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Chapter 3

Rural Life and Industry between the Eifel and the Rhine

Ricarda Giljohann, Angelika Hunold and Stefan Wenzel

The ancient quarrying and mining district in the federal state of Rheinland-Pfalz between Mayen on the edge of the Eifel and the river Rhine has been the subject of research by the Römisch-Germanisches Zentralmuseum (RGZM) in Mainz and Mayen since 1997. Over the years, mining techniques, production of and trade in the valuable volcanic rock, and settlement structures have all been investigated in detail. The products – primarily basalt lava millstones, tuffstone building material, and pottery – were extensively traded throughout much of Europe.

LANDSCAPE AND RAW MATERIALS

The area west of the confluence of the rivers Rhine and Moselle is a volcanic region (fig. 1). It comprises much of the Quaternary Eastern Eifel Volcanic Field with approximately 100 volcanoes (Landesamt für Geologie und Bergbau Rheinland-Pfalz 2005; Schmincke 2007; Schmincke 2008). Most of the volcanoes are scoria cones (in orange in fig. 1) that erupted in two main bursts of activity about 400,000 and 200,000 years ago. Some produced molten lava streams (in dark grey in fig. 1). These cooled to form basalt lava deposits that turned out to be a valuable raw material.

The latest and undoubtedly most significant volcanic episode in the region was the eruption of the Laacher See Volcano approximately 13,000 years ago. This highly explosive eruption is thought to have been the largest in the recent geological history of central Europe. Enormous quantities of ash and pumice were blasted more than 30 km into the stratosphere. Metre-deep pumice deposits covered the landscape around the volcano. Pyroclastic flows filled the bordering Brohl and Krufter Bach valleys (in light grey in fig. 1). They cooled to leave tuff deposits up to 35 m thick. Wherever the powdery tuff subsequently came into contact with water, it solidified as tuffstone, another important raw material.

The region also possesses equally significant non-volcanic raw materials, including clay (Landesamt für Geologie und Bergbau Rheinland-Pfalz 2005, 297). In our district, clay deposits are mainly found on the left bank of the Rhine (Friedrich 2012b) and in the Mayen basin (Redknap 1999, 52). The bedrock of the region is Devonian slate. It is well suited for roofing and has been exported from the region ever since Roman times. Iron and lead ores are also of economic significance.

ANCIENT INDUSTRIES AND THE ARCHAEOLOGICAL APPROACH

An extensive research programme named “The origin and formation of an industrial landscape – the ancient quarrying and mining district between the Eifel and the Rhine” was launched to examine the wealth of evidence about the ancient mining economy in the region and its effects on settlement structure. The programme was accompanied by the development of the Vulkanpark Osteifel, which was devised both to protect and investigate the local heritage and to present it to the public (Schaaff 2008; Hunold & Schaaff 2010; Hunold 2011a). The archaeological research carried out over the last 18 years falls into four categories (fig. 1):

