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Integrated geochronology of Acheulian sites from the southern Latium (central Italy): Insights on human-environment interaction and the technological innovations during the MIS 11-MIS 10 period

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ABSTRACT

We have explored the multimethod approach combining $^{40}Ar/^{39}Ar$ on single crystal, ESR on bleached quartz, and ESR/U-series on teeth to improve the age of four neighbours “Acheulian” sites of the Frosinone Province (Latium, Italy): Fontana Ranuccio, Cava Pompi (Pofi), Isoletta, and Lademagne. Ages obtained by the three methods are in mutual agreement and confirm the potential of dating with confidence Middle Pleistocene sites of Italy using these methods.

At Fontana Ranuccio, the $^{40}Ar/^{39}Ar$ age (408 ± 10 ka, full external error at 2σ) obtained for the archaeological level (unit FR4) and geochemical analyses of glass shards performed on the Unit FR2a layer allow us to attribute the studied volcanic material to the Pozzolane Nere volcanic series, a well-known caldera-forming event originated from the Colli Albani volcanic district. These new data ascribe the Fontana Ranuccio site, as well as the eponym faunal unit, to the climatic optimum of Marine Isotope Stage (MIS) 11. Ages obtained for the Cava Pompi, Isoletta, and Lademagne sites cover a relatively short period of time between 408 ka and 375 ka, spanning MIS 11 climatic optimum to the MIS 11–10 transition. Analysis of small collections of lithic industries, bifacial tools, and small cores technologies from Isoletta, Lademagne, and the neighbour site of Ceprano-Campogrande shows common technical strategies for the period comprised between MIS 11 and MIS 9 (410–325 ka), such as the elaboration of flaked elephant bone industries found over the whole Latium region. However, some features found only in the Frosinone province area, like large-sized bifaces, suggest particular regional behaviours. The presence of one Levallois core in the oldest layer of Lademagne (i.e. > 405 ± 9 ka) suggests a punctual practice of this technology, also proposed as early as MIS 10/11 in the neighbour site of Guado San Nicola (Molise) in central Italy.

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1. Introduction

The time interval between 450 and 300 ka is from an archaeological viewpoint a period of emergence of several cultural and technological innovations in hominin evolution and regionalisation of cultural features (Moncel et al., 2017). This time span encompasses the Marine Isotopic Stages (MIS) 11 and 9; the former of these sea-level high-stands is a low eccentricity interglacial that represents the culmination of a series of modifications of the Earth's climate system, known as the Early Middle Pleistocene Transition (EMPT, Head and Gibbard, 2015). Started at around 1.4 Ma, the EMPT transition is characterised by a progressive shift of the climatic cycles from ~41 ka to ~100 ka, and increase of the amplitude and asymmetry of the climatic oscillations, which induced longer, more intense and dryer condition during glacial periods (Berger et al., 2005; Head et al., 2008). Recent studies suggest influence of palaeoenvironnemental and climatic conditions on possible migration and techno-cultural development of hominin populations that lived in Western Europe during MIS 12 to MIS 10 (Moncel et al., 2017). After the very cold and dry MIS 12 and particularly during the MIS 11, when 100 ka cycles definitively established, several lower Palaeolithic sites suggest the expansion and regionalisation of the "Acheulian" culture (technological Mode 2 with bifacial technology) over the entire Western European continent. Generalization and high standardization of various types of bifacial tools also occurred during this period linked to a sporadic domestication of the fire (Kretzoi and Dobosi, 1990) and in some punctual cases with the emergence of new behaviours, such as the Levallois core technology (Mode 3) (Adler et al., 2014; Peretto et al., 2016; Pereira et al., 2016). However, time and evolutionary modes of the pre-Neanderthalian lineage during the second part of the Middle Pleistocene remain heavily debated as current researches are hampered by the relatively lack of long and well-preserved archaeological sequences and of precise and accurate chronologies. In particular, the acquisition of a reliable chronology is limited by the low precision of most of the dating methods suitable for the 400–800 ka timespan (e.g., palaeodosimetric methods such as Electron Spin resonance (ESR) and thermoluminescence (TL)), which is beyond the limit of more precise dating methods such as U/Th. Therefore, acquiring a fine and robust chronological framework for the European Lower Palaeolithic is definitively a challenging task. Such a difficulty makes the reconstruction of the evolutionary techno-cultural processes largely uncertain, as they often rely only on speculative correlations that are not fully validated by independent chronological data.

