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Discriminating pottery production by image analysis: a case study of Mesolithic and Neolithic pottery from Al Khiday (Khartoum, Sudan)

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ABSTRACT

Pottery from Al Khiday (Khartoum, Sudan), where a number of sites with well-preserved stratified archaeological sequences have been excavated and radiometrically dated to the Mesolithic and Neolithic periods (7000–4000 calibrated BC), was archaeometrically analysed with the main aim of quantifying the textural parameters of the inclusions in the ceramic pastes. A set of 360 samples was studied, and quantitative and qualitative information was obtained regarding paste production recipes and the raw materials used over time.

Three main petrographic groups were identified, according to contents in alkali-feldspar and quartz, and the grain-size of quartz inclusions. Further sub-groups were defined and described in terms of grain-size distribution and abundance of the various types of inclusions. Digital image analysis on both scanning electron back-scattered images and elemental maps enabled validation of petrographic groups by quantitative description of the type, abundance and shape of inclusions, and the inclusion-to-matrix ratio. Correlations among the paste production recipes and decorative motifs revealed changes in production technology over time.

1. Introduction

Archaeometric studies of archaeological materials often aim at defining the provenance of raw materials and production technology. Despite recent advances in this research field, problems concerning paste production recipes have often been only qualitatively tackled. Quantification of textural parameters in relation to bulk chemical composition and mineral chemistry represents a broad field of investigation which can provide substantial information, especially in terms of paste production recipes, technological choices and cultural changes over time (Reedy, 2006, 2008). More in detail, digital image analysis has been used in the last decades to quantitatively analyse textural features in pottery paste, such as abundance, grain-size distribution and shape of inclusions and voids, as well as matrix:temper ratio (Bouchain and Velde, 2001; Reedy, 2006; Livingood and Cordell, 2009; Knappett et al., 2011; Grifa et al., 2013; Eramo et al., 2013). These studies allowed to describe the petro-fabrics and to constrain, through the analysis of morphological and textural features, the provenance and the production recipes, like the deliberate addition of temper through the grain-size distribution of inclusions (Velde and Druc, 1999; Bouchain and Velde, 2001; Reedy, 2006; Livingood and Cordell, 2009; Grifa et al., 2013; Eramo et al., 2013). The quantification of the various components (matrix, inclusions and voids) and of the textural features of inclusions (grain-size distribution, morphology) are needed to properly describe differences between groups characterised by inclusions with analogous minero-petrographic composition.

In this paper, we present an archaeometric study of Mesolithic and Neolithic pottery from the 16D4, 16D5 and 10W4 sites east of the village of Al Khiday (Khartoum, Sudan), based on analysis of back-scattered electron (BSE) images and elemental maps obtained by scanning electron microscopy (SEM). The main aim was to assess the temporal distribution and evolution of pottery paste production recipes by quantitatively describing the minero-petrographic nature and textural features of added inclusions in terms of shape, grain-size distribution and matrix:temper ratio, and by correlating these characteristics with stylistic features.

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Al Khiday is a village located 17 km south of Khartoum (Central Sudan), along the western bank of the White Nile, about 3 km west of the present-day riverside (Fig. 1). Unlike other previously investigated sites in Central Sudan, the Al Khiday sites are unique, because they provide the first well-preserved, quite continuous Mesolithic stratigraphic sequence, overlain by sporadic Neolithic and more recent layers, and graves (Salvatori et al., 2011; Zerboni, 2011). Radiocarbon dating of organic remains from these closed contexts indicates that the area was occupied during the Early and Middle Mesolithic periods (16-D-5, 16-D-4, 16-D-4B) over a period of about 800 years (7000–6200 calibrated BC), Late Mesolithic (10-W-4: second half of 6th millennium cal. BC), Neolithic (16-D-5,

