Chronostratigraphy and Archeological Context of the Aurignacian Deposits at Geißenklösterle

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ABSTRACT Several models for the colonization of Europe by modern humans and the spread of Upper Paleolithic technology and fully modern behavior hinge on the dating of the Swabian Aurignacian. The key site for addressing these questions is Geißenklösterle, where a large series of radiometric dates indicates that the Swabian Aurignacian begins around 40 000 years ago. This paper reviews arguments for and against the stratigraphic integrity of the Aurignacian horizons at Geißenklösterle and considers archeological, taphonomic, geoarcheological and chronological data from the site. On balance the evidence indicates that the lower Aurignacian at Geißenklösterle is of great antiquity and probably dates to about 40 000 years ago. These data are consistent with the Danube Corridor and *Kulturpumpe* models for the colonization of Europe by modern humans and for the appearance of many innovations of the Upper Paleolithic.

Introduction

Geißenklösterle is one of the key sites indicating the early presence of the Aurignacian in central Europe (Fig. 1). The first season of excavation was directed by Eberhard Wagner in 1973, and from 1974-1991 Joachim Hahn directed 14 seasons of excavation. In 2000 fieldwork began again under Conard's direction and continued until a good stopping point had been reached following the 2002 field season. Background information on the site can be found in numerous publications including Hahn's monograph on the site from 1988, and other papers (e.g. Hahn 1989). The most recent information on Geißenklösterle can be found in the excavation report from 2001 (Conard and Malina, 2002) and in review articles on the early Upper Paleolithic of Swabia (Bolus and Conard, 2001; Conard, 2002; Conard and Bolus, 2003).

Over the years since excavation began at the site in 1973 dozens of radiocarbon dates have been made on finds from the site.

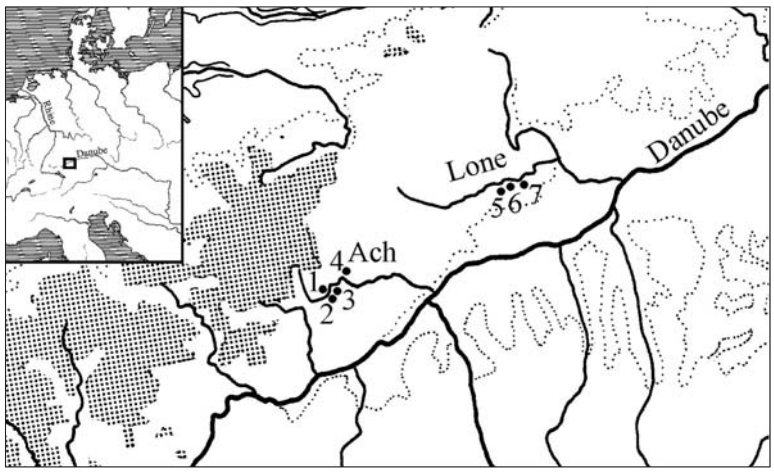

FIG. 1 – Map of Aurignacian sites in the Jura. 1 Sirgenstein, 2 Hohle Fels, 3 Geißenklösterle, 4 Brillenhöhle, 5 Bockstein, 6 Hohlestein, 7 Vogelherd.

The lower Aurignacian of archeological horizon III (AH III) has yielded numerous radiocarbon dates that mainly fall in the range between 30 and 40 kyr BP. The dates from the upper Aurignacian of archeological horizon II (AH II) overlap with those of AH III and lie mainly between 30 and 35 kyr BP. Six TL dates on burnt lithic artifacts published by Richter et al. (2000) for AH III provide a mean age of 40.2±1.5. Two TL dates from AH II lie in the range of 37 000. These radiometric dates make Geißenklösterle one of the best-dated Aurignacian sites in Europe.

If the lower Aurignacian at Geißenklösterle does date to about 40 kyr BP, this would have important ramifications for testing scenarios for the development and spread of the Aurignacian. If one assumes that modern humans produced Aurignacian artifacts, dating the earliest Aurignacian could be viewed as equivalent to dating the arrival of modern humans in Europe. Since very few Aurignacian deposits have yielded human skeletal remains, this assumption may or may not be valid (Churchill and Smith, 2000). Skeletal remains of Neandertals have never been found in a sound Aurignacian context, and skeletal material from modern humans has. Thus this assumption is a reasonable starting point for building hypotheses about the colonization of Europe by modern humans (Conard and Bolus, 2003).

In several publications Zilhão and d'Errico have argued that problems exist with the archeological and taphonomic context of the finds from the lower Aurignacian of Geißenklösterle (e.g. Zilhão and d'Errico, 1999; Zilhão, 2001). These authors' assessment is based mainly on their reading of Hahn's (1988) monograph on the site. Zilhão and d'Errico's criticism of the archeological context of the Aurignacian of Geißenklösterle is based primarily on three lines of reasoning. These are 1) typological and technological arguments; 2) evidence for mixing based on lithic refits depicted in Hahn's monograph; 3) large fluctuations in radiocarbon dates within the Aurignacian layers. An assessment of the typological and technological characteristics of the Aurignacian from Geißenklösterle lies outside the scope of this paper, but many data that refute the position advocated by Zilhão and d'Errico have been presented elsewhere (Hahn, 1988; Conard and Bolus, 2003). Bolus, Liolios and Teyssandier have also addressed these criticisms in their contributions to this volume. This paper addresses the question of stratigraphic mixing at the site and considers possible explanations for the patterns observed in the radiometric dates from the Aurignacian of Geißenklösterle.

