Exploring the Protoaurignacian technological variability at Fumane Cave (Italy) through core reduction intensity approaches

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Introduction

The Protoaurignacian represents the earliest phase of the Aurignacian technological complex, characterised by the appearance of distinctive tools and decorative elements, marking a crucial stage in the dispersal of modern humans across Europe approximately 44-42 ky BP.

This paper explores the production of blades and bladelets within the Protoaurignacian context to shed light on the technological behaviors and strategies of early human foragers. Despite their morphological similarities, the relationship between the production sequences of blades and bladelets remains elusive, mainly due to the lack of empirical data from comprehensive lithic refitting programs.

We aim to address this gap by introducing a novel quantitative method adapted from the Volumetric Reconstruction Method[1] to measure the reduction intensity of blade and bladelet cores.

Archaeological assemblage

Located in Western Lessini plateau (Fig. 1), Fumane Cave is a key site for understanding the earliest stages of the European Upper Paleolithic[2].

The early Protoaurignacian units A2 and A1 were excavated during several excavation fieldwords (1982-2006) across ca. 100 m^2.

Five main varieties of local raw material (<5km) were identified: Maiolica, Scaglia Rossa, Scaglia Variegata, Scaglia Variegata Type 3, and Other Rocks

To test the archaeological application of this VRM adaptation we used from levels A2 and A1[3].

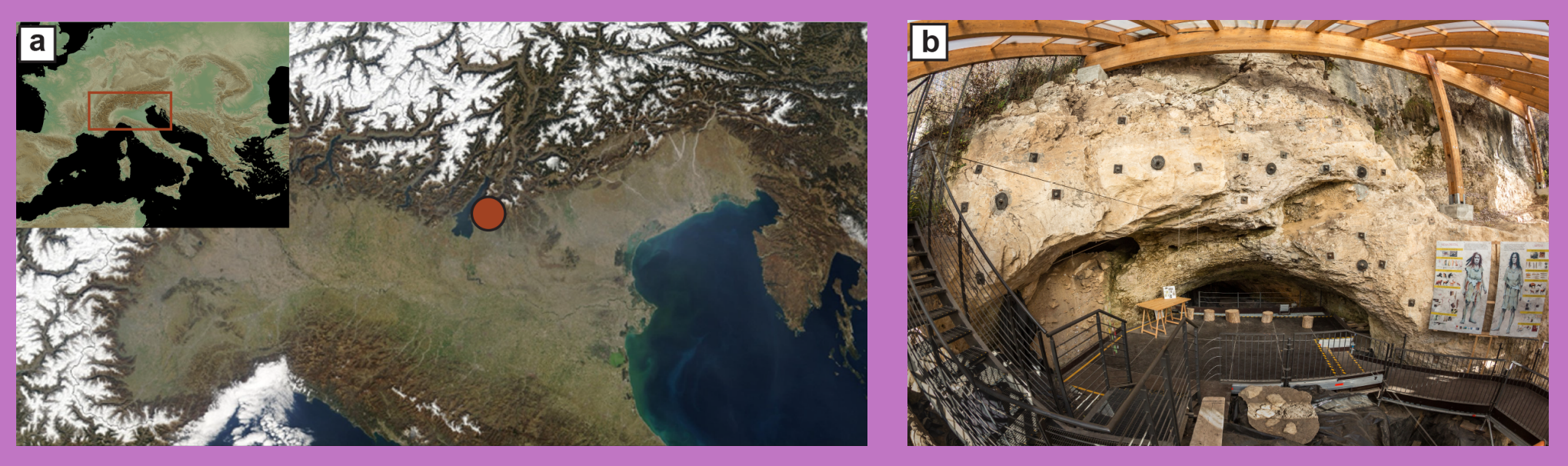
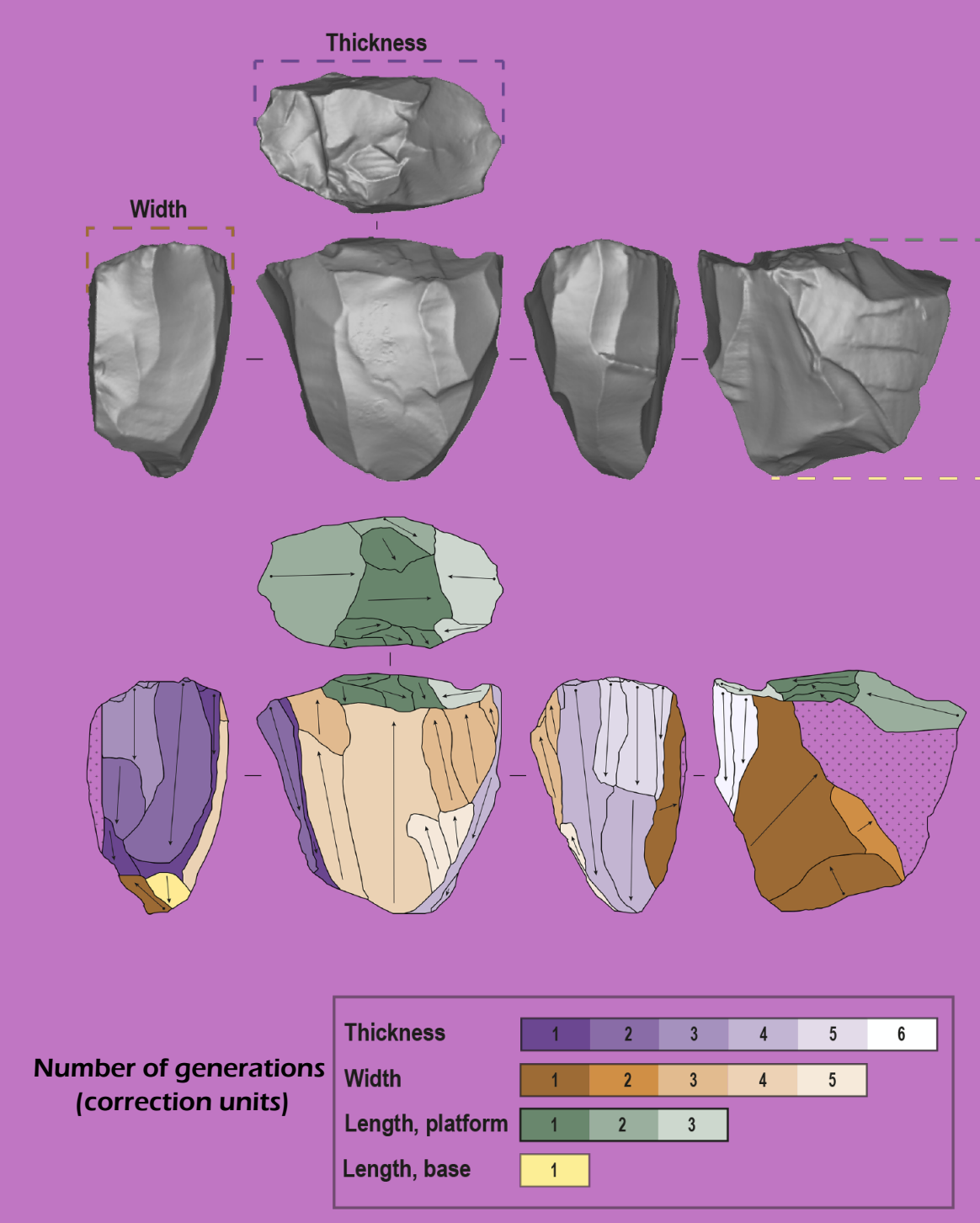


