Spiralled patchwork in pottery manufacture and the introduction of farming to Southern Europe

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Pottery-manufacturing sequences can act as proxies for human migration and interaction. A good example is provided by the 'spiralled patchwork technology' (SPT) identified at two key early farming sites in the Ligurian-Provencal Arc in the north-west of the Italian peninsula. SPT is distinct from the ceramic technology used by early farmer communities in south-east Italy that show technical continuity with the southern Balkans. Macroscopic analysis and micro-computed tomography suggests the presence of two communities of practice, and thus two distinct social groups in the northern Mediterranean, one of southern Balkan tradition, the other (associated with SPT) of as yet unknown origin. The identification of SPT opens the exciting possibility of tracing the origins and migrations of a second distinct group of early farmers into Southern Europe.

Keywords: Mediterranean, Early Neolithic, farming, ceramics, Impressed Ware, micro-computed tomography

Supplementary videos

Supplementary video 1. Related to Figure 3 a&b. µ-CT analysis of two experimental control sherds. Video shows segmented porous system (gold) and surfaces (grey). Left: spiralled coil, mimicking the patches used in SPT. Right: regular coiling technique. (3.3 MB, 9 seconds)

Supplementary video 2. Related to Figure 3c. µ-CT analysis of archaeological sherd 1 from Abri Pendimoun. Segmented as in Supplementary video 1. (3.2 MB, 9 seconds)

Supplementary video 3. Related to Figure 3d. µ-CT analysis of archaeological sherd 2 from Abri Pendimoun. Segmented as in Supplementary video 1. (3.1 MB, 9 seconds)

Supplementary video 4. Related to Figure 3e. µ-CT analysis of archaeological sherd 3 from Abri Pendimoun. Segmented as in Supplementary video 1. (3.1 MB, 8 seconds)

Supplementary video 5. Related to Figure 4. µ-CT analysis of a reconstructed archaeological ceramic from Abri Pendimoun. Tomogram data (bin = 2) is presented, followed by a segmentation of large inclusions (red) and ceramic surface (grey). (6.7 MB, 33 seconds)

Technical summary

Our macroscopic analytical protocol implemented in Abri Pendimoun, Arene Candide, Ripa Tetta and Colle Santo Stefano relies on ethnographic (Gelbert 2003) and experimental (Vandiver 1987; Courty & Roux 1995; Thér 2016) reference works, which showed a direct link between given technical gestures applied on the clay during the production of a ceramic and specific macrotraces on the sherd surfaces and sections. Each ceramic was thus examined macroscopically with the focus on 1) the organisation of the pores and the non-plastic inclusions, as well as the associated discontinuities in radial and equatorial sections; 2) the characteristics of the surface topography; 3) the variations in thickness and texture of the walls; and 4) the fracture networks (Livingstone Smith 2001). Macroscopic examinations were complemented by a micro-topographic mapping of sherds from Abri Pendimoun showing diagnostic macrotraces. Sherd surfaces were scanned using the Artec Space Spider device (with a resolution of 0.1mm and a point accuracy of 0.05mm) and were segmented using the Artec studio program. A planarity analysis, set with an index of tolerance of 0.3mm, was then performed using the 3D Reshaper program (Haxagon Technodigit), enabling reading the micro-reliefs on the surface of sherds.

In Abri Pendimoun, a non-destructive µ-CT protocol integrating different levels of resolution was implemented. Five archaeological sherds, chosen because they showed diagnostic macrotraces, and two experimental controls with controlled manufacturing conditions were scanned using a SkyScan-1178 X-ray micro-computed tomography system (Bruker) with a beam energy of 60kV, a 0.5mm thick aluminum filter, 0.9° rotation step and a resolution of 104µm. The potential of the µ-CT method in the visualisation of the porous system of archaeological sherds was recently demonstrated (Kahl & Ramminger 2012; Sanger *et al.* 2012), but to date, it was not associated with macroscopic analysis of archaeological and experimental sherds, and no reconstructed vessel was investigated with this level of resolution. A pot with reconstructed profile (vase AP_50) was acquired, using the V|tome|x L 240 device (GE Sensing & Inspection Technologies Phoenix X-ray) of the AST-RX platform at the Museum of Natural History in Paris, with a beam energy of 165kV and flux of 270µA. A 360° rotation with a 0.12° rotation step and a resolution of 91µm was used. The large multi-axis manipulator of this device enables the acquisition of an object of several centimetres. All of the data acquired with these different devices were visualised and processed on the free image-processing package Fiji (https://fiji.sc/). Data segmentation was performed on Amira software (FEI) at the Pasteur Institute in Paris. Semi- automated thresholding was used to segment the porous system and mineral inclusions. At the scale of the archaeological sherds and the experimental controls, the morphology, the density and the organisation of the porosity revealed 1) alignments of small pores trapped in the different shaped elements, and 2) discontinuities corresponding to the joints between those same elements. The closed porosity characterising the internal structure of the samples was distinguished from the open porosity in contact with the surface of the objects. At the scale of the reconstructed ceramic, the inclusions, and particularly the largest inclusions that are less prone to move during the surfaces regularisation, appeared to be the best indicator of the technical gestures implemented. These inclusions were segmented using the islands filter with a threshold of 50 voxels.

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