



“Renovatio imperii” on the Muensterhuegel of Basle? A reappraisal of mechanical mortar mixers

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In 2004 the well preserved remains of a mortar mixer were excavated on the northern tip of the Basle Muensterhuegel. Pieces of charcoal in the mortar disc were dated by ¹⁴C to the 10th century AD. At the same period a Roman stone structure nearby was rebuilt. The king rather than the bishop seems to be responsible for this act of “renovatio imperii”; the bishop had his cathedral – the “Muenster” - and his living quarters further south on the same hill above the Rhine.

Mechanical mortar mixers are closely connected with the renaissance of stone architecture between the 8th and the 11th century AD. They are understood as remains of large building sites authorised by the ecclesiastical or secular rulers of the High Middle Ages. Ten years after the last article giving an overview (Burnell 1998), and with nearly double the number of examples, this phenomenon should be reassessed on the base of over 59 mortar mixers from 36 sites across Europe.

The example from Basle-Muensterhuegel

The excavation “Martinsgasse 6+8”

In 2004 the Archaeologische Bodenforschung Basel-Stadt had to undertake a rescue excavation on the northern part of the Muensterhuegel in Basle (fig. 1). This northern tip of the plateau is called the Martinskirchsporn after the parish church dedicated to St. Martin, a saint who was popular with the Franks in the 7th/8th century AD.

The excavation at Martinsgasse 6+8 (Hagendorn/Stegmueller/Stelzle-Hueglin 2006) brought new results on the history of this less well known part of the Muensterhuegel (fig. 2): 3000 years ago, in the late bronze age, there must have been a fortified settlement on the northern end of the hill as is indicated by a ditch some 2.50 m deep and 9 m wide. In the late Celtic period, about 50 BC, several pits show that also this part of the Muensterhuegel was again used as a dwelling place and at the very south end of the plateau a “muris gallicus” - a defensive structure from wood stone and earth - was erected. In late Roman times a fortification – supposedly a stone wall - surrounded the whole plateau. There are remains of several large Roman stone buildings on the hill, their layout and function still being subject to discussion. By the end of the Roman Empire layers of so called “dark earth” start to accumulate. This sediment seems to develop as a result of the fortification, which stops erosion downhill, combined with a blocked drainage system and debris from the more and more agricultural usage.

The remains of the mortar mixer

In the upper part of the “dark earth”-layers a round disc of hardened mortar was found (figs. 3+4). It was about 2.5 m in diameter and had a central post-hole. On the surface there were four concentric grooves. The western part of the round plate showed traces of several small sticks; very often two close to each other. They divided this half of the circle into five sectors. One pair of sticks had not left round traces but elongated oval holes. The mortar disc sat in a pit, which was at least 30 cm deep.

The structure represents the remains of a special mortar mixing device found on large scale building sites between the 9th and 11th century. There are quite a few parallels mostly in the South of Germany and in Northern Switzerland which have been studied with respect to construction and mechanical function of such a rotary mortar mixing device. First a round pit is dug and a central post is erected. In some this post is held in place by a large four post construction. The post in the middle serves as a spindle for a revolving rake with two or four arms stretching out beyond the pit. They can be turned by man or animal power. What is special in the construction at Basle are the upright sticks set into the bottom of the pit. They are arranged in order to let the teeth of the rakes pass between them. This so called “Zwangsmischprinzip” - principle or method of forced mixing - would improve the process considerably. The sticks are present only in one half of the pit, so as to make it easier to add the components and to take out the mortar at the end. This device was probably turned clockwise, which

would explain why the first two fixed sticks in this direction have been hit by material and dents of the rake first.

The dating of the mortar mixer

There are two levels in the dark earth, which can be defined as walking surfaces, the upper of the two might be connected to the mortar mixing device and the reutilisation of the Roman foundations (fig. 2). Because the dating of the "dark earth"-strata by finds has proved to be rather difficult, an independent date was sought. Dr. E. Bonani from ETH Zuerich tried to get ^{14}C -AMS-dating for the mortar of the mixing plate itself and for charcoal embedded in the mortar. In the end it was not possible to date the mortar, but he succeeded in dating several charcoal pieces and could calculate a weighted average which gives a calibrated radiocarbon-age between AD 936-1018 (with a probability of 71.8 %). Thus the mortar mixing device and with it a major building in stone was most probably erected in the 10th or beginning of the 11th century AD.

Reutilisation of Roman foundations in the High Middle Ages

The installation of such a complex device has to be seen in connection with a major building project in the vicinity. It was used to produce large amounts of mortar. Micromorphological analysis by Dr. Philippe Rentzel and his team at the IPNA (University of Basle) has shown, that there are traces of several mixing processes.