Stratigraphic Context of AH II and III

Contrary to the arguments advocated by Zilhão and d'Errico (Zilhão and d'Errico, 1999; Zilhão 2001), a number of lines of argument indicate that relatively little mixing has taken place at Geißenklösterle. Here we consider the distribution of finds of worked mammoth ivory and the distribution of refitted lithic artifacts from the Aurignacian of Geißenklösterle. The point here is not to rule out any possibility of mixing between strata at the site, since this cannot be done, but rather to demonstrate that the composition of the Aurignacian assemblages is not significantly altered as a result of mixing between strata.

Results from the current excavations have brought the number of piece-plotted objects at the site to well over 30 000 finds. Many times this number of finds have been recovered during the water screening, which was conducted on all excavated sediments. These data allow very precise analysis of the provenience of all classes of artifacts and the abundant refitting data from the site.

Distribution of Ivory Artifacts

Worked ivory is particularly characteristic of the Swabian Aurignacian, and is lacking in the Middle Paleolithic of the region. Based on current data, which do not yet reflect the full assemblages, AH II has yielded 279 ivory artifacts including debris from ivory working. AH III has produced a still larger assemblage with 507 pieces. These figures are from Münzel's ongoing study of the faunal material from Geißenklösterle. Examination of the horizontal and vertical distributions of worked ivory from AH II and AH III (Figs. 2-5) shows that finds cover nearly all of the excavated areas for both horizons. The details of the distributions, however, differ with the relatively dense concentrations in the northern part of AH III, while AH II shows a less dense, but more uniform distribution of worked ivory. The vertical profile projections confirm the great abundance of worked ivory in both the lower and upper Aurignacian of the site. Since the lower Aurignacian contains considerably larger amounts of ivory working debris than the upper Aurignacian, it is highly unlikely that the worked ivory has migrated downward from AH II into AHIII, as has been suggested by Zilhão and d'Errico (1999) as a means of explaining the presence of organic artifacts in AH III. If at all, an upward movement of these finds seems more likely. These results based on the distributions of worked ivory are also consistent with Münzel's (1999) refitting studies of other classes of organic materials.

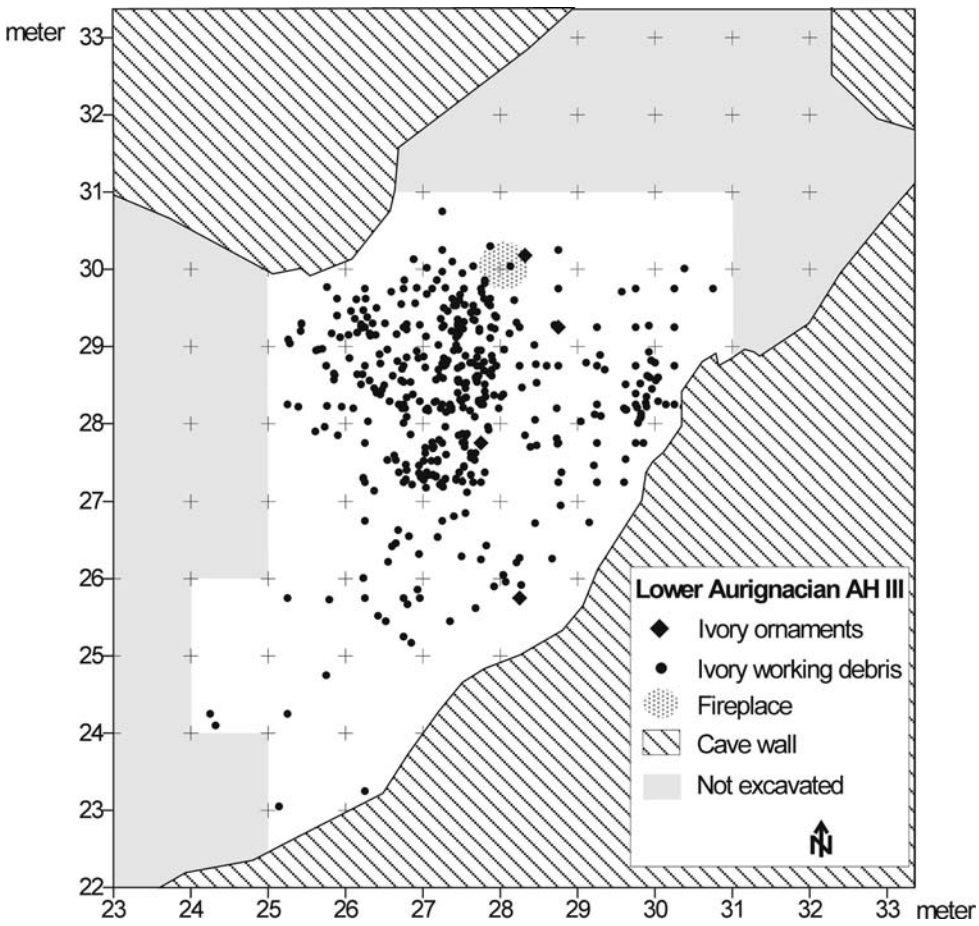

FIG. 2 – Geißenklösterle. The horizontal distribution of mammoth ivory artifacts and ornaments from AH III.

