Blade and Bladelet Cores in the Protoaurignacian: A New Method for Measuring Reduction Intensity

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Introduction

Reduction intensity is pivotal in understanding the technological variability of lithic assemblages as well as in identifying the processes involved in the formation of archaeological assemblages.

The reduction intensity allows to establish a time frame within the life history of cores, proving thus to be a useful tool when discussing core classifications and the interrelation of core types within a given assemblage.

While there are several methods to study reduction intensity in lithic artefacts such as retouched tools, large cutting tools and cores, blade and bladelet cores have generally been overlooked in this aspect.

In this paper we develop a method to measure the reduction intensity in blade and bladelet cores deriving from an adaption of the Volumetric Reconstruction Method (Lombao et al., 2020)

Goals

- To experimentally test the accuracy of the adaptation of VRM basis on blade and bladelet cores.
- To test the archaeological application in a Proto-aurignacian assemblage.

Fig. 1. Experimental knapping process.

Archaeological assemblage

Located in Western Lessini plateau, Fumane Cave is a key site for understanding the earliest stages of the European Upper Paleolithic (Falcucci & Peresani, 2018).

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 (mainly composed by Oolitic and Eocenic chert).

To test the archaeological application of this VRM adaptation we used 125 cores (3D models available at Falcucci & Peresani, 2022) from levels A2 and A1.

Methods

To check the perfomance of this method we applied the following tests:

Average error

Expresses the average of the difference between each estimated value and its actual one.

Bland-Altman test

A graphical method for comparing two measurement techniques on the same quantitative variable, in order to elucidate which of the geometric formulas is more accurate.

Weibull distributions

Is a continuous probability distribution commonly used to model failure rates. Here, we use this distribution to model core reduction intensity.

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. 3).

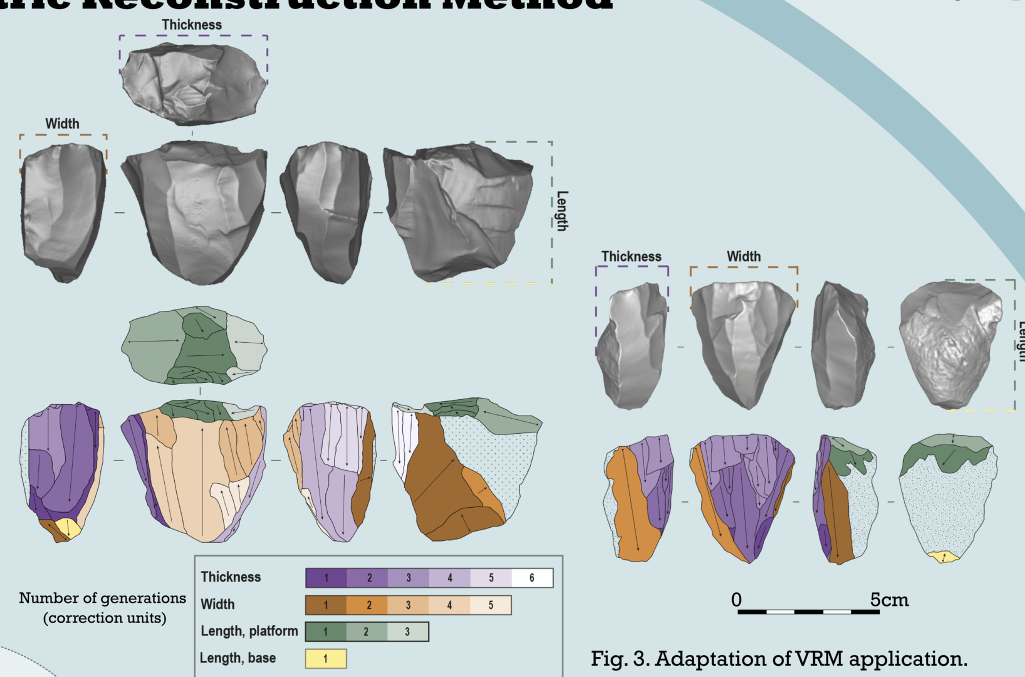

Fig. 3. Adaptation of VRM application.