The nearest stone building belonging to the same period is represented by the right angle of a wall which sits on a late Roman foundation, reused in the High Middle Ages (fig. 3). Unfortunately we know little about the layout of the stone building in either Roman or medieval times. It was demolished in the 12th century, which is proved by fragments of pottery and stove tiles in the debris dating to that time. The situation and orientation of the building make clear that the Martinsgasse does not follow a Roman road, but goes back to a late medieval restructuring process.

A precious enamelled metal-object

A beautiful piece of Ottonian metalwork (fig. 5) was found in the upper dark earth layers. It is a gilded bronze disc with central opening and pelta-shaped ornament with blue and red enamelling. There are no traces of a fastening device on the backside, so it did not serve as a brooch. What it could have been is part of a reliquary or of a small portable altarpiece.

King and bishop together on the Muensterhuegel?

Who could have been behind this extraordinary object or the rebuilding of Roman structures in the 10th century? The person first coming to mind - the bishop of Basle - actually has his cathedral and palace some hundred metres to the south separated from this part of the Muensterhuegel by a ditch. Has the Muensterhuegel of Basle for two centuries or even longer been divided between the bishop and the king? Was it a similar situation to that we find in Merovingian Paris on Île de France or at medieval Bergen in Norway? Did the buildings in the northern part of the Muensterhuegel at Basle belong to a palatial complex? Was it the king, who ordered in the 10th century the rebuilding of a Roman structure in a gesture of "renovatio imperii"? The historical sources will have to be reread under that light.

Mechanical mortar mixers in Europe

History of research and current distribution

The first to have excavated a mortar mixer seems to have been Emil Vogt in 1937/38 on the Lindenhof in Zurich; he made a reconstruction drawing with a post in the middle and the outer rim being strengthened by a post and wattle construction (Vogt 1948; Gutscher 1981, 180f). But neither he nor Borger in Moenchengladbach (Borger 1958), Jósefowiczówna in Poland (Jósefowiczówna 1967), Cramp in Monkwearmouth (Cramp 1969), List at Schuttern (List 1975), Ward-Perkins in Pavia (Ward-Perkins 1978) or Bierbrauer at Saeben (Bierbrauer/Nothdurfter 1988) understood the original purpose of the structure. Very often it was looked at as a lime-pit or misinterpreted like in Poland as a base of a

baptismal font.

Between 1973 and 1976 John Williams in Great Britain (Williams 1979) and 1977 Daniel Gutscher in Switzerland (Gutscher 1981; Schneider/Gutscher/Etter 1982) discovered mortar discs in their excavations at Northampton and Zurich-Muensterhof respectively and explained them, independently, as the remains of medieval mortar mixing devices. Williams published the first reconstruction drawing (Williams 1979). Gutscher based his article in ZAK from 1981 on 13 examples from eight sites; by then he knew about the Polish finds but not yet of the British. In 1991 Renata Windler published three mortar mixers from Uto-Kulm near Zurich, probably the site of a former castle, and used the possibility to show all known sites – by then 17 – on a distribution map (Windler 1991). The most recent overview has been provided by Simon Burnell in his book about the church of Sissach near Basle (Burnell 1998). His map (fig. 6) includes 15 sites; in the text he mentions another four locations from Britain and Poland.

Meanwhile the number of excavated mortar mixers has risen to over 59 from 36 sites (fig. 6+7) in Switzerland (11), Germany (8), Italy (8), Great Britain (4), Belgium (2), Poland (2) and France (1). The large number of examples from Northern Switzerland does reflect the long tradition and the better funding of archaeological research especially also of medieval sites there. It gives an impression how dense the distribution might be elsewhere. Italy, especially Tuscany, seems to be catching up on that standard: only in the last five years six mortar mixers have been excavated and published straight away. It is not clear why France or Austria should have just one or none to contribute.

Dating and technical aspects

Often there are several mortar mixers in one place. They can belong to the same building period or to different phases. Most of them seem to date between the 8th and 10th century AD, but many of these dates might have to be checked again. The earliest example – Grenoble – stands alone at the end of the 4th/beginning of the 5th century AD, as does the latest – Lenzburg, which is dated by dendrochronology to 1588. The early ones tend to be very large in diameter – up to 4 m (Grenoble, Muestair monastery, Moenchengladbach, Thier d'Olne, Posen A, Wiřliza) – while the later ones are smaller with an average diameter between 2 and 2.5 m.

Gutscher (1982, Abb. 64) discriminates two different types of construction: type A has a fixed central beam while with type B the central post would revolve together with the rakes. In Zurich-Muensterhof he also found the four post-holes of the timber structure holding the central post in place. A mortar mixer with fixed small posts in the mixing pit like in Basle has also been found at Moenchengladbach (Gutscher 1981, 182ff). There are probably more examples of mixers that utilised in this forced way of mixing ("Zwangsmischprinzip"), but the descriptions of the authors are usually not accurate enough to know how the devices worked in detail.

