Zeitschrift: Mitteilungen der Naturforschenden Gesellschaft in Bern

Herausgeber: Naturforschende Gesellschaft in Bern

Band: 32 (1975)

Artikel: The late upper paleolithic station of Moosbühl : a geological study and dating of the magdalenian occupation

Autor: Barr, J.H.

DOI: https://doi.org/10.5169/seals-319588

J. H. Barr

The Late Upper Paleolithic Station of Moosbühl

A Geological Study and Dating of the Magdalenian Occupation

Zusammenfassung

Dieser Artikel befaßt sich mit den geologischen Untersuchungen am Moosbühl und seiner Umgebung sowie mit der Altersbestimmung für diese jungpaläolithische Freilandstation.

Es konnte festgestellt werden, daß die bisher als Endmoränen bezeichneten Formen im unteren Moosseetal stattdessen Bildungen darstellen, die durch eine schnelle Abschmelzung stagnierter Eismassen entstanden sind. Der Moosbühl wurde auf diese Weise geformt. Seine Schichtenfolge beweist, daß die paläolithische Besiedlung nicht – wie bisher angenommen – von einem Sumpf umgeben war, sondern von Sandboden. Am Fuße des Moosbühls wurde ein früheres Toteisbecken entdeckt.

Die geologischen Auswertungen mit Hilfe von Pollenanalysen geben Hinweise auf die klimatischen Verhältnisse während der Späteiszeit in dieser Gegend. Die Magdalénien-Jäger erlebten eine Parktundra mit Birke und Kiefer. Eiskeile im Profil, deren Entwicklung nach Beendigung der Besiedlungsperiode begann, und ein plötzlicher Rückgang der Baumpollen deuten auf einen Kälteeinbruch mit Dauerfrostboden.

Nach den Ergebnissen der neuen C^{14}-Altersbestimmung wurde der Moosbühl gegen Ende des Bölling-Interstadials besiedelt. Die Datierung ist übereinstimmend mit anderen Stationen der gleichen Kulturstufe in Teilen von Frankreich und Süddeutschland.

Introduction

The Upper Paleolithic station of Moosbühl is located near the village of Moosseedorf, inside the large curve of the SBB line [1]. The site is situated on a small knoll surrounded by, and rising slightly above, a drained swamp that formerly filled the valley floor.

The site was discovered in 1860 by Dr. med. J. Uhlmann of Münchenbuchsee. However, the first excavations did not take place until the 1920's (O. Tschumi; 1924, 1925, 1926, and 1929). At that time the prehistoric occupation was assigned to the Magdalenian culture of the Upper Paleolithic. During 1952–1954 an analysis of all lithic material was carried out by the Seminar für Urgeschichte, Universität Bern (H.-G. Bandi, 1954). As a result of this study, the occupation of Moosbühl was placed in Magdalenian VIb, the final stage of the Magdalenian. In 1960 the construction of a roadway along the top of the knoll endangered

[1] Coord. 603900/207000, Landeskarte der Schweiz, Burgdorf, Nr. 1147, 1 : 25000.

a part of the site and made a short salvage operation necessary (H. SCHWAB, 1972). This excavation delivered the first C 14 age for the site.

Several questions required further investigation. A new geological study of the lower Moosseetal together with an examination of the internal structure and setting of the Moosbühl became requisite. Previous radiocarbon dating had made the site contemporaneous with Mesolithic cultures elsewhere in Europe, although the silex industry clearly belonged to the late Magdalenian VI. It was hoped that a combination of geological studies and pollen analyses together with new radiocarbon dates could provide solutions to some of the outstanding problems.

Thanks to the financial support of the Schweizerischen Nationalfonds, it became possible to conduct a new excavation of Moosbühl during the summer of 1971. The project was under the supervision of Prof. Dr. H.-G. BANDI of the Seminar für Urgeschichte, Universität Bern, with the writer as director of field operations. The following paper discusses the geological portion of the study and the new dates provided by radiocarbon age-determination on samples recovered during the excavation.