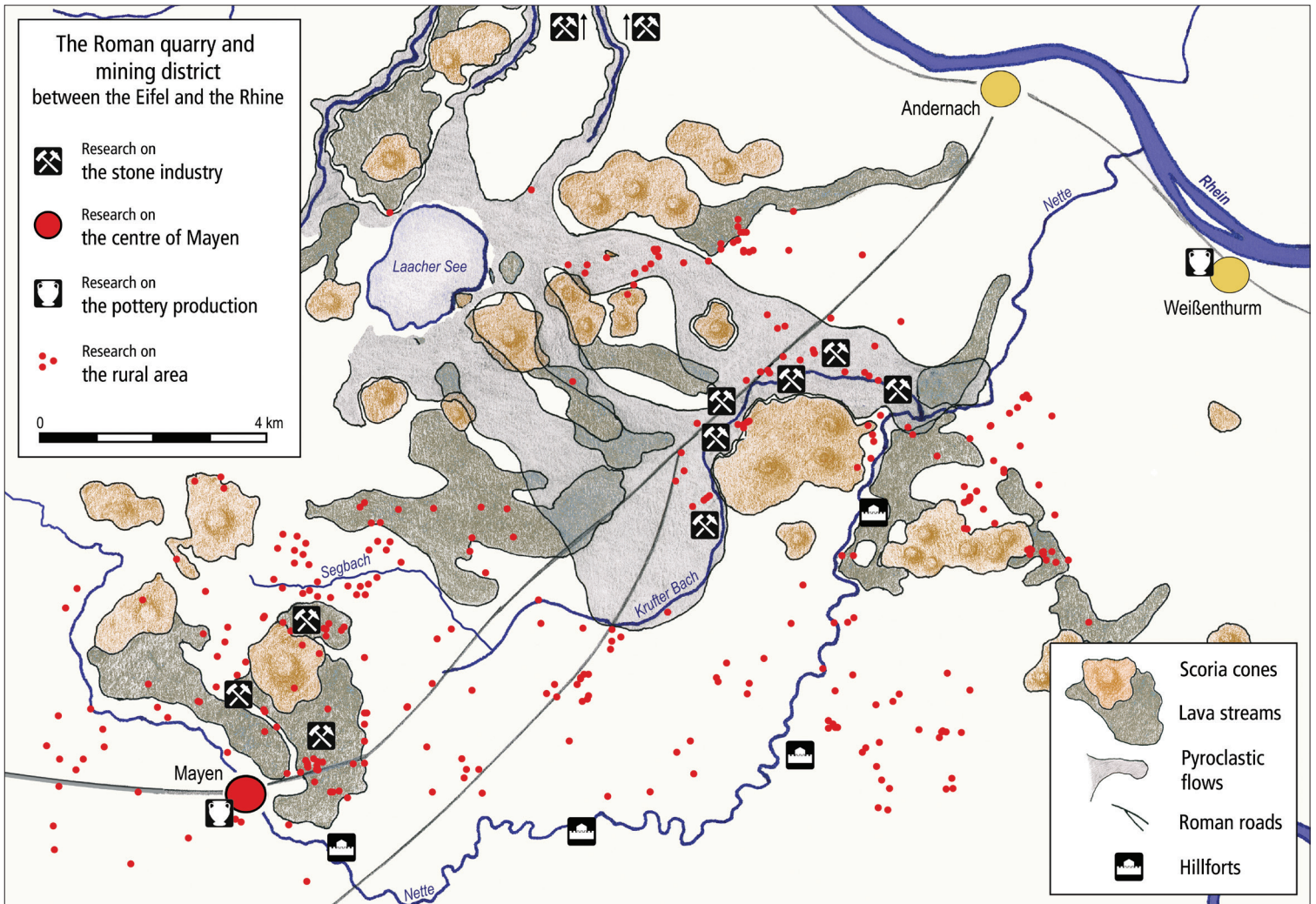


Fig. 1. The ancient quarrying and mining district between the Eifel and the Rhine (Illustration A. Hunold & B. Streubel, RGZM).

- the stone industry (basalt, tuffstone, scoria, pumice),
- the economic centre of Mayen,
- pottery production,
- the rural area.

Among the branches of the stone industry, basalt quarrying has the longest tradition. Neolithic farmers were the first to detect the special quality of the basalt lava for the essential task of preparing cereals for consumption (Belmont & Mangartz 2006, 25-34; Mangartz 2008, 6-10; 24-29). Some 7000 years ago, the first grain grinding stones were produced from the lava flows of the Bellerberg volcano near Mayen (fig. 1). The quality of the stone and the proximity of the river Rhine meant it was traded outside the region from an early date. The introduction of the rotary mill during the Iron Age led to further expansion (Mangartz 2008, 40-52; Wefers 2012). In the Roman period, Mayen millstone became a leading export (Mangartz 2008, 52-107; 196 Abb. 81; Mangartz 2012) to much of north-western Europe (fig. 2). The Roman quarries around the Bellerberg volcano developed into the largest millstone production works north of the Alps. They were worked as opencast mines and systematically separated

