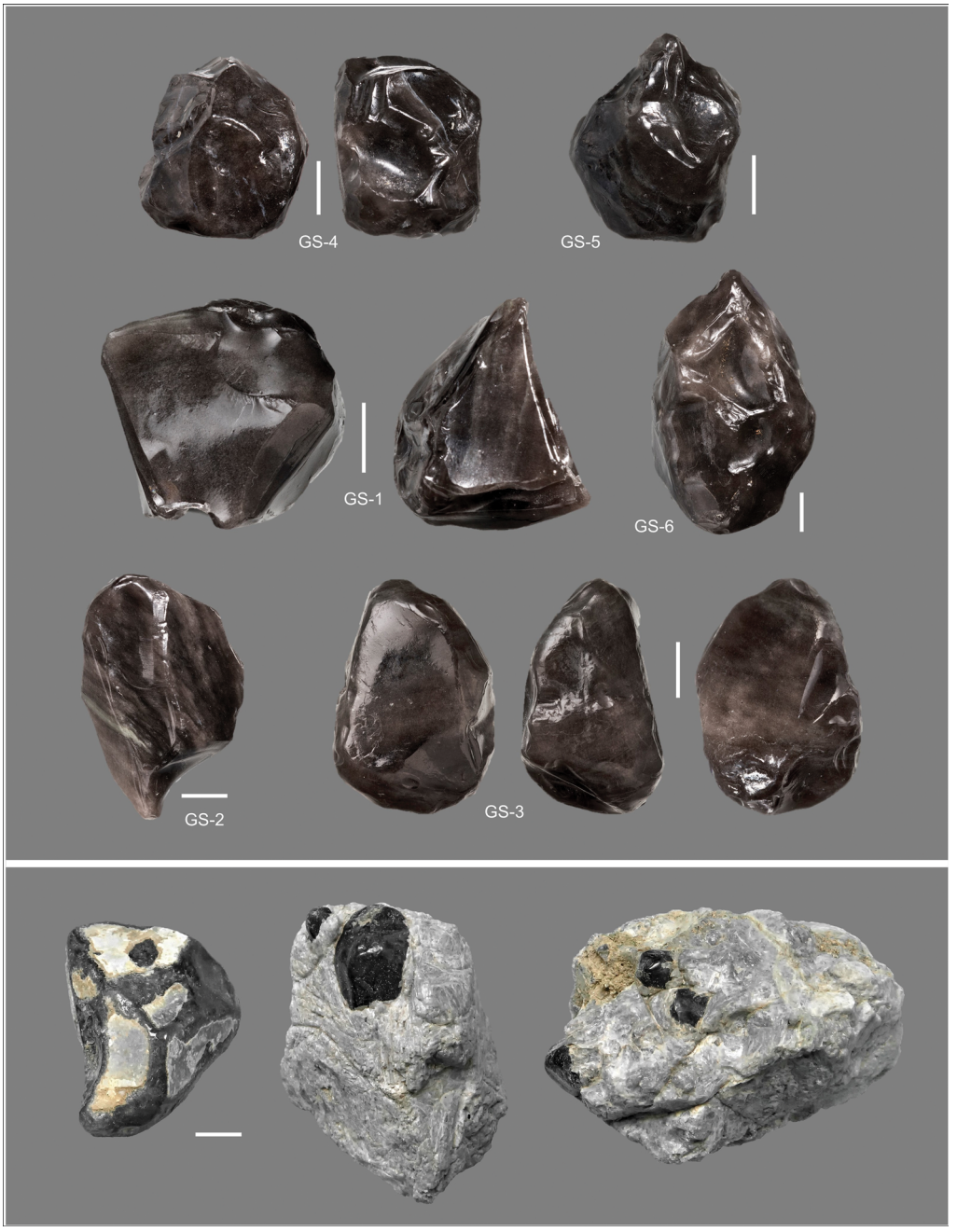

Figure 9. Carboneras: the obsidian pebbles. Top: the six geological samples (GS) analysed; GS-1–5 are from point 1a, GS-6 is from point 2a. Bottom: geological samples from point 2b, still encased in their volcanic matrix or with remnants thereof still visible. Scale bars are 5mm. Photographs by João Zilhão and José Paulo Ruas.