Fig. 1. a) Physical map of Europe showing the geographical location of Fumane Cave (red dot) in northeastern Italy; b) View of the site's main tunnel A, featuring modern scaffolds for musealization purposes.

Volumetric Reconstruction Method

The diacritic analysis of the cores allows to identify the number of generations of removals that affected the maximum morphometric dimensions, which will be considered as "corrections required" for each morphological axis (Fig. 2).



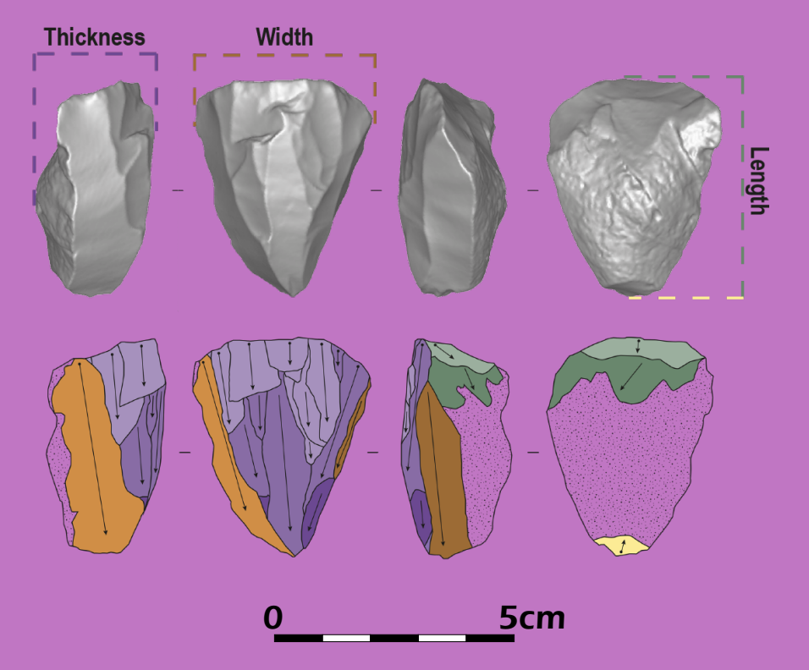


Fig. 2. Adaptation of VRM application.

