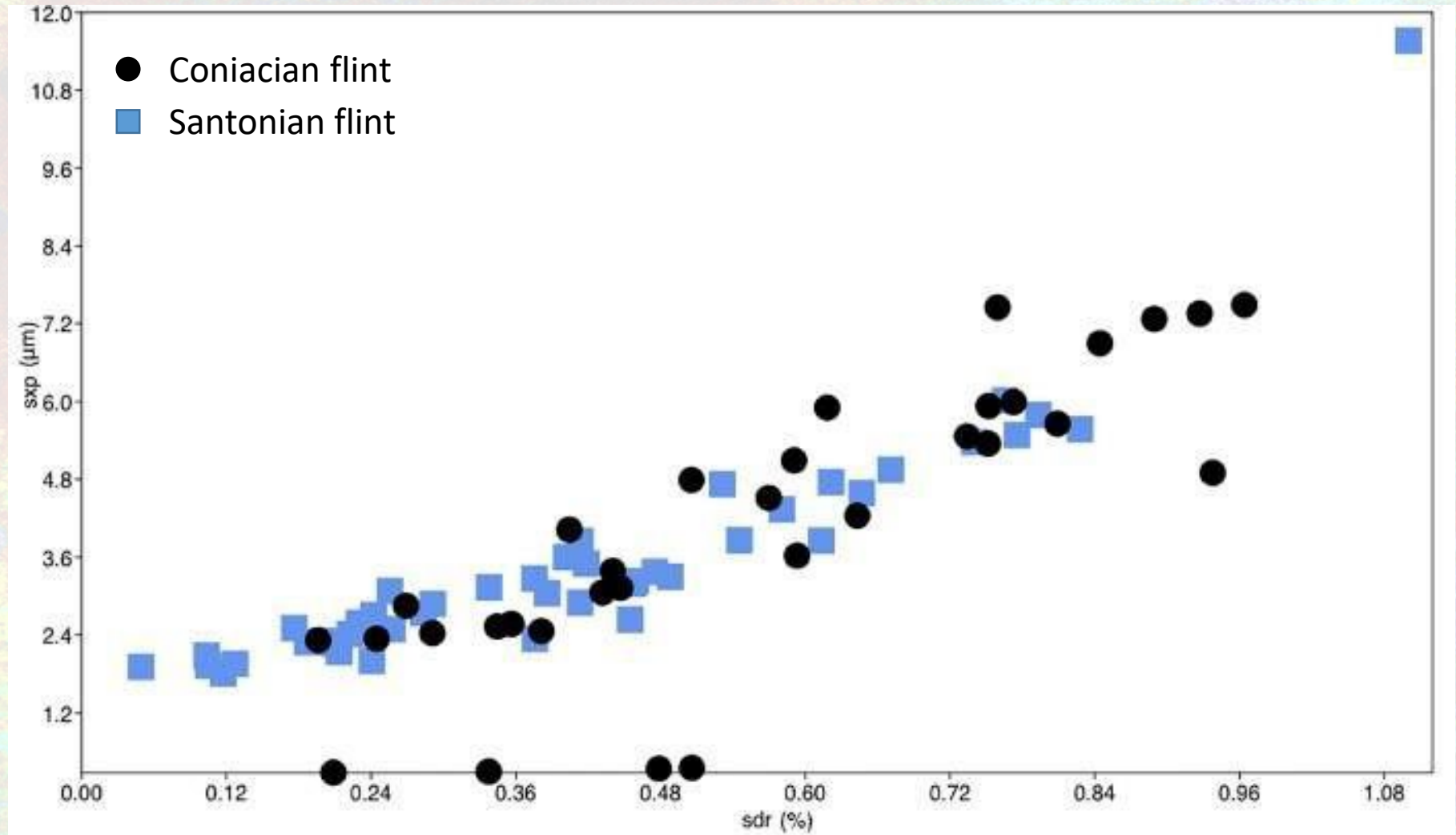
Discriminant analysis performed on different surfaces from the same chip :
Surface (3), with visible « white patina », is clearly different from surfaces 1 and 2 which shows visible « luster ».



Lithics surface at St. Césaire

Characterization of geological flints nearby the site

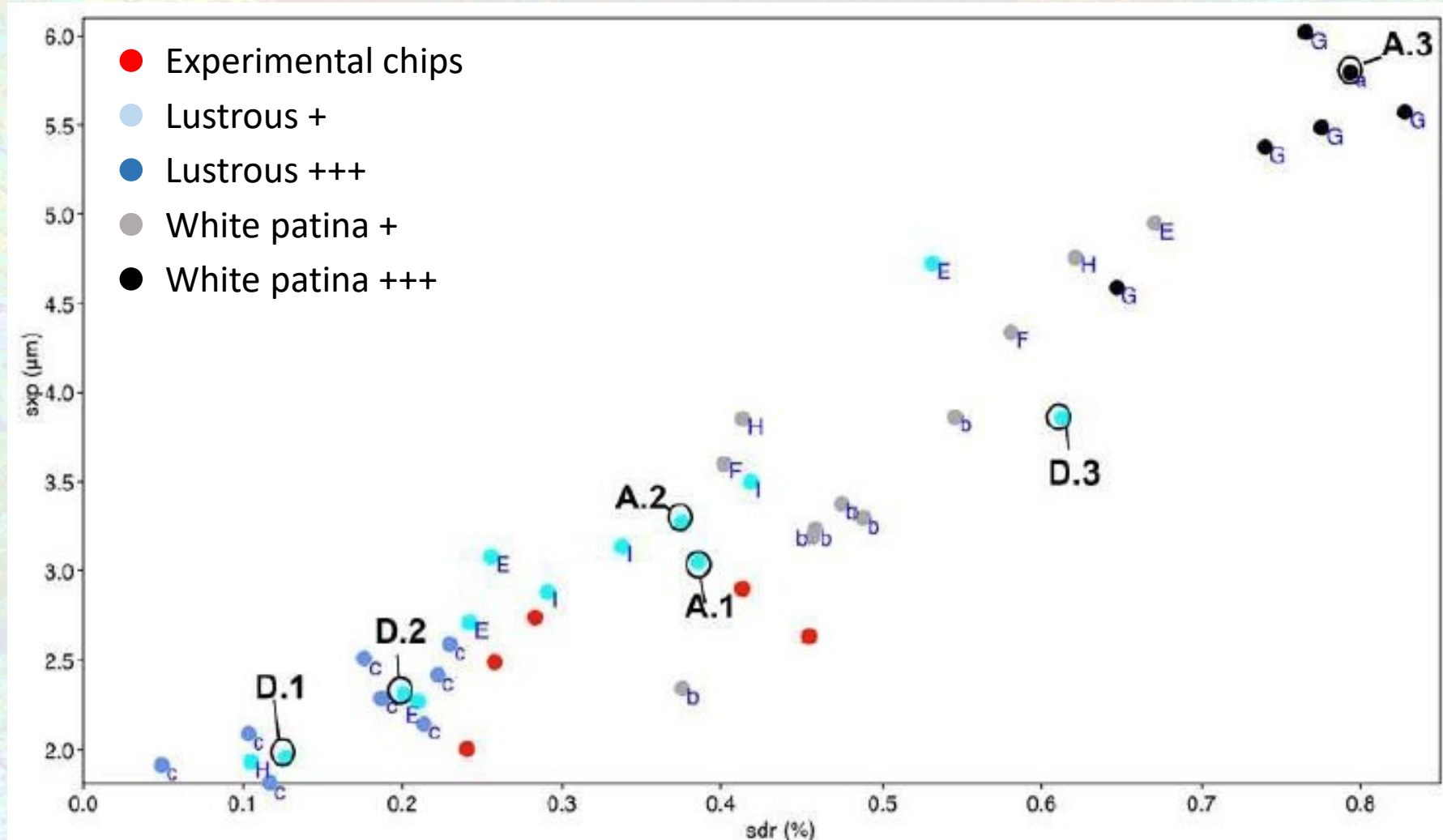
Flints sampled all around the site in different natural environments (in the limestone, in secondary deposits, colluvium etc.)