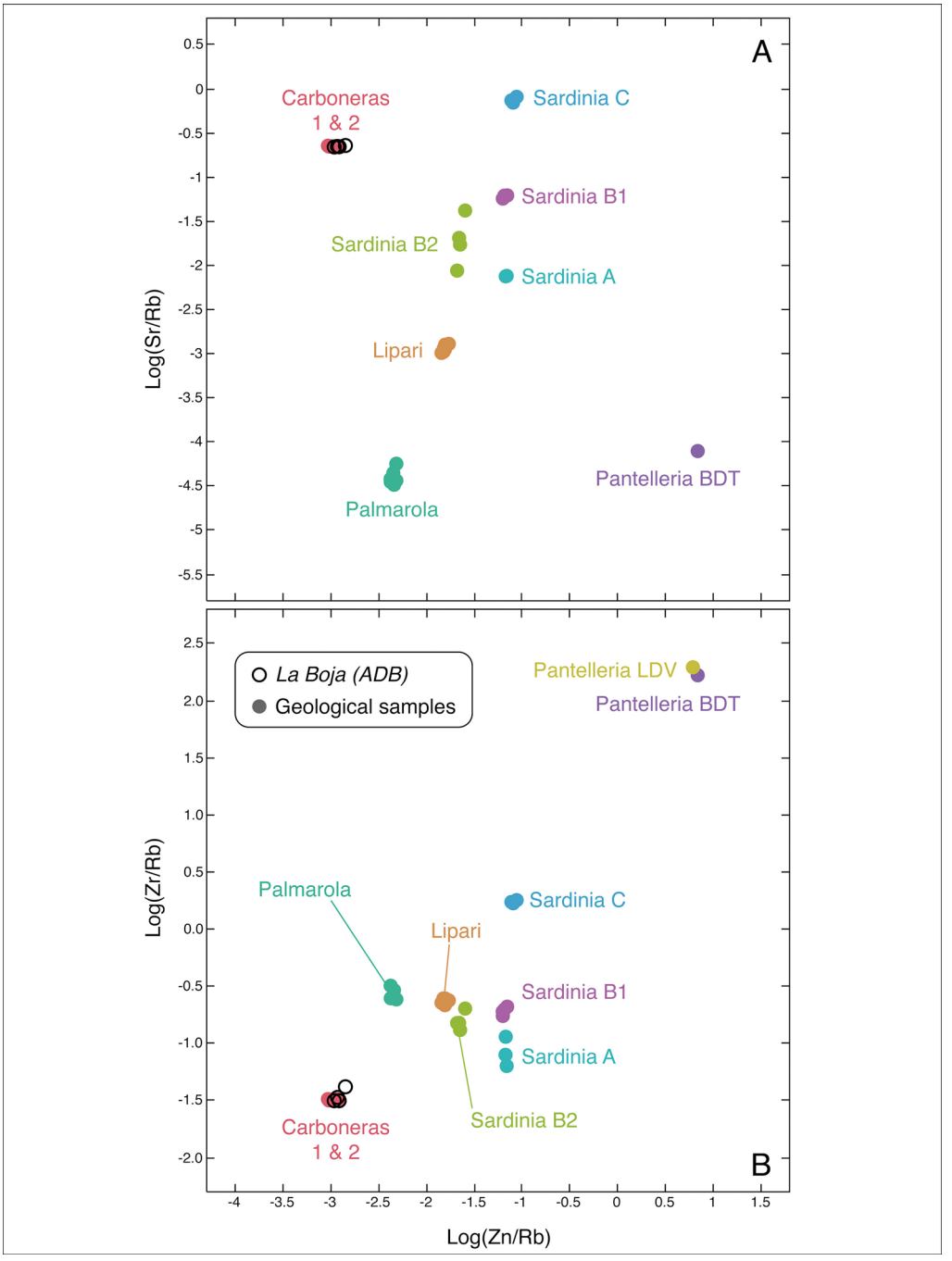

Figure 10. Chemical composition of the Carboneras and La Boja obsidians. Bivariate plots of the log ratios (A—Sr/Rb vs *Zn/Rb; B—Zr/Rb* vs *Zn/Rb) determined by energy-dispersive X-ray fluorescence analysis for the four obsidian finds from La Boja illustrated in Figure 5 and for sources in Carboneras, Lipari, Palmarola, Pantelleria (BDT, Balata dei Turchi; LDV, Lago di Venere) and Sardinia (A, B1, B2 and C). Illustration by François-Xavier Le Bourdonnec.*

kya) represent a human presence in the interior of Murcia under marginal survival conditions: the last such presence prior to the full establishment of essentially uninhabitable desert or semi-desert landscapes, and the first such presence after conditions improved following their disappearance. This hypothesis is consistent with the archaeological sterility of the intervening IL1b lens, which the ages of OH4 and OH3 constrain to the interval when the pollen indicators of semi-desert biomes in Alborán Sea marine core MD95-2043 reach their peak (pollen zone 24, approximately 16–18 kya; Fletcher & Sánchez Goñi 2008). In south-eastern Iberia increasing the size of their territory could have been one way in which humans responded to the adaptive stress caused by climate change. If so, the fact that obsidian appears at La Boja only at this time could reflect the unique harshness of the prevailing environment.

The abundant marine-shell beads present across the Aurignacian, Gravettian, Solutrean and Solutreo-Gravettian sequence of La Boja indicate that the exchange networks, if not the actual procurement territories of the regional Upper Palaeolithic, minimally encompassed the 60 or so kilometres that separate the site from the Last Glacial seashore (Zilhão *et al.* 2017). Under models that correlate distance to source with territory size one would therefore expect other Upper Palaeolithic sites of southern and western Murcia and eastern Andalucía found within a 60km radius of the Carboneras source to have yielded some obsidian finds. As yet, however, none has produced any evidence, and neither