Scheidegger (1990, 252, Tabelle 1 u. 2) estimates the output of the smaller mortar mixers with diameters around 2.5 m between ½ and 2 t per load; the larger ones with diameters over 3 m would produce between 2 and 3 t. He also discusses whether the devices were driven by man- or animal-power. According to his calculations it would need either four men or one ox or horse to move the apparatus effectively. With a mechanical mortar mill it should have been possible to mix about 50 m² of mortar per day, which is three times more than a team of 12-15 workers would be able to produce by hand.

Plenty of mortar at one time would have been needed to pour floors or to plaster walls, but Scheidegger (1990, 244) sees the main use connected with the rubble-filling of "double-faced" masonry. The foundations and vaults of the Carolingian and Romanesque period take up large amounts of concrete like mortar. Compared with this a church from the Gothic period can be built with much less mortar due to its trimmed stones, which allow the walls to be of much lesser width.

The wooden parts of a mortar mixer are easily taken apart and can be transported from one building site to the other. So it is the ideal machine for a travelling group of specialised craftsmen, who can not rely on skills of local work forces in respect to stone building techniques.

Historical sources, Benedict Bishop and the "magistri commacini"

There are no contemporary depictions or descriptions of mortar mixers, which is quite astonishing as in late medieval manuscripts building sites are a very popular topic. Workers often can be seen mixing sand, lime and water in basin like troughs and carrying the mortar in buckets up the scaffolding.

If the sources don't speak about the building process as such they tell us about the builders and their contractors. Bede (*Vita Beatorum Abbatum* I: 4-5) describes how Benedict Biscop, who had travelled the continent several times before he founded the monastery of Monkwearmouth in Northumbria in the late 7th century AD, called builders and specialised craftsmen from Gaul to help to construct and to

furnish the abbey. According to this source one should expect to find many more early examples of mortar mixers in France. Or this apparatus would be something the Gaulish workmen only developed when they went abroad.

Another early text from Italy, the *Leges Langobardorum* from the middle of the 7th to the middle of the 8th century AD, deals at length with the proper payment of the “magistri/maestri commacini”, a renowned group of builders at that time and later on. It is still being disputed (Salmi 1971, 409; Erb 1982; Lomartire 1996, 139) whether their name suffix is a geographical description - “comacino” meaning “from the region of Como” – or rather a professional specification – “commacino” “with machines”. The latter would be “cum mako” a word of German origin transformed into Latin “macio” from which English “mason” and French “maçon” are derived. Without being able to add to philological aspects the archaeological evidence would support strongly the version “cum macinis” as a mortar mixer and probably also a crane would have been the most visible landmarks at that time for a professional building site. One of the texts in the *Leges Langobardorum* (Item Memoratorio de Mercedes Commacinorum, 2. Si vero murum fecerit) gives the prices for walls according to their thickness and length. And when it speaks about “Si vero macinam mutaverit ...” – “If the machine should have to be shifted ...”, one would really like to be sure which device is talked about. The described shifting of the machine could be paralleled with something that can be witnessed on many sites: for large buildings several mortar mixing pits were dug in order to be always close enough to the place where the mortar was required.

Conclusion

On the one hand historical sources from Britain suggest many more mortar mixers in France than archaeology was able to find. On the other hand no written document proves the king to have built one of his palaces on Basle Muensterhugel as the archaeological situation puts to mind. We now try to reconstruct the mechanism of a machine that has been used for centuries throughout Europe, but was never depicted nor described by its contemporaries. This is how archaeology can shed a new light on history even when sometimes more questions seem to arise than can be answered.

There is still potential for more sites with mortar mixers to be discovered. The known ones should be looked at more closely and dated – if possible - independently. Data from experimental reconstructions like Pfalz Tilleda are needed to test the different models that have arisen. Between the 8th and the 11th century AD the mortar mixers are a sign of a European – or even beyond (?) – network of builders and their contractors. The research on it will be only successful, when our perspective reaches beyond boundaries of politics, languages and disciplines.