Natural samples variability for two different raw materials

Lithics surface at St. Césaire

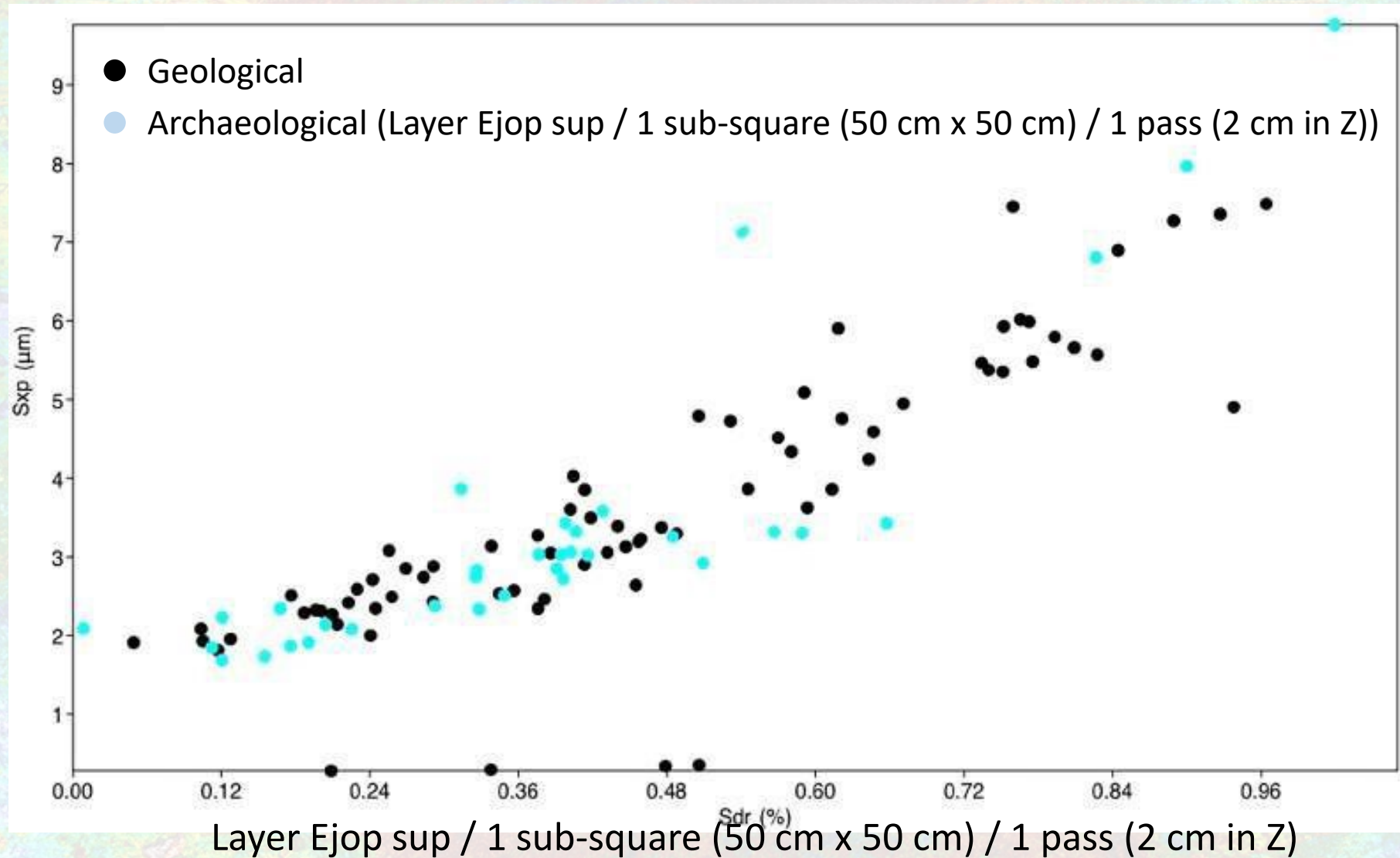
Characterization of archaeological flints



