News and views

Human remains from a new Upper Pleistocene sequence in Bondi Cave (Western Georgia)


Ilia State University, Str. Cholokashvili 3/5, Tbilisi, Georgia
Département de Préhistoire du Muséum National d'Histoire Naturelle, UMR 7194 du CNRS, 1, rue René Panhard, 75013 Paris, France
Georgian National Museum, Tbilisi, Georgia
UMR PACEA-LAPP, Université de Bordeaux, France

The Bondi Cave sequence

A new sequence containing human remains from a previously unstudied cave, Bondi Cave, has been discovered in Georgia, with deposits dating to the Caucasian Upper Pleistocene. This site lies in the basin of Rioni-Kvirila Rivers, in the Imereti region of northwestern Georgia. The site has yielded a long sequence with human occupations dated from \(39 \text{ ka} \pm 3 \text{ka} \) (uncalibrated) and thus covers the time span of the Middle Palaeolithic (MP)–Upper Palaeolithic (UP) transition in the region. Changes in the technological features between the lower and upper part of the sequence indicate that Bondi Cave could potentially highlight the tempo and mode of the population replacement. Indeed, recent studies in the southern Caucasus (notably in Ortvale Klide, Western Georgia) suggest a very rapid occupation by modern humans replacing existing Neanderthal populations (Adler, 2002; Meshveliani et al., 2004; Bar-Yosef et al., 2006; Adler et al., 2008). The rich UP levels at the upper and middle parts of the new sequence offer data on modern human subsistence and technological behaviors, and on the humans who occupied this cave, as a human tooth has also been discovered in this part of the sequence.

Bondi Cave is located ~5 km north of the town of Chiatura, near the sites of Ortvale Klide and Dzudzuana, which have yielded sequences of Early Upper Palaeolithic (EUP) and Upper Palaeolithic (UP) materials dated from ~38–32 ka \(^{14} \text{C} \) BP (Adler et al., 2008). It opens to the south onto the slope of a small valley lying approximately 30 m above the Tabagrebi River (Fig. 1). During excavations conducted in 2007 and 2009, six squares (A3-4, B3-4 and C3-4) were opened in the cave entrance (Fig. 1). This excavation has revealed a sedimentary sequence of more than 3 m in thickness. The limestone bedrock has not yet been reached.

Eight distinct lithological layers can be distinguished, with fallen blocks representing major roof collapses, notably those defining layer VI (Fig. 2). We observe two complexes: 1) the upper part (layers I to V, about 150 cm in thickness) that has yielded abundant material from the UP, and 2) the lower part, composed of layers VII (and VIII) (more than 60 cm thick) that has yielded less artifacts. The artifacts from the latter complex differ markedly from those in the upper layers by their typo-technological composition (i.e. less blades and elongated blanks), and relatively larger size.

In total, close to 10,000 well-preserved lithic and faunal remains have been recovered, including close to 3000 macro-faunal remains (\(n = 2851\)) and more than 7000 lithic artifacts. Layers II, IV and V contain the richest concentration, with nearly 90% of the sample of artifacts recovered within these layers. Evidence of fire has been recovered throughout the sequence (demonstrated by burnt bones and flint, as well as micro-charcoal fragments). A human tooth was recovered from the Upper Paleolithic sub-layer Vb, making this the third Georgian site with human remains of this period; the others are Devishkhvreli and Sakajia, which date to around 12 to 10 ka (Nioradze and Otte, 2000).

Radiocarbon dating

Twelve samples (bones) associated with various archeological layers were dated using Accelerator Mass Spectrometry (AMS) radiocarbon dating methods (Table 1). The results were calibrated using the Greenland-Hulu U/Th timescale (Weninger and Joris, 2008) to be comparable with other dates reported from this region by Adler et al. (2008). The dates indicate episodes of human
occupation from 38,750 ± 480 ka 14C BP (43,123 ± 632 ka Cal BP<sub>hulu</sub> (layer VII) to 14,050 ± 90 ka 14C BP (17,295 ± 225 ka Cal BP<sub>hulu</sub>) (layer III).