Gazetteer of the sites with mortar mixers:

Location	Technical data and (diameter type)	Dating (method)	Literature
B (Belgique)			
Thier d'Ogne 1 (arr. Huy, prov. Liège, Région wallonne)	about 4 m	middle 8 th - beginning of 9 th century AD (arch.)	Witvrouw 2005
Thier d'Ogne 2 (arr. Huy, prov. Liège, Région wallonne)	about 2 m	9 th -10 th century AD (arch.)	Witvrouw 2005
Wellin, church (arr. Neufchâteau, prov. Luxembourg, Région wallonne)	about 2 m	possible connection with ceramics of the 13/14 th century AD	Évrard 1986
CH (Switzerland)			
Aesch-Saalbuenten (Kt. BL)	about 2 m	10 th century AD (arch.)	Tauber 1985; Marti 2000
Basle, Martinsgasse 6+8 (2004/1)	about 2.5 m	AD 936-1018, 71,8% (¹⁴ C-Dating)	Hagendorn/Stegmueller/Stelzle-Hueglin 2006
Disentis, St. Martin (Kt. GR) 1 (Nr. 525)	about 2.8 m	8/9 th century AD, cut by grave 85 (arch./hist.)	Schneider/Gutscher/Etter 1982, 73; 146, Anm. 29; Windler 1991, Anm. 68, Scheidegger 1990, 250f.
Disentis, St. Martin (Kt. GR) 2 (Nr. 681)	about 2.8 m	8/9 th century AD (arch./hist.)	Schneider/Gutscher/Etter 1982, 73; 146, Anm. 29; Windler 1991, Anm. 68, Scheidegger 1999, 250f.
Disentis, St. Martin (Kt. GR) 3 (Nr. ?)	?	8/9 th century AD (arch./hist.)	Schneider/Gutscher/Etter 1982, 73; 146, Anm. 29; Windler 1991, Anm. 68, Scheidegger 1990, 250f.
Dornach (Kt. SO), Kohliberg 6	about 2 m	connection with late medieval stone building nearby?	Nold 2004
Embrach, Pfarrhausstrasse (Kt. ZH) 1	2.2-2.4 m	former ground of a monastery: 1044 AD <i>monasterium</i> (hist.)	Matter 1994
Embrach, Pfarrhausstrasse (Kt. ZH) 2	2-2.2 m	AD 1027-1243, 95.4% (¹⁴ C-Dating)	Matter 1994
Embrach, Pfarrhausstrasse (Kt. ZH) 3	about 1.8 m	former ground of a monastery: 1044 AD <i>monasterium</i> (hist.)	Matter 1994
Embrach, Pfarrhausstrasse (Kt. ZH) 4	1.8 m	AD 561-780, 95.4% (¹⁴ C-Dating)	Matter 1994
Embrach, Pfarrhausstrasse (Kt. ZH) 5	?	former ground of a monastery: 1044 AD <i>monasterium</i> (hist.)	Matter 1994
Lenzburg (Kt. AG), Eisengasse	2.75 m	AD 1588 (dendrochronology)	Kueng 2004; Weber 2004
Muestair-St. Johann, monastery (Kt. GR) 1	about 3.5 m	Carolingian period (arthist.)	Sennhauser 1995
Muestair-St. Johann, Plantaturn (Kt. GR) 2	about 2 m	AD 958 (hist.)	Sennhauser 1995
Muestair-St. Johann, Plantaturn (Kt. GR) 3	about 2 m	AD 958 (hist.)	Sennhauser 1995
Muestair-St. Johann, Plantaturn (Kt. GR) 4	about 2 m	AD 958 (hist.)	Sennhauser 1995

Muestair-St. Johann, Plantaturm (Kt. GR) 5	about 2 m	AD 958 (hist.)	Sennhauser 1995
Sissach, reformierte Kirche (Kt. BL)	2.5 m	8/9 th century AD (typological); connection with church II	Tauber/Hartmann 1988; Burnell 1998; Marti 2000
Ueetliberg, Uto-Kulm (Kt. ZH) Struktur 324	2.4 m	10 th century AD (arch.)	Windler 1991
Ueetliberg, Uto-Kulm (Kt. ZH) Struktur 319	2.65 m	10 th century AD (arch.)	Windler 1991
Ueetliberg, Uto-Kulm (Kt. ZH) Struktur 285	?	10 th century AD (arch.)	Windler 1991
Zurich, Muensterhof	2.9 m	connection with the building of the Fraumuenster abbey AD 853-874; destroyed during the first phase of the graveyard (arch./hist.)	Schneider/Gutscher /Etter 1982; Gutscher 1981
Zurich, Lindenhof 1	2.6 m	connection with the Carolingian palatial complex	Vogt 1948; Gutscher 1981
Zurich, Lindenhof 2	<2.6 m	destroyed by a Carolingian(?) wooden building (arch.)	Vogt 1948; Gutscher 1981
Zurich, Lindenhof 3	2.9 m	connection with the Carolingian palatial complex	Vogt 1948; Gutscher 1981
D (Germany)			
Aulendorf, Schloß (RV, Baden-Wuerttemberg)	about 2.5 m	previous to building activity of the 10 th century AD (arch.)	Schmidt 1995
Burg Wittelsbach (AIC, Bayern)	about 2.2 m	10/11 th century AD, „before 1210“	Gutscher 1988, 180; Windler 1991, Anm. 72
Herrieden, Stiftskirche (AN, Bayern)	about 3 m	10/11 th century AD (arch.)	Steege 2005
Kirchheim/Teck, Widerholtplatz (ES, Baden-Wuerttemberg)	about 2.5 m	possible connection with a predecessor of the church of St. Martin: AD 970 “basilika decimalis” (hist.)	Schaefer 1987
Moenchengladbach, Muenster St. Vitus (MG, Nordrhein-Westfalen)	3.4 m, “Zwangsmischer”	before the founding of the monastery in AD 974 (arch./hist.)	Borger 1958; Gutscher 1981
Reichenau, Mittelzell (KN, Baden-Wuerttemberg)	?	late 9 th /beginning of 10 th century AD	Zettler 1988
Reichenau-Mittelzell (KN, Baden-Wuerttemberg)	about 2.5 m	possible connection with Laurentiuskirche, dedicated before AD 1056 (hist.)	Schmidt-Thomé 2007
Schuttern (OG, Baden-Wuerttemberg)	2.6 m	early 9 th century AD (arch.)	List 1975; Gutscher 1981, 182ff
Tilleda, Koenigspfalz (MSH, Sachsen-	?	?	Dapper 2007