Rugosimetric measurements classified by macroscopic description

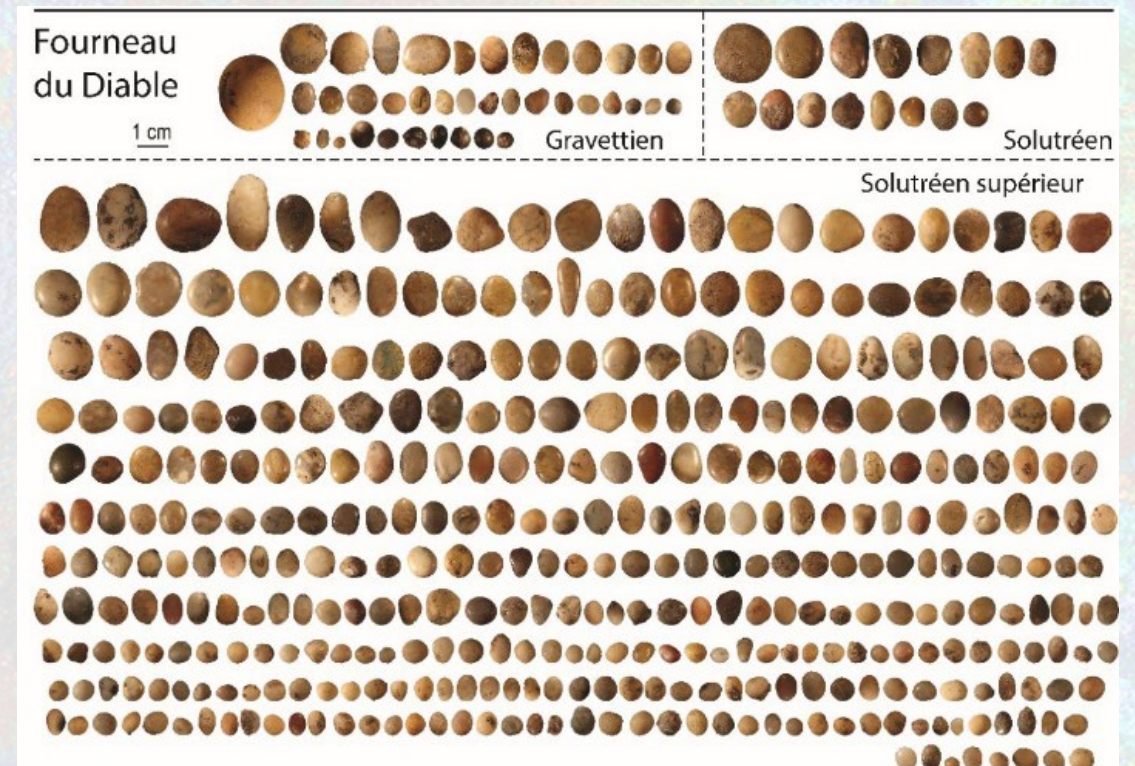
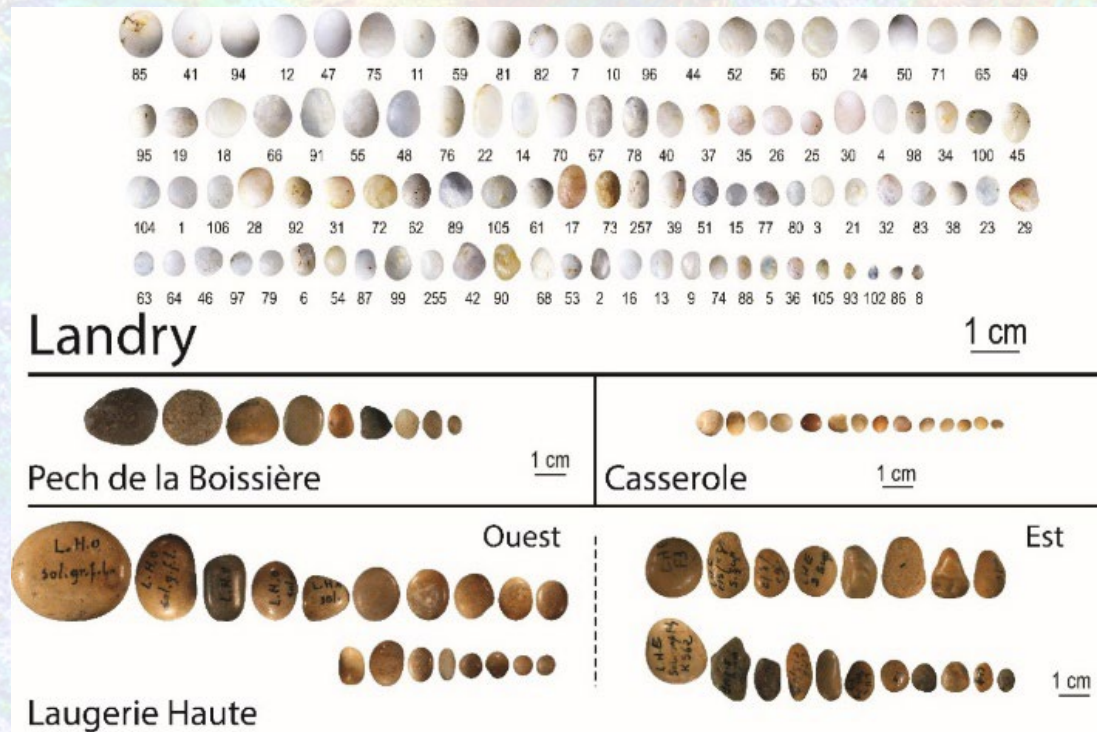
Lithics surface at St. Césaire

Comparison of archaeological vs. geological flints



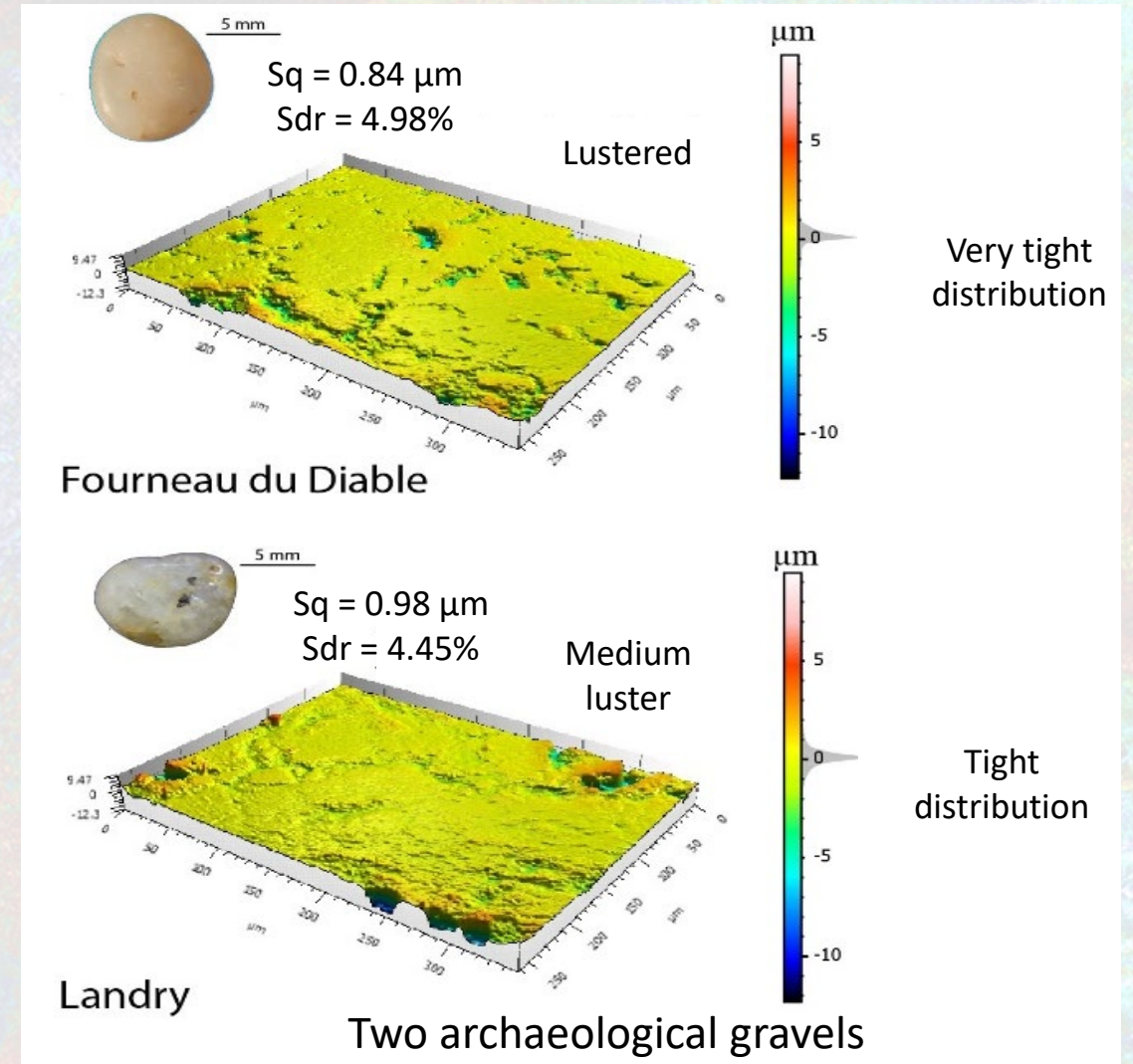
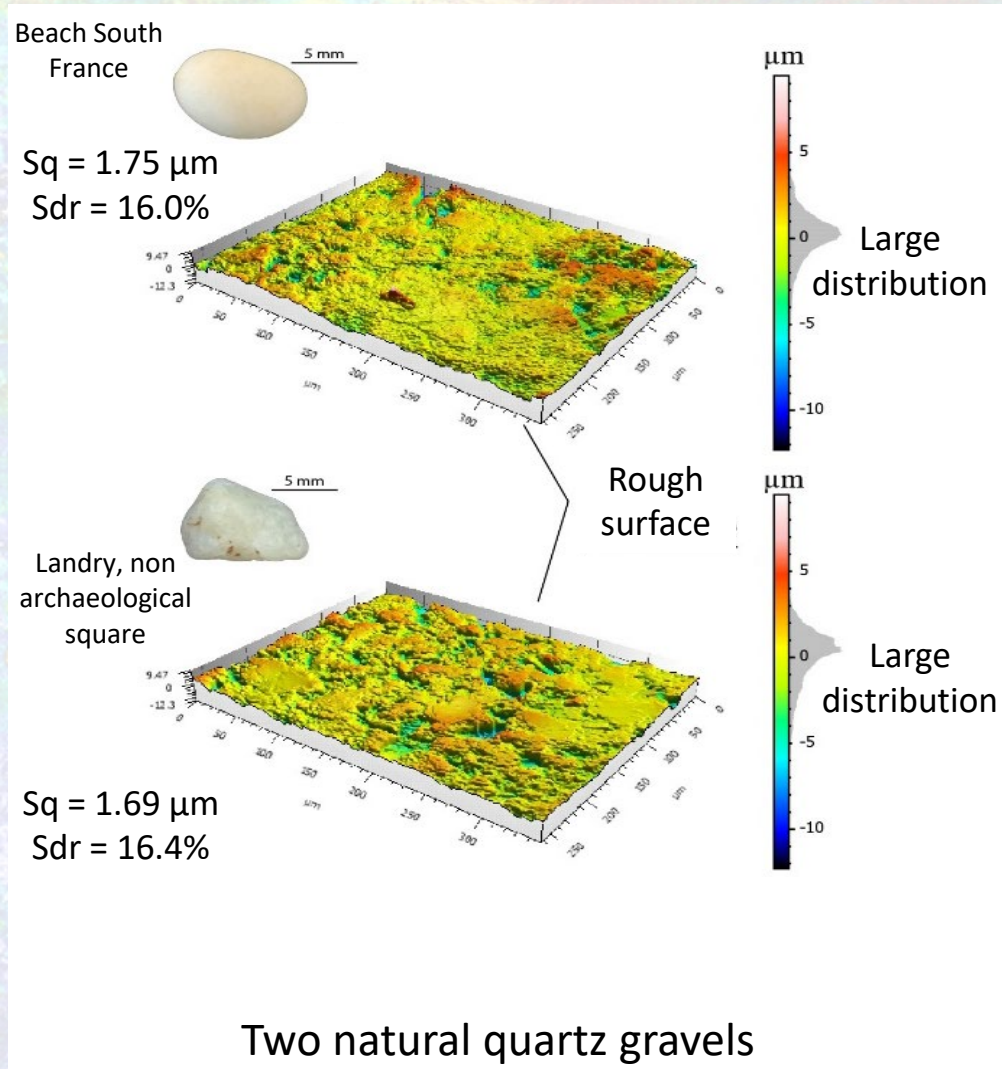
Lustered gravels in Solutrean sites