Late Pleistocene Geology of the Lower Moosseetal

The Moosseetal, in which the station of Moosbühl is located, is a fluvial valley, cut into the Lower Aquitanian sandstone (Lower Fresh-Water Molasse) that forms the substructure of the Swiss Central Plateau. The valley is approximately 9 km in length and extends from the village of Moosseedorf to Schüpfen in a southeast-northwest direction. The Moosseetal is partially filled with Pleistocene and Holocene sediments. Drilling for a well (in 1904) disclosed the Pleistocene gravel deposits to be between 70 and 80 meters in depth [2]. Postglacial swamp development and solifluction from the flanks of the valley, together with continuing erosion, have brought the valley floor to its present elevation of circa 525 meters above sea level.

A rather unusual situation for a fluvial valley exists, insofar as it is divided by a watershed (*Wasserscheide*) at approximately its midpoint. This is undoubtedly due to the action of glaciers during the Würm and may mark a stage of penetration by the glacier into the valley. Today, two small streams flow out of the Moosseetal in opposite directions. The Urtenen drains out of the southern end into the Emme, while the northern half is drained by the Lyssbach into the Aare.

The Würm Glaciation

The Rhone and the Aare glaciers were directly responsible for the surface features of the lower Moosseetal as they were seen by the Magdalenian reindeer hunters.

At the close of the Riss Glaciation, large deposits of morainic gravels remained behind in the area north of Berne. These deposits formed the surface

[2] Located northwest of Moosseedorf, between the village and the Moossee (Fr. KÖNIG and Fr. NUSSBAUM, 1927).

of the region during the Riss/Würm Interglacial. During the Early Würm (Würm I) the advancing Aare Glacier plowed these gravels in a northerly direction and constructed new moraines. Later, after a withdrawl of the Aare Glacier, the advancing Rhone Glacier overran these moraines, pushing them in a northeasterly direction, and reshaped the drift material into new features. Today, some of these may be observed as small drumlins on the terrace southwest of Moosseedorf (Wiliwald and Buchsiwald). They are composed of stratified drift, containing both Aare and Rhone erratics, and are covered with a layer of Rhone ablation till.

The withdrawl of the glacier from the lower part of the Moosseetal must have been rapid. So rapid, in fact, that it left no terminal moraines to mark the stages of retreat. Instead, we have many ice-disintegration features scattered throughout the flat area of the lower Moosseetal and along the Urtenen in a northeasterly direction, attesting to the fact that a large terminal portion of the glacier separated and remained behind as blocks of stagnant ice. The deep deposit of sand, filling the southern end of the Moosseetal, is neither varved nor stratified except at locations where it was in direct contact with the melting ice. In some sections of the valley, the sand attains a thickness of almost three meters. The valley floor was made up of this sand during the Late Pleistocene.

East of Schönbühl drumlin-like formations occur that are composed of pure sand. F. NUSSBAUM (1927) has described them as end moraines. A more recent study (U. GASSER and W. NABHOLZ, 1969), relating to the transport and deposition of Pleistocene and glaciofluvial sands, has demonstrated that the greatest percentage of the sand fraction within these formations consists of material derived from the molasse. The sand resulted from the grinding-action of the ice mass on the sandstone base and was deposited by meltwater-flow during a period of glacial stagnation; the sand component had only been transported a short distance from its source area. Recent excavations for new construction in the vicinity of Schönbühl have exposed the internal structure of some of these drumlin-like deposits. They are varved, which was caused by ablation flow from a mass of stagnant ice.