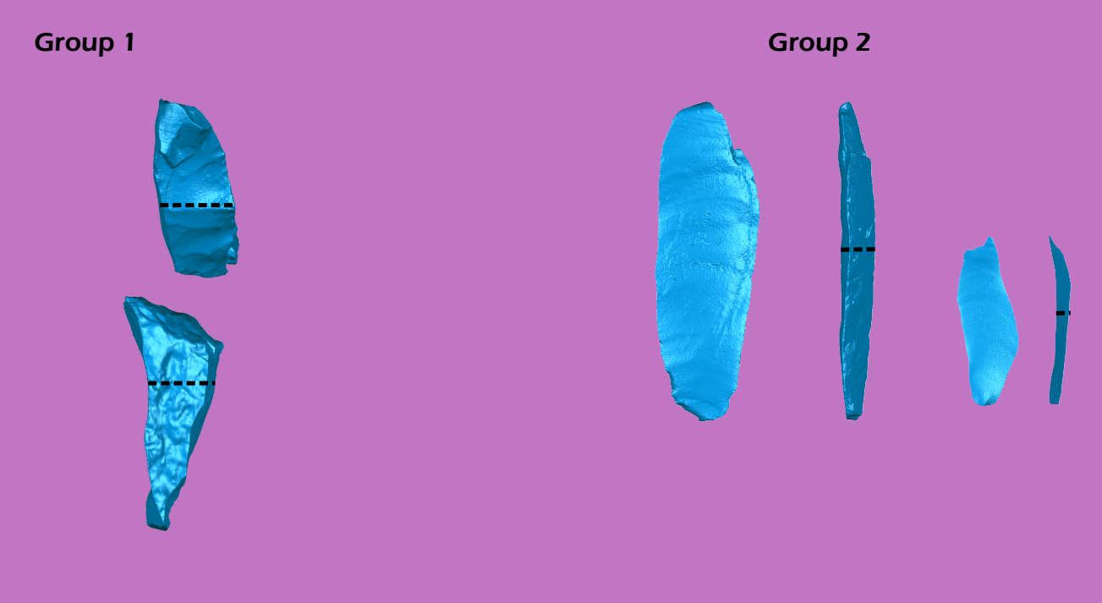


Fig. 3. Group of products used as Unit corrections.

Different from the original VRM approach[1], the mean/median flake thickness (FTh) of two groups of products were created to correct the dimensions of cores:

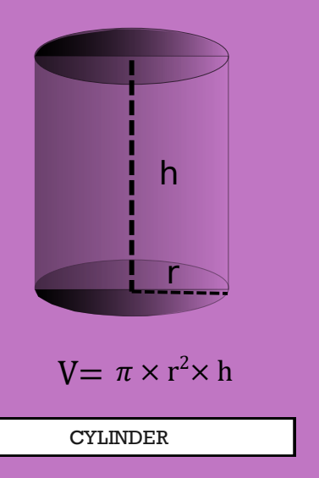
Group 1: flakes and tablets, was used to correct the length of cores in the platform area.

Group 2: flakes, blades, and bladelets was used to correct the distal length (base), width, and thickness of cores (Fig. 3).

These estimated original dimensions for each nodule are used as reference for applying the cylinder volume formula (Fig. 4) and reconstruct the Estimated Original Volume for the nodules.

Based on this parameter, we can calculate an estimated original volume.

Thus, reduction can be expressed as percentage (%) of extracted volume.



$$V = \pi \times r^2 \times h$$

Fig. 4. Cylinder volume formula to obtain the estimate volume used in this study.

Results

Raw material

The reduction intensity estimated using the VRM is relatively high with central values close to 70-80% of the extracted volume. This trend is consistent across different types of raw materials and there were no significant differences in the central values among them. However, some raw materials exhibit higher variability in reduction intensity (Fig. 5).