There is a clear differentiation between the two cultural complexes, with layer VII (MP affinities) dated to between 38.7 to 35 ka 14C BP (43 ± 40 ka Cal BP<sub>hulu</sub>) and the layers V to III (UP levels) from 26.6 to 14 ka 14C BP (29–17 ka Cal BP<sub>hulu</sub>). These two complexes are separated by a layer of large collapsed blocks (layer VI) dated to 31.2 ka 14C BP (35.4 ka Cal BP<sub>hulu</sub>) with certain UP artifacts. This date indicates either: 1) a first UP human occupation in the cave or 2) a hiatus of several thousand years between the bottom layer and the main UP sequence (assuming that certain UP pieces might originally derive from layer V).

The dates of both layers IV and V are within the time range from 26 to 11 ka 14C BP (~31–13 ka Cal BP<sub>hulu</sub>) but some of them appear erroneous. The date of 10,920 ± 40 ka 14C BP (12,860 ± 81 ka Cal BP<sub>hulu</sub>) obtained on a bone specimen sampled in layer Va close to the present-day surface of square A4 may have been contaminated. Secondly, one other date of Layer Va (18,010 ± 140 ka 14C BP; 21,726 ± 395 Cal BP<sub>hulu</sub>) and the date of layer IV (26,020 ± 170 ka 14C BP; 30,978 ± 348 ka Cal BP<sub>hulu</sub>) also appear under- and over-estimated respectively, if we consider the age sequence in its entirety (cf. Fig. 3).

Palaeoenvironmental reconstruction of the sequence

Eleven taxa are identifiable and the faunal assemblage appears homogeneous throughout the sequence. Within the faunal list (including Aves sp., Felis cf. silvestris, Canis lupus, Ursus cf. arcto, Equus sp., Sus cf. scrofa, cf. Capreolus capreolus, Cervus cf. elaphus, cf. Rupicapra rupicapra, Capra cf. caucasica), Bison cf. bonasus caucasicus Turkin and Satunin, 1904 is the most common species. Six micromammals species have also been identified, Microtus arvalis Pall, 1779, Arvicola terrestris Lacepede, 1799, Prometoeomys...
Figure 2. Synthetic stratigraphic section E–W (transversal) of 4/5 and 3/4 bands of Bondi Cave. Examples of Upper Palaeolithic artefacts of layers II–VI (flint (backed) blades and bladelets; endscrapers, flint crenated core, obsidian broken bladelet, polished pointed bone tools) and of Middle Palaeolithic affinity artefacts of layers VII–VIII (flint Levallois point and cores). The known sequence consists of eight lithological layers, with phases of blocks representing major collapses of the porch of the cave: — I: surface sediments with average thickness of 10–15 cm — II: orange-brown clay with many small pebbles and with thickness of about 60 cm. The sediment was deposited between the collapsed blocks. — III: gravelly brown clay, with a maximum thickness of 45 cm — IV: black layer markedly different from the other levels by its colour and the richness of the archaeological material. The average thickness of this layer is 20–30 cm (40 cm maximum). — V: dark brown and red coloured clay. This layer (~60 cm of thickness) can be divided into four sub-layers, with the same clayey matrix. Collapsed blocks are at the top (sub-layer Va). The sub-layer Vc is a pellicular blackish layer in the middle. Sub-layers Vb and Vd are identical and differentiated by the presence of small limestone blocks and gravels. — VI: major phase of the roof collapse of about 50 cm in thickness, marked by numerous indurated blocks. Sediments of layer V are included among the blocks. — VII: brown-greenish clay more than 60 cm thick, with blunt gravel. Its base has not been yet reached. — VIII: brown red-greenish clay, with small blocks (~20 cm). Its summit currently just appears in the north-eastern corner of the excavation. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)
The area (Bar-Oz et al., 2002, 2004, 2008; Bar-Oz and Adler, 2005). Grasslands near the cave, which agrees well with other studies from the period bracketed by the radiocarbon dates. The artifacts from the Epi-Gravettian (from 17 to 15–13 ka BP, Meshveliani et al., 2007; Bar-Yosef et al., 2011), Gwardzilas Klde (15 ka BP), Devishiwreli (10 ka BP) or Sakazhia (11 ka BP) (Nioradze and Otte, 2000). Flint knapping took place on the site (unipolar convergent or semi-tournant cores for blades; discoid, Kombeva and Levallou cores for flakes). Obsidian pieces (0.9%) are quite rare, occurring only in layers II, IV and V, and mainly composed of unretouched pieces, blades, bladelets, small flakes and a few tools (scrapers, burins, burin spalls, retouched blades). Obsidian sources are not present in this area. The closest identified outcrops are on the Chikiani volcanoes near Lake Paravani, more than 100 km south of the site. In addition, some broken bone points have also been discovered in layer II (Fig. 2), while a cockle-shell bead (3 mm wide and 1 mm in thickness) has also been found in layer Vb in the vicinity of the human tooth.