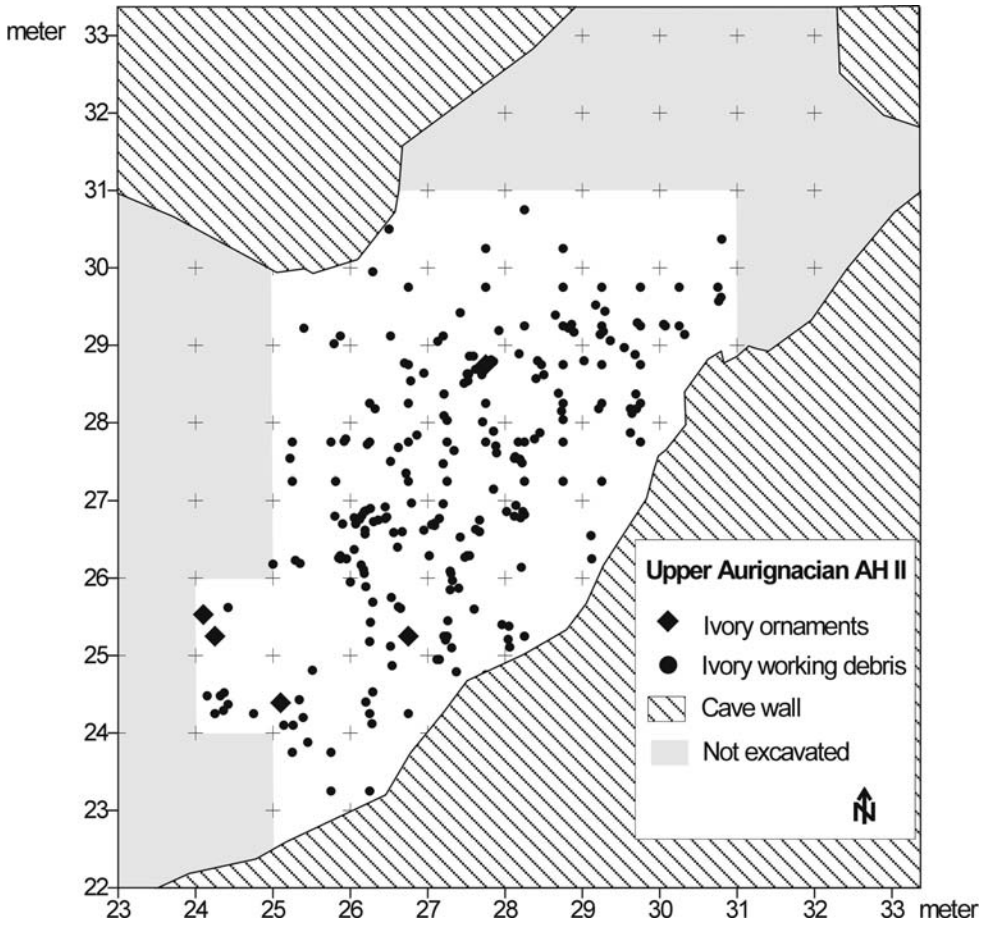

FIG. 3 – Geißenklösterle. The horizontal distribution of mammoth ivory artifacts and ornaments from AH II.

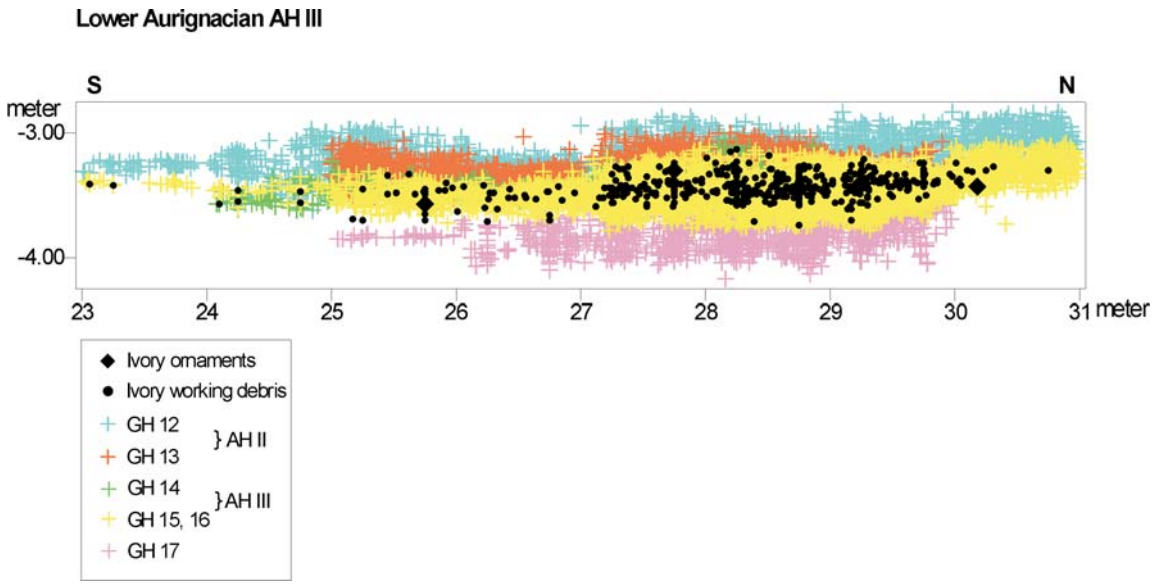

FIG. 4 – Geißenklösterle. The vertical distribution of mammoth ivory artifacts and ornaments from AH III.