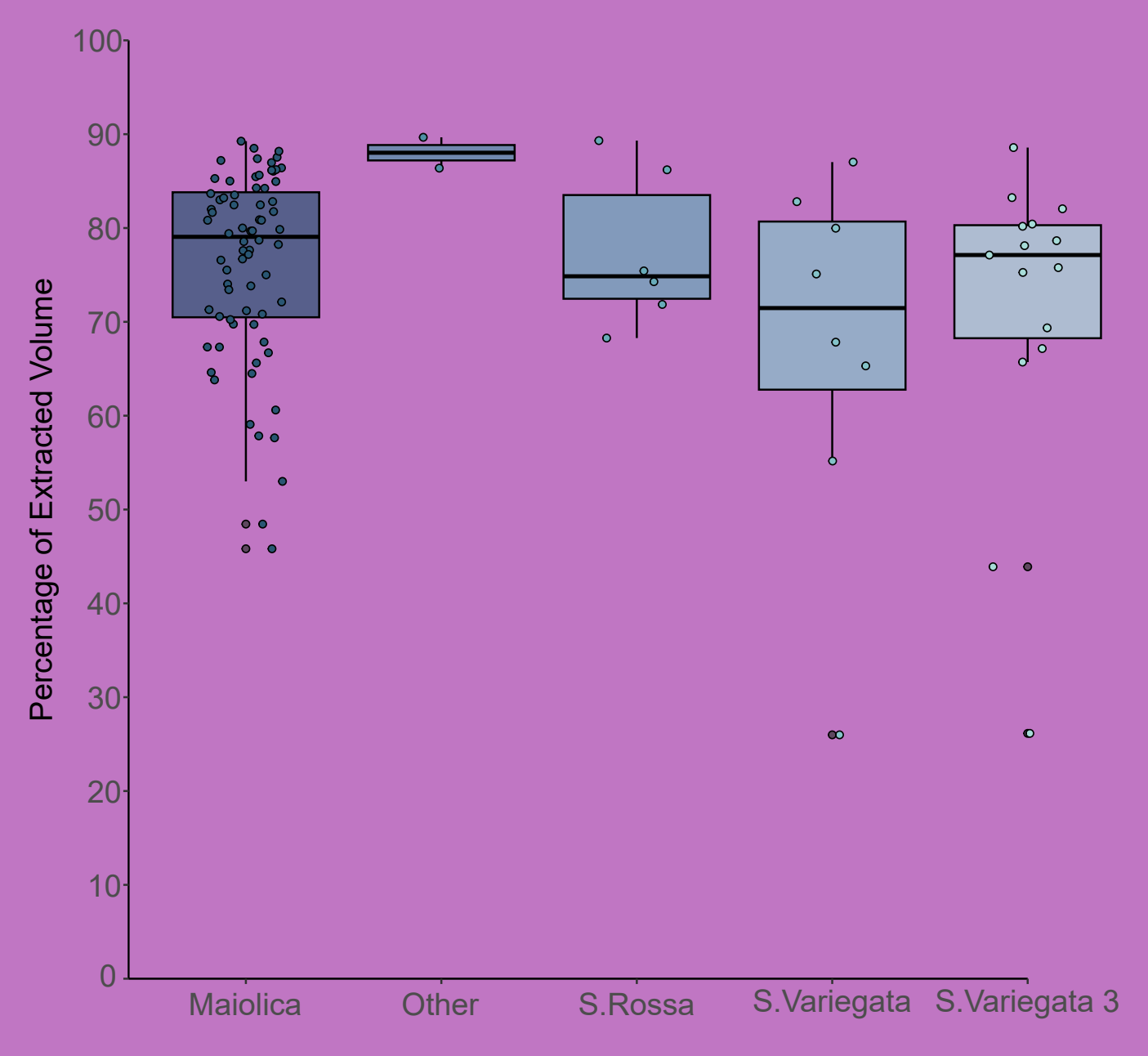


Fig. 5. Percentage (%) of Extracted Volume by raw material.

Weibull distributions reveal minimal disparities in the discard patterns of cores across raw materials. In general, the curves show a high degree of discard rate when the cores are more reduced and exhausted (Fig. 6).