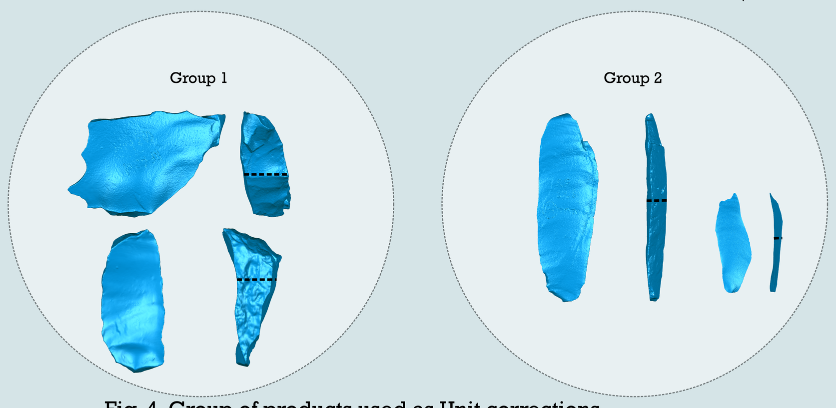

Fig. 4. Group of products used as Unit corrections.

Different from the original VRM approach (Lombao et al., 2020), the mean/median flake thickness (FTh) of two groups of products were created to correct the dimensions of cores:

Group 1: consisted of flakes and tablets and was used to correct the length of cores in the platform area.
Group 2: consisted of flakes, blades, and bladelets and was used to correct the distal length (base), width, and thickness of cores (Fig. 4).

The number of "correction units" required for each axis are applied, generating new "corrected" dimensions for each core, representing the presumed dimensions of the original nodule before knapping.

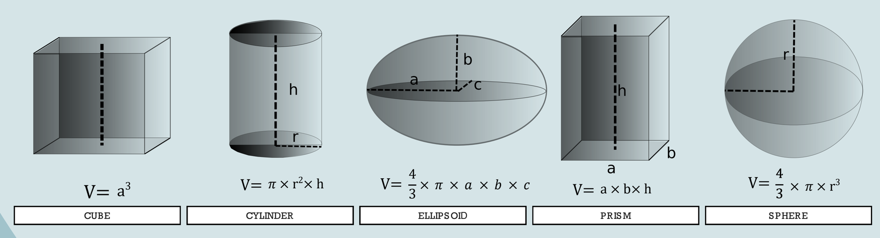

Fig. 5 Geometric formulas to obtain the estimate volume used in this study.

These estimated original dimensions for each nodule are used as reference for, applying different geometric volume formula (i.e. ellipsoid, cylinder...), reconstruct an 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.

Experiment

During the experiment, 7 knapping sequences were performed on 5 nodules of varying weight (220-1080g.), including two additional sequences using the largest pieces of a broken nodule.

The experiment was carried out by an experienced knapper (Fig. 1), who aimed to produce blades and bladelets using common platform reduction strategies and specifically targeted blade and bladelet implements.

To document the core reduction process, each core was scanned using an Artec Spider 3D scanner and weighed with a digital scale before and during the knapping process.

Multiple scans were done at different stages of reduction sequences (Fig. 2), with a minimum of four and a maximum of ten stages depending on the size of the core and duration of the knapping, resulting in a total of 50 3D cores.

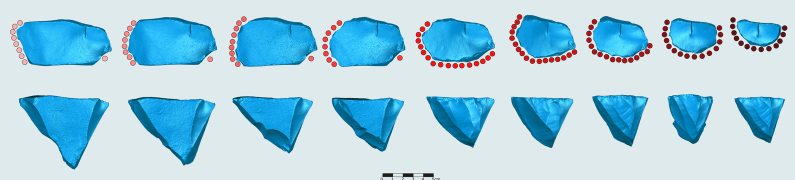

Fig. 2. Experimental core reduction sequence.

Experimental results

The Prism and Cube geometric formulas overestimate volumes while Cylinder, Ellipsoid and Sphere formulas are more similar compared to real data (Fig. 6).