- The presence of visibly lustered gravels and pebbles in several Solutrean sites in SW France. Are they of anthropogenic origin, what was their purpose?

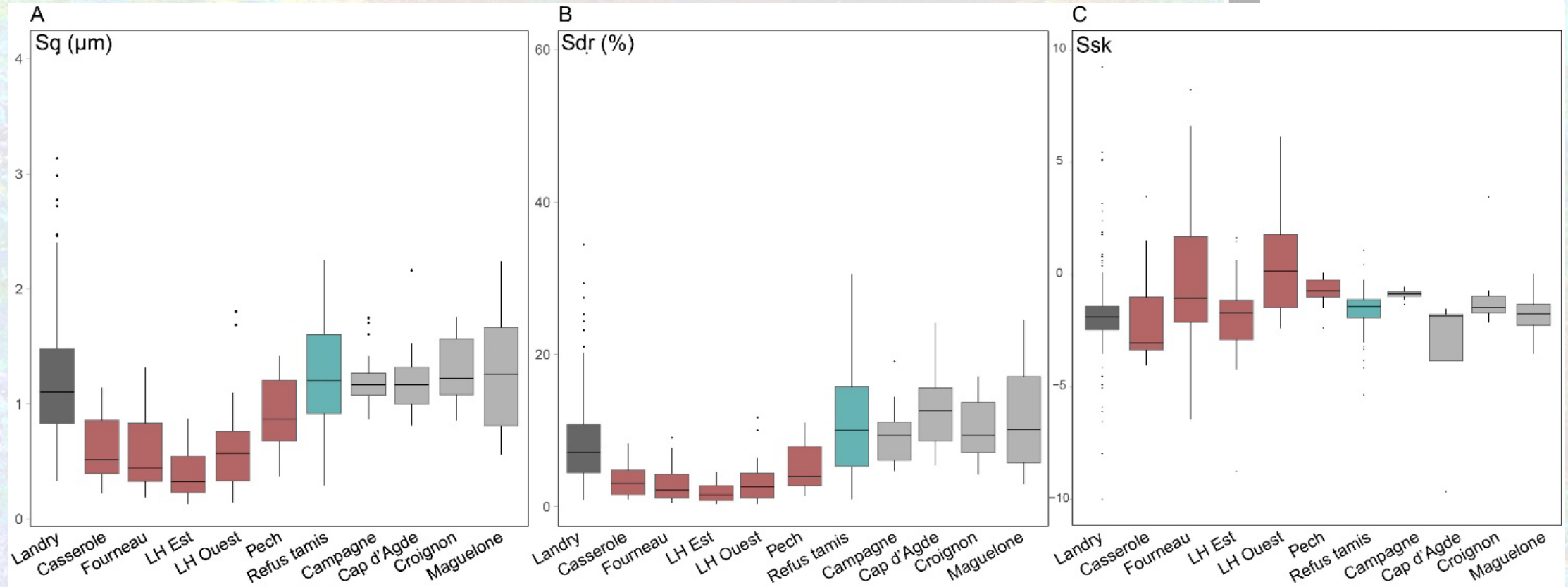
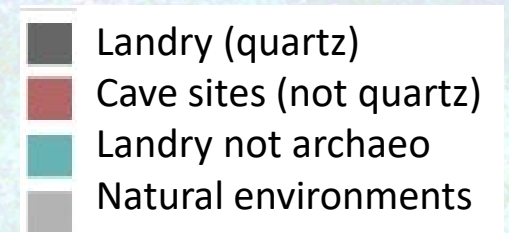


Highly polished and rounded gravels and pebbles in several Solutrean sites from SW France