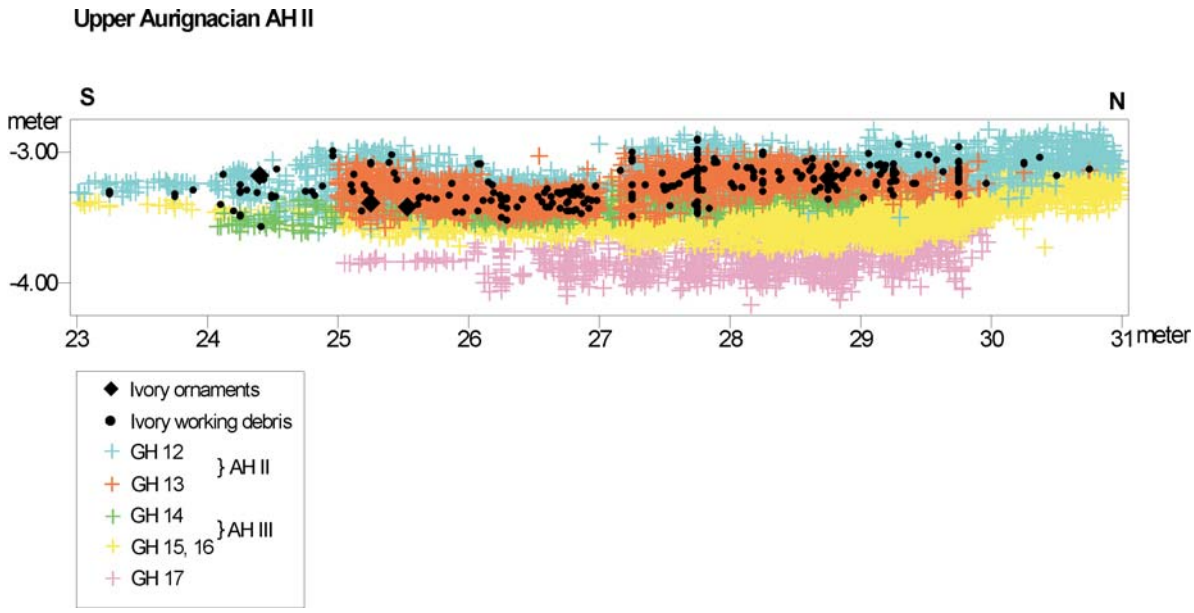

FIG. 5 – Geißenklösterle. The vertical distribution of mammoth ivory artifacts and ornaments from AH II.

Lithic Refitting

Several dozen groups of lithic artifacts from the Aurignacian of Geißenklösterle have been refitted to form groups, referred to as *Knolle* or *Werkstücke*. Since Hahn's publication additional refitting has been conducted, and, based on ongoing work, no fewer than 630 lithic artifacts have been refitted from the Aurignacian deposits at Geißenklösterle. As Hahn argued, although refits across units are documented, the majority of refitted finds are from within AH II or AH III. The best way to gain an impression of the spatial distribution of refitted artifacts is by viewing them in projections on a vertical profile. This has been done for many refitting groups as is seen, for example, in the plots for refitting groups A3, A9, A11, A16, and A20 presented in Figs. 6-10. These plots are based on coordinates of individual refitted artifacts, and the vertical scatter of the finds is remarkably low when one considers that the finds are scattered over irregular deposits covering an area of 38 complete and partially excavated square meters. These plots are a fair representation of the refitting complexes, and they reflect the general stratigraphic integrity of the deposits. Although the finds may not be completely *in situ*, and taphonomic factors almost certainly have affected the distribution of the finds, these plots indicate that large scale mixing has not occurred.

Based on the data presented above, we conclude that the lower and upper Aurignacian assemblages from Geißenklösterle are from good stratigraphic contexts. As Hahn (1988) described in detail, a number of factors including indistinct transitions between stratigraphic units, excavator error, cryoturbation, bioturbation, and anthropogenic mixing during the Paleolithic have made it difficult to separate the stratigraphic units at Geißenklösterle. These factors complicate the definition of cultural stratigraphic units at nearly all excavations in rich cultural deposits in caves. Using the data available in the 1980s from refitted lithic artifacts from refitting groups A9 and A14, Hahn (1988, p. 74) concluded that about 60% of finds stayed in their original stratigraphic subunits. Of the 40% of artifacts that migrated out of their original stratigraphic subunit or were incorrectly excavated, 90%