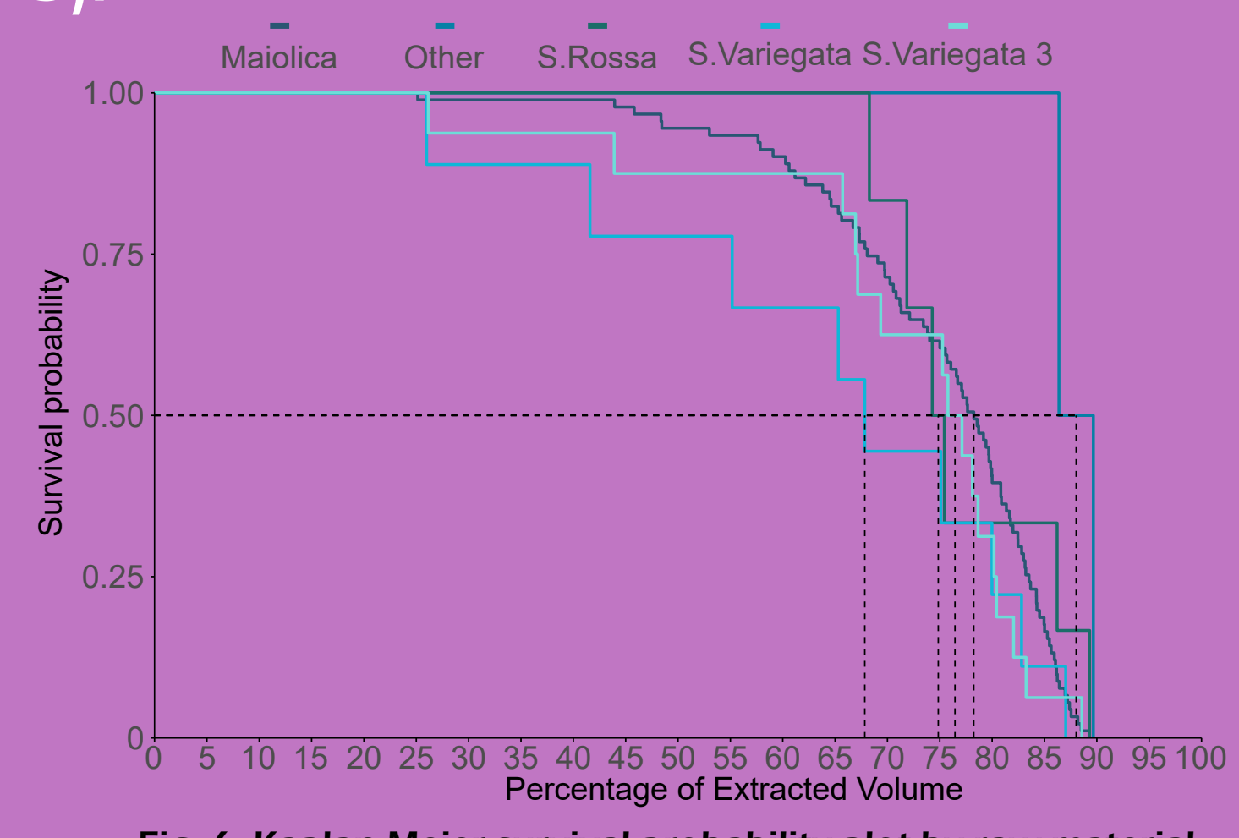


Fig. 6. Kaplan Meier survival probability plot by raw material.

Knapping strategies

Initial cores have lower reduction intensity but can reach up to 70-85% of extracted volume (Fig. 7).

Narrow-side and semicircumferential cores show slightly lower reduction intensity while wide-faced cores have higher values.

Multiplatform cores have higher reduction intensity as the knapping strategies applied are aimed at maximising raw material utilisation.

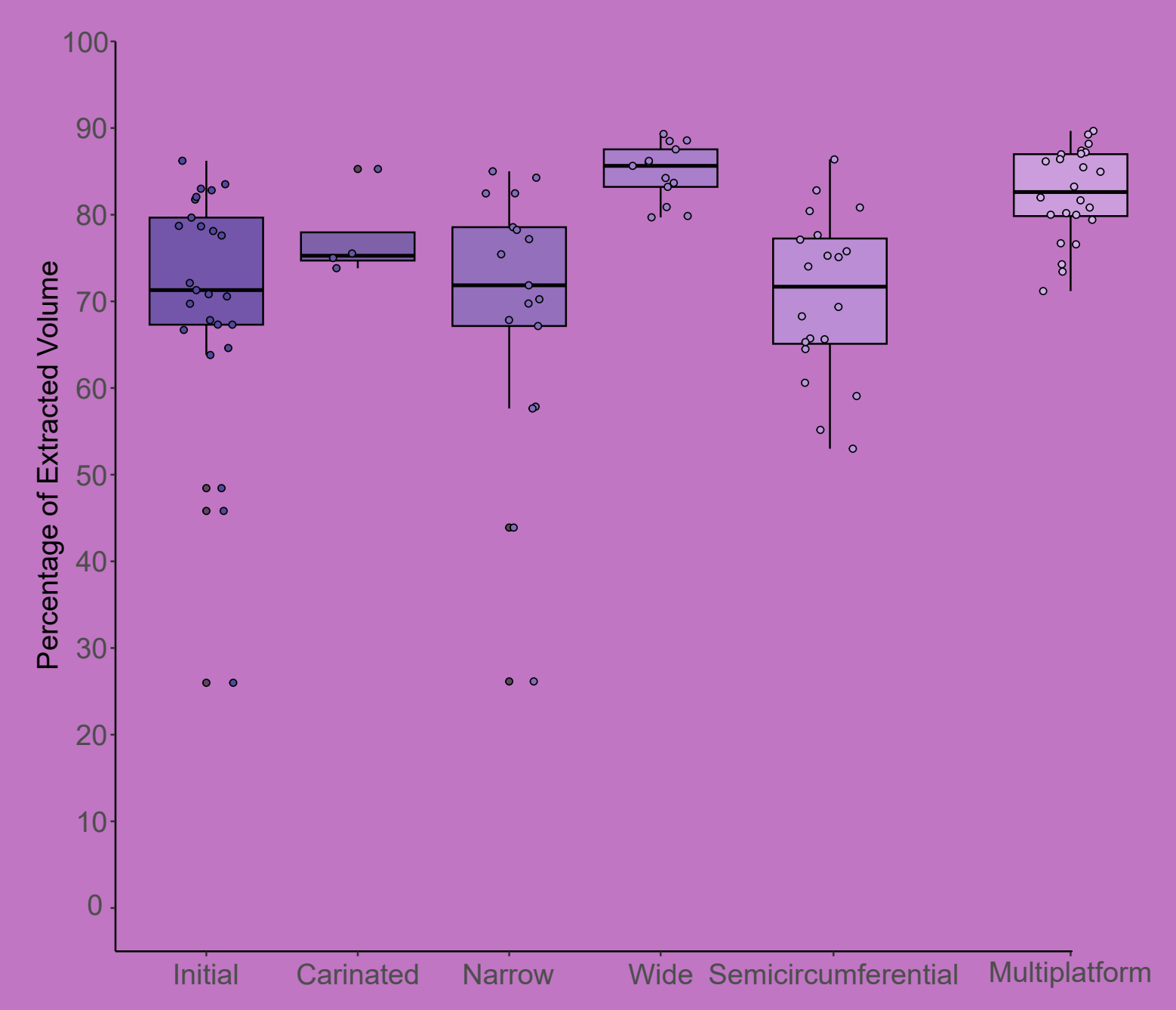


Fig. 7 Percentage (%) of Extracted Volume by core type.

