The use of ochre 40,000 years ago in Africa

This paper is authored by Alain Queffelec, Daniela Rosso and Francesco d'Errico. These researchers belong to the PACEA laboratory, a research unit of the Centre National de la Recherche Scientifique (CNRS), the University of Bordeaux, and the French Ministry of Culture. PACEA research mostly focuses on Palaeolithic cultures in Europe and Africa and their environment, biological anthropology, funerary practices, and rock art.

In the case study presented here, the aim of our research was to achive a better understanding of ochre use by Middle Stone Age populations in East Africa through the analysis of 4,213 pieces of iron-rich mineral fragments (40 kg) found at the archaeological site of Porc-Epic Cave, Ethiopia, in layers dated to ca. 40,000 years ago (Rosso, d'Errico and Queffelec 2017).

The term "ochre" refers to a variety of rocks characterized by a red or yellow colour or streak, from soil lumps to ore minerals, containing a high proportion of iron oxides. A large number of ochre pieces discovered at this site show traces of utilization, in particular flaking scars and striations produced by grinding. Twenty-one grindstones used for ochre processing were also recovered at the site (Rosso, Pitarch Martí and d'Errico 2016) in the same areas where most of the ochre pieces were found (Rosso, d'Errico and Zilhão 2014). The purpose of the tribological analysis, conducted in tandem with more classical analytical techniques, was to better understand how ochre pieces were processed and used.

The analyzed samples included ochre pieces bearing facets created by grinding (figure 1). Even though these facets are often described in literature, there have been no attempts to characterize them quantitatively. Experimental grinding of ochre lumps similar to those found at the site on grindstones made of different rocks allowed us to create a comparative framework. We recorded the variables commonly used to characterize facets (size, presence of grooves or striations, localization on the fragment etc.) and conducted a non-destructive tribological analysis by using a 3D

optical profiler.

Figure [1] *Ochre fragments modified by grinding (top left) and by scraping (bottom left) with close-up views illustrating traces diagnostic of the technique used (modified after Rosso et al. 2017).*

Measurements

The study was conducted on nineteen archaeological pieces of fine-grained ochre presenting one or more facets, and three very fine-grained, fine-grained and coarse-grained experimental ochre pieces. Each of them was abraded on limestone, quartzite and sandstone grindstones.

In order to capture large areas, we measured an area of 5x5 fields of view obtained with the 20X brightfield objective of Sensofar's S neox with a Z-range of few millimetres. Some of the resulting surfaces, after data processing (form and outlier removal, filling of non-measured points) are shown in figure 2.

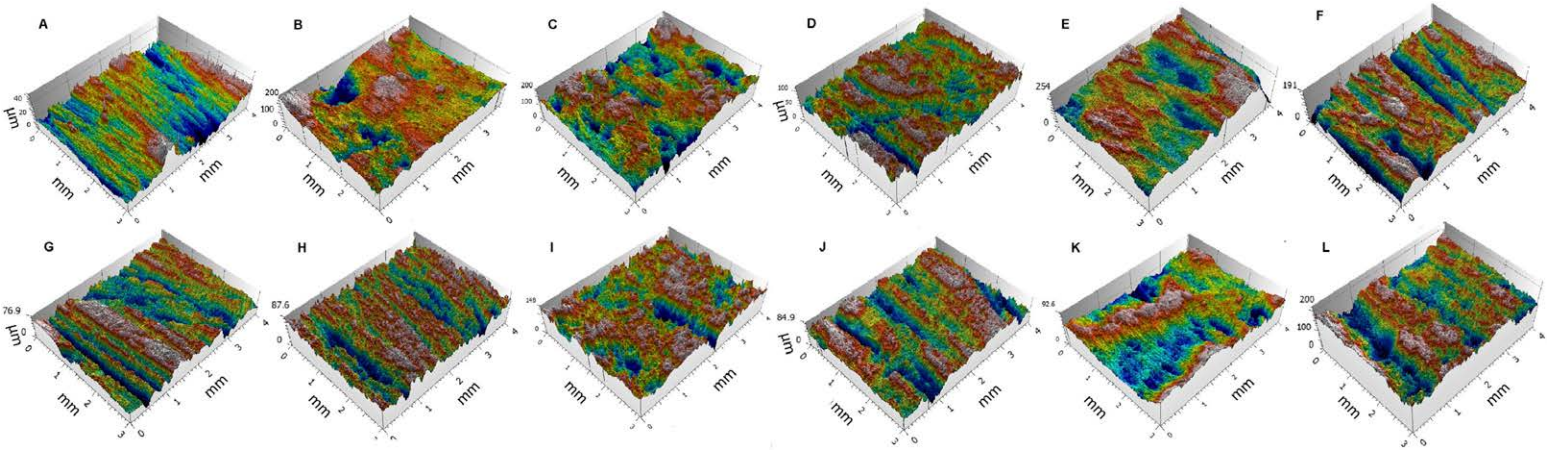

Figure [2] *3D renderings of experimental (A, B, C) and archaeological (D to L) facets measured using confocal technique (modified after Rosso et al. 2017).*

Gaussian filtering (0.25 mm cut-off) was applied to focus only on roughness and, after testing multiple standard parameters (ISO 25178), Sq and Sdr appeared as the most effective choice to discriminate experimental facets (figure 3A). In some cases results highlight significant differences in the roughness values recorded on facets belonging to the same ochre piece.