### Evidence of human occupations

Cut-marked bones and artifacts are associated within each lithological layer, attesting that the cave has been inhabited during the period bracketed by the radiocarbon dates. The artifacts from above layer VI (Table 2), are mainly composed of local flint blades and bladelets. The higher proportion of the bladelets at the top of the sequence with more numerous blades at the bottom indicates a slight, but continuous cultural change over time. The retouched products (on flakes, blades and bladelets) account for only ~4% of the total amount of the lithics collected from layers I to V (Table 2).

<table>
<thead>
<tr>
<th>Lab#</th>
<th>Square</th>
<th>Layer</th>
<th>Depth (cm)</th>
<th>Conventional radiocarbon age BP</th>
<th>14C Age (ka Cal BP)</th>
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<tbody>
<tr>
<td>SacA-12064</td>
<td>C3</td>
<td>III</td>
<td>130–150</td>
<td>14,330 ± 90</td>
<td>17,504 ± 257</td>
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<tr>
<td>SacA-12065</td>
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<td>III</td>
<td>150–160</td>
<td>14,050 ± 90</td>
<td>17,295 ± 225</td>
</tr>
<tr>
<td>Beta 239225</td>
<td>B4</td>
<td>IV</td>
<td>110–140</td>
<td>19,360 ± 120</td>
<td>23,124 ± 286</td>
</tr>
<tr>
<td>SacA-12066</td>
<td>C3</td>
<td>IV</td>
<td>170–190</td>
<td>20,080 ± 170</td>
<td>24,005 ± 340</td>
</tr>
<tr>
<td>Beta 270161</td>
<td>C3</td>
<td>IV</td>
<td>170</td>
<td>26,020 ± 170</td>
<td>30,978 ± 348</td>
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<tr>
<td>Beta 239226</td>
<td>A4</td>
<td>Va</td>
<td>145–165</td>
<td>10,520 ± 40</td>
<td>12,869 ± 81</td>
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<tr>
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<td>Va</td>
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<td>21,726 ± 395</td>
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<tr>
<td>Beta 270161</td>
<td>A4</td>
<td>Vb</td>
<td>185–205</td>
<td>21,550 ± 120</td>
<td>25,668 ± 405</td>
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<tr>
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<td>Vb</td>
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<td>29,462 ± 580</td>
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<tr>
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<td>35,438 ± 683</td>
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<tr>
<td>Beta 239227</td>
<td>B4</td>
<td>VII</td>
<td>270–280</td>
<td>35,070 ± 340</td>
<td>40,082 ± 867</td>
</tr>
<tr>
<td>Beta 270162</td>
<td>A4</td>
<td>VII</td>
<td>315–325</td>
<td>38,750 ± 480</td>
<td>43,123 ± 632</td>
</tr>
</tbody>
</table>

### Table 1

\(^{14}C\) dates at Bondi Cave (Cal. HULU [http://www.calpal-online.de/]).