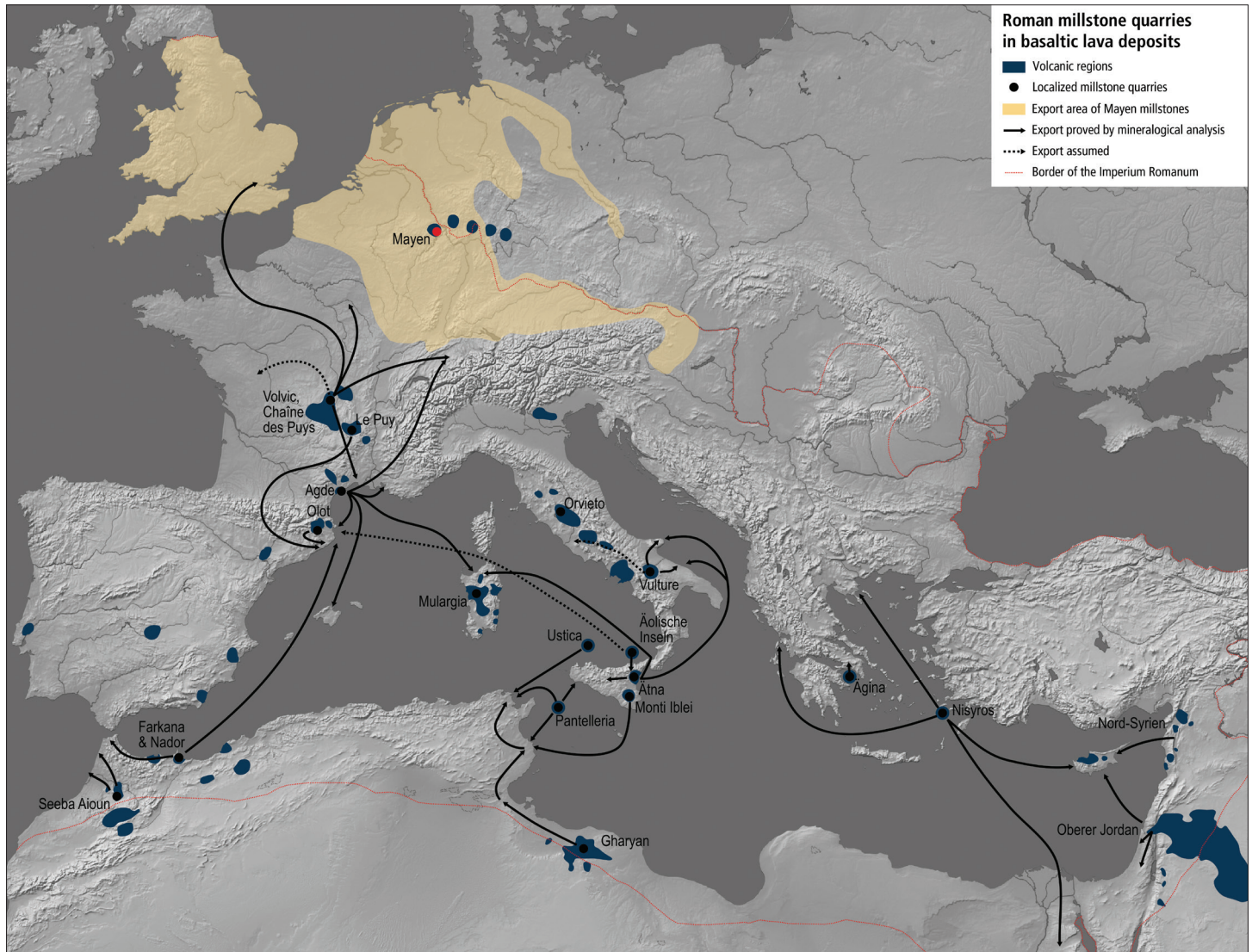


Fig. 2. Export area of basalt millstones in the Roman period, after F. Mangartz (Illustration B. Streubel, RGZM).

into parcels. Both output and numbers of workers soared between the Late Iron Age and Roman times (Mangartz 2008, 93-97). The Roman state wasted no time in adopting the high-quality Mayen millstones (Schaaff 2010). Mineralogical analyses (Gluhak 2010; Gluhak, *et al.* 2012, 25-33) of millstones from the forts on the river Lippe and from the Augustan town of Waldgirmes in the federal state of Hesse reveal they were ordered to supply the Roman army during Augustus' Germanic campaigns.