Other ice-disintegration features are the numerous kettles (*Toteisbecken*) or their remnants. A series of small peat-filled basins lie scattered between the area bounded by Schönbühl, Urtenen, Kernenried, and Lyssach. Their depth leads one to the assumption that they could well have existed as small ponds late into Postglacial times. Beyond any doubt, more of these kettles were to be found throughout the region during the Late Pleistocene and early Postglacial times. Today they are completely covered. During the excavation for a water line in 1972 such a buried kettle was exposed inside the curve of the SBB line, next to the Moosbühl. The wall profile reveals a black humus top-cover of one meter thickness above circa three meters of varved sand. The varves had been involuted by cyroturbation. Beneath the sand lies a base of circa 50 cm of blue boulder clay. The walls of the kettle incline steeply down to the clay base, an indication that the sediments had been deposited around a thick block of melting ice. The kettle itself is filled with circa two meters of peat. The lower portion of the peat is composed of *Betula* and *Pinus*, both branches and fragments of bark. The upper peat layer is made up of the remains of reeds and other aquatic plants, which offers proof for the continued existence of the pond into the Postglacial period.

Another surface feature of the Moosseetal, created by the retreating glacier, is the Moossee. Whether it resulted from a mass of stagnant ice, or whether the morainic deposit blocked drainage out of the valley, cannot be determined without a special study. NUSSBAUM (1927) visualized the Moossee as having at one time a much higher water level and extending over the whole lower end of the valley from Schönbrunnen to Sand. He accepted the peat deposits in the lower end of the valley as support for his hypothesis. If this would have been the case, the site of Moosbühl would have been surrounded by a swamp during its prehistoric occupation. It would have restricted the living area to the top of the knoll and drastically hampered the movement of the hunters. During the 1971 excavation it was discovered that the Magdalenian cultural remains extend out beyond the base of the Moosbühl, resting directly on the sand beneath the layer of black humus. Therefore, the Moossee could not have reached the Moosbühl at such an early date. From personal observation of new construction projects in this area, it would appear that the layer of peat is not continuous throughout the lower end of the Moosseetal, since only a thin layer of humus covers the sand at many locations. The only uninterrupted peat layer is in the immediate area around the Moossee. Here, peat and humus lie directly above the marl (*Seekreide*). Earlier pollen studies have revealed that this marl did not begin to develop until the Postglacial period (B. E. MOECKLI, 1952). Uhlmann's description of the stratigraphy for the Neolithic sites around the Moossee gives further evidence for the Postglacial development of the swamp (J. UHLMANN, 1860). He noted the presence of oak trees and logs within the layer of peat [3]. He attributed the rise in the water level with the accompanying swamp development to a partial blockage of the Urtenen. This seems to be a more likely explanation for the expansion of the swamp into the lower Moosseetal. It could well have been brought about by the extensive forest clearance during the Neolithic period. This, in turn, caused erosion and, thereby, could have partially dammed the Urtenen. Near the village of Urtenen where the stream (Urtenen) flows through a rather narrow channel, solifluction could well have blocked the drainage out of the Moossee. All of the former swamp is located above this point on the stream. The Urtenen was first deepened in 1919 from here to the Moossee for the purpose of lowering the ground-water level and draining the swamp.

[3] Oak (*Quercus*) was not found in this region during the Pleistocene.

The Geology of the Moosbühl

NUSSBAUM (1924) has described the Moosbühl as a flat terrace-like knoll on the southern edge of a one-time swamp. He considered the Moosbühl to be an alluvial terrace that had derived its material from the neighboring moraines and had been formed by Postglacial deposition following the retreat of the Moossee. E. GERBER (1950) also believed the Moosbühl to represent a secondary deposit of Würm morainic sands. Later ideas on the formation of the knoll were offered by H. W. ZIMMERMANN (1961), who questioned earlier theories. He felt that it was an alluvial deposit resulting from local stream action along the flanks of the terrace.

