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Our oldest children: Age constraints for the Krems-Wachtberg site obtained from various thermoluminescence dating approaches

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ABSTRACT

We present several approaches to directly date the prehistoric human activity of lighting a fire at the Early Gravettian infant burial site of Krems-Wachtberg (Austria) by thermoluminescence (TL) methods. Blue thermoluminescence (B-TL) from polymineral fine grain and orange-red thermoluminescence (R-TL) from fine-grained quartz separates, both extracted from the baked loess immediately underlying the hearth were employed. The B-TL dating followed the "classic" multiple aliquot-additive dose (MAAD) protocol. For R-TL dating, the multiple aliquot-regenerative (MAR) and a shortened single-aliquot-regeneration (SAR) protocol were tested. All thermoluminescence ages obtained agree within 1-σ uncertainties and assign a weighted mean age of 33.9 ± 2.3 ka to the last use of the hearth and by inference to the infant burial. Anomalous fading is precluded due to the agreement of results from all luminescence protocols as well as with independent dating methods. The TL ages are consistent with calibrated radiocarbon ages on associated charcoal, OSL dating of the sediment deposition and with age estimates obtained by two magnetic dating approaches.

1. Introduction

Located above the city of Krems, the loess-covered hill between the rivers Danube and Krems has been well-known for its Upper Palaeolithic sites for more than a century (Neugebauer-Maresch, 2008). Recent fieldwork at Krems-Wachtberg (see Fig. 1 in Lomax et al., 2013) carried out by the Department of Prehistoric Archaeology (former Prehistoric Commission) of the Austrian Academy of Sciences has led to the discovery and investigation of an Early Gravettian camp site which yielded a wide range of high-resolution data, due to the excellent conservation, e.g. of the base of the main archaeological unit (AH 4), where a surface with distinct anthropogenic structures (archaeological horizon AH 4.4) is preserved. Such a degree of conservation was possible due to the rapid accumulation of loess involving aeolian sedimentation and periglacial slope dynamics (Händel et al., 2009a; Terhorst et al., 2013). The latter led to the erosion of the upper part of a living floor and the deposition of sediment with a mixed archaeological assemblage (mainly AH 4.11) and therefore provided for the conservation of the remaining occupation surface (Händel et al., 2013; Terhorst et al., 2013). Radiocarbon dates on charcoal suggest that a part of the find material originates from an earlier Gravettian occupation (Einwögerer et al., 2009). This is no surprise, as earlier Gravettian dates have been documented in archaeological horizon AH 5 and also at the nearby Krems-Hundssteig excavations 2000–2002 (Wild et al., 2008; Einwögerer et al., 2009).

The most important anthropogenic structures associated with the occupation surface AH 4.4 include a multi-phased hearth (Thomas and Ziehaus, 2013) with a maximum diameter of almost 1.5 m. Initially, a round shallow depression had been dug to contain the fire. However, even after the depression had filled up, the same location was used to light subsequent fires on top of the refuse. The hearth's sediment consists of alternating layers of burnt loess, flat stones, and various fills (Händel et al., 2009b). Furthermore, hearth 1 was associated with around 20 small pits of unknown purpose, and three larger pits presumably used for cooking.

Received with much interest in the scientific community was the discovery of two graves, a double and a single infant burial in

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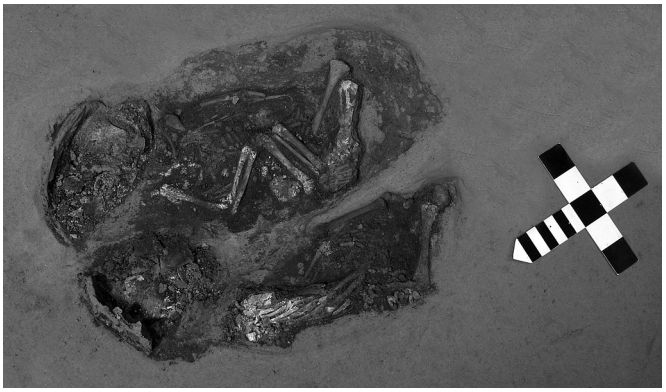

Fig. 1. Krems-Wachtberg 2005: Double burial of newborns associated to AH 4.4. Photo: Department of Prehistoric Archaeology, Austrian Academy of Sciences.

2005 and 2006 (Einwögerer et al., 2006). Both burials are associated with the occupation surface AH 4.4. The double burial (Fig. 1) showed an elaborate grave architecture, as the pit had been sealed by a mammoth scapula which even preserved a hollow space so that the very fragile bones of the two newborns were perfectly preserved. The pit of the single burial with the remains of a slightly older individual (age at death 0–3 months) had only been refilled but not sealed. All individuals represent Early Modern Humans. They had been buried in flexed positions facing east and were embedded in red ochre (Einwögerer et al., 2008). These burials show that even very young children were treated no differently than older children and adults during the Gravettian period (Einwögerer et al., 2006).