Anhalt)			
F (France)			
Grenoble, groupe épiscopal (Dép. Isère)	3.60 m	end of 4 th /beginning of 5 th century AD (arch.)	Baucheron et. al. 1998
GB (Great Britain)			
Duxford, Land off Hinxton Road (Cambridgeshire)	about 2.5 m	14/15 th century AD, connection with construction work at St. Peter's church? (arch.)	Lyons in preparation
Eysham, Abbey (Oxfordshire) 1	2.2 m	11 th century AD	Hardy/Dodd/Keevil 2003
Eysham, Abbey (Oxfordshire) 2	2.25 m	11 th century AD	Hardy/Dodd/Keevil 2003
Monkwearmouth Abbey (Sunderland, Tyne and Wear)	3.65 m	late 7 th /8 th century AD (arch.)	Cramp 1969
Northampton, St. Peter's church 1	2.2 m	early 9 th century AD (arch.)	Williams 1979
Northampton, St. Peter's church 2	3.0 m	early 9 th century AD (arch.)	Williams 1979
Northampton, St. Peter's church 3	2.2 m	early 9 th century AD (arch.)	Williams 1979
Northampton, St. Peter's church 4	2.4 m	early 9 th century AD (arch.)	Williams/Shaw/Denham 1985
Northampton, St. Peter's church 5	2.4 m	early 9 th century AD (arch.)	Williams/Shaw/Denham 1985
I (Italy)			
Abbazia San Salvatore al Monte Amiata (SI, Reg. Toscana), monastery	about 2 m	11 th century AD	Dallai 2003
Castello di Donoratico, Castagneta Carducci (LI, Reg. Toscana), castle	?	9 th century AD	mentioned in Nardini/Valenti 2007
Castello di Miranduolo (Chiusdino, SI, Reg. Toscana), castle	about 1.70 m	9 th century AD	Nardini/Valenti 2007
Castello di Montemassi (GR, Reg. Toscana)	?	14 th century AD	Bruttini et al. 2002
Saeben/Sabiona (BZ, Reg. Alto Adige), monastery and episcopal see	about 3 m	?	Bierbrauer/Nothdurfter 1988
San Pietro in Monteverdi, Monteverdi Marittimo (PI, Reg. Toscana), monastery	?	9 th century AD	Francovich/Bianchi 2006
San Vincenzo al Volturno 1 (IS, Reg. Molise), monastery	about 3 m	middle of 11 th century AD	Riddler 1993
San Vincenzo al Volturno 2 (IS, Reg. Molise), monastery	?	?	(oral communication Federico Marazzi, September 2007)
Torre Civica di Pavia	about 1.2 m	11 th century AD	Ward-Perkins 1978

(Reg. Lombardia)			
P (Poland)			
Poznań/Posen cathedral A,	about 4 m	3 rd quarter of 10 th century AD	Jósefowiczówna 1967; Gutscher 1981
Poznań/Posen cathedral B,	1.1 m	3 rd quarter of 10 th century AD	Jósefowiczówna 1967; Gutscher 1981
Poznań/Posen cathedral C,	?	3 rd quarter of 10 th century AD	Jósefowiczówna 1967; Gutscher 1981
Poznań/Posen cathedral D,	?	3 rd quarter of 10 th century AD	Jósefowiczówna 1967; Gutscher 1981
Wiśliza/Wiesling, parish church	4 m	connection with ceramics of the 9 th century AD, destroyed by a church of the 10 th century AD	Jósefowiczówna 1967; Gutscher 1981

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Fig. 1: Basle (CH), Martinsgasse 6+8 (2004/1). Excavation site on the Martinskirchsporn, the northern part of the Muensterhuegel; in the background to the north the church St. Martin and the Rhine (Photos: Christian Stegmueeller).