The archaeological excavation of 1971 provided an opportunity for a closer examination of the internal structure of the Moosbühl. For this purpose, a cross trench was dug through the knoll to expose the internal stratigraphy and to permit the collection of pollen samples (Fig. 1). It disclosed that the Moosbühl is

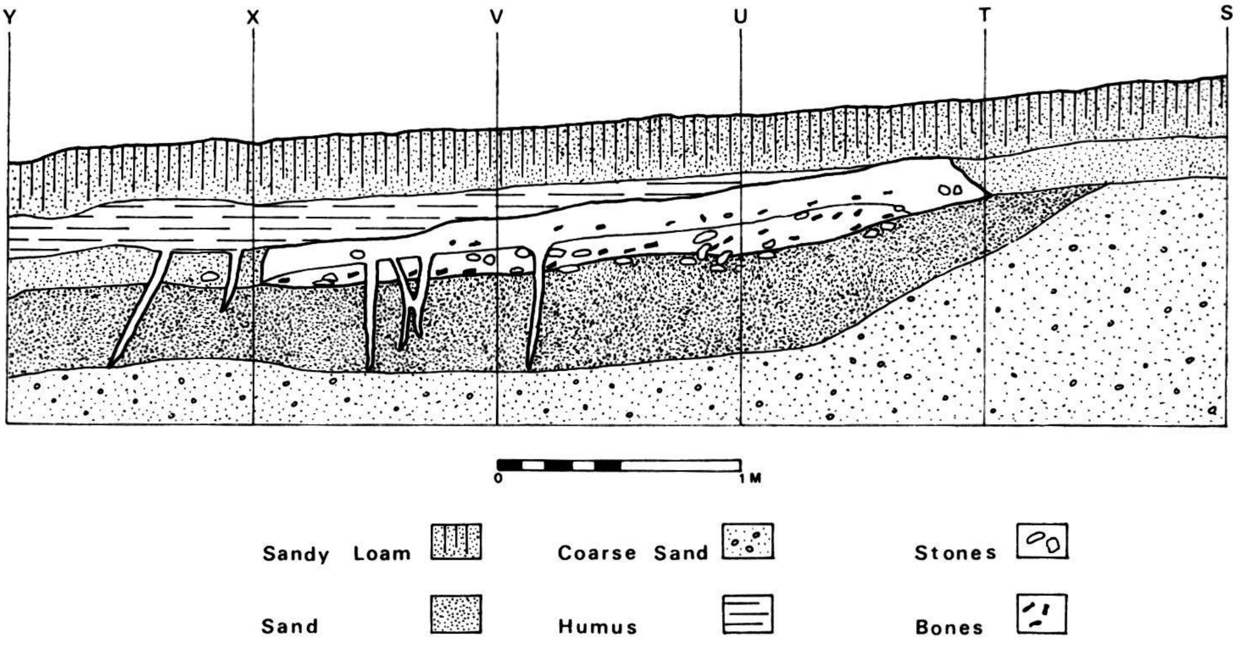

Fig. 1 Profile (Row 28) through Top of Knoll

composed of unsorted ablation till on a base of Würm ground moraine. Lenses of sand and clay are scattered throughout the layer of till. The presence of mudstones (*Tonsteine*) within the deposit rules out the probability that the material of which the Moosbühl is constructed, could have been transported any great distance by stream action.

The present flat terrace-like form is the result of erosion by wind and rain combined with agricultural activities over many years. The sides of the knoll must undoubtedly have been slightly steeper and its elevation higher at the time of occupation by the reindeer hunters. According to test borings during the course of this study, the Moosbühl was originally separated from the terrace to the west by a depression. This depression had been filled during Postglacial times by soil creep or sheet erosion from the terrace above. If one would, today, remove the humus from the base of the knoll and replace the eroded material of the upper surface, the Moosbühl would appear as an oval-shaped mound, rising more than three meters above a sandy plain.

Closer study of the internal structure of the Moosbühl has given the following facts: 1. It could not have been formed during the Postglacial period because the Magdalenian cultural deposit rests on the sandy till layer and is partly covered by black humus. 2. The Moosbühl is not an alluvial deposit because no bedding or sorting is present in its internal structure. 3. The unsorted nature and size of the stones within the deposit eliminate any possibility of aeolian action during its formative stages. As we shall see later, evidence does exist for post-formative aeolian deflation.