Another significant raw material is tuffstone which was used as a building stone (Schaaff 2012; Schaaff 2015). It was mined and the workings of the Krufter Bach valley have been examined in detail (fig. 3). An area of 2500 m², which today is presented to the public under the name of Römerbergwerk Meurin, was excavated (fig. 4). Tuff was used from early times although north of the Alps there is no pre-Roman evidence of it. It is likely that the tuffstone deposits were detected by specialists of the Roman army who easily recognized the tuff as a stone known from Italy, especially from the Vesuvius region. The working of tuffstone marks the beginning of stone architecture north of the Alps. In many cases the military was in charge of its extraction. Again it was the emperor Augustus who impelled the development of the economic use of tuffstone. Stone analyses (Gluhak *et al.* 2012, 33-39) reveal that the local tuffstone was used to build the "Ubirmonument" in Cologne. This tower was erected about AD 4-6 and is thought to be the oldest stone building in Roman Germany. It was part of the city wall of the *oppidum Ubiorum*,

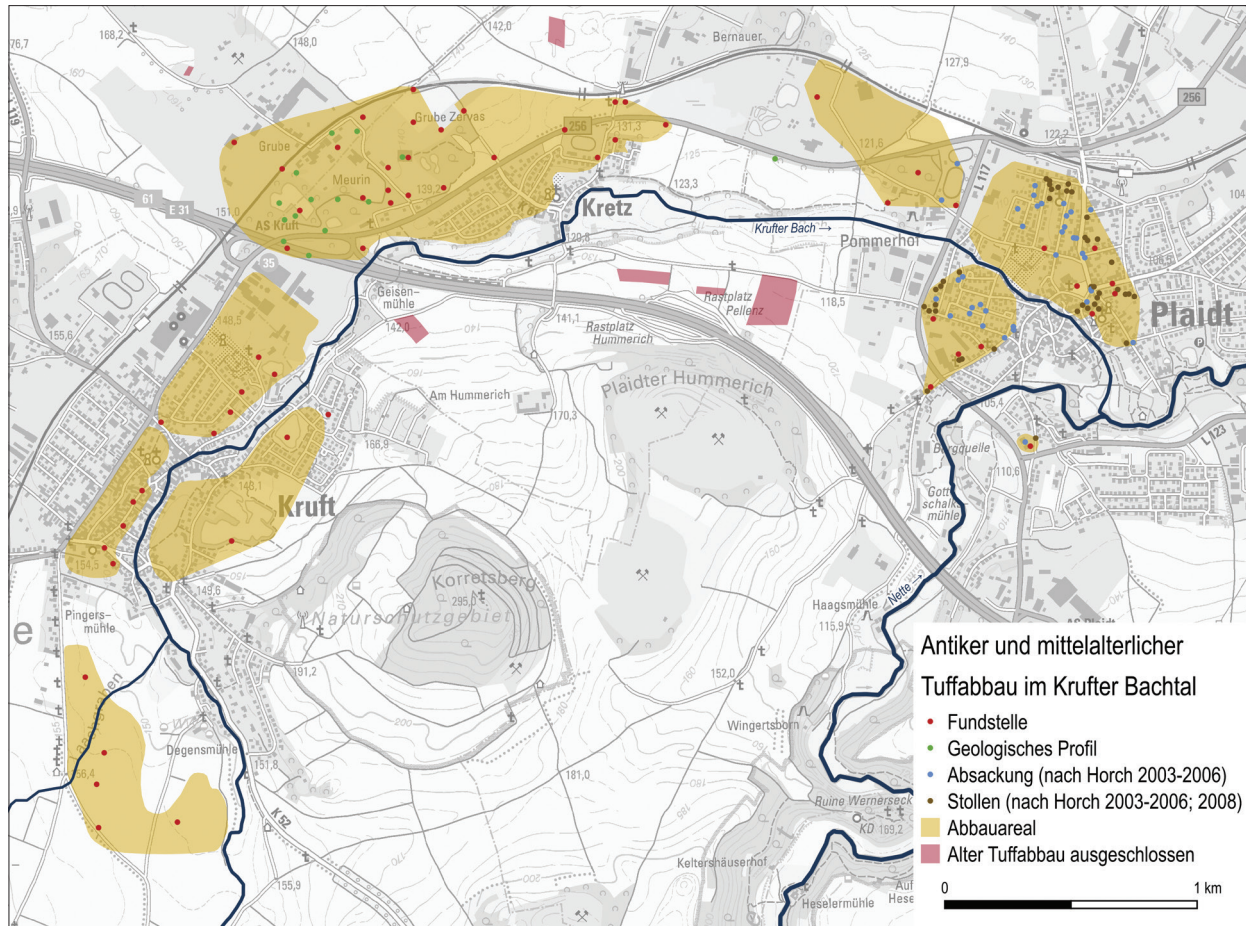


Fig. 3. The tuff mining area of Krufter Bach valley in detail. The red dots mark archaeologically confirmed mining sites, after Schaaff 2015 (Illustration B. Streubel, RGZM).

the earliest settlement on the site of what was later to be Cologne (Trier 2014). Later in the Roman period, the tuffstone of the Laacher See volcano was used in towns and forts along the Rhine, e.g. in Xanten or in the Late Roman fort of Cologne-Deutz (Schaaff 2015). Total tuff production in the Roman period is estimated at approximately 2 million metric tonnes.

The clay deposits had been exploited locally since pre-Roman times but it was not until the Roman period that they took on importance beyond the region. The potter's workshops at Weißenthurm on the Rhine (fig. 1) produced Urmitz Ware that supplied numerous forts on the *limes* in *Germania superior* during the late second century and the first half of the third century AD. The discontinuation of the production used to be attributed to the decline of the *limes*. Recent research (Friedrich 2012a; Friedrich 2012b), though, supported by mineralogical evidence (Gluhak *et al.