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Archaeological Survey in Guadalajara: Human Occupation of central Spain during the Late Pleistocene

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The central Meseta is a high plateau located in Spain in the heart of the Iberian Peninsula. Abundant evidence of Lower and Middle Palaeolithic occupations of the region contrasts with scarce evidence of a human presence during the early Upper Palaeolithic. On this basis, it has been suggested that climatic downturns triggered the temporary abandonment, or near abandonment, of the central Meseta during the Last Glacial period. We conducted three archaeological surveys in Guadalajara province, located in the southern part of the region, in 2009, 2010, and 2017. Survey results, interpreted in the light of a habitat suitability model, support a hypothesis of climate-driven abandonment (or near-abandonment) of the central plateau during the Last Glacial Maximum and suggest that the Tagus River Valley, which links the Spanish interior to the Atlantic seaboard, was a focus for the Palaeolithic occupation of the region at other times.

Keywords: Palaeolithic; Spain; central Meseta; spatial analysis; habitat suitability

Introduction

The challenges inherent in establishing a chronology of human dispersal and population replacement across Eurasia during the Last Glacial period are obvious. Recent archaeological (Nigst et al. 2014; Benazzi et al. 2015), chronological (Wood et al. 2013; Higham et al. 2014), and paleogenetic evidence (Seguin-Orlando et al. 2014) highlight the complexities of human population dynamics in Europe during the Last Glacial, which has led to the emergence of new models of dispersal, interaction, and population structure (Hublin 2014). During this timeframe, an interval marked by pronounced climatic instability, a genetically distinct western Eurasian metapopulation emerged ca. 36,000 years ago (36 kya) (Seguin-Orlando et al. 2014), and the initial expansion of modern human populations in Europe was followed by population contraction and fragmentation in response to climate fluctuations, as evidenced by the increasing regionalization and diversity of Palaeolithic cultures (Gamble et al. 2004) and the emergence of a European morphotype (Churchill et al. 2000).

The impact of climate change on human populations living in Europe during the Last Glacial appears to have been severe. During the Last Glacial Maximum (LGM), a period that lasted from 23–19 kya, the archaeological record suggests a general pattern of population displacement across most of Europe. The three southern European Peninsulas (Iberia, Italy, and the Balkans) are thought to have acted as glacial refugia for a variety of temperate fauna, including humans (Bailey et al. 2008; Gamble et al. 2004; Jochim 1987;Jennings et al. 2011). The impact of these displacements could be reflected in the observed decrease in human body size, which suggests suboptimal conditions and/or genetic drift (Niskanen et al. 2017). This somewhat simplistic biogeographic picture is challenged by evidence for human presence in northern Europe during the LGM, however (Terberger and Street 2003). Even within the southern refugia, archaeological, paleoenvironmental, and paleoclimatic evidence suggests that conditions were far from uniform, with a high probability that human populations responded to local-scale phenomena at finer temporal scales, such as interannual climate variability (Burke et al. 2014, 2017; Burke, Riel-Salvatore, and Barton 2018).

The archaeological record of the Iberian Peninsula provides the earliest evidence of hominin presence in western Europe. Hominins occupied the Sierra de Atapuerca, in Burgos, as early as ca. 1.2 mya (Bermúdez de Castro et al. 2013) and may have occupied the Guadix-Baza Basin in southern Spain, as early as ca. 1.4 mya (Toro-Moyano et al. 2013; but see Muttoni, Scardia, and Kent 2013; Oms et al. 2011). Although it spans the Pleistocene, however, the record of hominin occupation of the Iberian Peninsula is discontinuous, particularly during the Early and Middle Pleistocene (Bermúdez de Castro et al. 2013; MacDonald et al. 2012). During the Late Pleistocene, the peninsula is thought to have acted as a glacial refugium for temperate species, including humans (González-Sampériz et al. 2010; Gamble et al. 2004; Finlayson et al. 2006; Jochim 1987; Sommer and Nadachowski 2006). Relatively harsh, continental conditions in the Spanish interior (the Meseta) may have resulted in periodic abandonment of the region by humans during cold events, however (Alcaraz-Castaño et al. 2013; Delibes de Castro and Diez Martin 2006; Straus, Bicho, and Winegardner 2000; Straus 2015; Yravedra et al. 2016; Wolf et al. 2018).

The spatial distribution of known Palaeolithic sites confirms the existence of regional differences and discontinuities in the distribution of hominin populations in the Iberian Peninsula. The central Meseta is relatively underrepresented in the archaeological record, particularly during the Last Glacial. While this could reflect the episodic abandonment of the Spanish interior during cold climate events alluded to above, it may also be a result of the historically uneven distribution of research effort on the Iberian Peninsula (Alcaraz-Castano 2015; Aubry 2015; Cacho et al. 2010; Straus, Bicho, and Winegardner 2000; Straus 2018;). Historically, Palaeolithic archaeologists have tended to focus on coastal regions, particularly in Cantabria (Delibes de Castro and Diez Martin 2006), where a series of caves containing Palaeolithic art and with excellent fossil preservation was discovered in the late 19th century (Obermaier, Osborn, and Matthew 1924). Some of the earliest and best-known archaeological sites in Iberia are situated in the interior of the peninsula, however, e.g., at Sierra de Atapuerca (located in Burgos) and Torralba and Ambrona, the famous proboscidean sites discovered near Soria at the turn of the last century that have been the focus of numerous archaeological investigations (Villa et al. 2005; Yravedra et al. 2017). Furthermore, recent models of habitat suitability based on a suite of environmental variables suggest conditions in the Spanish interior would have been relatively unfavorable for human occupation during the LGM (Burke et al. 2014, 2017; Ludwig et al. 2018; Wren and Burke 2019).

Biogeographical evidence from Iberia, such as the existence of genetically distinct animal populations in the Atlantic and Mediterranean regions, are perfectly consistent with the archaeological data, supporting a hypothesis of discontinuous, spatially isolated glacial refugia on the Iberian Peninsula (Rodríguez-Sánchez et al. 2010; O'Regan 2008). Nevertheless, individual taxa respond differently to environmental conditions (Stewart et al. 2009), and doubts remain as to the representativeness of the archaeological record of the central Meseta. Our understanding of the spatial distribution of human populations on the Iberian Peninsula, particularly during the Late Pleistocene, is therefore incomplete.

The research described below was designed to address this problem, add to a growing body of archaeological evidence documenting human presence in the Spanish interior during the

Palaeolithic, and counter claims that the patterns observed in the archaeological record reflect the unequal distribution of research effort, rather than prehistoric population dynamics. To this end, we conducted three archaeological surveys in the province of Guadalajara, in the southern half of the central Meseta, in 2009, 2010 (Burke et al. 2013), and 2017, which are discussed below.

Background: Geography

The Iberian Peninsula is a large landmass (ca. 582,000 km^2) located in southwestern Europe, bordered by the Pyrenees, the Atlantic Ocean, and the Mediterranean Sea. The geography of the Peninsula was shaped by the convergence of the African and European tectonic plates during the Tertiary. The resulting deformation and uplift of Paleozoic rock formations created a vast, elevated plateau at the center of the peninsula known as the central Meseta (Figure 1). The plateau is roughly 211,000 km^2 in area and has an average elevation of 700 masl (García-Quintana et al. 2004). The central Meseta is bordered by the Cantabrian and Iberian ranges to the northwest and northeast, respectively, and the Sierra Morena to the south. The Central Range, which rises to a maximum elevation of 2592 masl, bisects the plateau, separating it into two unequal sub-regions. The northern sub-region encompasses the Duero River drainage. The southern sub-region, which is roughly twice the size of the northern sub-region, includes the Tagus and the Guadiana River drainages, which are in turn separated by the Montes de Toledo. The three major drainages of the central Meseta (the Duero, Tagus, and Guadiana) flow west and discharge into the Atlantic. The river basins are filled with marls and flysch; the mountain ranges that separate them are primarily comprised of siliceous rocks (to the west) and calcite formations (to the east). The research described here focuses on the southern sub-region, specifically the province of Guadalajara, located in the northern part of the Tagus River drainage, bordered by the Iberian Range, the Central System, and the Serranía de Cuenca (Figures 1, 2).

Climate patterns in the Iberian Peninsula are strongly influenced by the North Atlantic Oscillation and are latitudinally contrasted, with Eurosiberian conditions prevailing north of 40N and Mediterranean conditions south of 40N (Carrión García et al. 2000; González-Sampériz et al. 2010). Relatively wet conditions in the northwest foster the development of Atlantic forest (composed of deciduous oak, birch, hornbeam, and beech) and the presence of conifers at higher altitudes (e.g., in the Pyrenees). In the south, hot, dry summers and cool, wet winters promote the growth of Mediterranean forest (dominated by evergreen and deciduous oak and, at lower elevations, pistachio, olive, and drought-resistant shrubs) (Sánchez Goñi et al. 2008; González-Sampériz et al. 2010). Paleo-vegetation data recovered from marine cores and terrestrial sequences indicate that vegetation succession on the Iberian Peninsula during the Pleistocene is consistent with the patterns observed elsewhere on the European continent. The extent to which regional controls affect vegetation succession is debated (Carrión García et al. 2000; Sánchez Goñi et al. 2008) but, broadly speaking, the vegetation record of the peninsula correlates with global climate events up to and including the millennial scale (Desprat et al. 2009; Fletcher and Sánchez Goñi 2008; Fletcher et al. 2010; Harrison and Sanchez Goñi 2010;Sánchez Goñi et al. 2002).

During Late Pleistocene stadial intervals, the vegetation of the Iberian Peninsula was dominated by tundra and steppe, particularly during the LGM, although tree cover was regionally present (González-Sampériz et al. 2010). Conversely, Mediterranean and Atlantic forest cover expanded during interstadials (Sánchez Goñi et al. 2008; González-Sampériz et al. 2010). There is evidence for temperate vegetation refugia along coastal regions and in intermontane valleys, which formed local reservoirs of taxonomic diversity during stadial events (González-Sampériz et al. 2010). In the latter part of the Late Pleistocene, i.e., during the Tardiglacial, forest cover expanded, briefly regressed during the Younger Dryas (ca. 12.6–11.5 kya) and reached its maximal expansion during the first millennia of the Holocene (Carrión García et al. 2000; Carrión et al. 2010). The definitive decline of forest cover and the dominance of grasslands and shrublands observable today are recent phenomena, largely attributable to anthropogenic activity during the second half of the Holocene (Carrión et al. 2010; López-Sáez et al. 2014). Paleontological evidence indicates that temperate fauna still dominate vertebrate assemblages during the LGM, but they co-exist with cold-adapted fauna such as mammoth, woolly rhinoceros, and reindeer in the north of the Peninsula (Álvarez-Lao and García 2011a, 2011b; Sommer and Nadachowski 2006; Yravedra and Brugal 2005). A similar pattern of cold and temperate fauna prevails in the Italian Peninsula and the Balkans (Sommer and Nadachowski 2006), but the composition of Iberian faunal communities is distinct from other western and central European communities (Álvarez-Lao and García 2011b). With the exception of reindeer, which persists in the Iberian Peninsula until the Younger Dryas, cold-adapted fauna disappear after the LGM (Álvarez-Lao and García 2010; Gómez-Olivencia et al. 2014). A similar pattern is observed in the Iberian microfaunal record, with Euro-Siberian species coexisting with thermo-Mediterranean taxa during the LGM (Banuls-Cardona et al. 2014).