have the Neolithic sites around Vera and Cuevas de Almanzora, approximately 30–40km to the north-east (Figure 1). The lack of obsidian in the regional Neolithic is the more significant absence, as, during late prehistory, hard rocks used for polished stone tools and colourants used for rock art or tomb painting regularly travelled distances significantly greater than the 125km separating La Boja from Carboneras.

Given the distance from which the obsidian was brought to La Boja and the abundance of marine shell beads in the underlying occupation horizons, one would also expect the latter, for which much closer sources were available, to also be represented in OH4, yet this is not the case. The reason for this absence probably lies in the fleeting nature of activity at the site. That we are, indeed, dealing with brief, logistical visits is also supported by the parsimonious use of raw material made apparent by the small average size of the discarded lithics: excluding chips and chunks, 70.2 per cent (n = 373) of stone finds weigh <1g and 84.2 per cent <2g (Figure 6).

In light of this evidence, it becomes all the more significant that obsidian made its way to La Boja on both of the occasions, at most three generations apart, when people visited the rockshelter during OH4. The implication is that obsidian procurement must have been an unexceptional feature of the region's Early Magdalenian. The fact, however, that obsidian use occurred then and only then cannot be interpreted in terms of functional needs because there is no shortage of high-quality flint sources within a radius of 5–25km of La Boja (Zilhão *et al.* 2017). Rather, these Early Magdalenian obsidian imports provide a larger window into the social and territorial dimensions of the settlement-subsistence system and the associated networks of communication and exchange. In this scenario, the reason why the Early Magdalenian remained unique in its use of the Carboneras source—facilitating a clearer archaeological picture of the size of the exploited territory—would reside primarily in the specificities of that technocomplex.