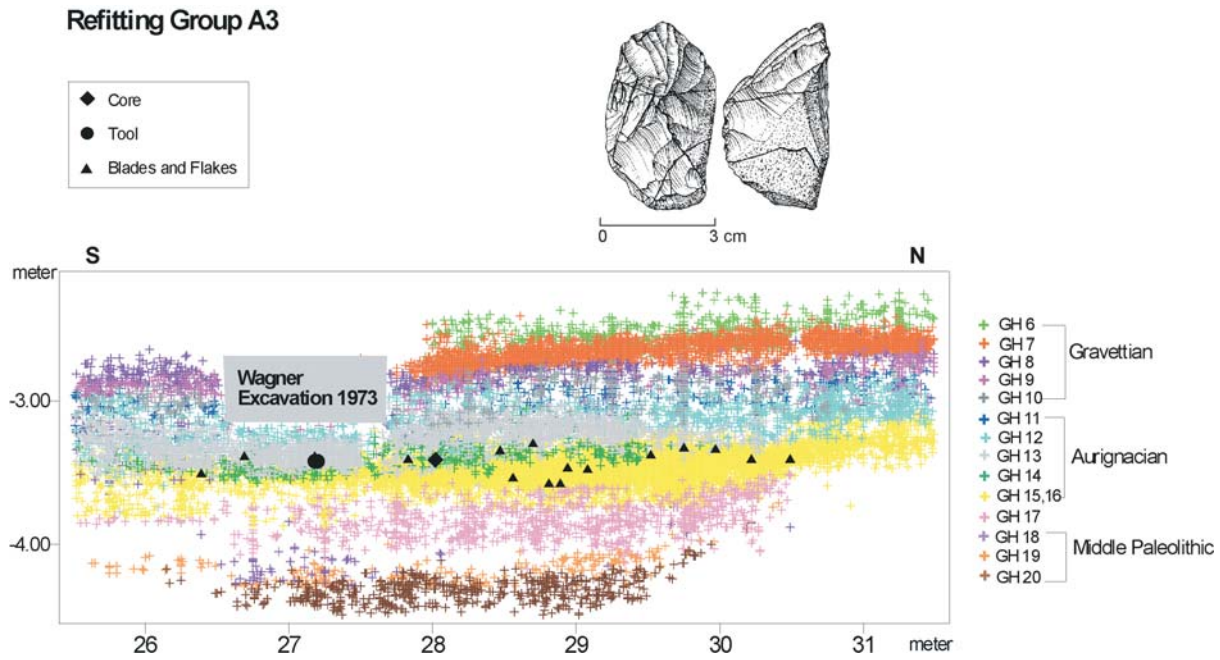

FIG. 6 – Geißenklösterle. Refitting sequence A3 from Geißenklösterle AH III.

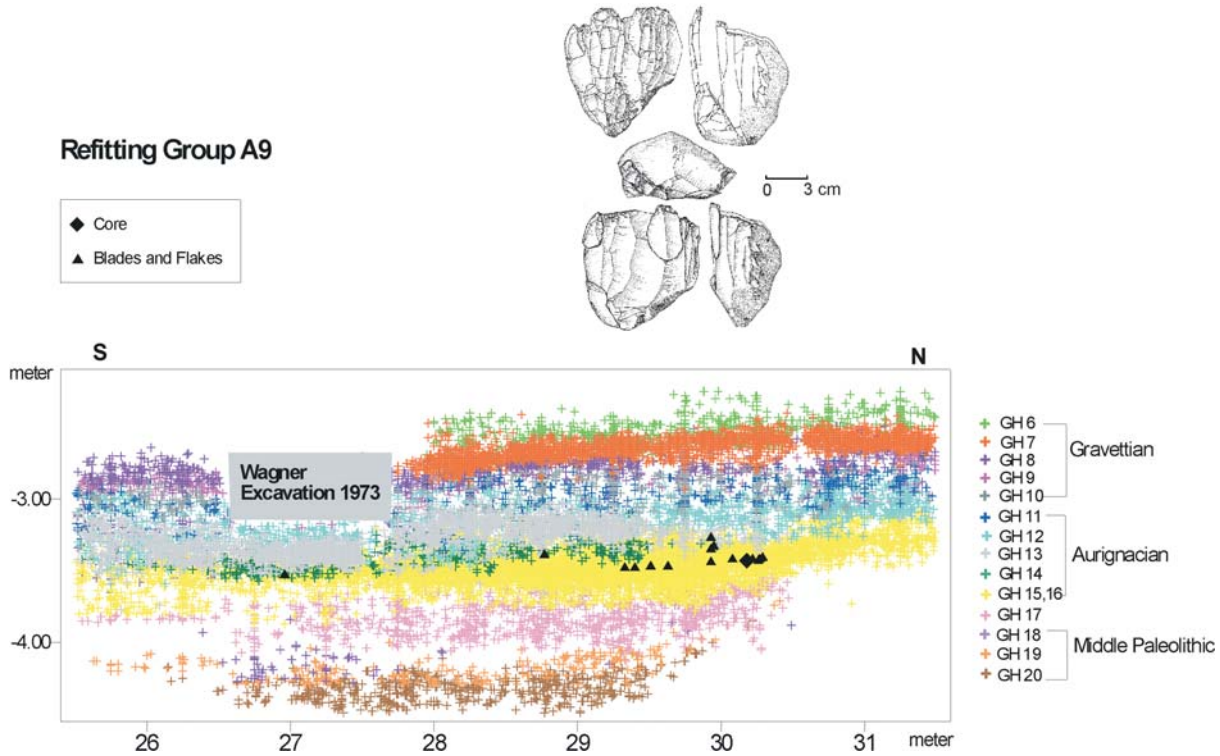

FIG. 7 – Geißenklösterle. Refitting sequence A9 from Geißenklösterle AH III.