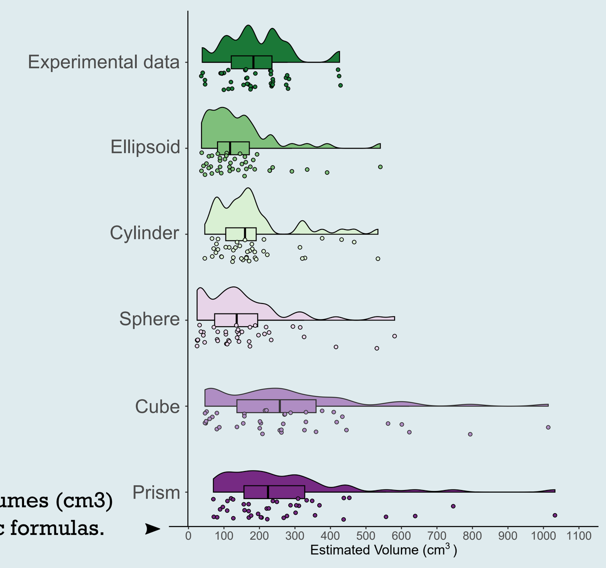

Fig. 6. Estimated Volumes (cm3) according geometric formulas.

Different geometric formulas have unequal performance in estimating core reduction intensity with only Cylinder and Sphere having no statistically significant differences in distribution.

However, Sphere formula present some inadequate errors up to -200% (Fig. 7).

Fig. 7. Percentage of difference between Actual % Extracted Volume and Estimated Extracted Volume according geometric formula.

The Bland-Altman test shows that for Cylinder (Fig. 8), there is a bias of 3.16 and a range of agreement from -28.73 to 35.06. The bias is not significant since the 95% confidence interval includes the value 0. Cases with larger differences are spread along the X axis and are not influenced by reduction intensity.

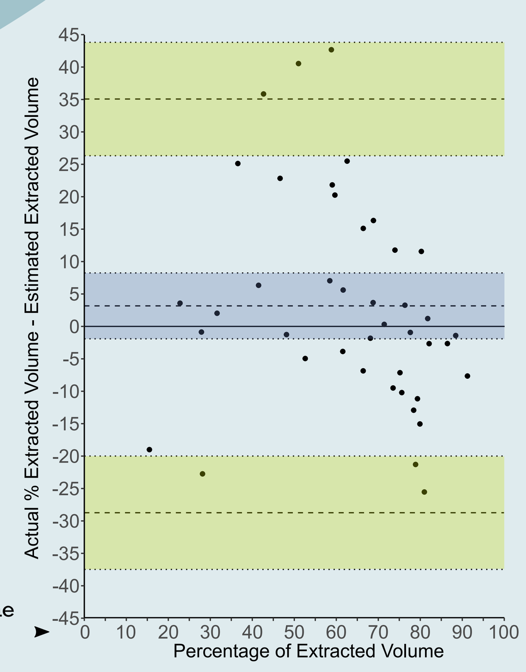

Fig. 8. Bland-Altman test for the cylinder geometric formula.

Archaeological 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. 9).

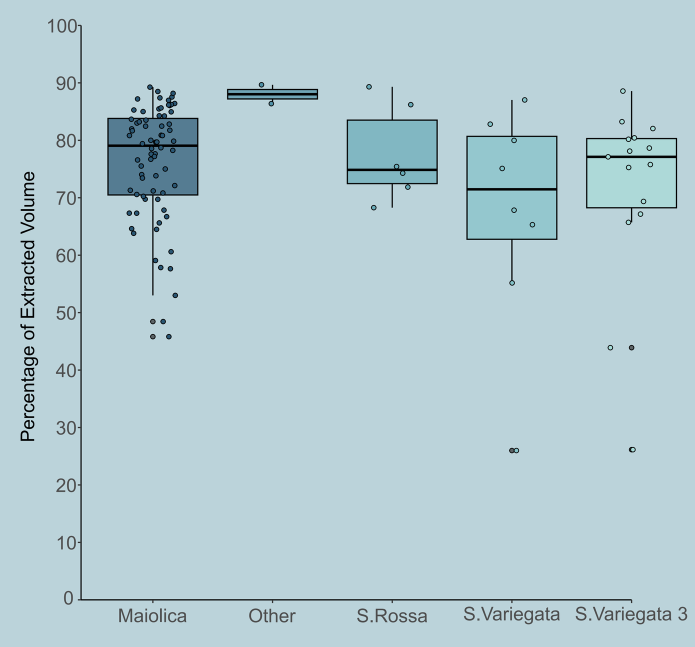

Fig. 9. Percentage (%) of Extracted Volume by raw material.