Indeed, OH4 is characterised by the production of bladelets that are smaller than those of earlier periods. While 69 per cent of its bladelet blanks are <20mm long (retouched and

unretouched, burin and splintered-piece spalls included; n = 167), the corresponding percentage is significantly lower in the Aurignacian and the Gravettian of La Boja and the adjacent rockshelter of Finca Doña Martina (the other periods for which metric data have already been acquired). Combining the two sites, the numbers are 59 per cent for the Aurignacian (n = 90) and 32 per cent for the Gravettian (n = 114). Bearing in mind the size of available pebbles—in Leal-Echevarría and García-Guinea's (2005) sample, the largest is 50mm; in our sample (Figure 9) it is 34mm—we are led to conclude that it is only in the context of a technology focused on pushing the miniaturisation of microliths to the limit that raw material volumes of this size could be deemed suitable for stone-tool production.

That the exploitation of the Carboneras obsidian was a regular feature of the Early Magdalenian of south-eastern Iberia is supported by extra-regional comparison. At Bondi Cave, in Georgia, the identified sources are found at a similar distance of 100–200km. Here, the obsidian counts given by Le Bourdonnec *et al.* (2012) translate into 1.22 per cent, 1.09 per cent and 0.70 per cent for the lithic assemblages in layers II, IV and V respectively, which span the 15–40 kya cal BP interval and suggest sustained, consistent exploitation throughout. If chips and chunks are excluded from the updated tally given in Pleurdeau *et al.* (2016), the Bondi numbers are, respectively, 0.56 per cent, 1.93 per cent and 0.88 per cent. The equivalent percentages in OH4 at La Boja are 0.4 per cent (of the total assemblage) and 1.9 per cent (excluding chips and chunks), that is, of a similar order of magnitude. This comparison supports the fact that the low obsidian count of the OH4 lithic assemblage at La Boja reflects the long distance to the source, rather than one-off, idiosyncratic behaviour.

Conclusions

Evidence from La Boja shows that obsidian was exploited as an exotic raw material during the Early Magdalenian of south-eastern Iberia. Finding obsidian items 125km away from the source and in the context of brief, logistical visits implies that lithic raw materials could travel across such distances in a wholly unexceptional manner. A corollary of this evidence is that obsidian items ought to be present elsewhere in the Early Magdalenian of Murcia and Almería, where La Boja's OH4 is, at present, the single known manifestation of the technocomplex.

This pattern may reflect the deliberate procurement, by cultural choice, of a prized raw material, or may be the archaeological consequence of the enhanced visibility fostered by technological miniaturisation and the attendant exploitability of sources that otherwise would have been ignored. Whichever the case may be, there is no question that finding Carboneras obsidian in the Early Magdalenian of La Boja provides important information on the size of regional territories during the Last Glacial Maximum.

Under a model where the obsidian is directly sourced by the individuals who use it and circulates as a reflection of the individuals' mobility patterns and social networking links, one would expect archaeological abundance to correlate inversely with distance to source. Where data are available for the Upper Palaeolithic of Western Eurasia—currently only in Transcaucasia and now Iberia—this expectation is not contradicted. This is because, even though no sites with evidence for obsidian use have so far been identified close to the sources,

those that we know of, more than 100km away, have very low relative frequencies of this raw material, in the range of 0.5–2 per cent.

The La Boja case study provides additional validation of the rule that inferring long-distance exchange based on raw material provenance requires that specific sources be positively identified to the exclusion of others. As La Boja eloquently illustrates, even in the case of obsidian, a rock whose European distribution was thought to be thoroughly mapped, there can be hitherto unknown sources whose representation in the archaeological record may depend more on culturally or technologically mediated human choices than on geological availability.

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