A hominin tooth (Fig. 4) was excavated in the sub-layer Vb. The tooth could be either a lower right permanent first molar (M1, dextra) or lower right deciduous second molar (m2). The tooth is fairly well-preserved; however some enamel is chipped off the mesio-buccal corner and along the cervical margin of the buccal side, and presents, at the disto-buccal angle, a small missing flake above the cervix. The advanced attrition of the crown, stage 5 of Molnar's classification (1971), further complicates its anatomical determination. Nevertheless, the height of the preserved crown, the rectangular shape, its still bulbous morphology, the size of the pulp chamber and the preserved parts of the roots support its identification as a second deciduous molar (Al Qahtani et al., 2010).

The tooth displays an ovoid contour; with clear evidence of all five cusps. The wear degree of this surface increases from the distolingual to the mesio-buccal direction. Despite the heavy wear, a part of the mesial fossa can still be observed.

Viewed buccally, the length decreases towards the cervix (a classical trait for a deciduous tooth). Just after its discovery, it was identified as a second deciduous molar (Al Qahtani et al., 2010).

The tooth displays an ovoid contour; with clear evidence of all five cusps. The wear degree of this surface increases from the distolingual to the mesio-buccal direction. Despite the heavy wear, a part of the mesial fossa can still be observed.

### The human tooth from sub-layer Vb

A hominin tooth (Fig. 4) was excavated in the sub-layer Vb. The tooth could be either a lower right permanent first molar (M1, dextra) or lower right deciduous second molar (m2). The tooth is fairly well-preserved; however some enamel is chipped off the mesio-buccal corner and along the cervical margin of the buccal side, and presents, at the disto-buccal angle, a small missing flake above the cervix. The advanced attrition of the crown, stage 5 of Molnar’s classification (1971), further complicates its anatomical determination. Nevertheless, the height of the preserved crown, the rectangular shape, its still bulbous morphology, the size of the pulp chamber and the preserved parts of the roots support its identification as a second deciduous molar (Al Qahtani et al., 2010).

The tooth displays an ovoid contour; with clear evidence of all five cusps. The wear degree of this surface increases from the disto-buccal angle, to the cervical margin of the buccal side, and presents, at the mesio-buccal direction. Despite the heavy wear, a part of the mesial fossa can still be observed.

Viewed buccally, the length decreases towards the cervix (a classical trait for a deciduous tooth). Just after its discovery, it was identified as a second deciduous molar (Al Qahtani et al., 2010).
In the lingual view, again the bulbous morphology of the crown can be noted with the MD length decreasing as one approaches the cervix. On this surface, a classic shallow groove, separating metaconid and entoconid, is observed, and between the two roots, the enamel of the cervix dips clearly into the bifurcation.

When viewed mesially and distally, the cemento-enamel junction appears straight. The interproximal contact facets have an oval shape in distal view and half-ellipsoid when viewed mesially. The longest margin of each of these facets is probably reduced at the occlusal border, due to attrition of the crown. Still, the facets have different sizes with the mesial one being wider (5.73 mm versus 4.1 mm). Note that there are no subvertical grooves on both interproximal facets as can be observed on some Neanderthal permanent molars.

The roots are resorbed (or broken, if the specimen is a permanent molar, but the regularity of the border of the dentine is very similar to the one that can be observed on an antemortem shed milk molar) almost up to the cervix and the pulp chamber is open, revealing a small, rhomboid cavity. If the specimen is an antemortem lost m2, then the age of the juvenile specimen could be around 11.5 years, when compared to modern human samples (Al Qahtani et al., 2010).

The Bondi Cave specimen is small relative to a sample of deciduous extant human teeth and Neanderthal ones (Table 3). For both crown diameters, significant overlap between modern humans and Neanderthal samples makes it difficult to assign the Bondi tooth to either species, based solely on crown size. All the observed traits could equally be found within the extant or any Upper Palaeolithic human group, or within a Neanderthal population. Presently, we prefer to attribute this tooth to Homo sapiens sp. and await further hominin material that will clarify the exact taxonomic position of the Bondi Cave hominin.