Lustered gravels in Solutrean sites

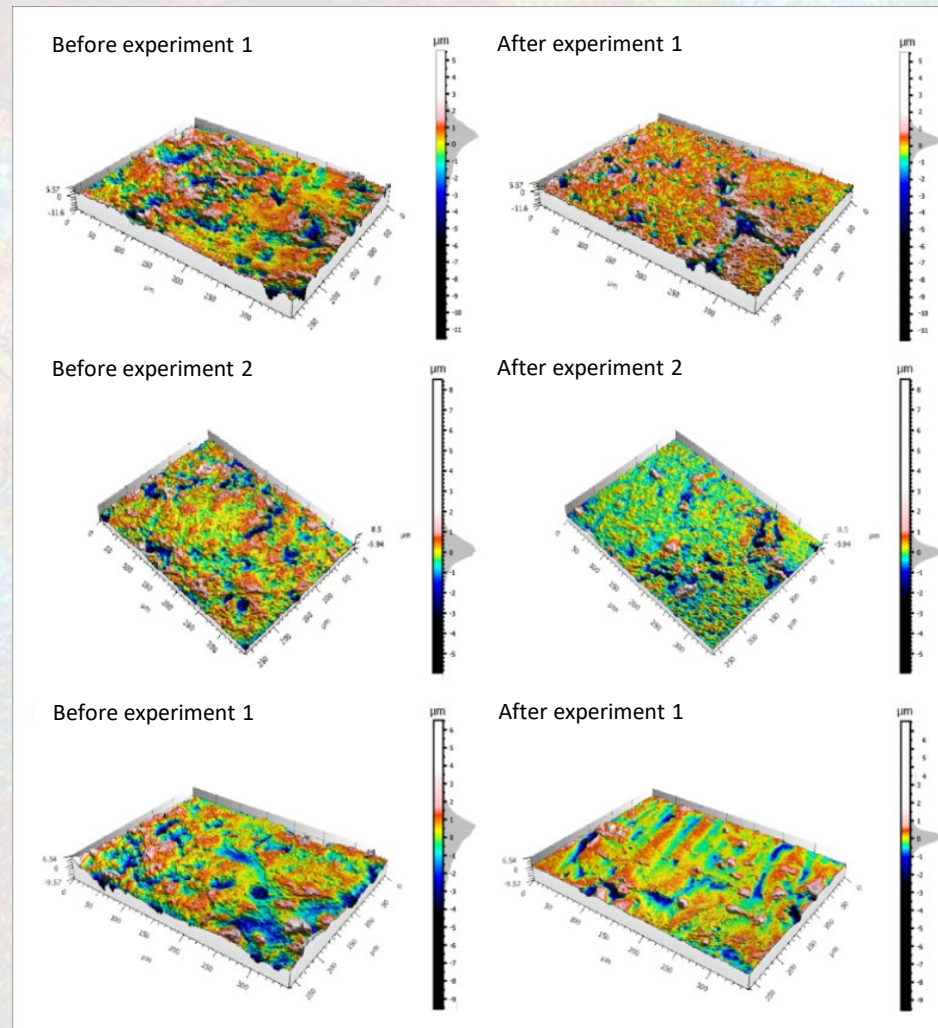
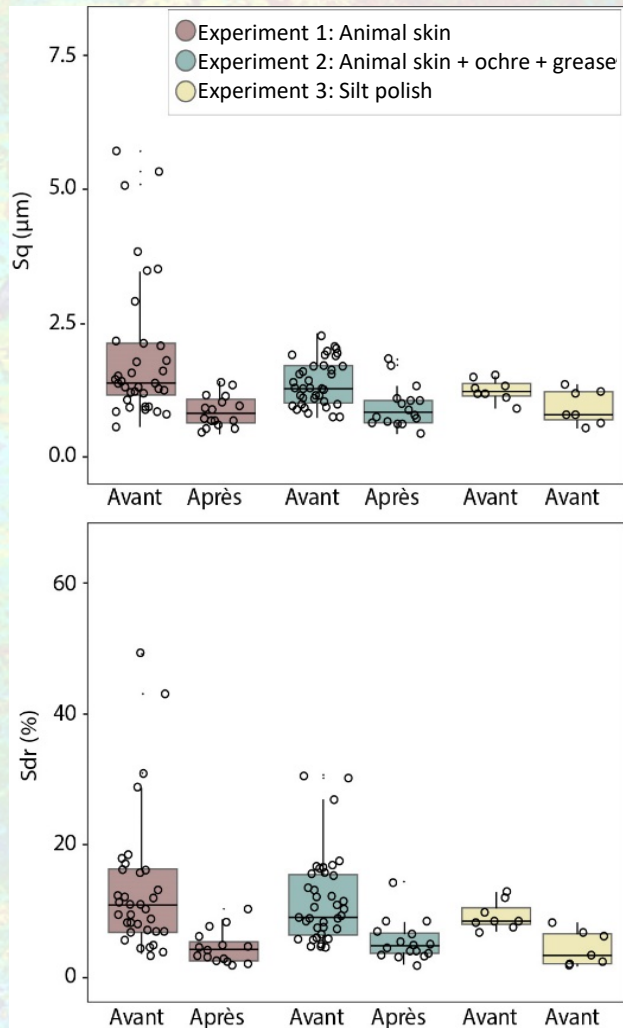


Lustered gravels in Solutrean sites



Boxplots showing the distribution of 3 roughness parameters for natural and archaeological gravels

Lustered gravels in Solutrean sites



Polishing experiments showing lower Sq and Sdr after experiment, quite close to archaeological artifacts but other uses could also tend to this result (equifinality issues)

Middle Stone Age ochre use

- Diversity of ochre powder production at Porc-Epic cave

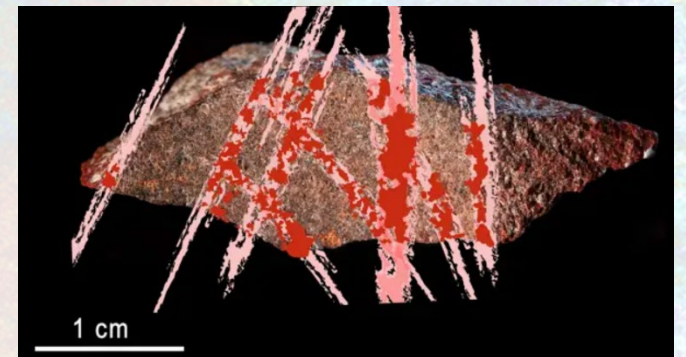
ROSSO D.E., D'ERRICO F., QUEFFELEC A. (2017) – Patterns of change and continuity in ochre use during the late Middle Stone Age of the Horn of Africa: The Porc-Epic Cave record, *PLOS ONE*, 12, 5.