The design of the burials, the archaeological find material which includes objects formed of loess sediment which were fired for durability, the mammoth-dominated archaeofauna, its geographic position, and the chronological assessment place the Krems-Wachtberg site in a Pavlovian context (Händel et al., 2009b). The anthropogenic activities are preserved in an 8 m loess sequence, making Krems-Wachtberg one of the best-studied multilayer Upper Palaeolithic loess sites in Central Europe.

2. The age of the Krems-Wachtberg site

Various attempts to establish the age of the Krems-Wachtberg site include magnetic dating methods placing the archaeological occupation (AH 4.4) between 34 and 32 ka (Hambach et al., 2008; Hambach, 2010), and more precisely in Greenland Interstadial GI 6 at ~33.5 ka according to the NGRIP time scale (Terhorst et al., 2013) which is congruent to calibrated radiocarbon dating of associated charcoal of ca. 32 ka cal BP (Einwögerer et al., 2009). More precisely, the calendric range of the radiocarbon data (Einwögerer et al., 2009) for AH 4.4 (software Oxcal with IntCal09 calibration data at 95% probability) provides a range between 32 and 31 ka cal BP, or even as early as 33.25 ka cal BP, if the result for VERA-3937 is included, which was rejected by Einwögerer et al. (2009). Optically stimulated luminescence (OSL) dating of the loess deposition for the geological strata immediately above and below AH 4.4 provide ages of 31.6 ± 2.3 to 28.0 ± 3.5 and 31.4 ± 2.8 to 27.9 ± 3.3 ka, respectively (Lomax et al., 2013). Nevertheless, thermoluminescence (TL) dating was carried out in order to date an anthropogenic event (the lighting of a fire) directly, which is presumably correlated to the charcoals recovered, and thus to the radiocarbon data.

A variety of TL protocols are available to establish the heating age of burnt sediment. Given the available age control of sedimentological processes (magnetism and OSL), as well as on material assumed to be associated with the human occupation (^{14}C). We here present a comparison study with blue TL multiple aliquot additive dose (B-TL MAAD), orange-red TL multiple aliquot-regeneration (R-TL MAR), and orange-red TL single aliquot-regeneration (R-TL SAR) protocols. To our knowledge, dating of a single sample with these different protocols has not been attempted before with the aim of providing a methodological comparison as well as a new age estimate.

3. Material and methods

A 2–2.5 cm thick brick-red horizon from the base of the excavated hearth 1 (Fig. 2a) consisting of heated loess was sampled for luminescence dating (sample code BT483; excavation number WA-85110). A cube of ~30 cm length with the brick-red horizon at its top was carefully cut out of the loess underlying the hearth (Fig. 2b). The border between visibly heated and unheated loess was marked in black at the aspects of the cube, in order to allow sampling of the appropriate parts under the dim luminescence laboratory illumination by red diodes (Mauz et al., 2002). The marking was set slightly higher than the fuzzy border between unheated and heated loess in order to exclude any visibly unheated material from sampling. The upper 3 mm of the

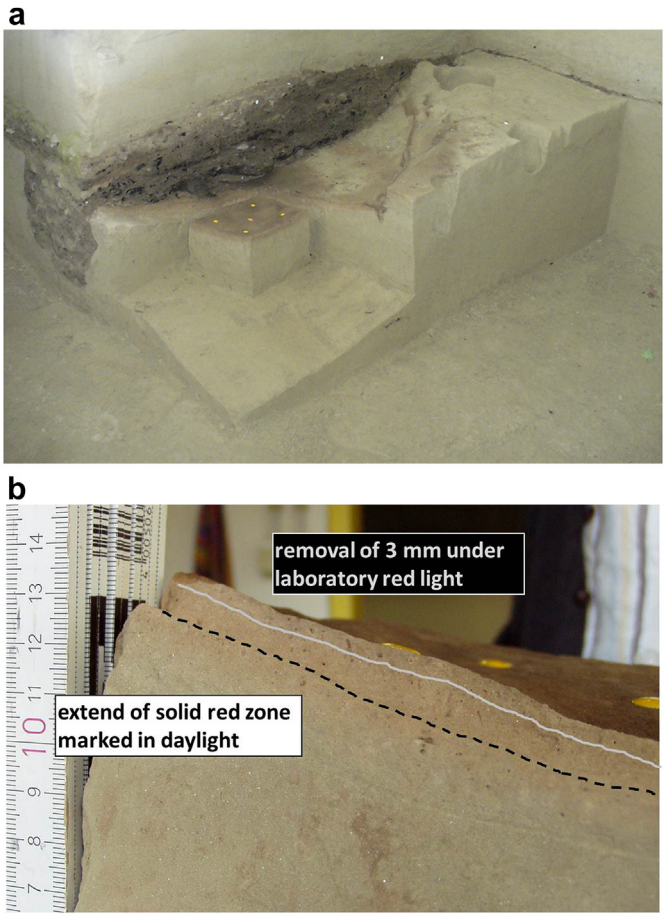

Fig. 2. Krems-Wachtberg 2007: hearth 1, a) Photo of block cut out of hearth for sampling in laboratory; b) detail of sampling block. ((a) Department of Prehistoric Archaeology, Austrian Academy of Sciences; (b) University of Bayreuth).

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