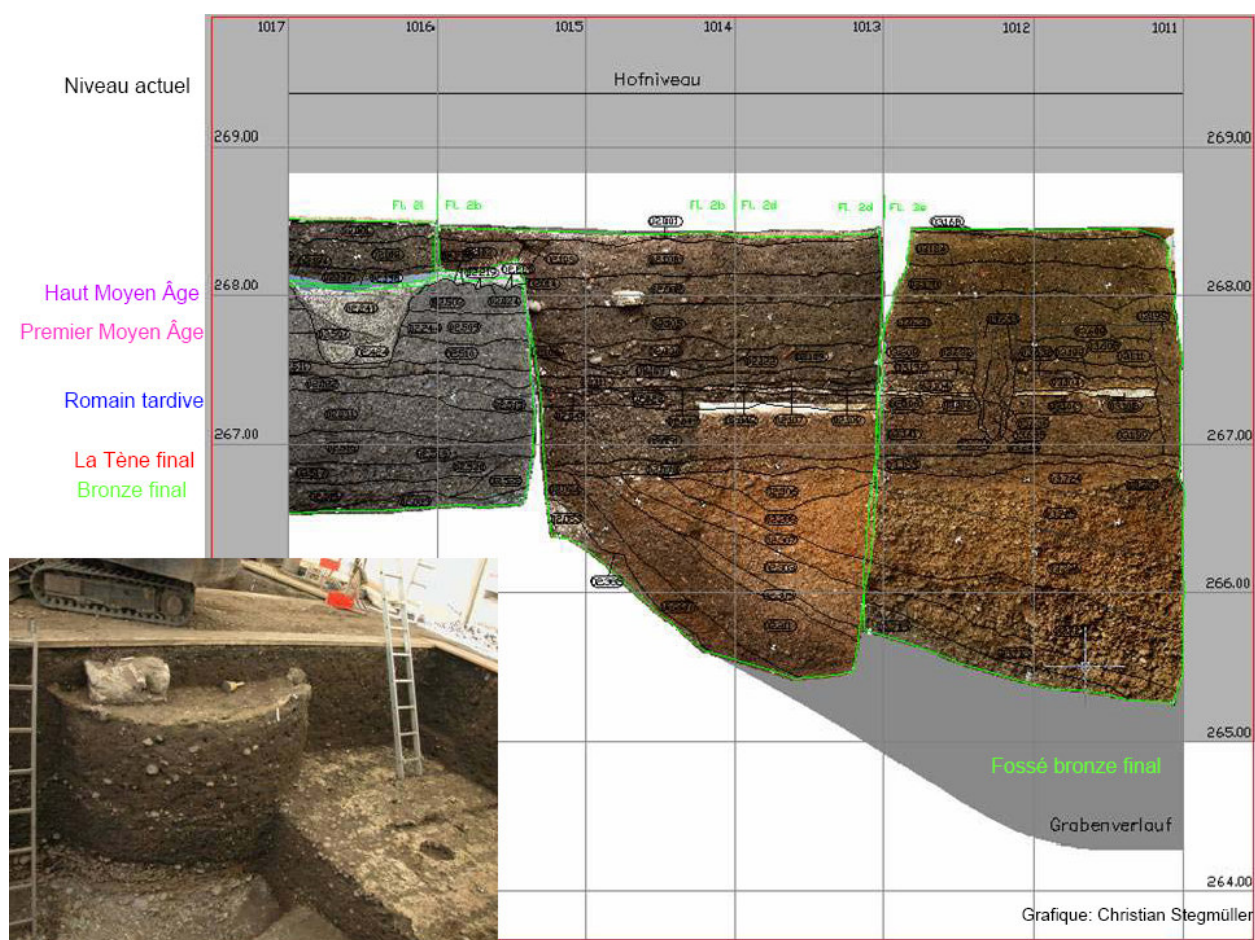


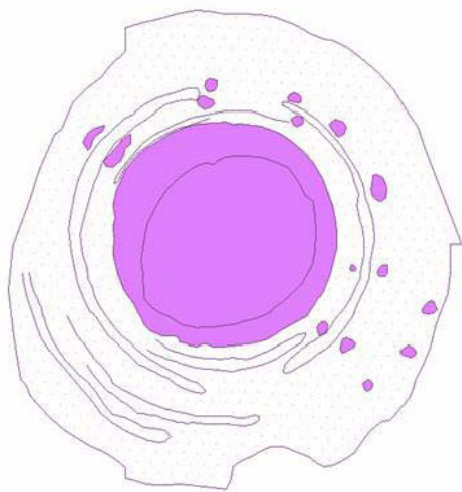
Fig. 2: Basle (CH), Martinsgasse 6+8 (2004/1). The medieval mortar mixer on the higher level to the left and the Roman mortar mixing place on the lower level to the right. Section through the layers (large in the back) and seen from above (small inset picture) (Graphics: Sophie Stelzle-Hüglin; Photo: Christian Stegmüller).