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. 10).

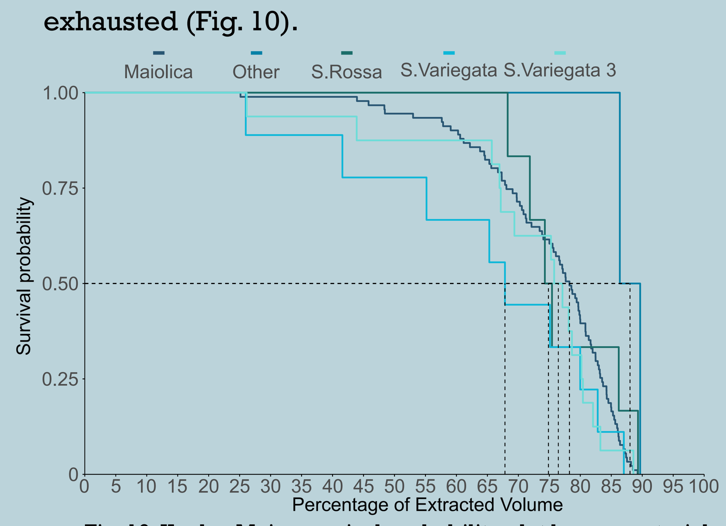

Fig. 10. Kaplan Meier survival probability plot by raw material.

Knapping strategies

Initial cores have lower reduction intensity but can reach up to 70-85% of extracted volume (Fig. 11).

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.

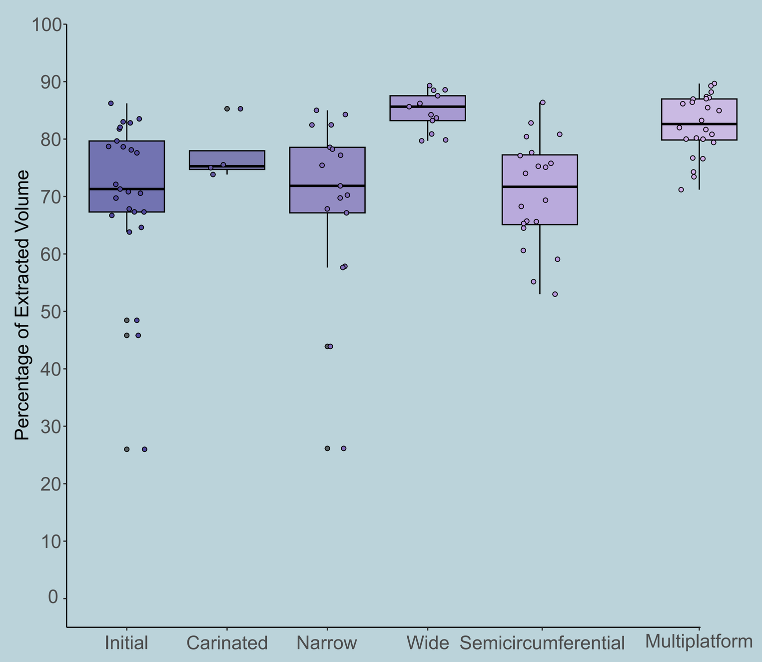

Fig. 11. Percentage (%) of Extracted Volume by core type.

Blank production

Percentage of extracted volume indicates no significant differences, particularly between Blade-Bladelet and Bladelet cores (Fig. 12). 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.