The Central Meseta

Currently, climate conditions in the central Meseta are characterized by long and very dry summers with moderately high temperatures (average August temperatures of 22.7ºC, with maximum temperatures exceeding 44ºC) and cold, long winters (average January temperatures of 4ºC and average rainfall of 39 mm), which corresponds to a Continental Mediterranean climate, following Köppen's Classification scheme (Csa), with an annual rainfall average of 500 mm. Topographic relief produces variable climatic conditions across the region, and the degree of continentality increases on an east/west gradient along the Central System, while rainfall patterns create more humid conditions on southern slopes, offset by differences in altitude (López-Sáez et al. 2014). Topographic controls will have produced similar climate patterns during the Late Pleistocene, against a backdrop of generally colder and drier conditions associated with glacier formation in Gredos, Ayllón, and Guadarrama during the Last Glacial (Oliva et al. 2019).

Regional vegetation patterns are primarily influenced by topography and climate, and the patterns described above will have influenced the character and distribution of vegetation cover during the Pleistocene. Unfortunately, suitable sites for pollen sampling are rare in the central Meseta (Morales-Molino and García-Antón 2014). For the initial phases of the Late Pleistocene, we rely on regional syntheses of vegetation succession, a knowledge of local topography, and climate patterns, as well as botanical and/or pollen data from isolated archaeological sites to reconstruct paleo-vegetation cover (e.g., Cacho et al. 2012). From the LGM onwards, the vegetation history of the Duero Basin is better documented; plant macrofossils and pollen cores reflect the spread of deciduous trees at mid to low elevations and the migration of pine species to higher elevations during the Tardiglacial (García-Amorena et al. 2011). A similar pattern is observable in the Central System during the early Holocene, when latitudinal gradients control the taxonomic composition of mixed forests located in the west, while pine forests dominate central and eastern areas, and shrublands and broom dominate above 1600 masl (López-Sáez et al. 2014). During the Holocene, the Younger Dryas produced a temporary decline in forest cover and changes in the relative frequency of deciduous and evergreen taxa. Human impact on regional vegetation patterns becomes apparent during the second half of the Holocene (as elsewhere on the Iberian Peninsula), leading to forest regression and the propagation of cultivars and other vegetation types associated with agricultural exploitation. In terms of the paleontological record, although the number of sites is relatively small, it appears that cold-adapted fauna, including woolly rhinoceros and allied species, dispersed into the central Meseta during the coldest phases of the Last Glacial (Álvarez-Lao and García 2011a).

The Archaeological Record of the Central Meseta

The Lower Palaeolithic record of the Meseta is well documented and includes the earliest evidence of hominin presence in Europe, at Sierra de Atapuerca (Burgos). Deep karst deposits in the northern Meseta at Sierra de Atapuerca and in the south at Calerizo (Cáceres) document the long history of human occupation in the region, which spans the Pleistocene (Carbonell et al. 2005). The famous proboscidean sites of Torralba and Ambrona, located in the central Meseta (Soria), generated significant debates during the second half of the 20th Century about the efficacy of Acheulean hunting techniques and our ability to recognize human butchering activities (Villa et al. 2005; Santonja and Pérez González 2005). The weight of archaeological evidence suggests that Acheulean populations were successfully established deep in the Spanish interior during the Early Pleistocene (Baena Preysler et al. 2002; Yravedra et al. 2010). Middle Pleistocene deposits along major river drainages, such as the Tagus, the Manzanares, and the Jarama, have yielded abundant archaeological remains, and several sites attributable to the Acheulean have been discovered on terraces dating to MIS 15-13 (Moloney 1992; Rubio-Jara et al. 2016; Santonja and Pérez González 2000–2001), adding to our appreciation of the long history of human occupation of the Spanish interior (Yravedra et al. 2018).

The early Middle Palaeolithic record of the central Meseta is equally rich, with abundant evidence for Neanderthal occupation of the Duero (Sánchez Yustos and Diez Martín 2015), the Guadiana (Canals et al. 2014c, 2014d), and the Tagus basins (Jordá Pardo 2011; Torres Navas and Baena Preysler 2017; Rubio 2011;). Numerous stratified archaeological sites have been excavated in the region, including open-air locations and caves, such as Prado Vargas (Navazo and Díez 2008; Navazo et al. 2005), Cueva Millán and La Ermita (Moure and García-Soto 1983), Cueva Corazón (Sánchez et al. 2011), El Cañaveral and Ahijones (Baena Preysler et al. 2008), Navalmaíllo (Arsuaga, Baquedano, and Pérez-González 2011), Los Casares (Alcaraz-Castaño et al. 2017b), El Abrigo del Molino (Segovia) (Álvarez-Alonso et al. 2018), San Quirce (Palencia) (Terradillos-Bernal et al. 2014), Valdegoba (Burgos) (Terradillos-Bernal and Díez 2018), Cuesta de la Bajada (Teruel) (Santonja et al. 2014), Maltravieso, Vendimia, and El Millar (Cáceres) (Canals et al. 2014a, 2014b, 2014c), and Peña Cabra (Alcaraz-Castaño et al. 2017a; Quintana et al. 1997). Recent evidence from Jarama IV and Los Casares, however, supports the suggestion that climatic deterioration following Greenland Interstadial 11 (GI 11) may have caused Neanderthal groups to abandon the central Meseta by ca. 42 kya (Alcaraz-Castaño et al. 2017b; Jordá Pardo 2011; Kehl et al. 2013; Wolf et al. 2018).

Following the apparent withdrawal of Neanderthal populations around 42 kya, there is a hiatus in the record of human occupation of the central Meseta. Recent paleoecological studies show that cold-adapted fauna reached the southern limit of their distribution in the central Meseta at this time (Sala et al. 2020). The earliest evidence of a modern human presence in the region is not recorded until 25.5 kya (Alcaraz-Castaño et al. 2013). Early Upper Palaeolithic sites are scarce and, when they do occur, tend to be located on the periphery of the region (Mosquera et al. 2007; Wolf et al. 2018). As a result, it has been suggested that the Spanish interior was abandoned during the Last Glacial during stadial events and the LGM, in particular. This perception has been challenged recently (Alcaraz-Castaño et al. 2013, 2019; Yravedra et al. 2016) with the re-evaluation of the Solutrean record of the Manzanares Valley (Alcaraz-Castaño et al. 2017c) and new excavations at Peña Capón which point to a human presence in the central Meseta during MIS 2 (and see Fano 2012, fig. 8). Although this evidence indicates that human populations may have persisted in the Meseta during the Last Glacial cycle, there is still a lack of evidence for human presence in the region during the LGM *sensu stricto*, i.e., between 23 and 19 kya (Corchón Rodriguez 2002; Mix, Bard, and Schneider 2001; Straus 2018; Yokoyama et al. 2000). The hypothesis of human abandonment, or near abandonment, of the Spanish interior due to local climatic conditions during the coldest phases of the Last Glacial (Sala et al. 2020; Wren and Burke 2019), including the Glacial Maximum, may still hold, therefore. Following the LGM, human occupation of the region is once again well-attested (Cacho et al. 2010, 2012; Delibes de Castro and Diez Martin 2006; Utrilla et al. 2010, 2012; Yravedra et al. 2019).

Several archaeological surveys have been conducted in the central Meseta prior to this research in both the northern (Diez-Martín et al. 2008; Sánchez Yustos and Diez Martín 2010, 2015; Clark, Straus, and Fuentes 1975) and southern subregions (Álvarez-Alonso et al. 2018; Diez-Martín et al. 2008; de la Torre 2007; Rubio-Jara et al. 2016; Santonja and Pérez González 2000–2001; Tembleque, Santonja, and Pérez-Gonzáles 2000), including the communities of Castilla-León, Castilla la Mancha, Estremadura, and Madrid. With some exceptions (e.g., Sánchez Yustos and Díez Martín 2010), survey results are rarely published in full, however, often appearing in publications primarily devoted to excavation reports (e.g., Alcolea González and de Balbín Behrmann 2007; Jordá Pardo 2011). The value of reporting survey results in full, including negative results, cannot be overstated, and one of the goals of this research, which focuses on Guadalajara province, is to encourage archaeologists to adopt a more systematic approach to survey design and reporting, including full disclosure of the research methods deployed in the field and survey results (see below).

The Survey Region: Guadalajara Province

The province of Guadalajara is located in the southern part of the central Meseta, in the upper reaches of the Tagus River (see Figure 1). The hydrological system of the province incorporates the drainages of the Tagus and its tributaries, including the Jarama, the Henares, and the Tajuña. The Central System, a high mountain range that separates the Tagus and the Duero basins, forms the northern border of the province, and the Iberian System, which separates the watersheds of the Meseta from the Ebro valley and the Mediterranean coast, rises to the east. As a result, the average elevation of the province is ca. 1000 masl, reaching a maximum elevation of 2253 masl in the north (see Figure 2).

The archaeological record of Guadalajara fits within the broader context of the record of human occupation of the central Meseta (see above). Chronostratigraphic evidence from Jarama VI in the Alto Vale del Jarama and from Cueva de Los Casares (Alcaraz-Castaño et al. 2017b; Barandiaran 1973; Romero et al. 2018; Jordá Pardo 2011; Kehl et al. 2013) suggests that Neanderthal populations withdrew when climate conditions deteriorated towards the end of MIS 3. Fossil evidence for the presence of modern humans in the southern Meseta during the Late Pleistocene is limited to an undated specimen from Torrejones associated with Upper Palaeolithic material (Arribas, Díez, and Jordá 1997), recently reassigned to *H. sapiens* (Pablos, Sala, and Arribas 2017). Proto-Solutrean and Solutrean occupations at Peña Capón, a stratified site in the Sorbe River valley (Alcaraz-Castaño et al. 2013, 2019; Yravedra et al. 2016) and the open-air site of Las Delicias, in the Manzanares River Valley (Alcaraz-Castaño et al. 2017c) confirm that modern human populations reached Guadalajara and adjacent regions prior to the LGM. The Upper Palaeolithic record of the region is discontinuous, however, and evidence for a human presence during the LGM, *sensu stricto* is still lacking. The resettlement of Guadalajara following the LGM was swift, judging from the evidence from Jarama II, Buendia cave in the bordering province of Cuenca (de la Torre et al. 2007), and other Magdalenian sites in the region (Cacho et al. 2010; Straus 2018). The presence of parietal art at El Turismo and Cueva del Reno, Cueva de Los Casares (Alcolea González and de Balbín Behrmann 2003), and Cueva de La Hoz (de Balbín Berhmann et al. 1995) reinforces this impression, although some of the depictions could pre-date the Magdalenian on stylistic grounds.

Previous archaeological surveys in Guadalajara have tended to focus on cave deposits (de Balbín Behrmann, Valiente, and Mussat 1995). Despite active and ongoing surveys in the middle Tagus Basin, encompassing sections of the Jarama, Sorbe, Manzanares, and Tagus rivers (Rubio-Jara et al. 2016), the area east of the Jarama River, i.e., the upper Tagus Basin, including the province of Guadalajara, is still relatively unexplored (Jordá Pardo 2011). The need for further survey in the central Meseta is obvious and has been highlighted elsewhere (Corchón Rodriguez 2002; Diez-Martín et al. 2008). The research program we initiated in 2009, therefore, was conceived with the intention of contributing to the archaeological record of Guadalajara in the hopes of better understanding the impact of climate change on the dynamics of human populations in the central Meseta during the Late Pleistocene.