Rosso et al. in a few minutes



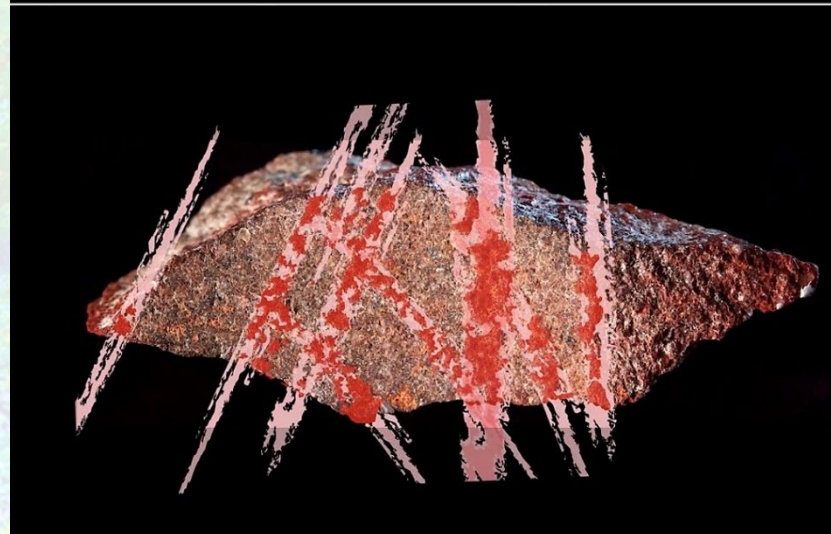
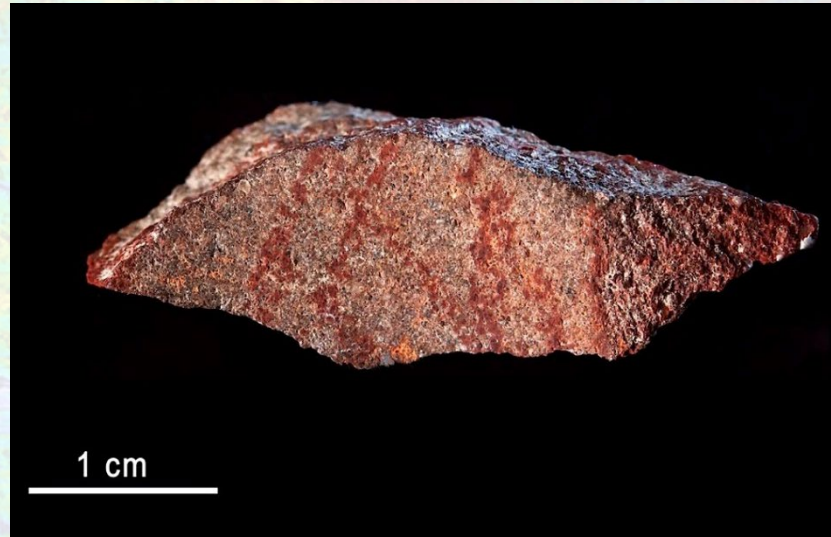
- Preparation (?) of silcrete surface before drawing at Blombos Cave

HENSHILWOOD C.S., ERRICO F. D', NIEKERK K.L. VAN, DAYET L., QUEFFELEC A., POLLAROLO L. (2018) – An abstract drawing from the 73,000-year-old levels at Blombos Cave, South Africa, *Nature*.



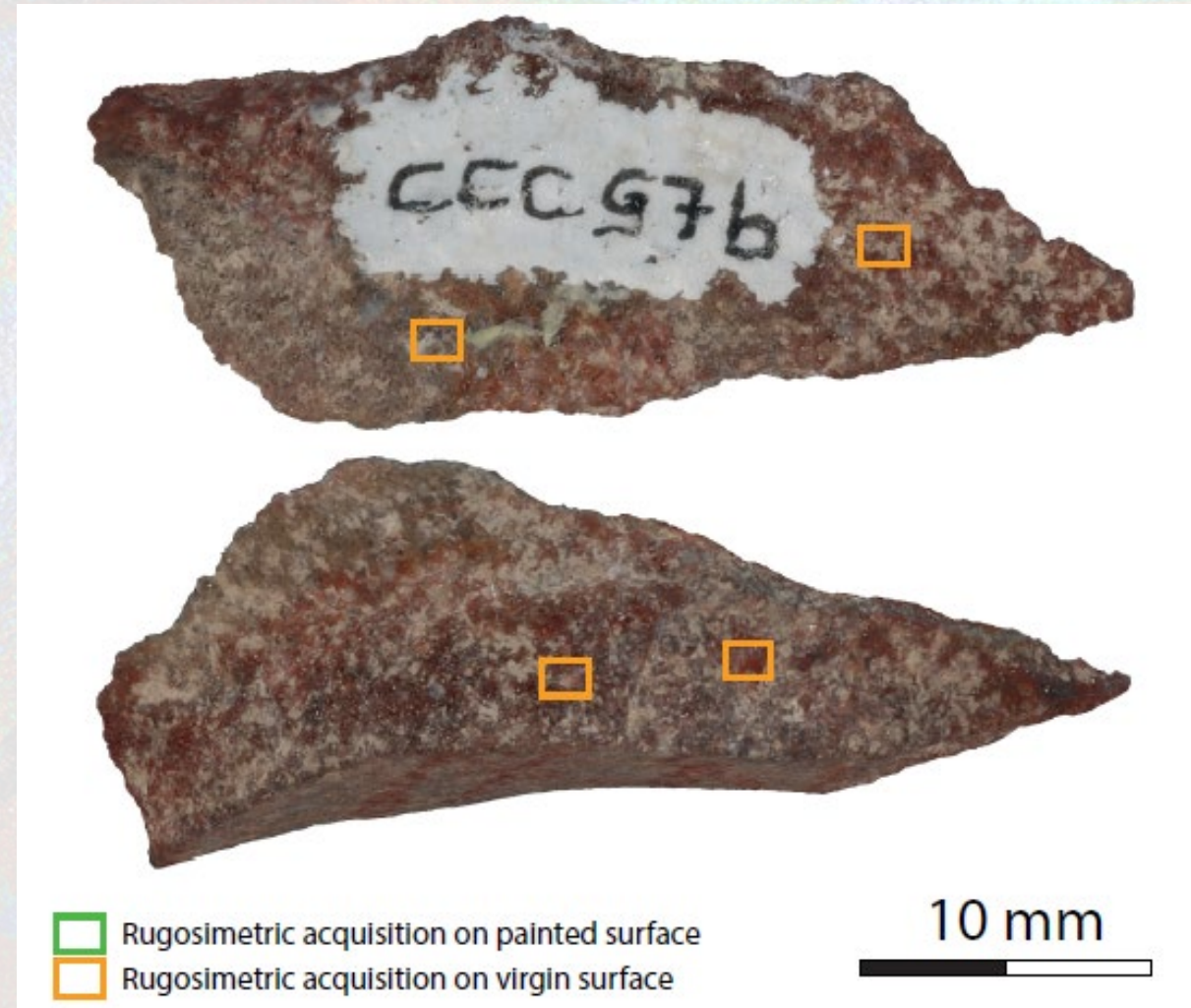
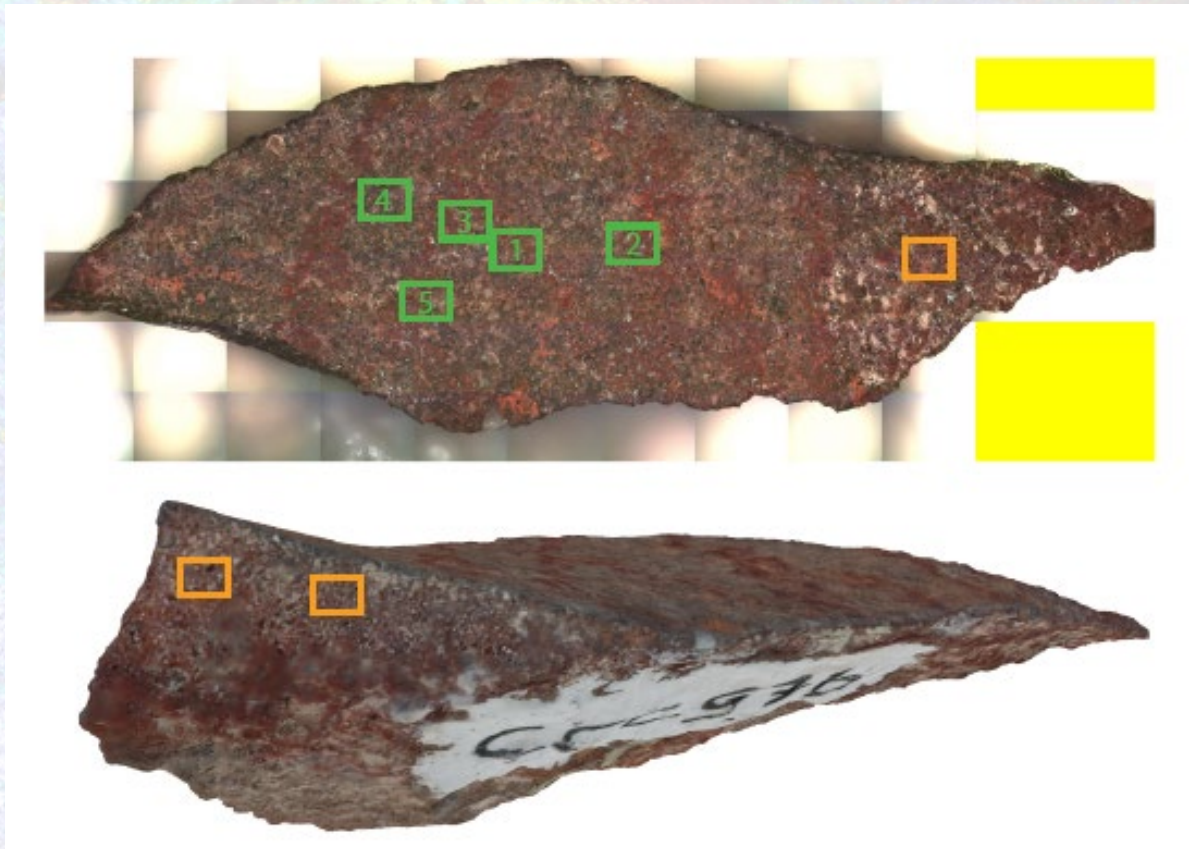
Preparation (?) of surface before drawing