* 2012, 40-45) has shown that production continued at least into the first half of the fourth century while the marketing area switched from the right to the left bank of the Rhine (fig. 5). Like the potters' workshops of Weißenthurm, those of Mayen have been the subject of archaeological research for more than a hundred years. From the Late Roman period onwards, production increased and long-distance trade developed (Grunwald 2012; Grunwald 2015; Grunwald 2016). It was frequently wondered whether the mass of "Mayen Ware" pottery finds across much of western Europe came from a single potters' centre or not. Mineralogical analyses now make it possible to determine the origins of samples of exported pottery (Gluhak *et al.* 2012, 40-45) and so define the area over which Mayen Ware was exported.

Fig. 4. "Römerbergwerk Meurin", Roman tuffstone mine (Photo B. Streubel, RGZM).



Fig. 5. Export area of the Weißenthurm potters' workshops in the *limes* phase (yellow dots) and in the Late Roman period (brown dots), after S. Friedrich (Illustration B. Streubel, RGZM).



A HISTORICAL APPROACH

Historically, the Roman mining territory between the Eifel and the Rhine was lacking in *civitas* structures. It used to be part of the tribal area of the *Treveri* until the tracts of land on the Rhine were separated from the *civitas Treverorum*. This separation most likely occurred in the reign of Augustus. Then, from about AD 85, the area was part of the newly established province of *Germania superior*. The land was probably *ager publicus* and therefore the property of the Roman state.

By analogy with sources from other parts of the Roman Empire, the historian Elena Köstner argues that the *vicus* of Mayen was the commercial and economic centre of a *territorium metallum* with defined limits. The *vicus* had its own economic, administrative, and judicial functions and was governed by a *procurator* (Köstner 2012, 73-74.79-81; Köstner 2013, 14-15). Köstner infers the limits of the Mayen district, as well as those of the adjoining *fiscus* of Andernach, from medieval administrative structures (Köstner 2015, 220-227).

Thus the basalt and tuff quarries were state-owned, as were the potteries and the farmland. Köstner claims that the local elites acted as *conductores*, purchasing licences from the *procurator* in order to lease out the basalt quarries or pottery workshops to *coloni*. Tuff mining, however, in the early Roman period was a matter for the military (Schaaff 2010; Schaaff 2015, 203) although there are indications of private tuff mining from the period of Claudius onwards (Schaaff 2015, 207-208). One hint is the occurrence of tuffstone cists in the burial grounds around Andernach from the early first century AD (Giljohann 2013).