The reconstructed shape of the Moosbühl resembles very closely that of a «collapsed mass». R. F. FLINT (1971) describes a collapsed mass as an ice-contact feature resulting from the deposition of a concentrated mass of ablation drift. Normally, the outward form of a collapsed mass is that of a low mound, similar to a small drumlin. However, the material of which it is constructed is not as tightly consolidated as the base upon which it rests. A collapsed mass may be stratified or not, depending upon the rapidity of the ablation of the ice. There are several of these mound-like structures between Moosseedorf and Schönbühl. In the case of the Moosbühl, some of the contour may have been caused by the pressure of the ice block that was simultaneously melting and forming the kettle at its base. The collapsed mass structures, together with the numerous *Toteisbecken,* strengthen the impression that a large section of stagnant ice was left behind by the rapid withdrawl of the glacier. The melting of this ice then completed the shaping of the topography in the lower Moosseetal, and especially around the Moosbühl.

At the time of the occupation by the reindeer hunters, the Moosbühl was an oval-shaped mound, rising circa three meters above a sandy plain, with a small body of open water at its base.

Dating of the Magdalenian Occupation of Moosbühl

The date for Moosbühl's Magdalenian occupation was one of the problems to be clarified during the 1971 excavation.

Typologically, the silex industry left no doubt about its assignment to very late Magdalenian VI b. The radiocarbon age resulting from the 1960 excavation was 10300 ± 180 years B.P., a period when the Mesolithic cultures had already replaced the Paleolithic in other parts of Europe. Geologically, this would have been the Alleröd Interstadial and, therefore, would have been one whole geological phase younger than Magdalenian VI in France and southern Germany.

It was hoped to arrive at a more acceptable age for the occupation by the combined efforts of a closer stratigraphical study, a palynological study, and further radiocarbon dating.

Geological and Palynological Dating

The profile through the cultural deposit exposed some very interesting features (Fig. 1). The cultural deposit was marked at the upper end by an undercutting line of separation passing at an angle from the sandy loam down to the coarse sand. At the opposite end, the line of demarcation passed from the humus to the coarse sand. The cultural deposit itself was divided into approximately two halves along a horizontal plane. Its lower portion measured circa 15 cm at the thickest point and contained a concentration of bones and silex artifacts. The upper half measured circa 20 cm, but held only scattered bone fragments and few artifacts. Wedge-shaped features were noted in some parts of the profile. These were filled with dark-colored sandy humus and contained bone fragments. The upper ends of these wedges began at approximately the horizontal line dividing the cultural deposit and extended downward into the sterile sand base.

A closer examination disclosed that we were dealing with a cross section through a small trough-shaped deflation basin, or «blow-out». The geological structure designated as a «blow-out» is created by wind deflation of fine material from exposed ground surfaces and is a common feature to both desert and tundra. In the tundra they are formed only in locations where the land surface is sufficiently elevated above the ground-water level to permit dehydration of the soil. When the already scant tundra vegetation has been destroyed by either natural (desiccation) or other causes (man), the wind begins to remove the unprotected surface material. This causes a trough-shaped depression to develop with its long axis parallel to the prevailing wind. The sides of a deflation basin are undercut because the surrounding plant cover retains a grip on the top soil, thereby resisting the aeolian action. The final depth of a blow-out is determined by climatic change (increased precipitation), a decrease in wind activity, or when the included stone material becomes concentrated enough to build a pavement-like surface. This is known as «desert armor», or «deflation pavement». In the case of Moosbühl the latter condition applies, since a concentration of stones was noted on the floor of the cultural deposit. A second example of this sort of stone pavement was laid free at the opposite side of the section excavated. At one time it may have extended over a greater portion of the area. The former living floor had been too much disturbed by the prehistoric occupants to state definitely if the stone pavement had once covered the whole surface of the blow-out floor.

The horizontal division within the cultural deposit resulted from redeposition of finer material during later stages of the occupation and following the departure of the hunters. In the case of our blow-out, the partial refilling was possible only because of the ever-accumulating rubbish (bone fragments and stone settings) that offered an obstruction to the wind-blown sands.