Blombos Cave



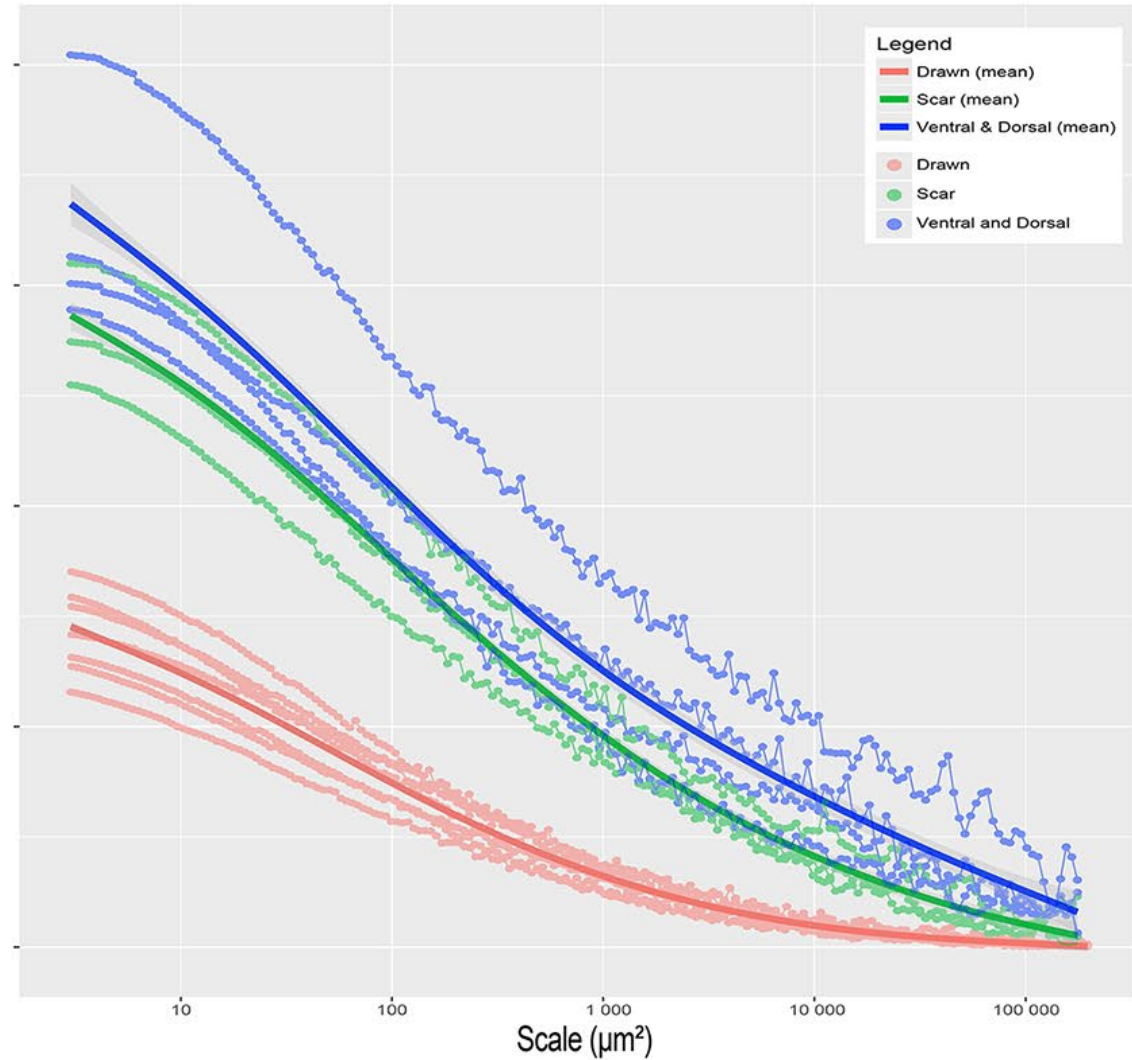
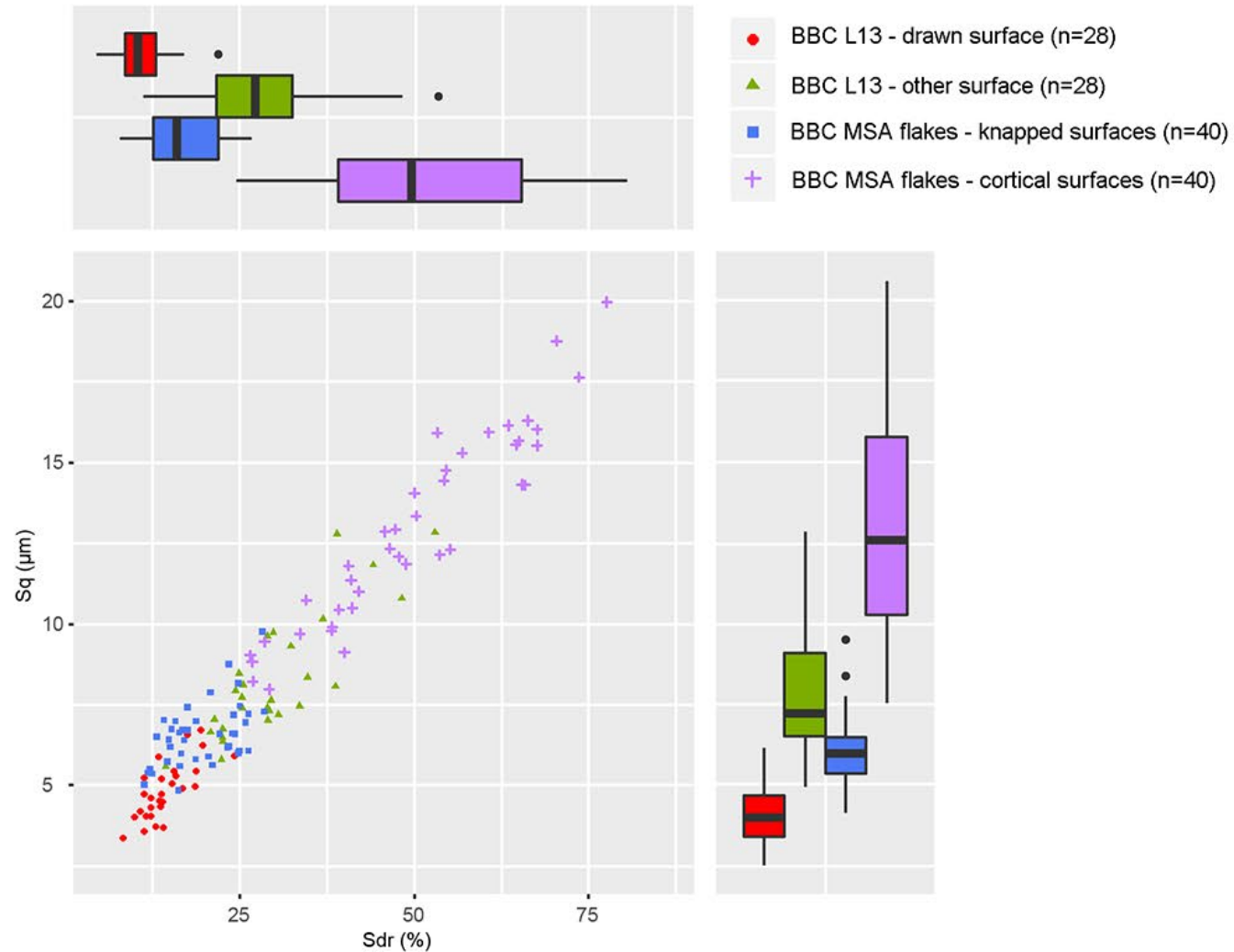
Preparation (?) of surface before drawing