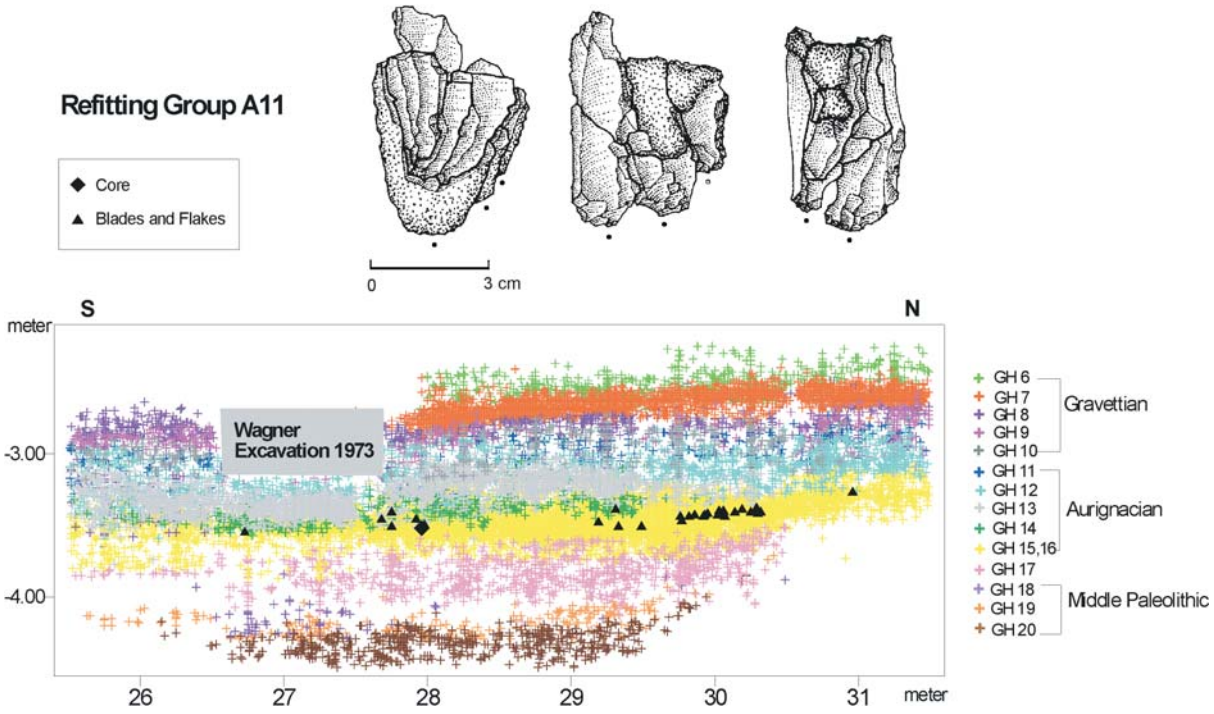

FIG. 8 – Geißenklösterle. Refitting sequence A11 from Geißenklösterle AH III.

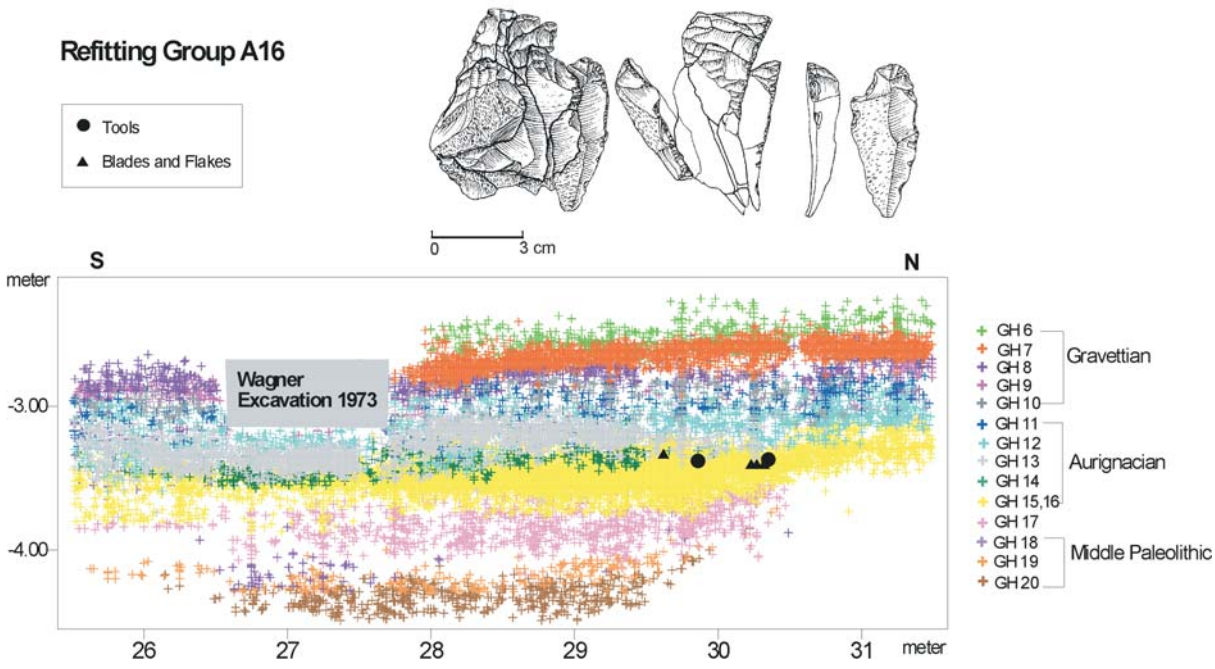

FIG. 9 – Geißenklösterle. Refitting sequence A16 from Geißenklösterle AH III.