**Discussion and conclusion**

The Bondi Cave sequence complements recent research in the southern Caucasus (Fourbouley et al., 2003; Adler et al., 2008; Pinhasi et al., 2008; Fernandez-Jalvo et al., 2010). Several Upper Palaeolithic occupations seem to have occurred at this site and date to between \(^{31/24.5}{\text{ka}}\) and \(^{14}{\text{C}}\) BP. These layers would be contemporaneous in part with the Dzudzuana UP (Units D at \(^{32}{\text{ka}}\), C at \(^{23}{\text{ka}}\) and B at \(^{13}{\text{ka}}\)) and the Ortvale Klde UP (38 ka BP for layer 4d and 34 ka BP for layer 4c) (Meshveliani et al., 1999, 2004; Adler and Tushabramishvili, 2004; Bar-Yosef et al., 2006, 2011; Adler et al., 2008; Kvavadze et al., 2009).
The base of the sequence (~38.7–35 ka 14C) has yielded occupation levels with affinities to the MP of the region. Due to the dating hiatus between layer VII and layer VI/V, we cannot assess whether or not a rapid transition from MP to UP and replacement of populations around 35–31 ka occurred, as has been observed for Ortval Kilde (~34–38 ka) and Mesmaiskaya (~36–32 ka) (Cohen and Stepanchuk, 1999; Golovanova et al., 1999, 2006, 2010; Ovchinnikov et al., 2000; Bar-Yosef et al., 2006; Bar-Oz et al., 2008; Adler et al., 2008).

Several aspects of the archeology, the palaeontology and the paleoenvironmental data from the upper part of Bondi Cave sequence resemble those observed in the UP of Dzudzuana and Ortval Kilde. Specifically, these aspects relate to the raw material exploitation (with local flint predominating and exogenous obsidian used in the UP levels), the laminar and bladelet production, and finally, the presence of microlithic tools. The absence of Aurignacian components is also common to these sites (only few carinated cores have been recovered from the upper layers of Bondi as in Dzudzuana unit C; Mesveliani et al., 2004; Bar-Yosef et al., 2006, 2011), while they appear to be a local development from MP in certain neighbouring areas, for instance in Zagros and Taurus in Iran, which date to between 35 and 23 ka BP (e.g. Megnien, 2006; Otte et al., 2007; Otte and Kozlowski, 2007). The observed differences between sites could relate to different management of the environment and the territory, to different seasons of occupation, or to the wide variety of ecological niches evident at these different sites: for instance dominant Capra caucasica at both the MP and UP levels at Ortval Kilde and Bison bonasus caucasicus at Bondi Cave and Dzudzuana (Bar-Oz et al., 2002, 2004; Adler et al., 2006). Moreover, bone tools are rare in Bondi Cave while they have been recovered at Dzudzuana (Bar-Yosef et al., 2006, 2011), and in the final UP of Sakaja and Gvardjilas Klde (Nioradze and Otte, 2000) and in the later EUP of Mezmaiskaya (Golovanova et al., 2010).

The lower layers VII and VIII, although providing fewer artifacts, contain material with very different technical features. Indeed, the presence of thick elongated lithic products contrasts markedly with the thin and elongated blades found in layers VI and V, and the presence of Levallois cores is also remarkable. Further work and excavation of the Layers VII and VIII (bedrock has not yet been reached) will help to provide more techno-cultural features in order to assess whether the layers are transitional MP/UP or strictly LMP.

Finally, although it is widely accepted that the EUP occupations in the region are those of early modern humans, this hypothesis remains tentative since there are few or no remains of H. sapiens definitively associated with the EUP. So far, only two sites in Georgia have yielded H. sapiens remains within an Upper Paleolithic context: Deviskhvreli, with a fragment of mandible, and Sakja with some cranial remains. At both sites, human remains have been unearthed in recent levels dated ~12–10 ka (Nioradze and Otte, 2000). The lack of sites preserving human remains underlines the importance of the Bondi Cave in the archaeological landscape of Georgia. The human tooth has been discovered in the UP context of Ortval Kilde (~34–38 ka) and Mesmaiskaya (~36–32 ka) (Cohen and Stepanchuk, 1999; Golovanova et al., 1999, 2006, 2010; Ovchinnikov et al., 2000; Bar-Yosef et al., 2006; Bar-Oz et al., 2008; Adler et al., 2008).

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References