Survey Design

Pedestrian surveys were carried out during two one-month-long field seasons in 2009 and 2010, and a third survey was conducted in the summer of 2017. Three distinct survey zones were investigated for this research: two larger zones along the Tagus River valley (the South and East zones) and a smaller zone along the Badiel River, a tributary of the Henares (itself a tributary of the Tagus) and adjacent plateaux (the North zone) (see Figures 2, 3A). We used geological (IGEO Magma 1:1,000,000 and 1:50,000 series) and topographical (CNIG MTN 1:25,000 series) maps, a speleological catalogue for southern Guadalajara (Tabera and Yebra 1982,) and online map services (hosted by ESRI) to devise stratified, random surveys of the three survey zones. A predictive model of habitat suitability for the LGM (Burke et al. 2017) also informed the 2017 survey (Figure 3B).

From a geophysical perspective, the North and South survey zones are in similar contexts and stand in contrast to the East zone. At 1291 masl, the average elevation of the East survey zone is considerably higher than the North and South zones, which average 918 and 942 masl, respectively (see Figure 2). The geological contexts of the North and South zones are also similar (Figure 4). The North zone is closer to the Central Range, while the South zone is in contact with the Serranía de Cuenca, but both survey zones are dominated by Cambisols, formed in Neogene deposits composed of sandstones, conglomerates, slate, and limestone. Fluvisols are also present, dominated by gravels, conglomerates, and alluvial deposits; fluvial terraces line the main waterways. The geology of the East zone is more complex, since it impinges upon the older formations of the Iberian Range, formed of Jurassic limestone and volcanics. The lithology of this zone includes limestone, nodular limestone, marls, mudstones, radiolarite, and volcanics. Cambisols occur in the river valleys, but Leptosols are prevalent in this survey zone.

Ploughed fields and orchards provide the best opportunities for pedestrian survey, which means that the distribution of soils suitable for agricultural exploitation will affect survey results. There are fewer limitations to agricultural production in the North and South zones, according to the distribution of suitable soil types obtained for our study region from the European Commission's Joint Research Centre: European Soil Data Centre (ESDAC). A common limitation in the North and South zones is the presence of gravels, which tend to distribute along waterways. In contrast, thin Leptosols are widely distributed in the East zone, where bedrock is frequently present within 50 cm of the soil surface, which may have an impact on survey results (see below).

Teams of 3–4 archaeologists equipped with handheld WAAS-enabled DGPS units (Garmin© 60CSx) conducted stratified, random surveys concentrating opportunistically on areas with exposed soil (ploughed fields, groves, or olive plantations) and more systematically on river terraces and limestone outcrops. The DGPS units, which have a typical accuracy of 3–5 m, were used to record the location of all artifacts encountered. Lithic artifacts were systematically recorded and collected for further analysis; ceramic artifacts, generally left in situ, were also recorded, in addition to landscape features such as surface concentrations of flint or other raw materials. Field conditions were generally favorable (little vegetation cover and clear skies), and recording did not start until the DGPS units reported an accuracy of ca. 2–4 m. Each operator's movements were tracked at 5 second intervals for the duration of the survey, and the tracks were downloaded, along with the location of all artifacts encountered, to a GIS project (using ESRI® ArcMap Desktop software). Team leaders took note of the vegetation cover type and any relevant factors that could affect visibility and/or geolocation services. All information recorded in the field (artifact locations, feature locations, and tracks) was uploaded to the GIS project and processed.

Lithic densities for the survey parcels were calculated per 10 m^2, since the native resolution of the DGPS devices does not permit calculations at a smaller scale. Survey tracks were merged for each survey location and layered over satellite imagery, available as an ESRI map service layer. The parcels were then mapped using the merged tracks and local topographic boundaries (e.g., field boundaries, fences, roads, or abrupt changes in elevation), creating polygon features. Survey intensity was calculated as a function of the coverage (equal to the length of the merged survey tracks times a sweep width of 1 m) and the total area of each polygon. The total length of the merged tracks, coverage area, and the total area of the polygon were calculated using the geometry calculator. The Field Calculator tool was then used to calculate survey intensity (I) according to the equation

$$I = (Lt * m) / Ap$$

where I is intensity, Lt is the length of the merged tracks, m is the sweep width (set at 1 m), and Ap is the total area of the polygon.

We chose a conservative sweep width estimate of 1 m, calculated on either side of the survey tracks (Banning, Hawkins, and Stewart 2011). The number of artifacts per polygon (artifact density) can thus be compared across the study region, accounting for variation in survey intensity, as well as environmental factors such as visibility. We calculated polygon area, survey intensity, and number of artifacts per polygon and then extracted contextual information for the polygons (elevation, geological context, and habitat suitability). To extract the geological context data, we loaded the relevant feature classes into ArcGIS Online and imported the geological service layers provided by the Instituto Geológico y Minero de España (IGME).

Spatial Analysis

The list of potential predictors of the presence and abundance of lithic artifacts includes seven numerical variables (elevation, distance to water, slope, rate of soil erosion, preservation capacity of cultural material [stratigraphy], and habitat suitability) and four categorical variables (soil type, dominant type of deposit, and lithology at 1:1 M and 1:50,000 scale, survey region). Elevation was extracted from the SRTM 1-arc sec dataset distributed by the USGS. Distance to water was calculated in arcGIS (10.5.1) using a hydrology vector file downloaded from diva-gis.org and a cost-surface raster calculated from the SRTM 1-arc sec dataset. Net annual soil aggradation rates for the region were obtained from the European Commission's Joint Research Centre: European Soil Data Centre (ESDAC) (Borrelli et al. 2018). The preservation capacity for cultural material, which includes stratigraphy, bone, metal, and organics (Kibblewhite, Tóth, and Hermann 2015), and soil type (Panagos et al. 2012) were obtained from ESDAC. An index of habitat suitability for the LGM derives from a previously published model (Burke et al. 2017). Geological data were extracted from the National Geological Map of Spain (MAGNA 50) and the 1:1 M Geological Map of Spain, produced by the Spanish Geological Survey (IGME) and hosted as ArcGIS Map Service layers.

1 × 1 km rasters were produced for the candidate predictor variables and stacked, and cells containing survey parcels were extracted from the stack for the spatial analysis. Attributes were added to the resulting table using Zonal Statistics and Spatial Join tools in ArcGIS. Binary values based on the presence/absence of artifacts in the extracted cells (corresponding to survey parcels) were assigned to the table using two scales: BIN1 absence = 0, BIN2 absence < 10. The impact of individual variables was tested in Excel using the F-test to test the variance of the two

populations of survey parcels (presence/absence) followed by the T-test to test the population means. Spatial autocorrelation of parcel locations with and without artifacts was tested using Global Moran's I in ArcGIS (Spatial Statistics Toolbox) using inverse distance and row standardization. Exploratory regression was carried out in ArcGIS (Exploratory Regression tool, Spatial Statistics toolbox). Finally, a generalized linear model (GLM) was applied with backward selection using the glm function in R (version 3.6.3) (R Foundation for Statistical Computing 2020) and both binary response variables (BIN1 and BIN2). Preliminary exclusion of variables was done using a correlation threshold ≥ 0.8, and model selection was based on Akaike's Information Criterion (AIC). The proportion of deviance explained by the resulting model was calculated using the Dsquared function in the modEVA package (Barbosa et al. 2013).

Lithic analysis and chronology

Chronological attributions are notoriously difficult to make when dealing with surface lithic scatters, which often lack diagnostic tools. This is due to the relative scarcity of diagnostic tool types and their distinctive features, which make them more likely to be collected during uncontrolled surveys. While many of the sites described below could not be reliably attributed to a specific timeframe, we were able to attribute tentative chronologies to several spatially discrete, techno-typologically homogeneous assemblages. Toolkits composed of sidescrapers, notches, denticulates, and points and evidence for discoid and/or Levallois knapping methods were attributed to the Middle Palaeolithic. Toolkits including endscrapers and burins, associated with blade and/or bladelet cores obtained by direct percussion (either soft or hard), were attributed to the Upper Palaeolithic. Assemblages comprised of irregular flakes produced using hard percussion, single-platform, or informal cores and, if present, blades produced using punch or pressure techniques, were attributed to the Chalcolithic. Historical flint knapping in the survey region is associated with unpatinated flakes with wide, thick butts struck from multi-surface cores using an iron-hard hammer. A generic Palaeolithic attribution was possible when techno-typological traits associated with recent prehistoric or historic lithic production were absent.

Results

Over the course of three survey seasons, a total of 310 locations were explored, of which 237 were surveyed (Figure 5; Supplemental Material 1). Field reports (Yravedra Sainz de los Terreros, Burke, and Alcaraz Castaño 2017; Fuertes Prieto, Burke, and Maillo Fernández 2009, 2010) were submitted to the Ministry of Education, Culture and Sports of Castilla la Mancha. In the East zone, 68 locations were visited, but only 14 locations were surveyed, due to adverse conditions (poor visibility due to vegetation cover, soil erosion, etc.). In the South, 157 locations were surveyed, and 167 survey polygons were created (some locations were allocated more than one polygon), and in the North, 92 locations were visited, and 56 were surveyed. Ploughed fields and orchards provided the best visibility (Figure 6). The surveys yielded a total of 4118 artifacts. Of these, 3067 lithic artifacts have been analyzed and are reported here. 1,898 of these artifacts, from 162 locations, are techno-typologically assigned to the Palaeolithic.

Localities with lithics are almost exclusively located in the North and South survey zones, occurring most frequently in the Neogene sediments that fill the Tagus River basin at lower elevations, which are mostly composed of conglomerates and sandstones with clays and occasional limestone deposits. This explains the negative relationship observed between elevation, slope, and the occurrence of artifacts. Relatively abundant lithic material was recovered in the Tagus and Garrigay River Valleys (the Garrigay is an affluent of the Tagus) and in the Badiel River Valley (the Badiel is an affluent of the Henares River, which in turn flows into the Tagus) in calcaric Cambisols and Fluvisols. Topographically, localities with artifacts tend to be situated on river terraces or on bluffs above the river valleys. In the East zone, situated in the upper course of the Tagus and characterized by thin Leptosols and complex bedrock formations (see Figure 4), a single survey parcel (PRUB) yielded lithic material (n = 4) (see Figure 5A).

Spatial analysis

Moran's I, a spatial autocorrelation tool that tests whether features are randomly distributed across the landscape, was used to evaluate the spatial distribution of the survey parcels with and without artifacts. Results indicate that their distribution is non-random (p = 0.000, z-score = 5.487) with a tendency towards clustering, albeit not a strong one (Moran's Index = 0.147). We also tested the impact of surface visibility on the presence/absence of artifacts in the survey parcels using the chisq.test function in R and BIN2. We defined six visibility categories, from "poor" (heavily vegetated) to "very good" (recently ploughed fields), finding no significant relationship between surface visibility and presence/absence: X^2(df = 6, p = 0.517). This means that our sample of archaeological locations is not biased by regional differences in contemporary land-use patterns across the study regions, although visibility affects the number of artifacts recovered. As a result of this test, visibility was not included in the list of potential predictors in the ensuing analyses.