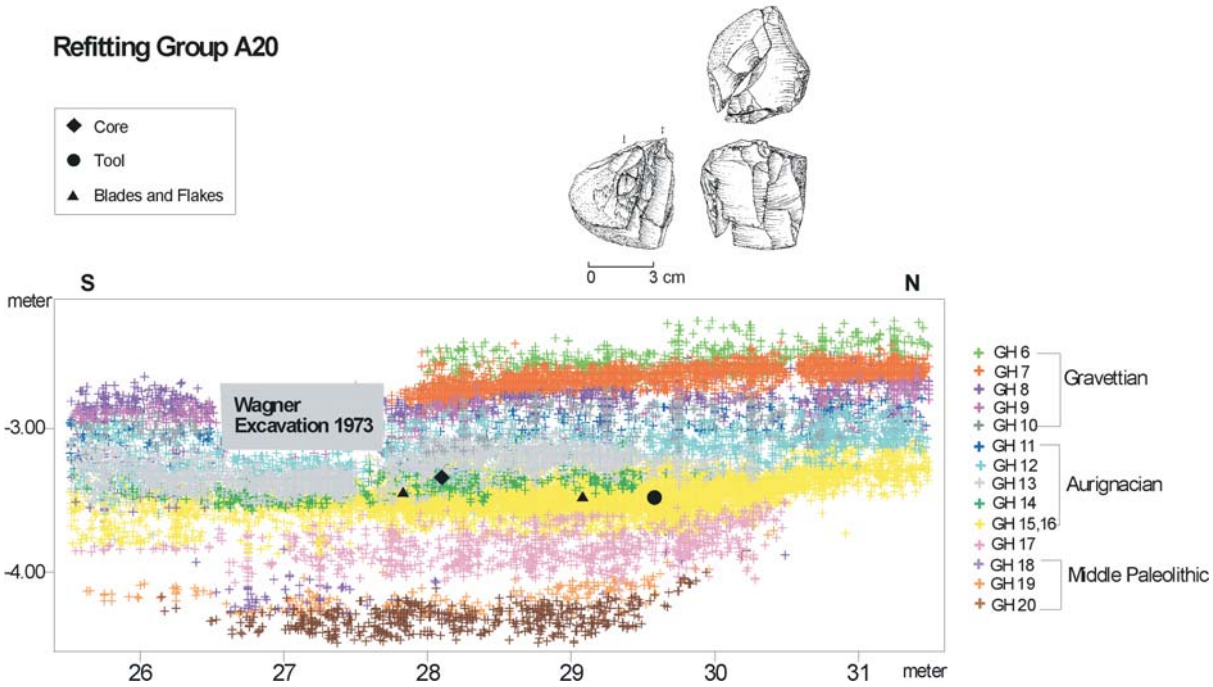

FIG. 10 – Geißenklösterle. Refitting sequence A20 from Geissenklösterle AH III.

apparently migrated upward and 10% migrated downward. Hahn's assessment is a reasonable characterization of the problems related to the separation of fine cultural stratigraphic units. Thus Hahn abandoned attempts to analyze the many subdivisions of AH II and III at Geißenklösterle and instead concentrated his efforts on specific archeological features and the analysis of the major cultural stratigraphic units that he termed archeological horizons II and III. All subsequent work in Tübingen has confirmed Hahn's interpretation and demonstrated that large scale mixing between the major stratigraphic units II and III has not occurred.

Micromorpholoy and Geoarcheology

Geoarcheological analyses have formed an important focus of the work at Geißenklösterle since the dig was reopened in 2000. Some of the first results from the Aurignacian deposits are now available (Dippon, 2003) and can be summarized as follows. Micromorphological analyses show marked distinctions between geological horizons GH 15, the main unit at the base of AH III, and the underlying archeologically nearly sterile layer GH 17. Since GH 16 is highly localized, GH 15 directly overlies GH 17 in most areas. The contact between the units is sharp. GH 15 has less fine-grained silt and clay rich matrix and more limestone rubble than the more homogeneous, underlying GH 17. The laminar structure that is recognizable in GH 15 and probably results from ice segregation does not extend into GH 17, which is characterized by a more porous structure and small spherical aggregates of sediment. The sharp contact between these distinct units rules out the possibility of significant mixing between the horizons, and the unconformity may well result from solifluction or gelifluction between the deposition of the two units (Dippon, 2003).

Additional observations indicate that GH 15 has not been reworked or mixed. The horizon contains well-defined stratified deposits of secondary iron oxides that have not been disturbed since their accumulation. In the northern part of excavation in unit 88, micromorphological analyses in the area of a fireplace (Hahn, 1989) show high concentrations of phosphates and phytoliths, as well as fragments of charcoal. Had significant mixing taken place these indications of burning would have been stratigraphicaly less well defined (Dippon, 2003).

Although fewer samples from the upper Aurignacian and Gravettian have been studied, results from samples from these layers in the northern part of the excavation show significant distinctions. The Gravettian unit GH 10 shows clear signs of cryoturbation, while indications of cryoturbation are lacking in the upper Aurignacian of GH 11 and 12. Both of these upper Aurignacian deposits show minor indications of bioturbation including high porosity and small spherical aggregates of sediment. The micromorphological studies, however, have not yielded indications of significant mixing between these layers. These results are consistent with the archeological arguments summarized above.

Interpreting the Radiometric Dates

The 37 published AMS radiocarbon dates from the Middle Paleolithic, Aurignacian and Gravettian of Geißenklösterle are presented in Fig. 11. The radiocarbon dates from decay counting do not contradict the results from AMS dating, but have not been included. This decision was made because precise provenience is only available for the AMS dates of individual finds, and the dates from decay counting reflect the ages of samples containing multiple bones. Many of the dates were made on organic artifacts and anthropogenically modified bones. Excellent bone preservation at Geißenklösterle provides good yields of collagen for dating, and the likelihood of contamination is generally low (Conard and Bolus, 2003).