The wedge-shaped features in the profile are ice-wedge pseudomorphs (*Pseudoeiskeile*), shown in Fig. 1 and 2. Ice wedges are formed only under conditions of

Fig. 2 Photo of Profile showing Ice Wedges (Photo by S. Rebsamen, Bern. Hist. Museum)

permafrost. In turn, permafrost is only found in regions where the mean annual temperature is 0 °C or below. Therefore, the presence of ice wedges is a good climatic indicator. The ice wedges continue to grow downward until the mean annual temperature begins to rise and the permafrost starts to thaw. As this melting progresses, the cavity is slowly filled with inflowing material from the surface, thus creating a cast of the original ice wedge. The growth rate of ice wedges has been measured in the continuous permafrost zone of Alaska. In that region it approximates 0.5 mm to 1.5 mm annually (K. W. BUTZER, 1966). Based on the assumption of a similar growth rate at Moosbühl, the duration of the permafrost, i.e. ice wedges, must have been between 150 to 200 years. Similar manifestations of a cold climate have been noted in the alpine region for both the Older and Younger Dryas stadials. From the observations by K. KAISER (1960) the ice wedges in the alpine region did not begin to develop until shortly before the close of a stadial. The ice wedges at Moosbühl evolved subsequent to the deposition of the cultural layer and would be termed «epigenetic». TSCHUMI (1926) reported humus-filled funnel-like features during his excavation of 1926. At that time they were not recognized as ice wedges, and no further attention was placed on them.

Pollen samples, taken from the profile during the 1971 excavation, have shown only pioneer vegetation (*Artemisia, Chenopodiaceae, Helianthemeum,* and *Compositae lig.*) below the cultural layer. The cultural deposit itself contained pollen from *Pinus* and *Betula*. *Salix* may also be assumed during this period because the remains of all three trees (*Pinus, Betula,* and *Salix*) were recovered as charcoal from a hearth. A colder climate began shortly after the departure of the hunters. This was marked in the pollen profile by a sudden decrease in tree pollen and a corresponding increase in cold-climate flora; especially *Selaginella selaginoidae,* a plant that today is found only above the tree line in the alpine region.

From the combined evidence of the geological studies and the pollen analyses, it would appear that the occupation of Moosbühl took place shortly before the close of an interstadial or during the beginning of a colder stadial. Following the occupation a decrease in temperature occurred, which led to conditions of permafrost throughout the region. Similar climatic changes took place at least three times during the Late Pleistocene: Prior to the Oldest Dryas, between the Bölling and Older Dryas, and between the Alleröd and Younger Dryas. Our knowledge of the prehistory for this part of Europe rules out the possibility that this part of Switzerland was occupied by the Magdalenian prior to the Oldest Dryas; Magdalenian VI did not develop until later. No evidence is yet available for any group earlier than Magdalenian VI in the Swiss Central Plateau. The Alleröd-Younger Dryas may also be eliminated because, as already stated, by this time the Upper Paleolithic cultures had been replaced by Mesolithic groups.

Therefore, the remaining climatic sequence, end of the Bölling/beginning of the Older Dryas, is the most likely setting for the occupation of Moosbühl.

Radiocarbon Dating

During the excavation of 1971 it was possible to collect charcoal for age determination. In the sector at the top of the knoll, only scattered fragments could be secured since wind action had redeposited the charcoal outside of the hearth area. The amount of charcoal collected here was sufficient for only one test. The age resulting from this sample was 10 140 ± 120 years B.P. (B-2306). In the meantime Dr. F. Schweingruber had completed his identification of the wood and charcoal samples and reported that *Picea* was present as an intrusive in this part of the site. No *Picea* was found in the entire pollen profile, so that the charcoal must have been introduced from the outside. Apparently, it is difficult to obtain an uncontaminated sample from the top of the knoll where erosion has removed large amounts of material from the surface, thereby permitting the plow to penetrate ever deeper. For this reason, we may assume that sample B-2306 was contaminated with *Picea* [4].

The hunters also utilized an area on the southwestern side, below the crest of the knoll, where they were sheltered from the prevailing northeasterly winds.