The results of the exploratory regression models indicate that elevation is a strong predictor of the presence/absence of lithic artifacts. Survey locations at lower elevations, situated on relatively flat ground, are more likely to contain artifacts. A T-test assuming equal variance confirms that the mean elevation of survey parcels with and without artifacts is dissimilar ($p < 0.05$, df = 149). The mean elevation of parcels with and without artifacts is 834 m and 1196 masl, respectively. Only one of the survey parcels in the East zone, which has a higher mean elevation than the other two survey zones, yielded any artifacts. The logistic regression (GLM) produced a model combining elevation and geological strata (from the IGME 1:1 M map service layer) that accounts for ca. 45% of the deviance according to the adjusted Dsquare value. This reflects the preferential distribution of parcels with artifacts in the red layers (marly limestone levels) and limestones that predominate in fluvial contexts in both the North and South survey zones.

Since soil erosion may result in the secondary deposition of artifacts (see discussion below), we also examined soil accumulation rates (Borrelli et al. 2018) across our survey region. Because agricultural activity can create favorable survey conditions but result in high soil erosion rates, relatively more survey parcels are distributed in areas with net soil loss. An F-test demonstrates that the variance in erosion rates for parcels with and without artifacts is unequal, and a T-test (with unequal variance) confirms that we should reject a hypothesis of equal means. There is a significant difference ($p < 0001$) in the distribution of parcels with and without artifacts, with lower mean erosion rates for parcels with artifacts (-1.36 Mg ha^{-1} yr^{-1}) versus for parcels without (-0.8 Mg ha^{-1} yr^{-1}). This suggests that artifacts tend to occur where soils are eroding, although the distribution of erosion rates in parcels with and without artifacts overlaps and, as mentioned above, both sample populations are situated in areas with net annual soil loss. Nevertheless, this observation has implications for the interpretation of site formation processes (see discussion below).

Archaeological sites

In the South survey zone, five open-air sites stand out due to the large size and relative homogeneity of the lithic series they contain (Figure 7): CARRA (La Carrascosilla), ELVIL (El Villar), SAC6 (Sacedón 6), MAJ (las Majadillas), and CMAJ (Camino Majadillas). Preliminary lithic analyses of three of these sites, CARRA, SAC6, and CMAJ, are published elsewhere (Burke et al. 2013) and are presented in more detail below. At a regional scale, the sites are all located in geological contexts characterized by the presence of conglomerates and sandstones, alternating with clays, evaporites, and bands of limestone. In the North survey zone, 56 parcels yielded several small lithic series (totaling 310 artifacts). Two localities yielded relatively high concentrations of lithic material attributable to the Palaeolithic or Epipalaeolithic, however, and we have designated them as open-air sites: OLM (El Olmillo) and UTA (Utanda). Both sites are located on the margins of the Badiel River, an affluent of the Garrigay, in deposits characterized by the presence of conglomerates, sandstones, and clays. No sites were designated in the East survey zone.

CARRA 1 and 2 (La Carrascosilla) are adjacent parcels located on an alluvial terrace, roughly 665 masl on the left bank of the Tagus, downstream and approximately 3 km west of the village of Sacedón, in a zone locally characterized by Fluvisols. The geological context is characterized by the presence of silts, clays, red sands, and marls with pockets of gravel, conglomerates, and breccias. The terrace is mainly comprised of large cobbles and is currently exploited for growing olives. CARRA experiences a relatively low rate of net annual soil loss (-0.7095 Mg ha^{-1} yr^{-1}). A sizeable lithic assemblage (n = 328) presents techno-typological features consistent with an early Middle Palaeolithic date (Figure 8; Supplemental Material 2). The assemblage, which is primarily composed of flakes and flake fragments, includes 53 cores, predominantly informal types, of which 20.8% are single-platform (unipolar) cores on flakes. 28 (8.6 %) formal tools include: notches (25%), denticulates (21.4%), Levallois flakes, endscrapers on flake blanks, sidescrapers (14.3%), a borer, a Mousterian point fragment, and a possible Mousterian cleaver. Maximum density of the finds is 7 lithics per 10 m^2. The topographic location and low soil erosion rate indicate that the assemblage is probably in a primary depositional context.

SAC6 (Sacedón) is located at an altitude of ca. 730 masl, roughly 1.5 km north of the village of Sacedón in a sandy pocket between parallel sandstone ridges on the east side of the Entrepeñas reservoir, which is situated on the Tagus River. The sandstone ridge formation runs parallel to the eastern shoreline of the reservoir, and several smaller lithic scatters were discovered in similar sedimentary contexts between SAC6 and the residential developments of Las Brisas and Paraísos. The net annual soil loss rate at SAC6 is negligible (-0.4058 Mg ha^{-1} yr^{-1}). The site lies between two flint outcrops located within a 1 km radius of the site, which are likely to have provided the raw materials exploited there. The assemblage contains 956 artifacts dominated by an Upper Palaeolithic component, but it incorporates a Middle Palaeolithic and a possible post-Palaeolithic component (Figure 9; Supplemental Material 3). The maximum density of finds is 22 lithics per 10 m^2. The more numerically important Upper Palaeolithic component includes blades (5.12% of the total assemblage, which includes blades, crested blades, and bladelets obtained using soft percussion), as well as blade and bladelet cores (representing 19.23% of all cores). Formal tools are rare (3.9%) but include Upper Palaeolithic types such as endscrapers, endscrapers on retouched blades, a truncated blade, and a backed bladelet. The Middle Palaeolithic component is represented by *éclats débordants* and Levallois flakes. Eight nearby parcels were surveyed, yielding small lithic series that have yet to be analyzed. A raw material source was located nearby. The low soil erosion rates, large lithic assemblage, and lack of evidence for post-depositional retouch, coupled with the topographic location of SAC6, makes it likely that the site is in a primary depositional context.

CMAJ (Camino Majadillas) is located 12 km east-northeast of Sacedón at an elevation of ca. 820 masl in a zone locally characterized by the presence of limestone and marls. The site is located on a low ridge between two gullies (Fuente Gris and Arroyo del Tejar) that flow into the Garrigay River. A dirt road runs along the top of the ridge, which is covered in scrubland and surrounded by worked fields where naturally occurring flint is abundant. Net soil erosion rates for the cluster of survey parcels that surround the ridge are very high (-8.4760 Mg ha^{-1} yr^{-1}), indicating significant erosion and soil loss occurring around the ridge. The ridge top itself has a relatively lower, but still substantial, rate of soil erosion (-4.1568 Mg ha^{-1} yr^{-1}). A total of 249 artifacts were recovered along the ridge from 5 adjacent parcels; spatial information is lacking for 34 artifacts (Figure 10; Supplemental Material 4). The maximum density of finds is 6 lithics per 10 m^2. Post-depositional retouch is high, which is consistent with the high soil erosion rates and the likelihood that post-depositional processes have affected the spatial distribution of the artifacts. Flake and flake fragments dominate (75.5 %), while formal tools make up 6.4% of the assemblage, including notches (25% of tools) and denticulates (18.7%). Levallois cores are common, followed by more casual cores.

UTA (Utanda) is a series of small, adjacent olive groves on a terraced hillside overlooking the Badiel River Valley at the junction between the Badiel and the Valdeiruega rivers, less than 1 km from the village of Utanda at an average elevation of ca. 890 masl. Soils are weakly aggrading at UTA (SL = 0.3895 Mg ha^{-1} yr^{-1}), possibly due to colluviation, given the topographic setting of the fields, as well as the protective effect of terracing. Maximum lithic density is relatively low, at 2 lithics per 10 m^2. Preliminary analysis of the lithics from this site indicate prolonged use of the area during the Palaeolithic period, with clear evidence of a Middle and Upper Palaeolithic/Neolithic/Chalcolithic presence. The lithic assemblage (n = 100) (Supplemental Material 5) includes pieces clearly related to the Middle Palaeolithic, such as Levallois flakes (18%) and cores (3%), a discoid core, and *éclats débordants* (3.4%). Together with artifacts broadly classified as Palaeolithic, including a large number of single flakes and fragments (49.6%), these pieces comprise 75% of the total assemblage. The Upper Palaeolithic component is potentially represented by some blades, several endscrapers, a bladelet core, and a burin-bladelet core (Figure 11Bi-iii). However, these artifacts are also found in Neolithic and Chalcolithic contexts, and, thus, a Holocene age for these artifacts cannot be ruled out.

OLM (El Olmillo) consists of two adjacent survey parcels, OLM1 and OLM2. OLM2 is a Middle Palaeolithic knapping station located on a raw material source on the north side of the Badiel River Valley ca. 3 km from UTA at an altitude of 856 masl. The site is located in sandy sediments on a remnant Pleistocene terrace currently planted with pine and olive trees. Lithic density is 9 finds per 10 m^2 (n = 122) (Supplemental Material 6). Net annual erosion rates at OLM are very low (-0.009 Mg ha^{-1} yr^{-1}), and there is no reason to suggest that the artifacts were secondarily deposited by soil movement. Where road or agricultural work has cut into the terrace, a band of flint nodules is visible. The Middle Palaeolithic component of OLM is sound and is basically represented by a technologically homogeneous assemblage, mostly affected by a white-yellowish patina, including a relevant number of Levallois cores (5.7%) and Levallois flakes (11.8%), sidescrapers (2.5%), and other retouched tools (2.4%) and cores (2.5%), together with a large number of raw single flakes and fragments (73.9%) (Figures 11, 12). The presence of at least one small-sized or “micro-Levallois” core (Figure 11A: iii) and a Vale Comprido point

(Figure 11A: ii) is noteworthy. Signs of a more recent, but limited, modern exploitation of the flint source are also present (i.e., cores made by *trilleros* (flint-knappers specialized in making threshing boards) in historic times).

Two lithic raw material sources were identified during the 2017 survey in the North zone. The first is OLM (see Figure 7), in addition to which there is a large flint exposure at PALACIOS (toponym: Los Palacios), where flint outcrops on the brow of a plateau overlooking the Val de Obispo slightly more than 3.5 km north of the Badiel River. A series of large caves, which were converted into livestock pens ("*ganaderos*") at some point in the past, ring the plateau. These two flint sources are approximately 6 km apart along the Badiel River Valley but are at different elevations. The flint outcrops at PALACIOS are located ca. 1005 masl, whereas OLM is located at 856 masl in the river valley. Both sources contain large nodules of good quality flint, which resembles the material recovered elsewhere during the 2017 survey of the North region. The parcels surveyed below PALACIOS (TAL and REG) contained an abundance of natural flint and a small number of artifacts, but no obvious concentrations, despite the excellent visibility that prevailed in freshly ploughed fields.

Discussion

Surveys conducted in the province of Guadalajara in 2009, 2010, and 2017 resulted in the discovery of several open-air archaeological sites attributable to the Middle (CARRA, CMAJ, OLM) and Upper (SAC6) Palaeolithic, in addition to evidence for the persistent use of strategic locations (e.g., UTA, located at the junction of two rivers) over the course of the Palaeolithic and Late Prehistoric periods. Lithic encounter rates vary from 0 to 2.2 artifacts per m^2 or 0–220 artifacts per km^2, which is higher than the lithic densities reported for the Duero Basin (Sánchez

Yustos and Díez Martín 2010) but considerably lower than the average densities reported for the Polop Alto valley, Valencia (Barton et al. 1999). Most of the survey parcels with artifacts encountered in this project were found in river valley locations and are associated with red marls or limestone deposits; lithic artifacts predominate, and the overall density of ceramics is extremely low across all three survey zones (an observation also noted by Barton and colleagues [1999]). The discovery of numerous localities with small lithic series, though lacking diagnostic material, provides evidence of a stable pattern of landscape use across the region.