sépultures – mélangeur à mortier – bâtiments en bois – mur romain/hautmédiéval



Bâle, Martinsgasse 6+8, époque médiéval - moderne

Fig. 3: Basle (CH), Martinsgasse 6+8 (2004/1). General plan of the medieval and modern structures. In violet (8th-11th century) from left to right: graves, mortar mixer, wooden buildings and stone wall joined with Late Roman wall angle in blue (Graphics: Sophie Stelzle-Hueglin).



Mélangeur à mortier

Diamètre 2.50 m

894 – 925 AD (28,2 %)

936 -1018 AD (71,8 %)

Âge de radiocarbon calibré calculé de la valeur moyenne évalué de deux échantillons de carbon de bois dedans le mortier (Dr. Bonani, ETH Zürich)



Fig. 4: Basle (CH), Martinsgasse 6+8 (2004/1). Remnants of the 10th century mortar mixing device embedded in layers of "dark earth"; diameter about 2.5 m (Photo: Christian Stegmüller).



Fig. 5: Basle (CH), Martinsgasse 6+8 (2004/1). Gilded bronze disc with central opening and pelta-shaped ornament with blue and red enamelling; diameter 24 mm; Inv.-Nr. 2004/1.390 (Photo: Philippe Saurbeck).

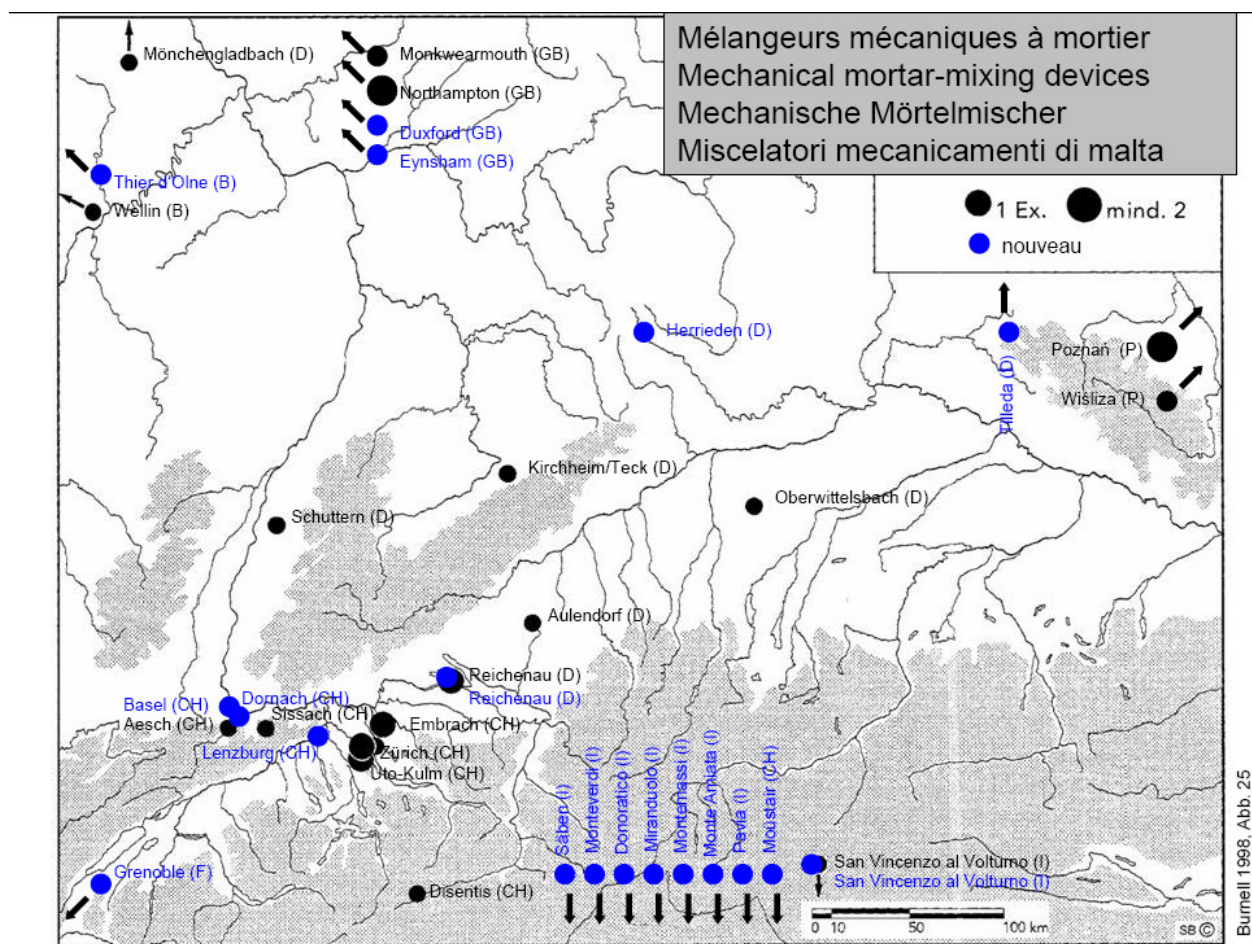


Fig. 6: Distribution of medieval mortar mixers based on the map published by Burnell 1998 with the new sites in blue.

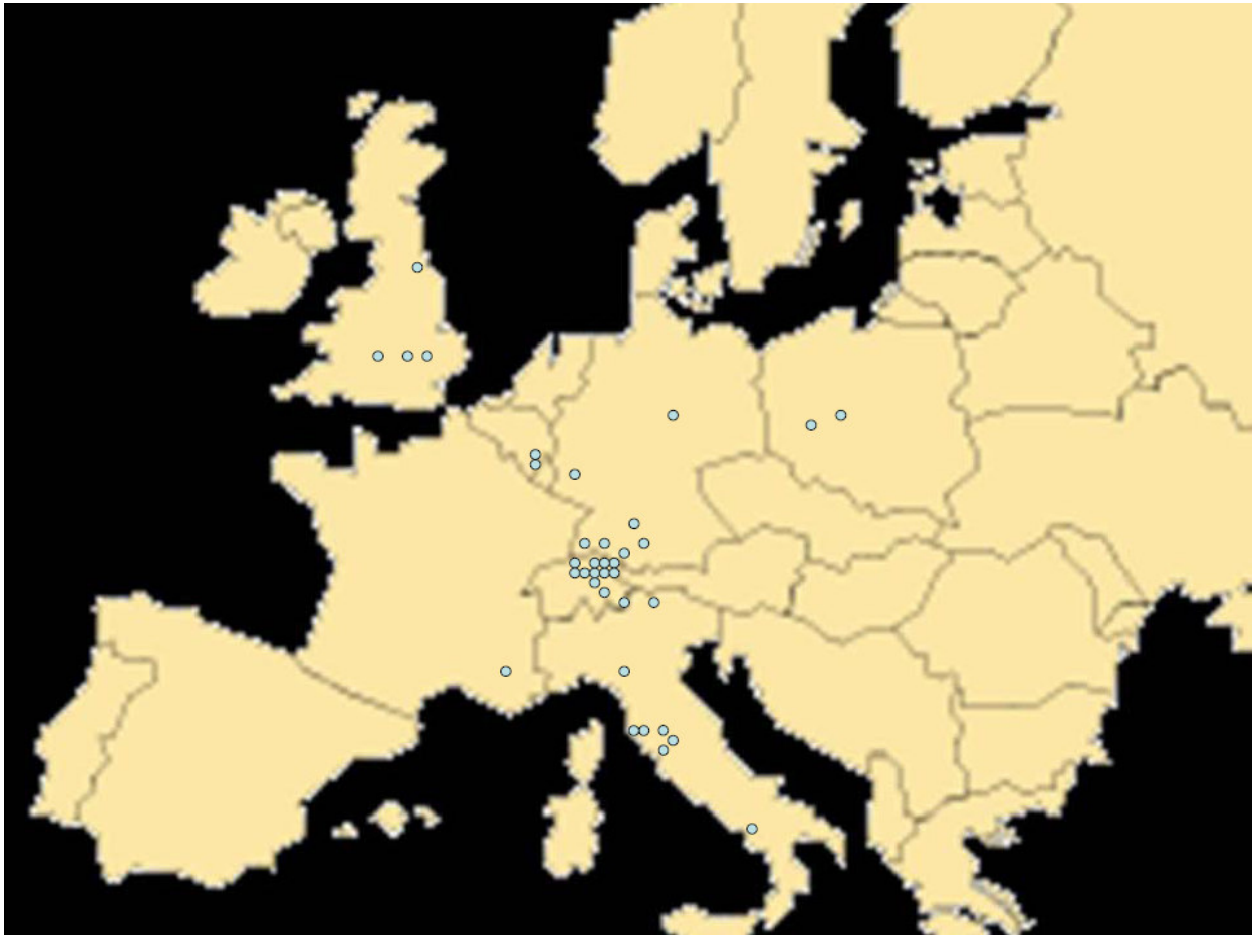


Fig: 7: Distribution of medieval mortar mixers throughout Europe (Graphic: Sophie Stelzle-Hueglin).