[4] This invalidates the hypothesis of successive occupations as formulated in the earlier report of the Moosbühl excavation (J. H. Barr, 1972).

This location proved to be favorable for us as well as the hunters: Here we were able to collect charcoal from an undisturbed fireplace. In addition, we had the fortune to lay free a large amount of birch bark *in situ* next to this hearth. Birch bark is one of the best materials for radiocarbon age-determination, producing the most accurate results. It served as control for the charcoal samples. Only *Betula, Pinus,* and *Salix* occurred as charcoal in this fireplace.

The samples from the hearth and the birch bark gave the following ages:

11 900 ± 130 years B.P.	(B-2310)	Charcoal
11 180 ± 120 years B.P.	(B-2313)	Charcoal
12 060 ± 130 years B.P.	(B-2316)	Birch Bark

The average for these samples is 11 710 ± 130 years B.P. (9760 B.C.). It places the occupation close to the end of the Bölling Interstadial and the beginning of the Older Dryas, in accordance with the results of the geological and pollen studies. S. WEGMÜLLER (1966) has dated the Older Dryas to 9780 B.C. for the southwestern Jura region. The climatic shift during this period would explain the formation of the ice wedges and the permafrost subsequent to the departure of the hunters from Moosbühl.

The new dates also bring the occupation of Moosbühl closer to Magdalenian VIb sites located in the neighboring regions. Some stations with ages close to those of Moosbühl are: Le Chamois Boivin Grotte, Blois-sur-Seille (French Jura) – 12 040 ± 270 years B.P. (Radiocarbon Magazine, New Haven 1973); Pincevent, Habitat 1 – 11 610 ± 610 years B.P. (Radiocarbon Magazine, New Haven 1969); and Andernach am Rhein – 11 300 ± 220 years B.P. (Science Magazine, New Haven 1957:126:194). We can say that the hypothesis, Moosbühl represents a late remnant of the Upper Paleolithic culture, is no longer tenable.

Conclusions

The purpose of this study was to add to our knowledge about the geology of Moosbühl as well as to gain additional information about the prehistoric occupation. The results have exceeded expectations in many ways. Not only has it been possible to establish an age for the occupation that agrees with other stations belonging to the same Upper Paleolithic culture, but the geological setting of the site could be reconstructed, so that we now know something about the environment in which these early hunters lived.

It has been determined that the retreat of the Rhone Glacier from the lower Moosseetal was rapid. The structures earlier thought to represent end moraines are instead ice-disintegration features resulting from a large mass of stagnant ice. The Moosbühl itself was formed in this manner. The Moossee never extended over as large an area as formerly believed. The swamp, supposed to mark the limits of the late glacial Moossee, did not develop until Postglacial times. This became obvious when the Magdalenian cultural deposit was found to lie beneath the humus of the former swamp.

The kettles, remnants of the melting glacier, appeared on the landscape as numerous small lakes or ponds, scattered throughout the lower Moosseetal. One such kettle was discovered at the foot of the Moosbühl. Its connection with the site offers a project for future research. Birch and pine hint at a park tundra environment during the time of the reindeer hunters.

The prevailing winds must have been out of the northeast because our profile exposed the cross section of a blow-out extending in a northeast-southwest direction. These winds were of sufficient strength and duration to remove the fine material from the top of the knoll and shape a basin, later to be utilized by the hunters as a working area.

We have also learned that the climate was growing slowly colder. After the departure of the Magdalenian hunters, the birch tundra became a zone of permafrost with only sparse alpine and arctic plant growth to cover the sandy soil. The ice wedges, their tops level with the upper surface of the cultural deposit, indicate that this stage of extreme cold did not commence until after the site had been abandoned. It was, however, only of short duration.

The new radiocarbon dates for Moosbühl make the Magdalenian settlement contemporaneous with other Magdalenian VI stations in the neighboring regions of France and southern Germany. This also makes the similarity in tool assemblages between Moosbühl and those of other stations more understandable. Moosbühl was not a late vestige of the Upper Paleolithic culture, but a part of it.