The most striking feature of the radiocarbon dates from Geißenklösterle is the enormous fluctuations of samples from similar stratigraphic positions. This situation has troubled us for many years, since these results contradicted the good stratigraphic context of the site. In connection with the results from his dissertation on thermoluminescence, Richter concluded that the TL and AMS dates from AH II and AH III were consistent with devel-

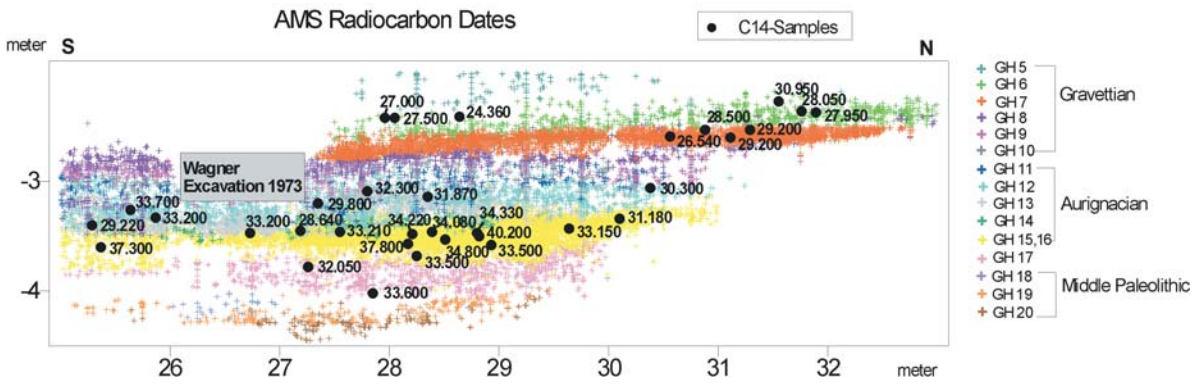

FIG. 11 – Geißenklösterle. The vertical projection of AMS dates on archeological material from the Middle Paleolithic, Aurignacian and Gravettian horizons.

opment of an early Aurignacian in Swabia around 40 kyr BP (Richter et al., 2000; Hahn, 1995; Housley et al., 1997). Particularly important were six TL dates on burnt flints from AH III that provided a mean age of 40.2±1.5 kyr BP and two TL dates on burnt flint from AH II that yielded ages of ca.37 kyr BP. Richter et al. (2000) pointed to a mean age of ca. 38 kyr BP for AMS radiocarbon measurements from AH III, and in their view this offset between TL and radiocarbon dates was consistent with other data suggesting an underestimate of radiocarbon ages by several thousand years in the period. In recent years we undertook addition radiocarbon dating to test the conclusions of Richter and colleagues (Conard and Bolus, 2003). These new results tended to confirm early dates for the Aurignacian, but also provide further documentation of great fluctuations in the radiocarbon dates.

The best explanation for the high variability in the ^{14}C dates is that they reflect natural fluctuations in atmospheric radiocarbon. Other non-archeological records including the signals from North Atlantic benthic foraminifera (Voelker et al., 2000), Japanese varves (Kitagawa and van der Plicht, 1998) and stalagmites from the Bahamas (Beck et al., 2001) provide archives with similar very large fluctuations in radiocarbon concentrations. Results of measurements of the flux of ^{10}Be and ^{36}Cl provide further support for the existence of this phenomenon (Baumgartner et al., 1998). This explanation for the radiocarbon signal at Geißenklösterle and a discussion of its ramifications has been presented in more detail in other publications and will not be repeated here (Conard, 2002; Conard and Bolus, 2003). We conclude, however, that the variations in radiocarbon ages in the Aurignacian deposits at Geißenklösterle are largely the result of global fluctuations in atmospheric radiocarbon content rather than large scale reworking of sediments and finds.

Conclusions

We conclude based on the diverse archeological data including the distributions of ivory artifacts and refitting lithic artifacts that the Aurignacian finds from Geißenklösterle are from a good stratigraphic and archeological context. The radiocarbon dates for these deposits generally underestimate the calendar ages of the deposits, and the great fluctuations reflect the global variation in atmospheric radiocarbon rather than mixing between archeological layers.

These results are in agreement with geoarcheological arguments including micromorphological analyses summarized above that demonstrate that the composition of the find horizons is not significantly affected by the reworking of the site's sediments (Dippon, 2003). The micromorphological results rule out the possibility of large-scale mixing between the archeological units.

Thus we conclude that the Aurignacian at Geißenklösterle began around 40 kyr BP and that differences in the compositions of the assemblage from AH II and III as described by Hahn (1988) and Bolus (this volume) reflect the activities that took place at the site rather than a series of taphonomic biases as suggested by Zilhão and d'Errico (1999). These observations are consistent with the Danube Corridor and *Kulturpumpe* hypotheses for the arrival of modern humans in Europe and the timing and spread of innovations of the Upper Paleolithic. The available data support the hypotheses that the upper Danube Basin and especially Swabia was settled very early by modern humans, and that Swabia provided one of the key regions for development of early Upper Paleolithic cultural innovations including those of the Aurignacian (Conard, 2002; Conard and Bolus, 2003).

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