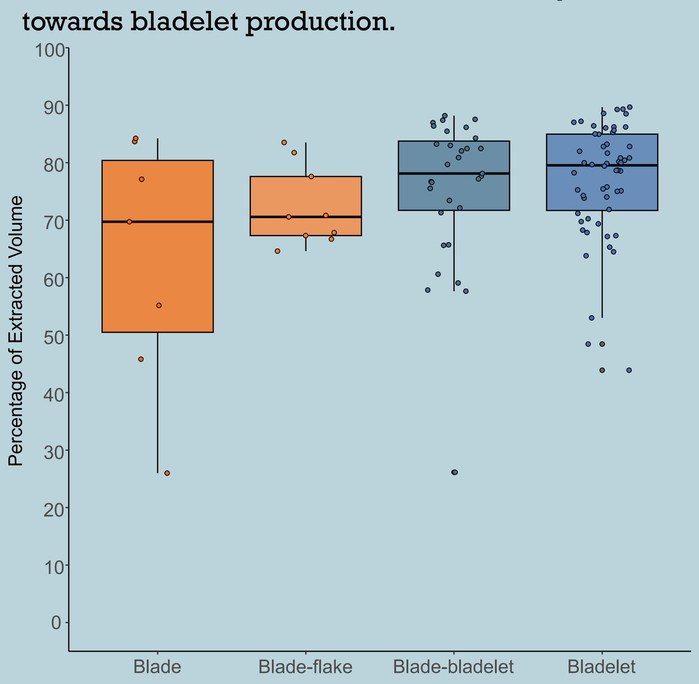

Fig. 12. Percentage (%) of Extracted Volume by blank production.

Discussion

Cylinder formula provides the best fit between the estimated and real original volume values.
The results show that this adaptation VRM is a robust and reliable method for studying reduction intensity in Upper Palaeolithic assemblages.

Raw material

The study found slight differences in the management of raw materials, with lower reduction intensity 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.

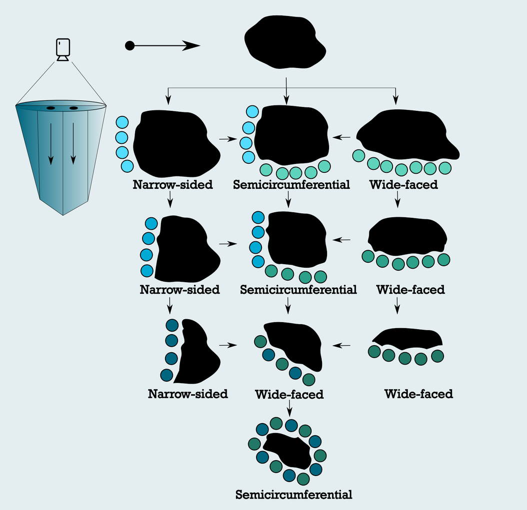

Fig. 13. Operatory Field of blades and bladelets cores.

Core type

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.13-14).

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. 13-14).

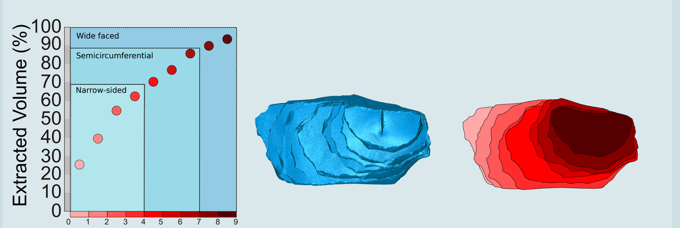

Fig. 14. Changes in the type of cores along the same reduction sequence.

Blank production

The main production goal is to obtain bladelets, (Falcucci & Peresani, 2018) 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. 15a).

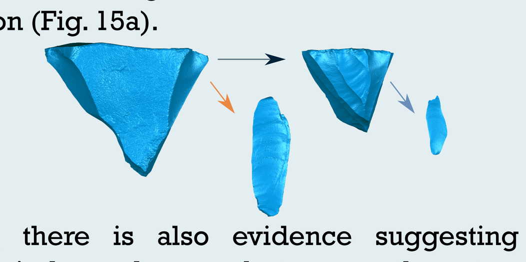

Fig. 15a

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. 15b).

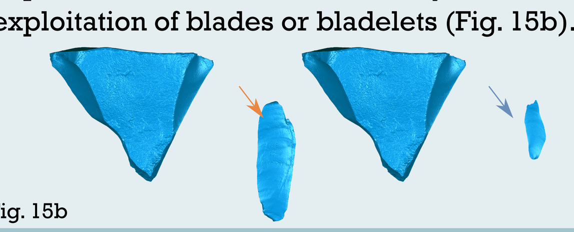

Fig. 15b

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