THE MAYEN VICUS – AN ECONOMIC CENTRE

From the Late Iron Age, the economic centre of the region was the *vicus* of Mayen (Oesterwind 2012; Glauben 2012; Köstner 2012). It was located in a shallow basin astride the small river Nette (fig. 6). The Roman “Auf der alten Eich” main cemetery (Grünwald 2011) extends to a slope north of the settled area. It superseded the Late Iron Age “Amtsgericht” cemetery at the end of the reign of Augustus. The nearest Roman basalt quarries lie at a distance of 500-800 m (Mangartz 2012, 2-4). The Roman potters’ workshops are located east of the river Nette (Redknap 1999, 23; Glauben 2012, 92-94; Grünwald 2012, 112-116). Metal processing and other crafts are represented locally.

Archaeological evidence has accumulated over the last 150 years from 421 discovery sites, ranging from single finds to large-scale excavations (Glauben 2012, 87). The transformation of the indigenous settlement into a Roman *vicus* took place at the same time as the surge in millstone sales triggered by Augustus’ Germanic campaigns. From the first century AD, a developed infrastructure can be observed. The *vicus* had paved streets, a water pipe system, and public baths. A dedicatory inscription from the Middle Roman era may be evidence of a temple. In Late Antiquity, pottery production became a significant factor of the economy, especially after the warring incidents of AD 355 (Grünwald 2016). In the fourth and early fifth centuries, additional water pipes were installed to supply the potters’ workshops. At the same time, the production of glass vessels probably developed into another significant branch of industry (Grünwald & Hartmann 2014).

Besides these items, we know a group of seven millstone workshops within the *vicus* where the half-worked millstones were brought for finishing (Mangartz 2008, 74-75; Glauben 2012, 89-90). The location of the workshops on the opposite riverside from the quarries seems surprising at first. But on closer inspection, the distribution of the sites appears sensible. They were concentrated in a limited area near the river Nette. So it is likely that after being transported from the quarries and completed in the *vicus*, the millstones were carried down the river Nette for sale.

The Nette flows into the Rhine just upstream from the port of Andernach, which had been a central trading place since the Late Iron Age. In the Late Roman period, the waterway was protected by a string of four military hillforts (fig. 1) (Hunold 2011b, 284-294). Upstream, the string ends with the hillfort on Katzenberg, approximately 2 km south-east of the *vicus*. From about AD 300 to the middle of the fifth century, this fortification guaranteed the continuing production and distribution of the export goods (Hunold 2011b; Hunold 2012).

Research into the regional industry based on mineral resources has clearly shown that production and trade boomed in the Roman period (see above; Mangartz 2008; Grünwald 2011; Grünwald 2012; Grünwald 2015; Grünwald 2016; Schaaff 2015). In order to handle the increasing workload, the population must have increased as well. In the Mayen *vicus* cemetery, the