Blank production

Percentage of extracted volume indicates no significant differences, particularly between Blade-Bladelet and Bladelet cores (Fig. 8). Blade and Blade-Flake is generally less reduced, suggesting a possible shift from blade to bladelet production in some cores, while others are initially oriented towards bladelet production.

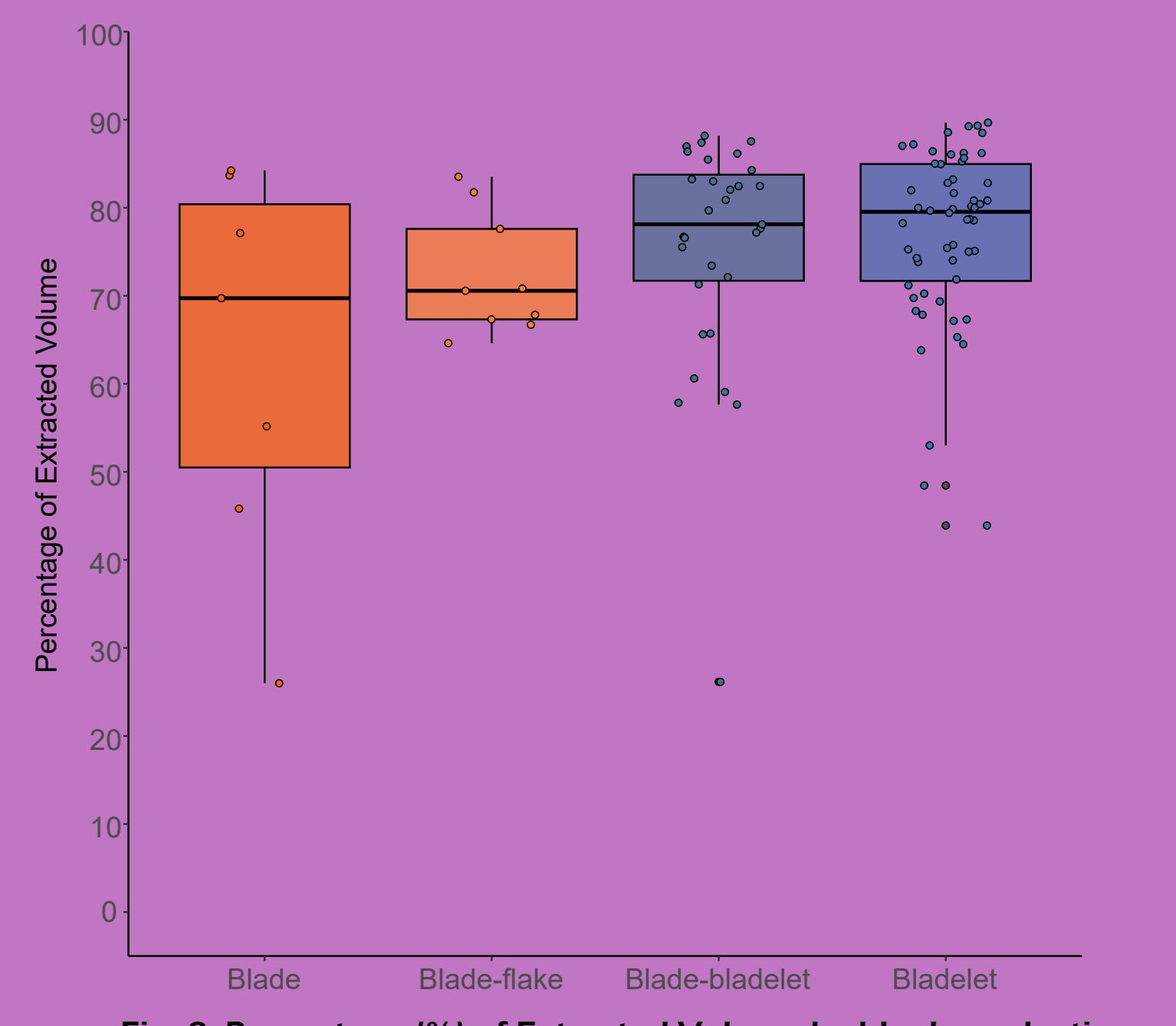


Fig. 8. Percentage (%) of Extracted Volume by blank production.

Discussion

Raw material

The study found slight differences in the management of raw materials, with lower reduction intensity observed in some Maiolica cores due to its abundance in the surrounding area.

The chert varieties used were locally sourced within a kilometer of the cave, indicating possible systematic transport of blanks to the site.