Acknowledgment

Without the support of the Schweizerische Nationalfonds, this study would not have been possible.

The writer appreciates the opportunity, granted by Prof. Dr. H.-G. Bandi, to have conducted the archaeological excavation of Moosbühl, which in turn permitted the study presented. I am grateful to Prof. Dr. W. K. Nabholz for his assistance and advice in geological matters. Thanks is expressed to Dr. F. Schweingruber for the identification of the wood and charcoal samples.

The following institutions contributed to the success of this research project: The Archäologische Dienst des Kantons Bern; the Biologische Institut, Universität Bern, by analyzing the pollen samples; the Physikalische Institut, Universität Bern, by performing the tests for radiocarbon age-determination.

References cited

BANDI, H.-G. (1954): Das Silexmaterial der Spätmagdalénien-Freilandstation Moosbühl bei Moosseedorf (Kt. Bern). Jahrbuch Bern. Hist. Mus., Jg. 32/33, Bern 1952/53, pp. 77–134.

BARR, J. H. (1972): Die Spätmagdalénien-Freilandstation Moosbühl. Jahrbuch Bern. Hist. Mus., Jg. 49/50, 1969/70, Bern, pp. 199–205.

BUTZER, K. W. (1966): Environment and Archaeology. Aldine, Chicago.

FLINT, R. F. (1971): Glacial and Quaternary Geology. John Wiley & Sons, New York.

GASSER, U. and NABHOLZ, W. (1969): Zur Sedimentologie der Sandfraktion im Pleistozän des schweizerischen Mittellandes. Eclogae Geologicae Helvetiae, Vol. 62, Nr. 2, pp. 467–516.

GERBER, E. (1950): Erläuterungen zum Geologischen Atlas der Schweiz. Blätter: 142, Fraubrunnen; 145, Burgdorf. Schweiz. Geol. Kom.

KAISER, K. (1960): Klimazeugen des Periglazialen Dauerfrostbodens in Mittel- und Westeuropa. Eiszeit und Gegenwart, Vol. 11, pp. 121–141.

KÖNIG, Fr. and NUSSBAUM, Fr. (1927): Neue Beiträge zur Heimatkunde des Moosseetales. Stämpfli & Co., Bern.

NUSSBAUM, F. (1924): Die geologische Beschaffenheit der Silexschlagstelle Moosbühl. Mitt. Natf. Ges. Bern.

– (1927): Das Moosseetal, ein diluviales Fluß- und Gletschertal. Mitt. Natf. Ges. Bern.

SCHWAB, H. (1972): Moosbühl, Rettungsgrabung 1960. Jahrbuch Bern. Hist. Mus., Jg. 49/50, Bern 1972, pp. 189–199.

TSCHUMI, O. (1924): Die Silexfundstelle Moosbühl bei Moosseedorf. Jahrbuch Bern. Hist. Mus., Jg. IV, Bern, pp. 19–22.

– (1925): Die zweite Ausgrabung auf dem Moosbühl bei Moosseedorf. Jahrbuch Bern. Hist. Mus., Jg. V, Bern, pp. 17–22.

– (1926): Die dritte Ausgrabung auf dem Moosbühl bei Moosseedorf. Jahrbuch Bern. Hist. Mus., Jg. VI, Bern, pp. 12–19.

– (1929): Die vierte Ausgrabung auf dem Moosbühl bei Moosseedorf. Jahrbuch Bern. Hist. Mus., Jg. IX, Bern, pp. 31–33.

UHLMANN, J. (1860): Geologisch-Archäologische Verhältnisse am Moosseedorfsee. Mitt. Natf. Ges. Bern.

WEGMÜLLER, S. (1966): Über die Spät- und Postglaziale Vegetationsgeschichte des südwestlichen Juras. Beitrag Geobot. Landesaufnahme Schweiz.

ZIMMERMANN, H. W. (1961): Die Eiszeit im westlichen zentralen Mittelland (Schweiz). Diss. Zürich.