



Neolithic pottery from the Trieste Karst (northeastern Italy): A multi-analytical study☆



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ABSTRACT

A group of Neolithic potsherds from caves of the Trieste Karst (northeastern Italy) belonging to the Vlaška Group has been studied through a multi-analytical approach mainly based on non-destructive X-ray computed microtomography (μ CT) and portable X-ray fluorescence (XRF), combined with X-ray diffraction (XRD) and optical microscopy (OM) to investigate both manufacture technology and provenance of the vases. Most samples, probably produced using a modelling technique, were made using clay-silt size paste containing quartz inclusions, tempered with the addition of abundant calcite and some limestone fragments. Calcite minerals, very common in the karstic environment, were probably obtained by grinding speleothems. This peculiar paste seems to be typical of the Karst area since prehistoric times. One single sample (5880), characterized by an unusual shape recalling those of the Fiorano culture (present in Emilia-Romagna and Veneto), shows a fine-grained fabric with numerous grog fragments, quartz, minor feldspar but without calcite. The 2D and 3D μ CT-derived fabric parameters, reflecting the manufacture technology, are also quite different from those of the local vases. These features suggest that sample 5880 was manufactured elsewhere and later reached the Karst, directly or indirectly. The combined use of conventional techniques and non-destructive XRF and μ CT, which allows the quantification of clay material, lithic inclusions and porosity, has proved to be an effective approach to investigate both technology and provenance of ceramic materials.

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1. Introduction

The physical–chemical study of prehistoric pottery can provide information on provenance (local vs. non-local raw materials and manufacturing) and forming technology of the artefacts. Different analytical techniques, including non-destructive methods such as portable X-ray fluorescence (XRF), neutron activation analysis (NAA) and prompt gamma activation analysis (PGAA), provide chemical composition of ancient pottery [1–5], while thin section optical microscopy (OM) and X-ray diffraction (XRD) give information on paste fabric, mineral components and manufacturing techniques. Recent studies have shown that X-ray computed microtomography (μ CT) can provide useful textural and technological information in the study of archaeological pottery [6].

In this work we have adopted a multi-analytical approach mainly based on non-destructive methods (XRF and μ CT) combined with traditional XRD and OM to investigate both technology and provenance of a group of vases from the Trieste Karst (northeastern Italy, Table 1), found in layers attributed to the Neolithic Vlaška Group [7].

Scientific studies of Neolithic pottery from the northeastern Adriatic regions are still limited [8–12]: the present work aims to understand if differences recognized through traditional typological analysis reflect also differences in paste composition, ceramic forming process and area of production, i.e. local vs. non-local manufacturing processes and thus connections with more or less distant areas.

2. Archaeological background

Evidence on the human presence in the Italian part of the Karst (northeastern Italy) throughout prehistory comes almost exclusively from caves and rock shelters – approx. 180 out of more than 3000 natural cavities – investigated by both speleologists and professional archaeologists since the last decades of the 19th century [13]. The

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Table 1

List of the Neolithic analysed samples with the indication of the chronology, archaeological site, typology, analytical methods, voxel size of μ CT data-sets and references. XRD: X-ray diffraction; OM: optical microscopy; XRF: non-destructive X-ray fluorescence; μ CT: X-ray computed microtomography.

| Number | Chronology | Cave | Typology | Analytical Methods | μ CT voxel size | References |
|--------|-------------------------|-----------|---------------------|------------------------|---------------------|--|
| 3523 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 37.61 | Gilli, Montagnari Kokelj 1996, n. 112 [21] |
| 3533 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 39.71 | Gilli, Montagnari Kokelj 1996, n. 47 [21] |
| 3534 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; μ CT | 37.61 | Gilli, Montagnari Kokelj 1996, n. 45 [21] |
| 3540 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 39.71 | Gilli, Montagnari Kokelj 1996, n.67 [21] |
| 3541 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 30.95 | Gilli, Montagnari Kokelj 1996, n. 46 [21] |
| 3543 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 39.71 | Gilli, Montagnari Kokelj 1996, n. 73 [21] |
| 3545 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 37.61 | Gilli, Montagnari Kokelj 1996, n. 72 [21] |
| 3546 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 30.95 | Gilli, Montagnari Kokelj 1996, n. 74 [21] |
| 3548 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 37.61 | Gilli, Montagnari Kokelj 1996, n. 48 [21] |
| 3556 | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 39.71 | Gilli, Montagnari Kokelj 1996, n. 2 [21] |
| NP | Neolithic, Vlaška Group | Zingari | <i>vaso a coppa</i> | OM; μ CT | 37.61 | Gilli, Montagnari Kokelj 1996, n. 75 [21] |
| 2697 | Neolithic, Vlaška Group | Tartaruga | <i>vaso a coppa</i> | XRD; OM; XRF; μ CT | 37.61 | Cannarella and Redivo 1983 [22] |
| 5880 | Neolithic, Vlaška Group | Ciclami | mug | XRD; OM; XRF; μ CT | 11.98 | Gilli, Montagnari Kokelj 1993, n. 102 [23] |