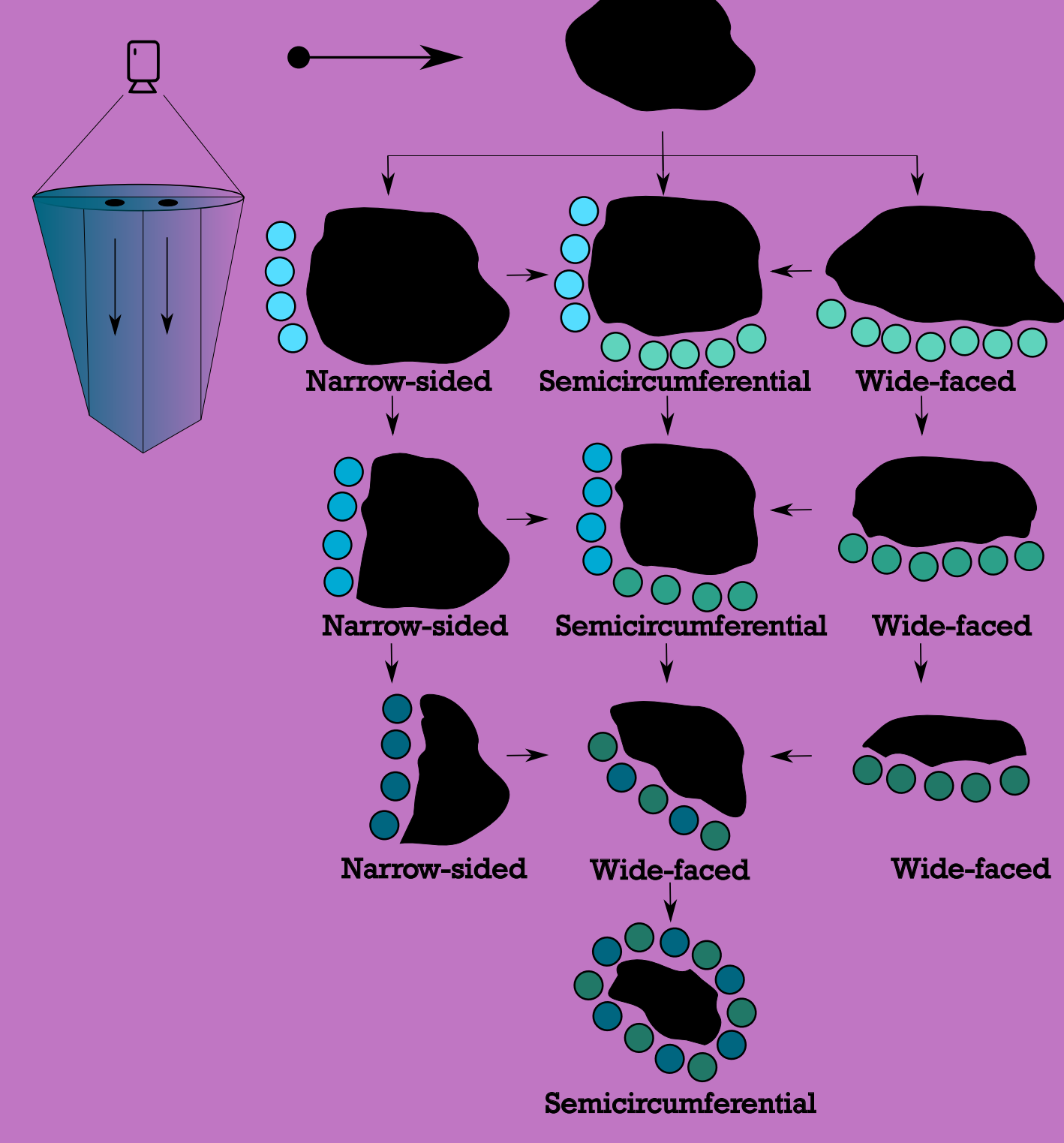


Fig. 9. Operatory Field of blades and bladelets cores.

Knapping strategies

Allometric changes during the reduction process can result in semi-circumferential cores with removal scars on adjacent faces. Exploitation on narrow or wide faces or multiple surfaces can lead to allometric changes and a change in core typology, with wide-faced cores having a higher reduction intensity and percentage of extracted volume. These changes can be observed through examination of the platforms of the cores (Fig.9).

Equifinality is present in reduction sequences where increasing reduction intensity eventually leads to wide-face core types, after recurrent knapping on narrow and semicircumferential surfaces (Fig. 10).