Globally, our survey results suggest a regional pattern of prehistoric occupation focused on river valleys that spans the Late Pleistocene—though perhaps not continuously. Although some material was recovered from Holocene alluvial contexts, most of the archaeological material recovered derives from older sediments within the Tagus river basin and its tributaries. The question, therefore, is whether this pattern reflects a preference for fluvial settings, with the Tagus River acting as a major conduit for human movement across the region, or whether geomorphological and taphonomic processes are at work. Within Guadalajara province, there is little or no indication of a Palaeolithic human presence at higher elevations, either in interfluvial regions in the North and South zones or, more strikingly, in fluvial settings in the East survey zone. Erosion processes are known to have actively shaped the Iberian landscape during the late Pleistocene and early Holocene, and it is possible that erosion processes have redeposited evidence of human activity from upland regions downslope. Conversely, active soil erosion could also be responsible for uncovering Palaeolithic deposits in some locations. The results of the spatial analysis (above) do not support either of these suggestions, however, since the rate of local soil erosion/aggradation did not emerge as a predictor for the presence/absence of archaeological material.

In the East survey zone, vegetation cover (fairly dense at times) and topographic relief hindered the survey and may explain the lack of archaeological evidence. Alternatively, in a region sparsely populated at the best of times, the colder upland regions and more mountainous territory of the East zone may not have been used intensively enough during the Late Pleistocene to leave traces in the archaeological record. Our results contrast with the results of surveys of upland plateaus in the northeastern Duero river basin (Sánchez Yustos and Díez Martín 2010), where karst features have revealed evidence of human occupation. Differences in survey strategy could account for this observation, indicating the need for further exploration of the Eastern zone. While Middle and Upper Palaeolithic material, in addition to Late Prehistoric material, was encountered during our surveys, no lithic material attributable to the LGM (aka, the Solutrean or early Magdalenian) was identified. As discussed above, other authors have suggested that the central Meseta was abandoned during climatic downturns, although recent evidence for human occupation during MIS 2 immediately preceding the LGM calls into question the definition of a climatic downturn. A previously published model of habitat suitability for the LGM in western Europe (Burke et al. 2017) also suggests that the Spanish interior would have been relatively unsuitable for human habitation during the LGM due to its relatively high elevation and degree of climate variability, among other factors. Relatively high suitability values for the East survey region are still well below suitability values for regions known to have been inhabited during the LGM (suitability in the model is scored on a scale of 0–1). The model does predict that river valleys would have been relatively more suitable habitats than intervening, interfluvial regions, which is consistent with our results. The absence of diagnostic lithics indicative of human occupation in the survey region during the LGM and the apparent focus on river valleys could be explained in terms of the model, therefore, although it is difficult to draw firm conclusions from undated surface deposits.

Conclusion

The results reported above are consistent with other surveys conducted in the central Meseta, which suggest: 1) that open-air sites are more often located in river valleys or in fluvial (more rarely, fluvio-lacustrine) sediments (Santonja and Pérez González 2000–2001; Sánchez Yustos and Díez Martín 2010); and, 2) that the Tagus River Basin was occupied fairly continuously during the Palaeolithic, although evidence for occupation during the LGM is still lacking. Most of the artifacts recovered are from the Tagus River Valley, and it seems likely, as others have suggested, that the Tagus acted as a biogeographic corridor during the Late Pleistocene, linking the Atlantic region to the interior.

Globally, despite the fact that we are dealing exclusively with surface collections (with all the attendant difficulties in establishing chronological control), our results demonstrate that Guadalajara province has a rich Palaeolithic record that is certainly worth exploring further. As previous publications have also shown, Lower and Middle Palaeolithic components are present in the region, as are later Upper Palaeolithic and Late Prehistoric components. Our results could support the hypothesis of at least partial abandonment of the central Meseta (including Guadalajara province) during the LGM, possibly as a result of variable rainfall patterns, as suggested by the habitat suitability model (Burke et al. 2017). The results of this research neither refute nor support this proposition, however, and the corpus of currently available archaeological material dating to the LGM does not enable us to test it. Finally, the survey results reported here will help refine Palaeolithic survey design in the central Meseta and, more specifically, Guadalajara province, in the very near future.

Supplemental Material

A link to an online story map is provided here: http://arcg.is/0jm45L The map illustrates the distribution of the survey parcels (see Supplemental Material 1) across all three survey zones, including survey intensity and the number of artifacts recovered with topographic and geological contexts. The distribution of artifacts is not included to protect the integrity of the sites.

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Figures

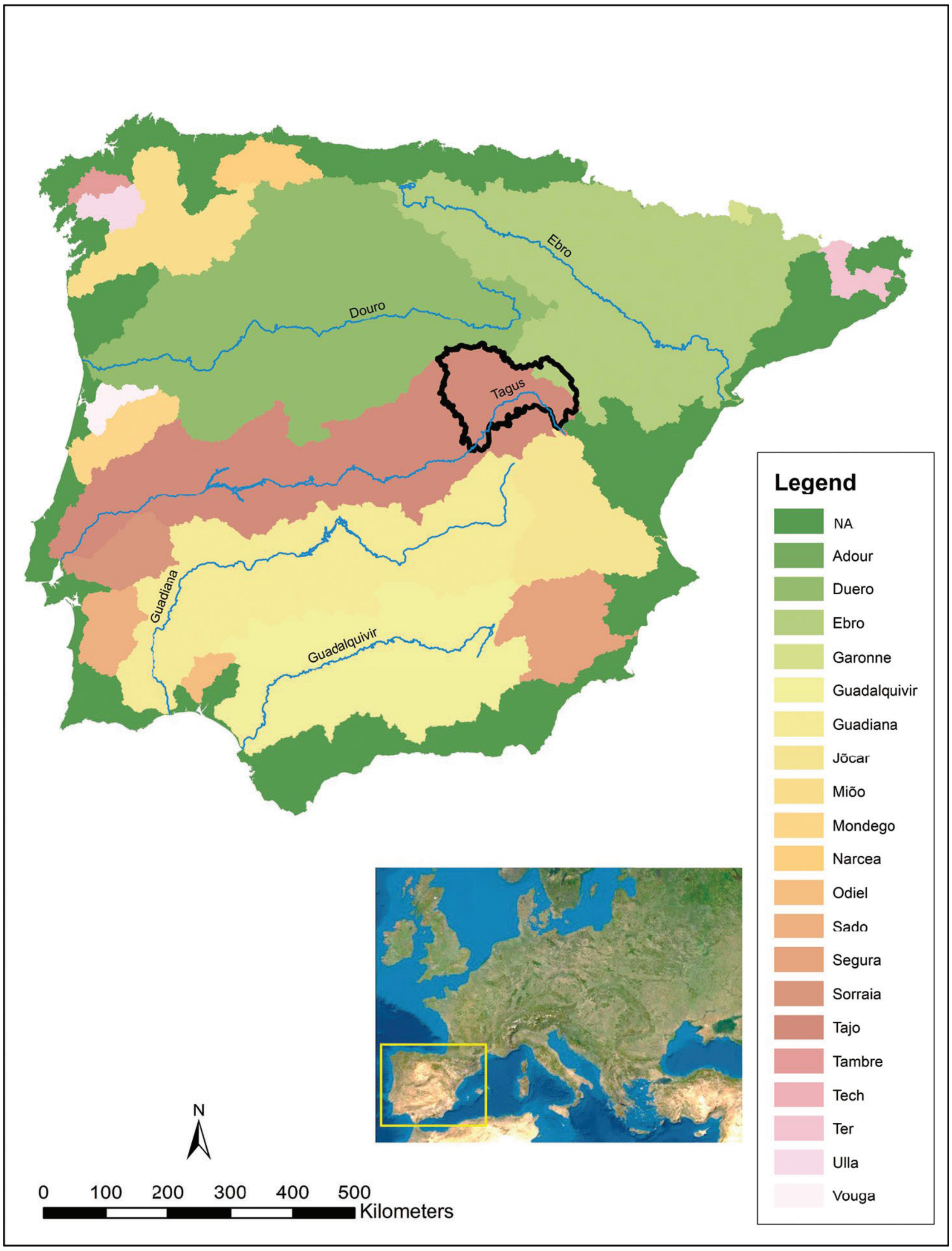

Figure 1: The Iberian Peninsula and major watersheds. This research focuses on the province of Guadalajara (outlined in black), located in the southern subregion of the central Meseta in the Tagus River drainage.

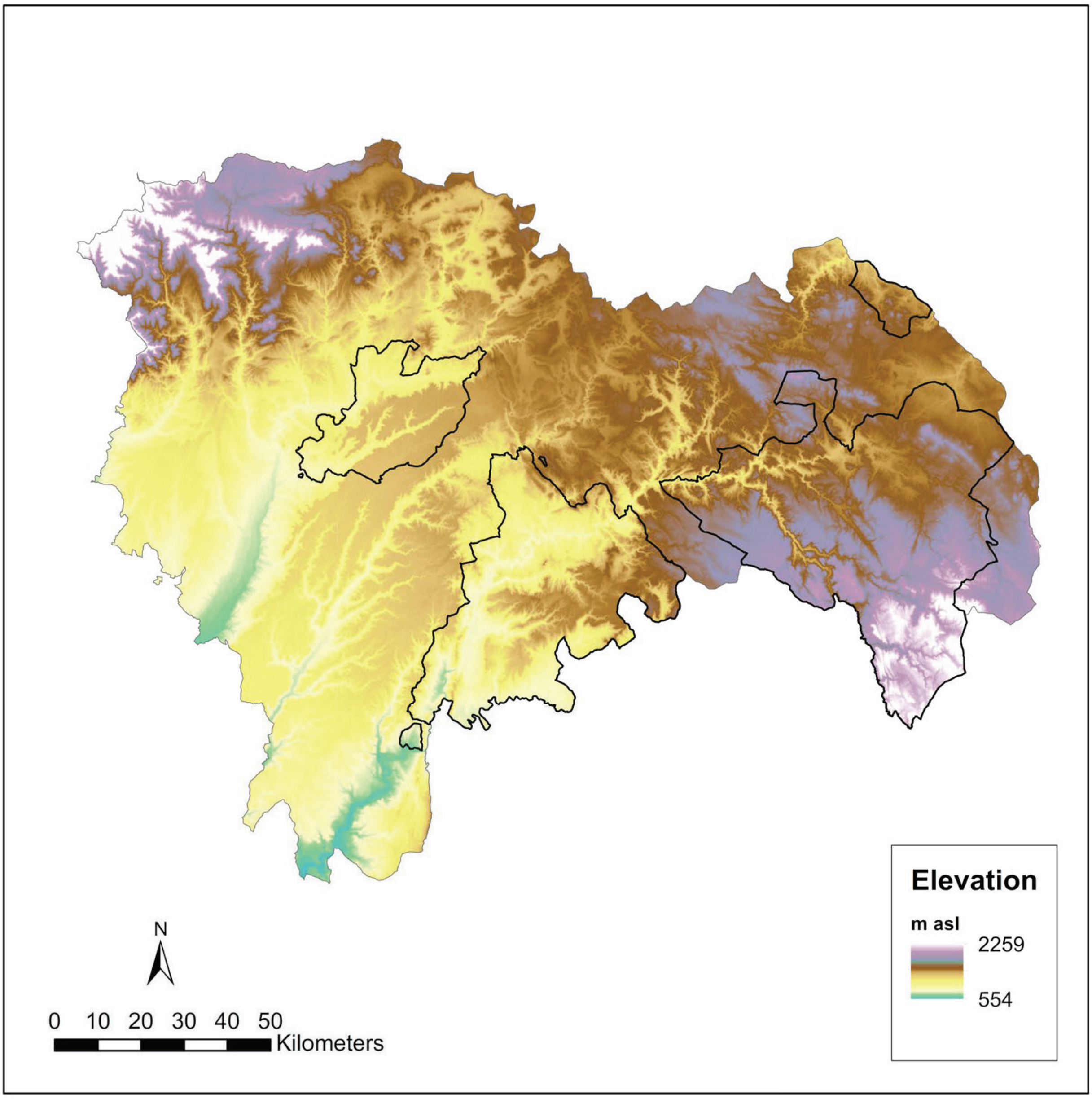

Figure 2: Elevation model of Guadalajara province (source: USGS EROS SRTM 3 Arc-sec.).