On this background, the Mediterranean basin and particularly the Italian territory are of particular interest in Western-European Lower Palaeolithic panorama. Three main peculiar features make this area unique in Western Europe for investigating the Lower Palaeolithic times: 1) There is a large number of well-preserved archaeological sites tentatively ascribable to the MIS 11–9 interval (Moncel et al., 2016), which in turn depends on two favourable factors. The first one is the Quaternary geodynamic context of the Italian Peninsula, which favoured the development of intermountain tectonic basins filled with fluvial and lacustrine sediments (Vezzani et al., 2010) that are ideal geological settings for the preservation of the Palaeolithic occupations (e.g., Biddittu et al., 1979; Muttoni et al., 2009; Villa et al., 2016; Nicoud et al., 2016). The second one relies on the fact that the Mediterranean basin and the Italian Peninsula played a role of refuge for temperate vegetation during glacial periods despite the general opening of landscapes (Hofreiter and Stewart, 2009; Orain et al., 2013). The persistence of temperate taxa and fertile volcanic soils may have contributed to the large mammal herds and hominids settlements through this area (Moncel et al., 2017).

2) Besides being fundamental for preserving the archaeological traces, Italian sedimentary basins are also exceptional archives of both local and regional environmental and climatic changes (e.g., Russo Ermolli and Cheddadi, 1997; Vezzani et al., 2010; Petrosino et al., 2014; Regattieri et al., 2016; Degeai et al., 2018). They can provide crucial information for framing the evolution of lithic technology and understanding its potential interplay with the various components of the human ecosystems.

3) Last, but not least, the continuous K-rich explosive volcanism from Italian magmatic provinces led to the deposition of numerous tephra and abundant volcanic material all over Central and Southern Italy, allowing the use of the $^{40}Ar/^{39}Ar$ dating method to provide precise and accurate chronological control for both palaeoenvironmental records (e.g., Karner and Marra, 1998; Giaccio et al., 2015; Petrosino et al., 2014; Marra et al., 2014, 2016; Regattieri et al., 2016) and archaeological sites (e.g., Peretto et al., 2016; Pereira et al., 2015, 2016; Villa et al., 2016; Degeai et al., 2018). The $^{40}Ar/^{39}Ar$ method offers also the opportunity of integrating and eventually testing the ages provided by palaeodosimetric methods (e.g., ESR on bleached quartz and ESR/U-series on teeth; Pereira et al., 2015, 2016), commonly applied to date Middle Pleistocene sites in Northern Europe, where the $^{40}Ar/^{39}Ar$ can only rarely be used (e.g., Bahain et al., 2007; Voinchet et al., 2010; Moncel et al., 2013).

The present study is focused on the Latina valley where numerous Lower Palaeolithic sites have been discovered over the last 40 years (Fig. 1). Main goal is to build a homogeneous chronological framework for 4 adjacent Acheulian sites (Fig. 1): Fontana Ranuccio, Isoletta, Lademagne, and Cava Pompi (Pofi) (Biddittu et al., 1979, 2012; Biddittu and Segre, 1984). This chronological framework is defined using several methods based on different physical processes (radioisotopy and palaeodosimetry) to ensure the most accurate chronology following the approach developed in Pereira et al. (2015, 2016).

Applied dating methods in our work are (*i*) $^{40}Ar/^{39}Ar$ on single crystal of K-feldspars, (*ii*) ESR on bleached quartz grains and (*iii*) ESR/U-series on large mammal teeth. At Fontana Ranuccio we also applied (*iv*) the tephrochronology approach, an indirect dating method based on chemical fingerprinting of volcanic deposit (level FR2a, Fig. 2). This last method allows in the most favourable case to identify a specific eruption and therefore the age of the volcanic material. All studied sites are found within alluvial deposits that contain material potentially suitable for each of the considered dating methods; i.e., (*i* and *iv*) tephras or reworked volcanoclastic material originated from the Middle Pleistocene volcanoes located close to the investigated sites (i.e., Colli Albani, Ernici-Valle Latina and Roccamonfina districts; Fig. 1, (Karner et al., 2001; Gaeta et al., 2016); Basilone and Civetta, 1975; Civetta et al., 1981, Boari et al., 2009; Rouchon et al., 2008) – (*ii*) quartz and (*iii*) mammal teeth.

The new chronological framework will be used to compare for the first time with confidence at local scale, a corpus of bifacial tools from Isoletta, Lademagne (Biddittu and Segre, 1984; Biddittu et al., 2012; Comerci et al., 2015 dated in this study) and Campogrande sites (e.g., Manzi, 2016). The studied industries are then compared with the bibliographic data available for Fontana Ranuccio (Biddittu and Segre, 1984). Finally, in order to identify possible regional/micro-regional affinities or differences, the comparison is extended to other sites sharing a similar age on a wider regional scale, including Latium (Torre in Pietra, Castel di Guido; Villa et al., 2016) and Molise (Guado San Nicola; Pereira et al., 2016).

2. Geological settings

The Latina Valley is delimited by two major tectonic structures of regional relevance: the Olevano-Antrodoco line to the West and