This suggests that some ochre fragments were processed on different grindstones, arguably at different times, to produce small quantities of ochre powder. Colorimetric and granulometric analyses, conducted in parallel, indicate that the resulting powders differed in colour and grain size and were used for different purposes, either functional or symbolic in nature (Rosso, d'Errico and Queffelec 2017).

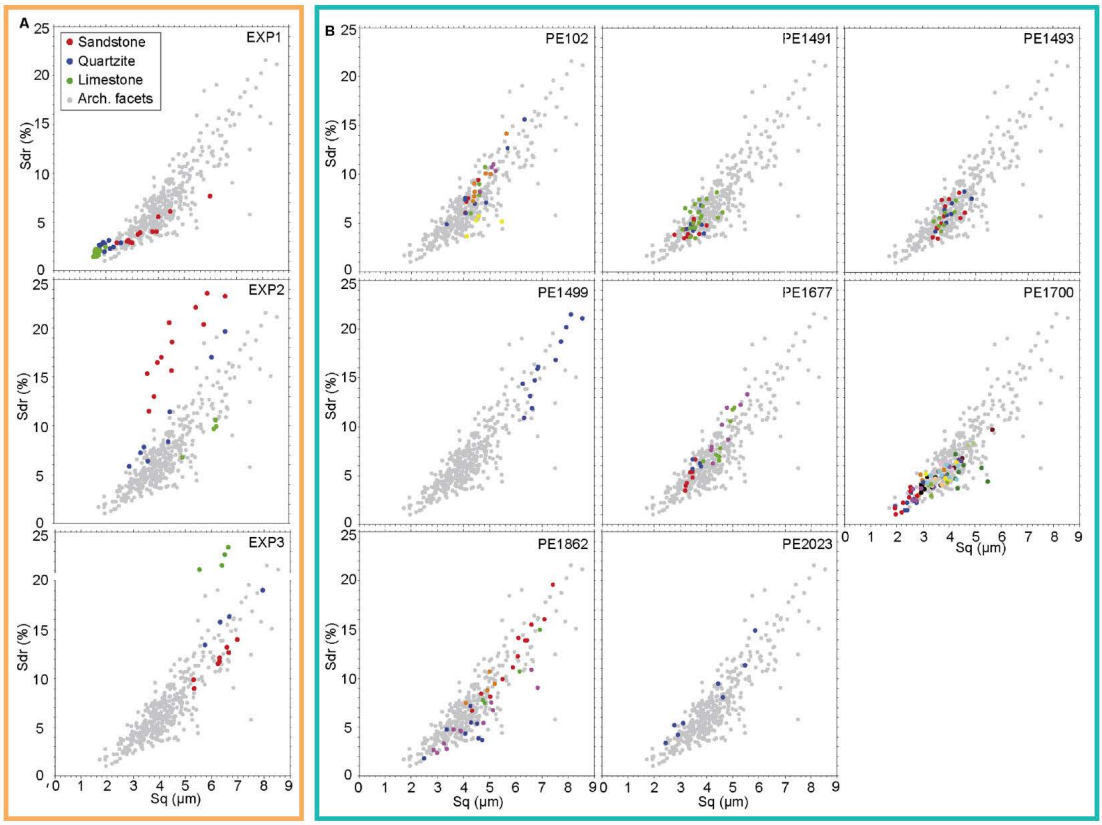

Figure [3] *Scatter plots correlating Sq and Sdr values on experimental and archaeological facets. (a) results obtained when grinding very fine-grained ochre (EXP1), fine-grained ochre (EXP2) and coarse-grained ochre (EXP3) on grindstone made of different rocks. (b) Results of the roughness analysis of ground facets on archaeological pieces. Dots of the same colour identify measurements taken on the same facet. Grey dots identify the overall variability of the archaeological sample (modified after Rosso et al. 2017).*

Conclusions

Confocal technology is an effective technique to identify facets of ochre pieces ground on different rocks. Results were instrumental to improving our understanding of ochre processing and use by the Middle Stone Age hominins that inhabited Porc-Epic Cave 40,000 years ago. Application of the same methodology to collections of ochre pieces from other Middle Stone Age sites may identify changes through time in the way ochre was modified, provide key information on the function it fulfilled in those societies, and help establish when pigments were first used symbolically in the history of mankind.

SENSOFAR®
METROLOGY

SENSOFAR is a leading-edge technology company that has the highest quality standards within the field of surface metrology.

Sensofar Metrology provides high-accuracy optical profilers based on confocal, interferometry and focus variation techniques, from standard setups for R&D and quality inspection laboratories to complete non-contact metrology solutions for in-line production processes. Sensofar Metrology offers technology that enables our customers to achieve real breakthroughs, particularly in semiconductor, precision optics, data storage, display devices, thick and thin film and materials testing technology fields.

The Sensofar Group has its headquarters in Barcelona, also known as Spain's technological heart. The Group is represented in over 30 countries through a global network of partners and has its own offices in Asia.

HEADQUARTERS

SENSOFAR METROLOGY

Parc Audiovisual Catalunya

Ctra. BV-1274, KM 1

08225 Terrassa (Spain)

T. +34 937 001 492

F. +34 937 860 116

info@sensofar.com

www.sensofar.com

SALES OFFICE

SENSOFAR ASIA

Room 102, Building C, No. 838

GUANGJI Road, HONGKOU District

Shanghai 200434 (PR China)

T. +86 021 51602735

F. +86 021 61400059

info.asia@sensofar.com