The three survey zones studied in this research are outlined in black.

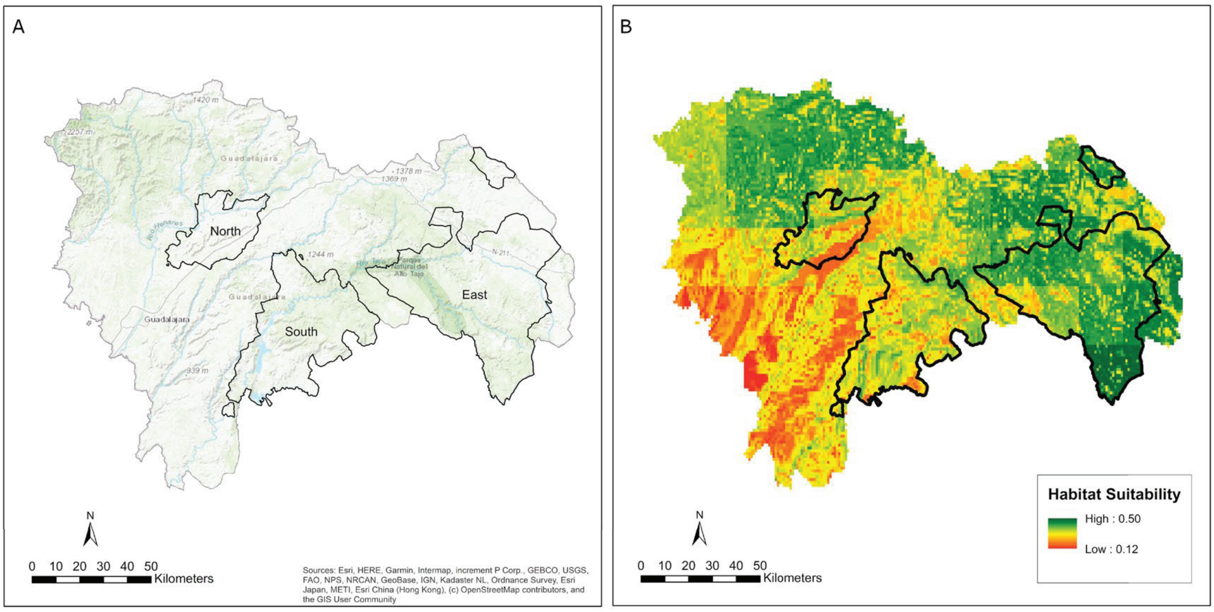

Figure 3: A) Topographic map of Guadalajara province highlighting the location of the three survey zones studied in this research, outlined in black. B) LGM Habitat Suitability model (Burke, Kageyama et al. 2017); habitat suitability is scored from 0–1 at a continental scale.

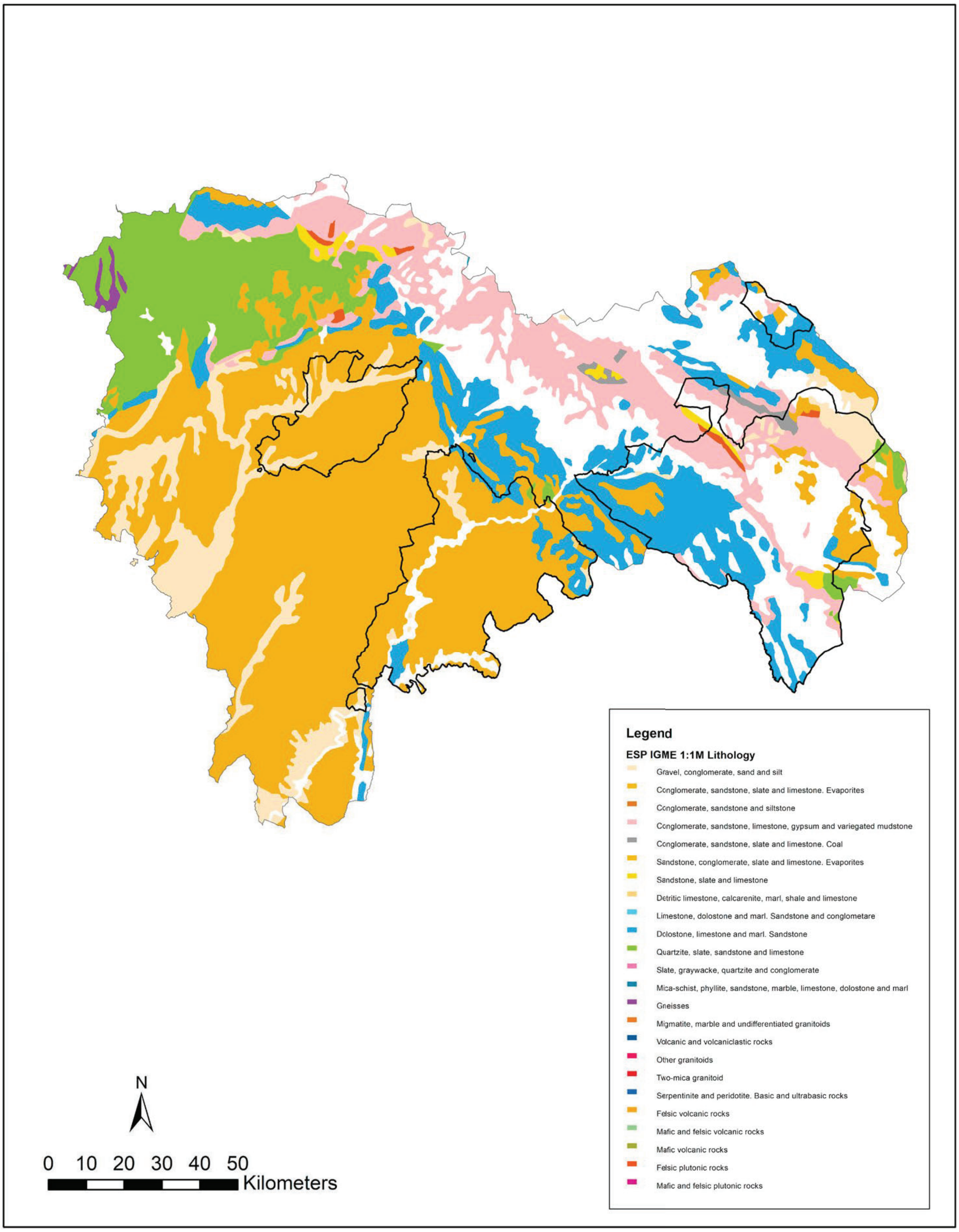

Figure 4: 1:1 M scale geological map of Guadalajara province (source: IGME). The three survey zones are outlined in black.

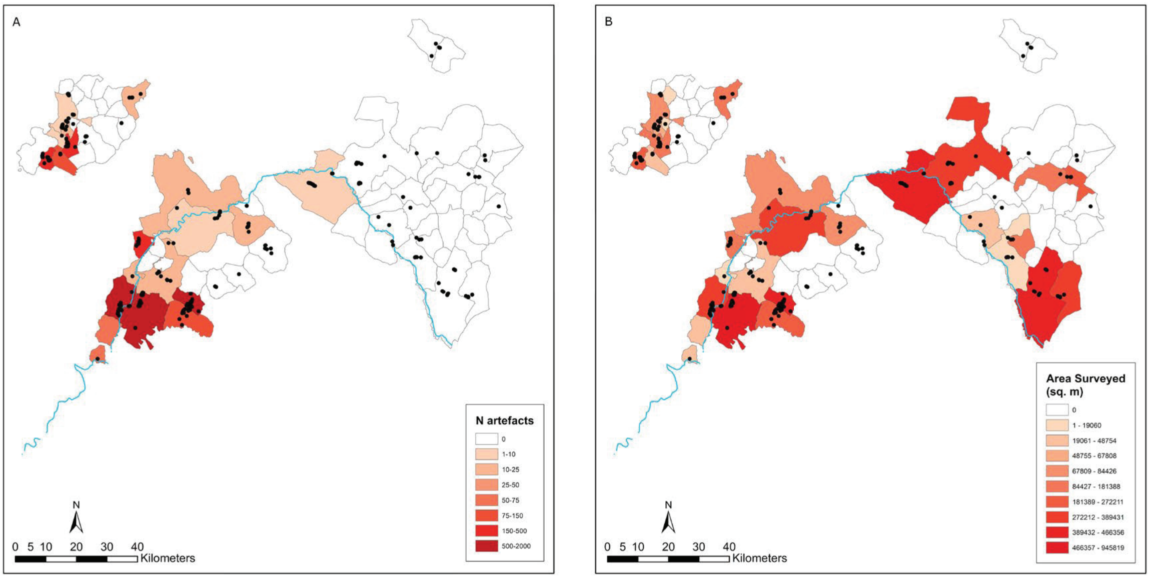

Figure 5: A) Artifact count by municipality. B) Area surveyed by municipality. Black dots represent all areas explored, irrespective of visibility.

Figure 6: OLM (El Olmillo), illustrating good visibility in a typical olive grove during the 2017 survey season.