Blombos Cave



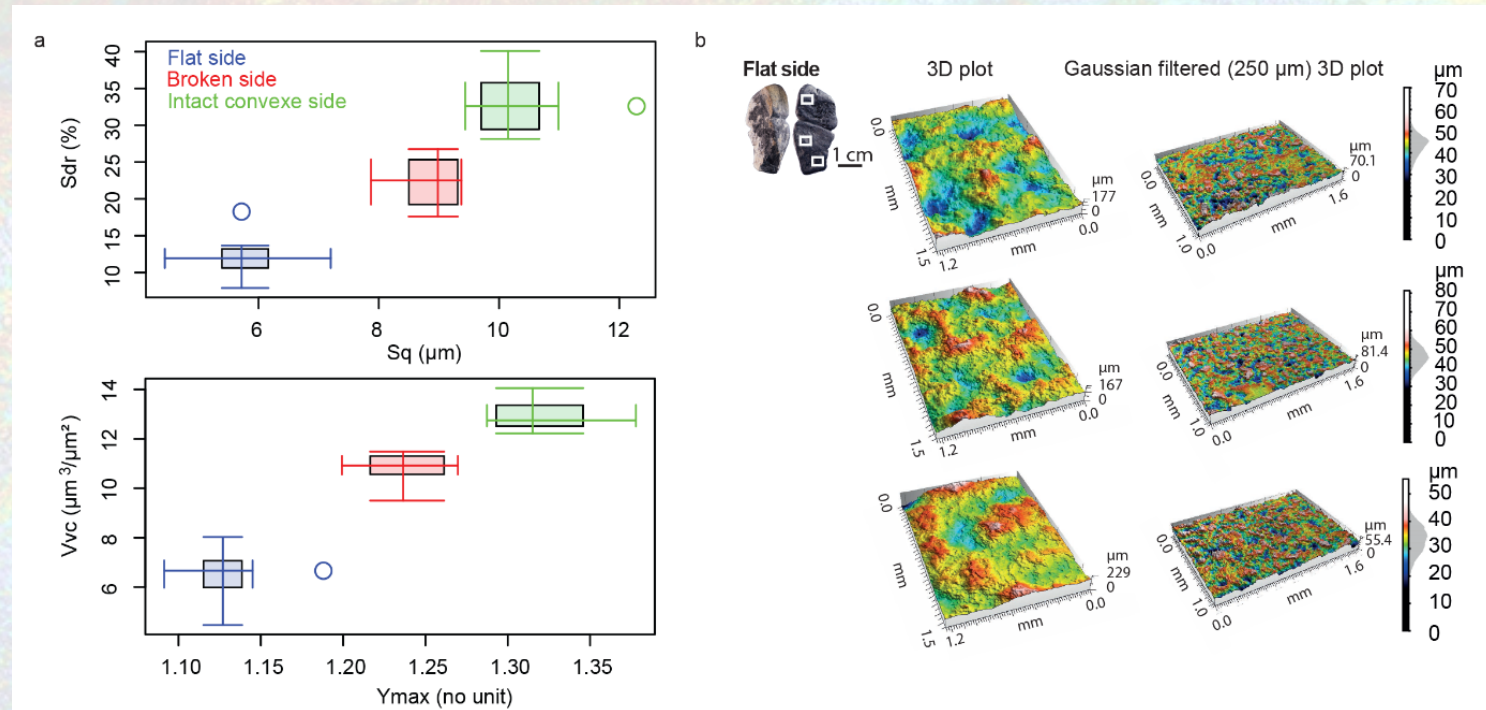
Preparation (?) of surface before drawing

Blombos Cave



Different surface textures on same artifact

Tolbor pendant



An anthropomorphic pendant discovered on the site of Tolbor shows different textures on its different faces.

Intra-object surface texture comparison with confocal microscopy confirms the naked-eye observations.

Probably use-wear pattern from contact with soft material for a long time.