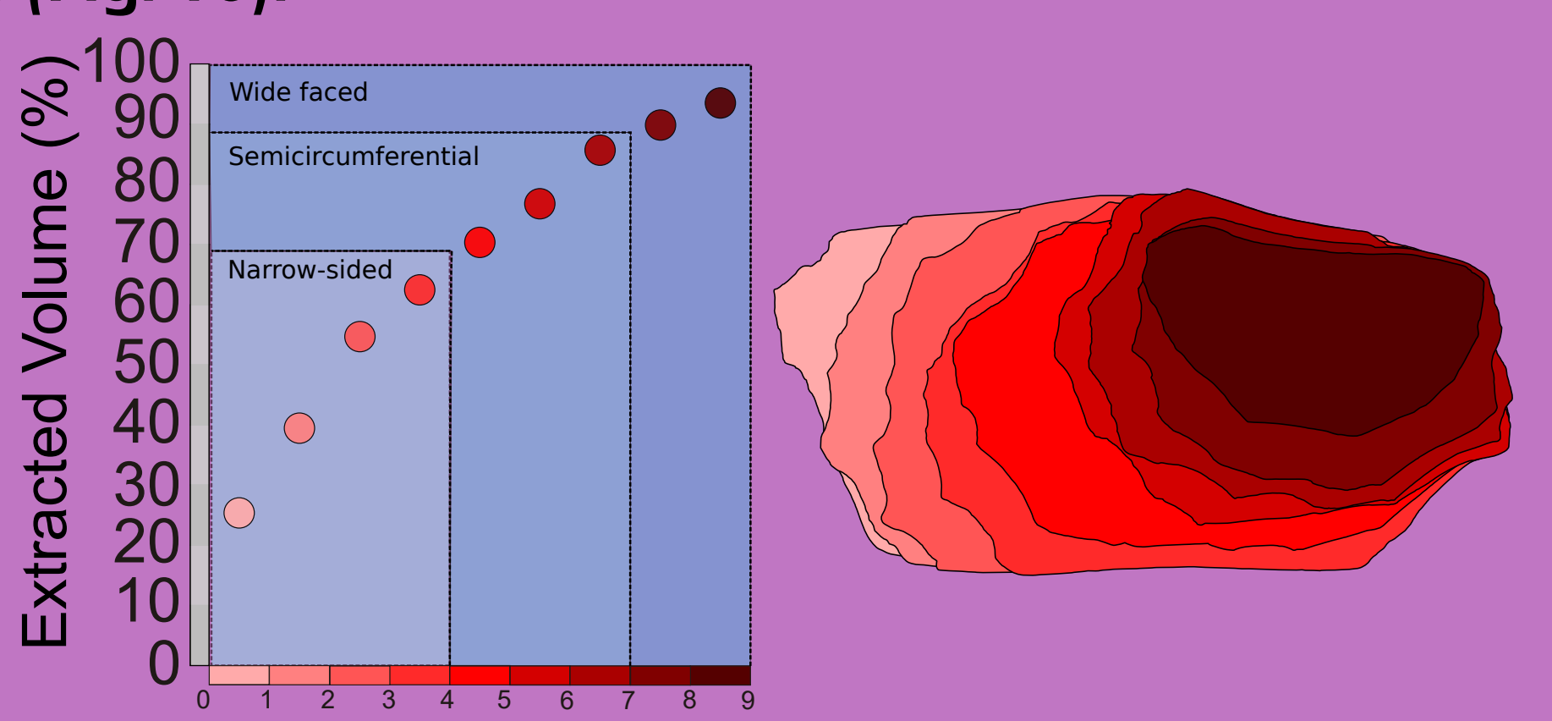


Fig. 10. Changes in the type of cores along the same reduction sequence.

Blank production

The main production goal is to obtain bladelets[2], but there is some flexibility observed with a transition from blades to bladelets throughout the reduction sequence.

Allometric changes and the presence of both scar blades and bladelets in some cores allow for a certain degree of flexibility in exploitation objectives, switching from blade to bladelet production (Fig. 11a).

However, there is also evidence suggesting greater independence between the two objectives, such as the high degree of general reduction of the cores regardless of the type of reduction and the existence of types of exploitation oriented exclusively towards the exploitation of blades or bladelets (Fig. 11b).

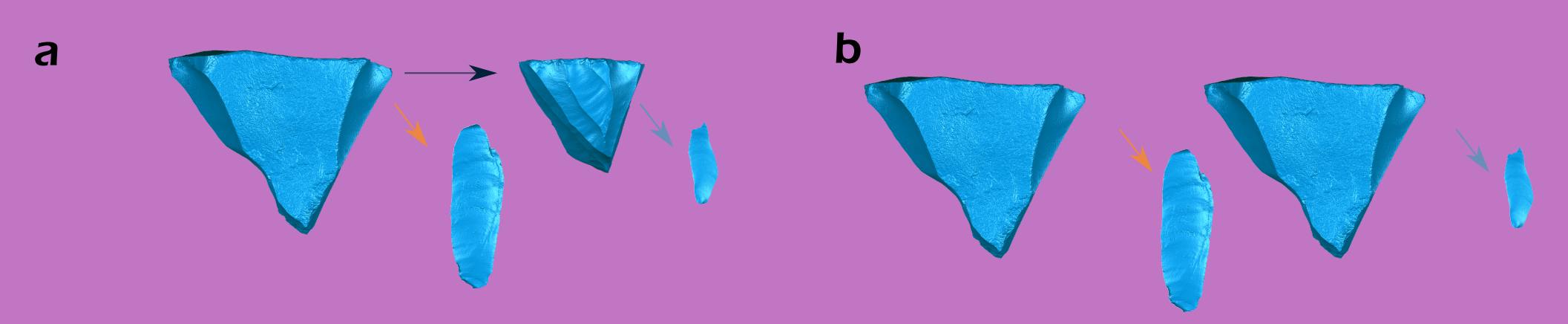


Fig. 11. Scheme of the relationship between blades and bladelet reduction sequences.
a)Interrelated reduction sequences b) Independent reduction sequences

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