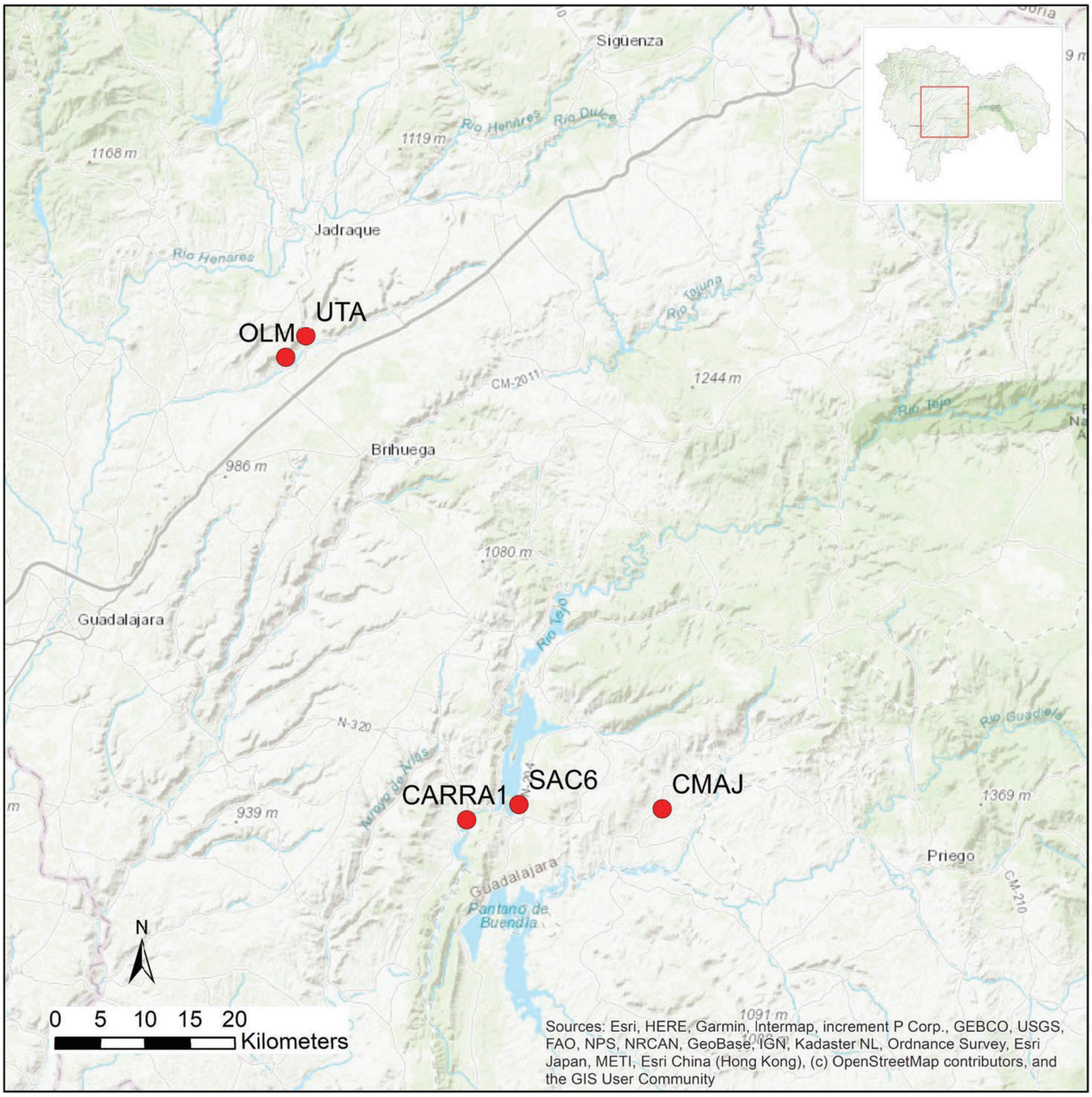

Figure 7: Location of the five archaeological sites with diagnostic lithic elements (OLM, UTA, CARRA, SAC6, and CMAJ).

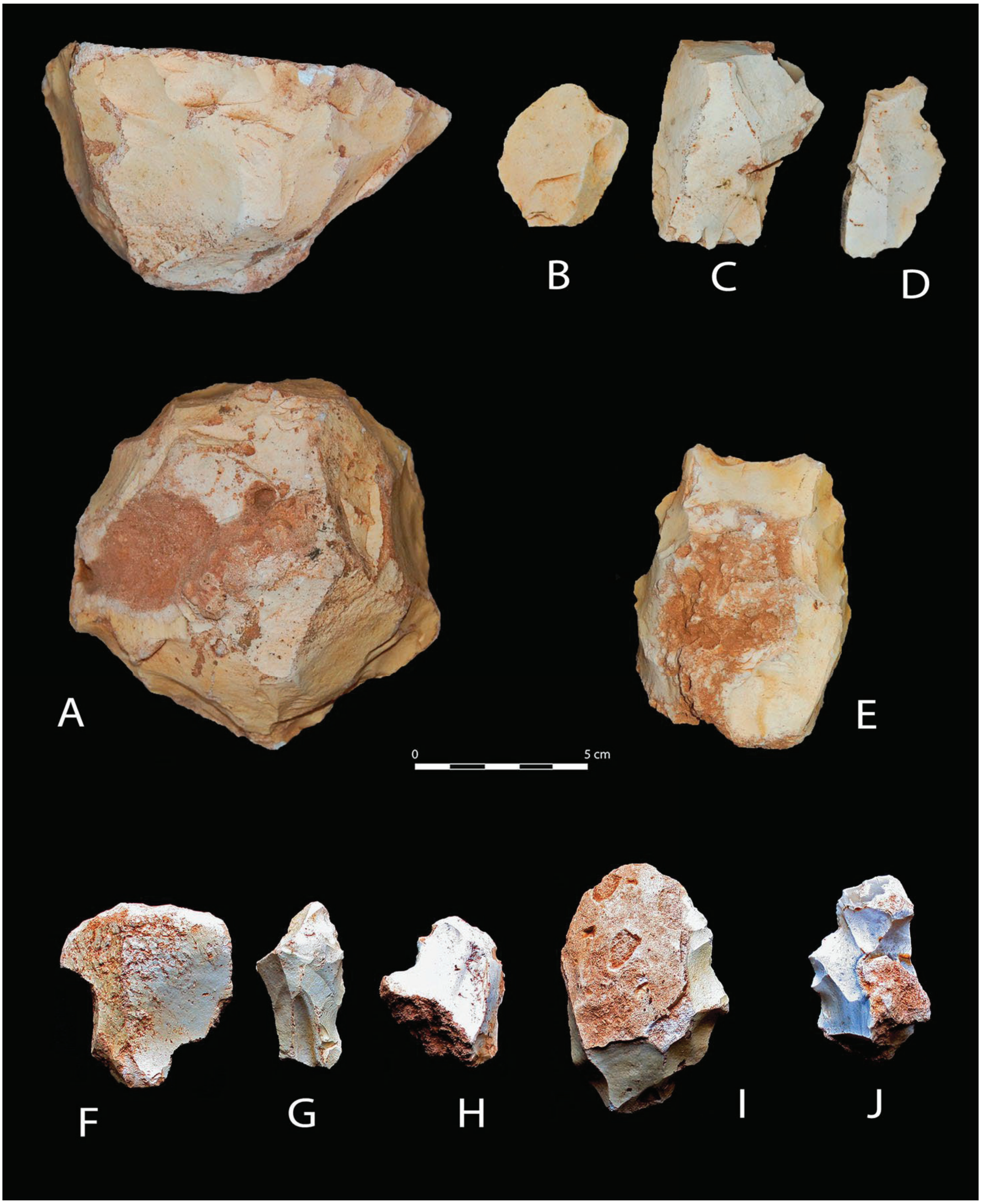

Figure 8. CARRA (La Carrascosilla) lithics: A) large atypical rabot/single platform core; B–D) unmodified flakes; E) cleaver; and, F–J) denticulates and notches on flake. All on flint.

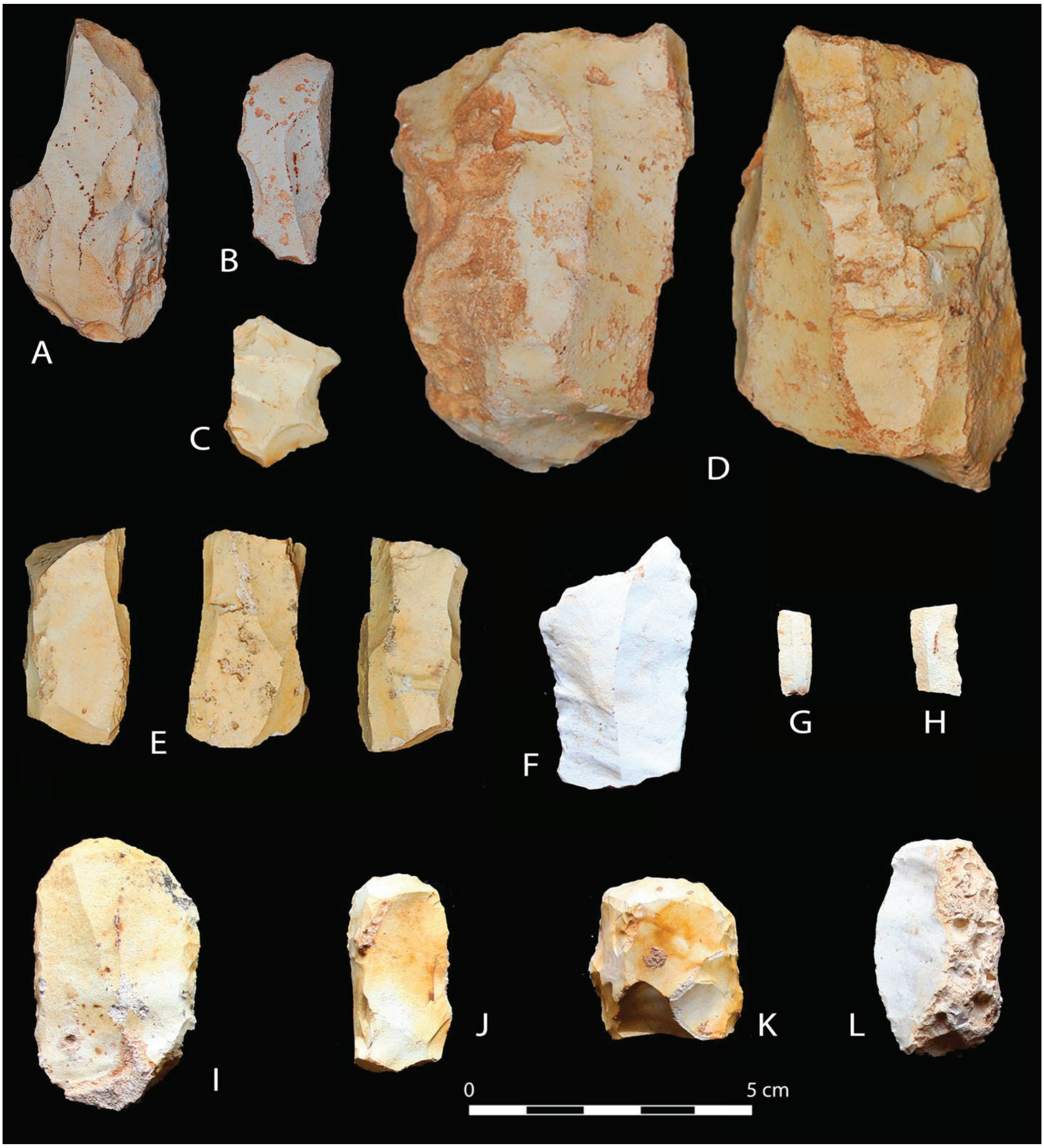

Figure 9. SAC6 (Sacedón 6) lithics: A) elongated flake with a distal burination; B) blade; C) notch on a flake; D) blade core; E) prismatic bladelet core; F) retouched flake; G) bladelet; H) backed bladelet; and, I–L) endscrapers. All on flint.