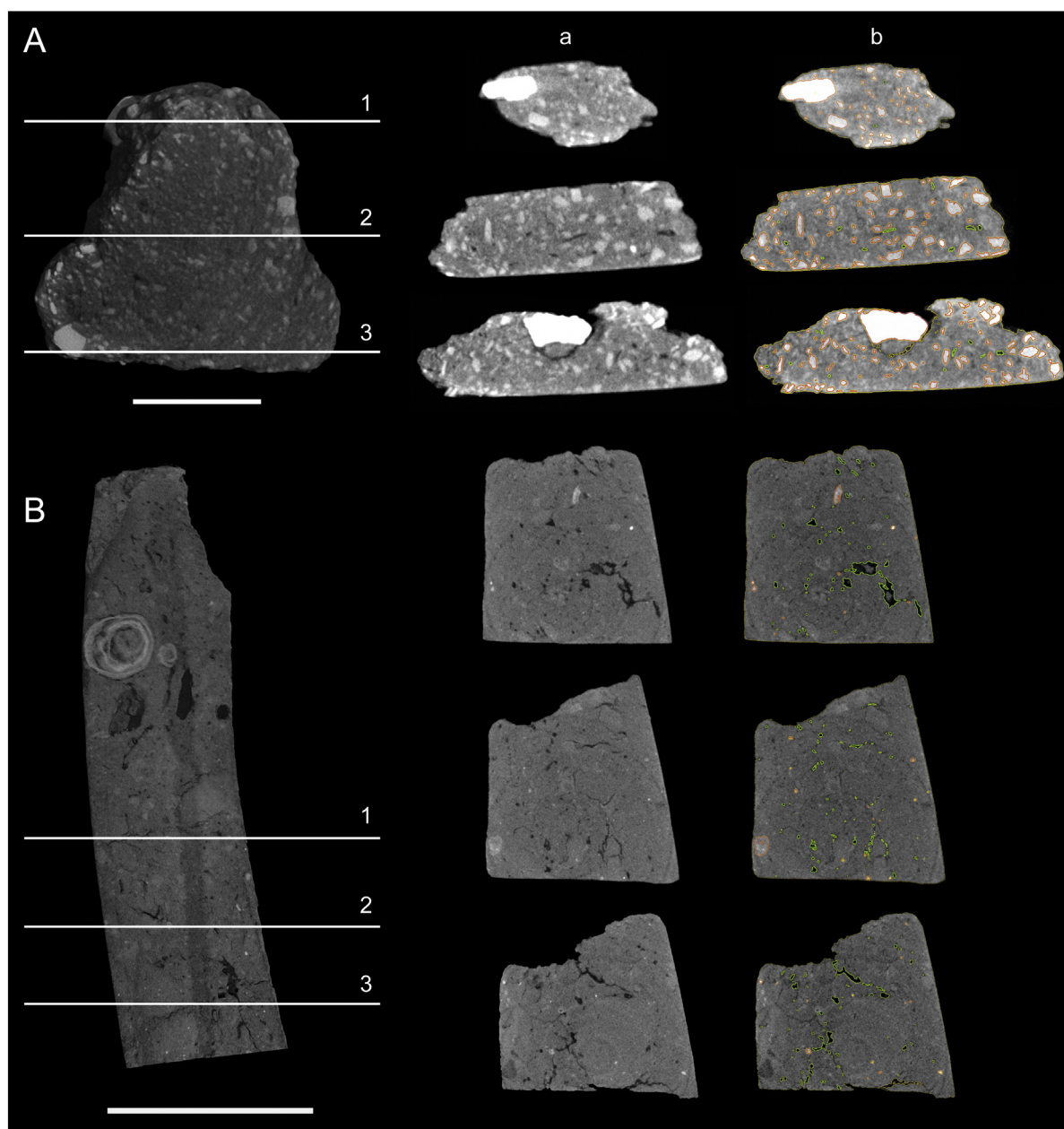


Fig. 1. μ CT volume renderings and virtual cross-sections of the *vaso a coppa* 2697 (A) and the sample 5880 (B). Numbers 1 to 3 show the position of the cross-sections. Letter a indicates the plain cross-sections while letter b shows the same segmented cross-sections where the clay material (yellow), the inclusions (red) and the pores (green) have been separated. Scale bar: 1 cm. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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