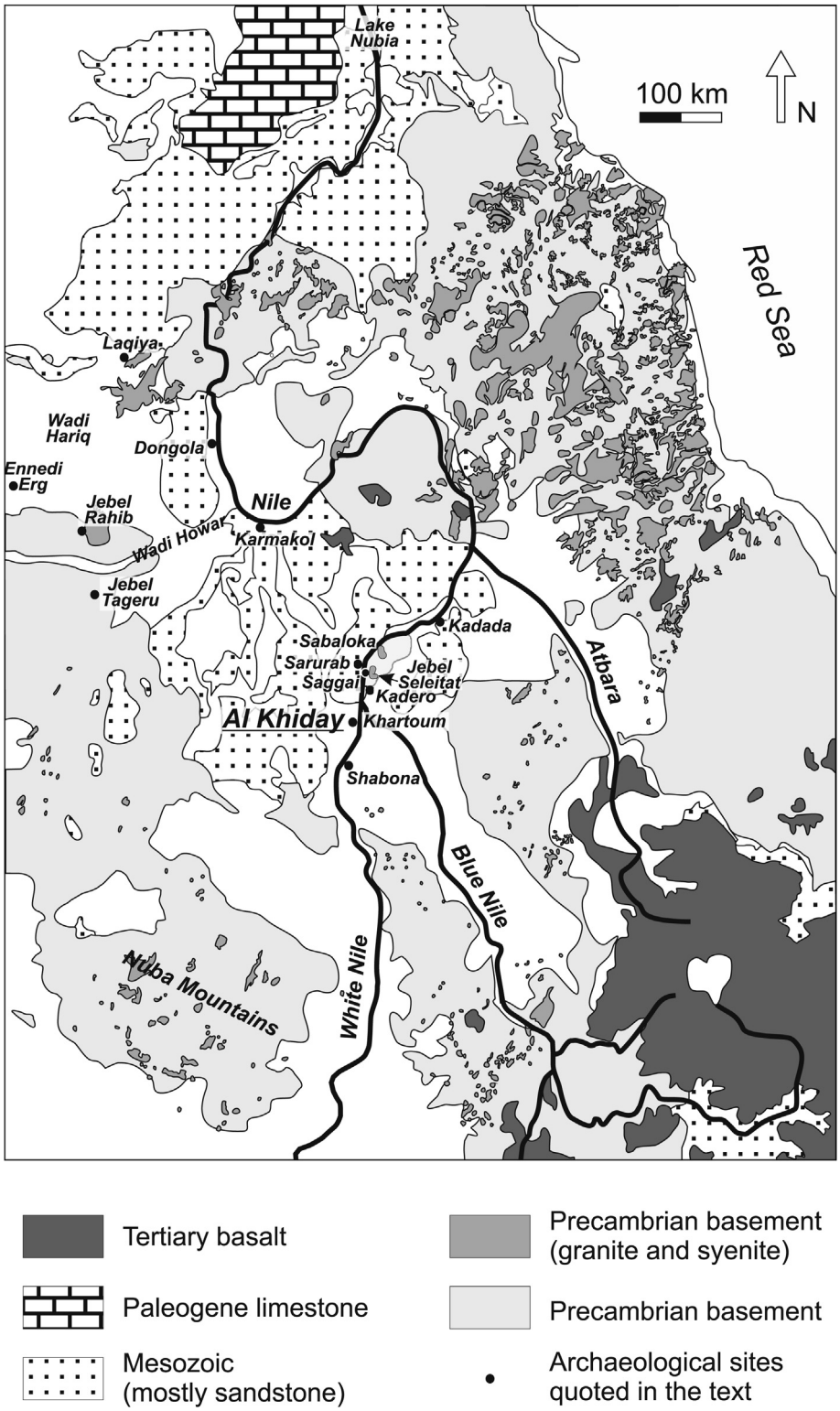

Fig. 1. Geological sketch of Central Sudan (modified after Ministry of Energy & Mining, Geological Research Authority of Sudan, 2004) and geographic location of archaeological sites of Al Khiday (Khartoum, Sudan) and other Mesolithic sites in Central Sudan.