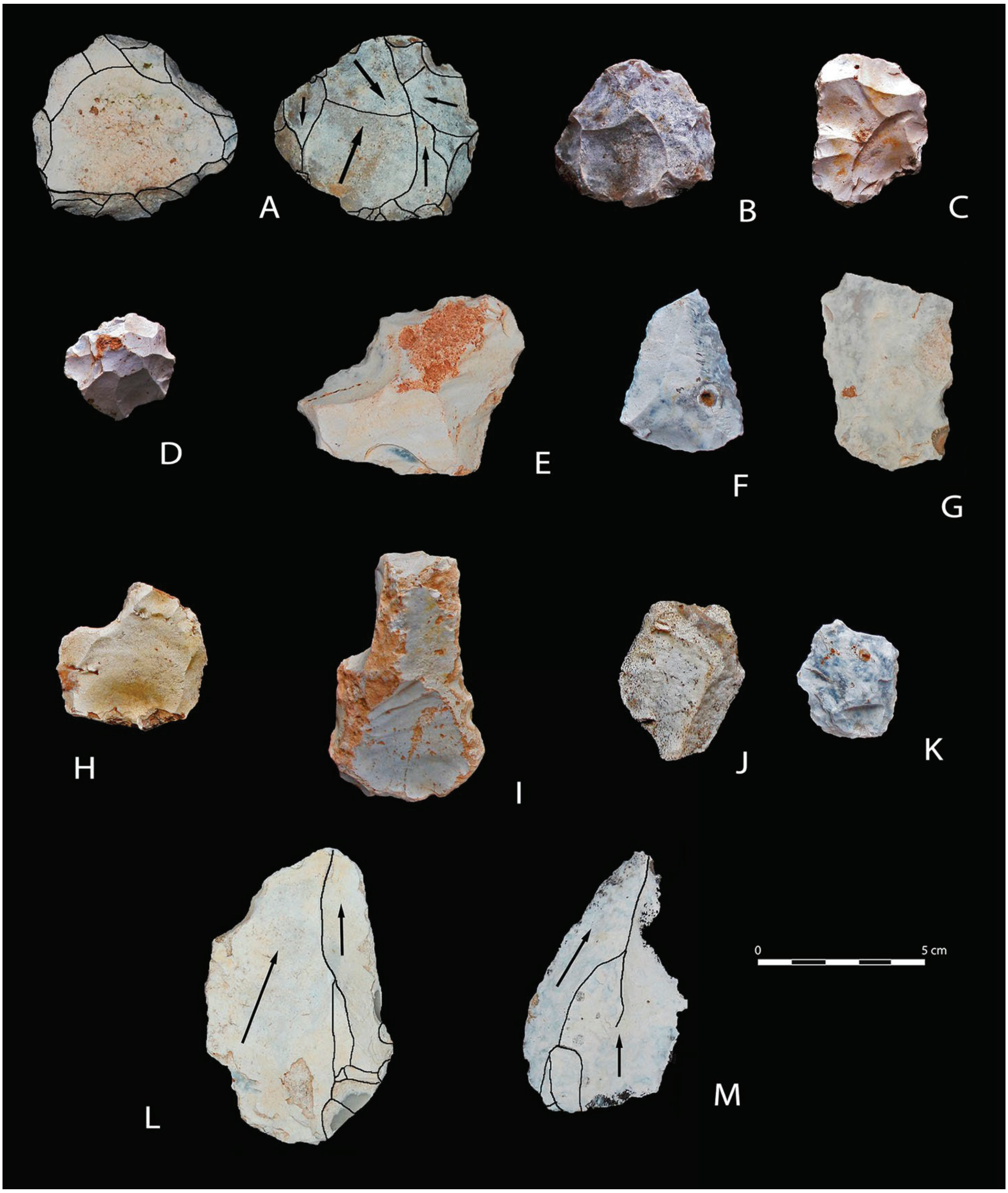

Figure 10. CMAJ (Camino Majadillas) lithics: A–D) discoid and Levallois cores; E) denticulate; F–L) Levallois and discoid flakes; and, M) pseudo-Levallois point (notch on distal right margin is probably post-depositional damage). All on flint.

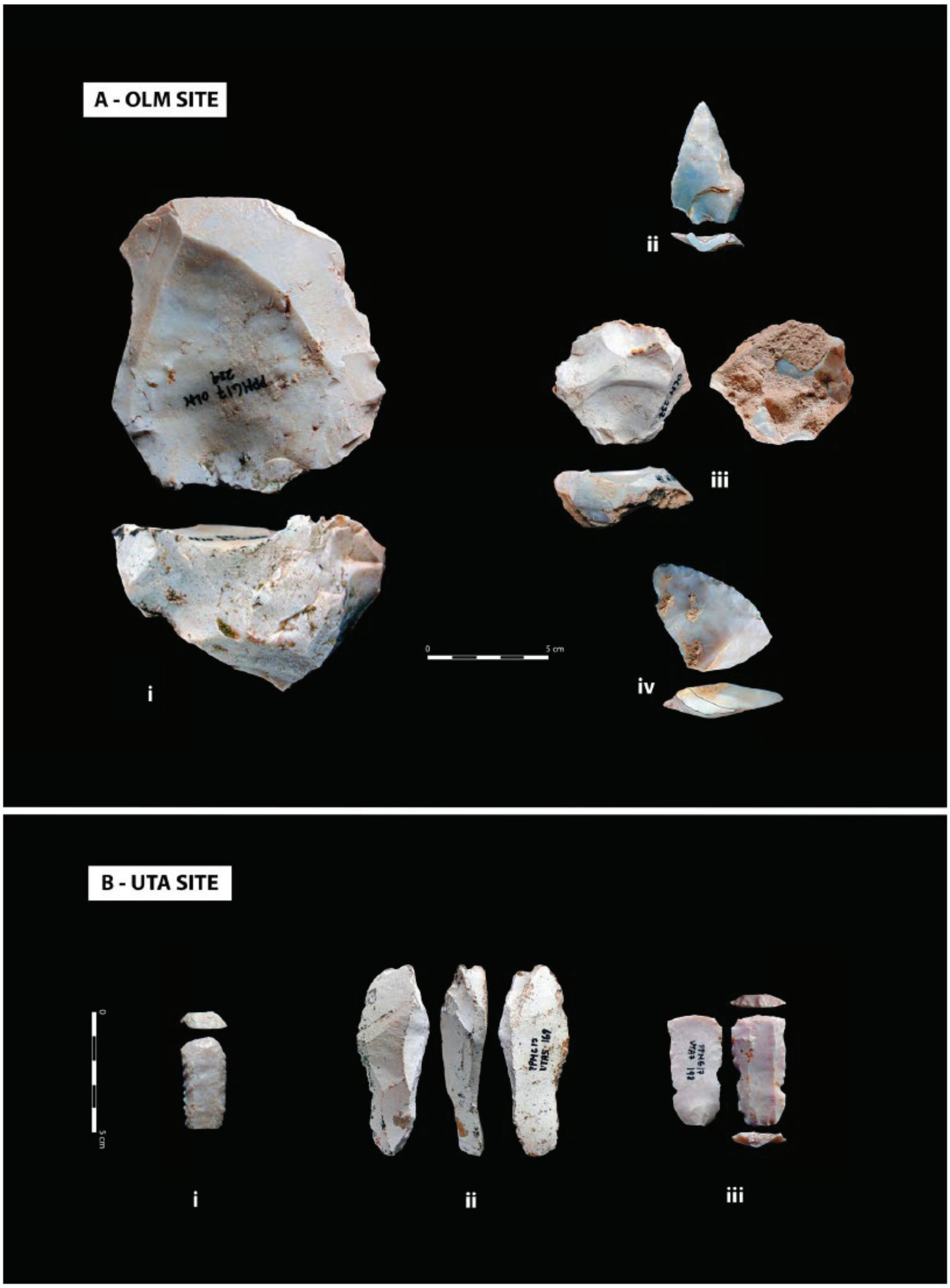

Figure 11: A: Lithic artifacts recovered at OLM. i: Levallois point core. ii: Vale Comprido point. iii: “Micro-Levallois” core. iv: Sidescraper. B: Lithic artifacts recovered at UTA. i: Endscraper on retouched blade. ii: Burin-bladelet core. iii: Endscraper on retouched blade.

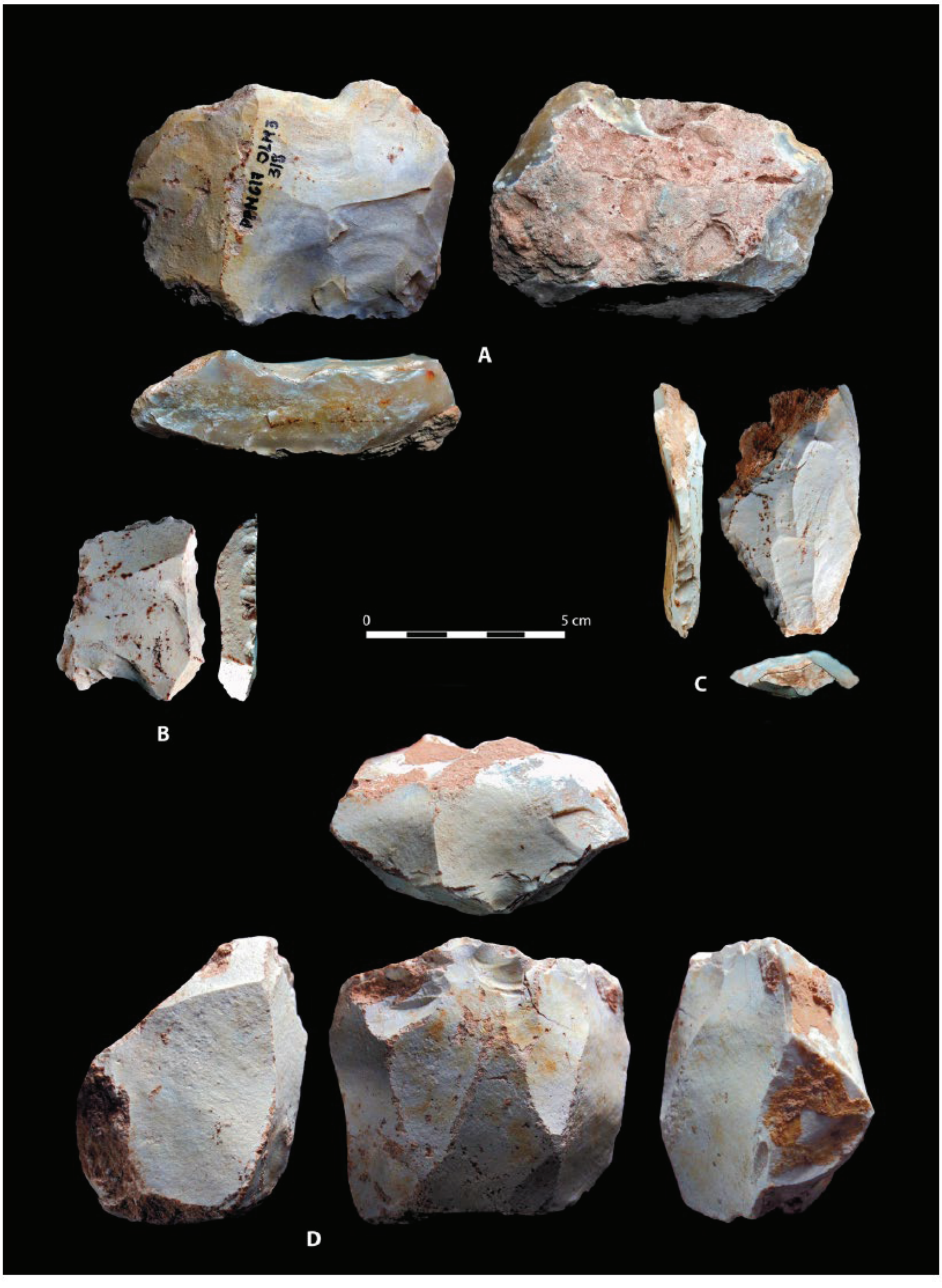

Figure 12: Lithic artifacts recovered at OLM: A) recurrent Levallois core; B) sidescraper on flake; C) retouched cortical blade; and, D) blade core.