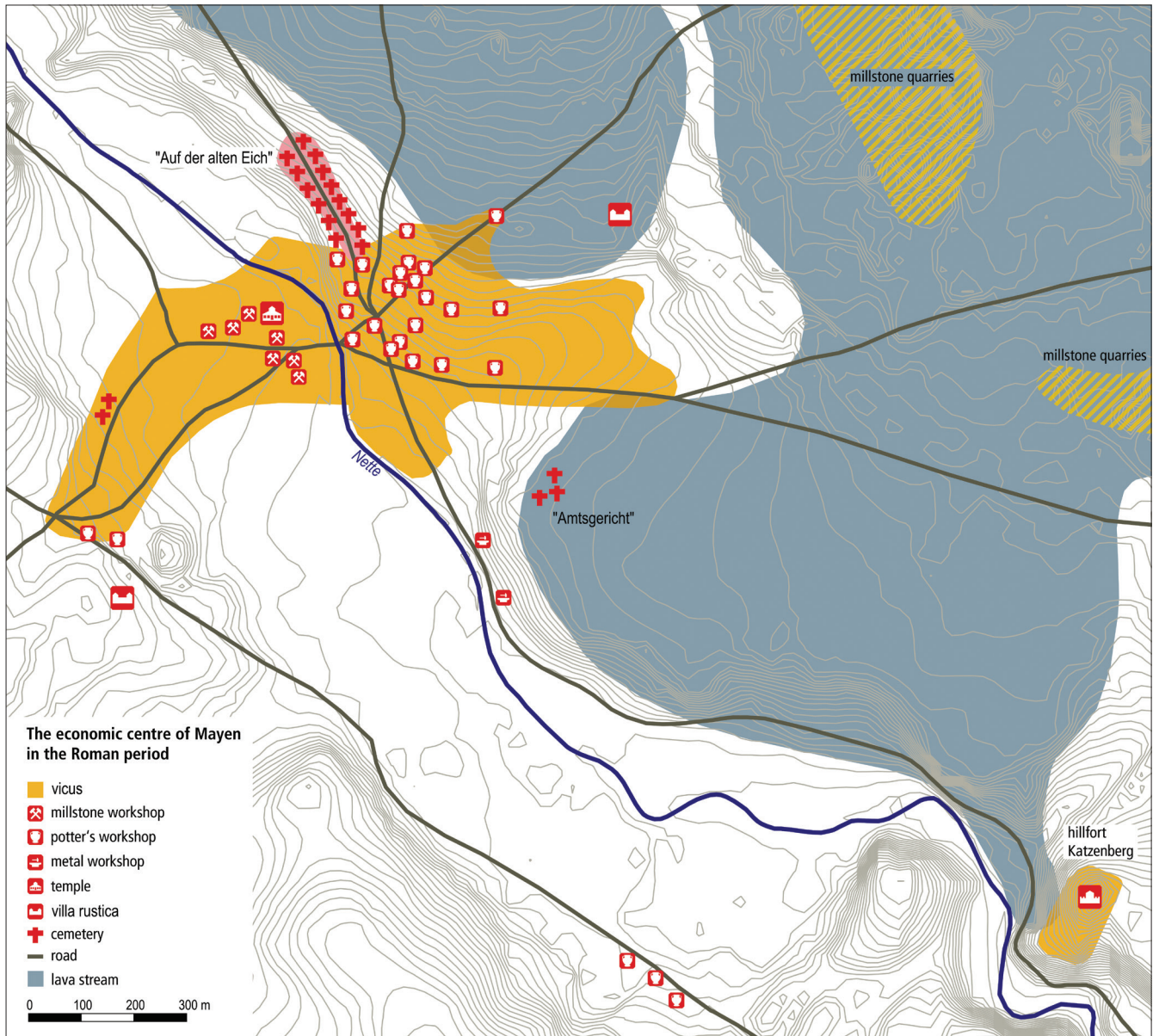


Fig. 6. The Mayen *vicus* and its surroundings, after A. Glauben, M. Grünewald, L. Grunwald & F. Mangartz (Illustration B. Streubel, RGZM).

arrival of a group practising Mediterranean burial rites can be observed for the early Flavian period (Grünewald 2011, 140-141; 199-201; Glauben 2012, 92). During the fourth century, Germanic groups moved into the *vicus* while the provincial population continued to settle there (Grünewald 2011, 202-208). Initially, the cultural groups buried their dead in separate places within the cemetery, but from the middle of the fifth century onwards both burial groups merged into a single group forming a link with the earliest Merovingian graves.

The population of the *vicus* may be estimated, by comparison with the nineteenth century situation and with regard to the number of workers in the stone industry, at approximately 2000 or 2500 inhabitants (Hunold 2011b, 274-275). That number remained stable until the fifth century at least. About 500 AD, evidence from the cemetery, which may admittedly be distorted by the small number of graves, indicates a certain decline in the population (Grünewald 2011, 202-216), but the continuous development of the ceramic types together with a newly established potters' workshop area (Grunwald 2015; Grunwald 2016) demonstrate that there was no hiatus in settlement but a smooth transition between Late Antiquity and the Early Middle Ages.

RURAL SETTLEMENT IN THE VICINITY OF MAYEN

Two doctoral theses have been undertaken in order to determine whether the particular industrial character of the region influenced the rural settlement pattern. One thesis compiles the Roman settlement sites in the vicinity of the basalt quarries and the Mayen *vicus* (Baur 2012; Baur 2014); the other focuses on Roman settlement in the vicinity of the tuffstone mines (Giljohann 2012; Giljohann 2013). The first finding is that both areas were densely populated (fig. 1).

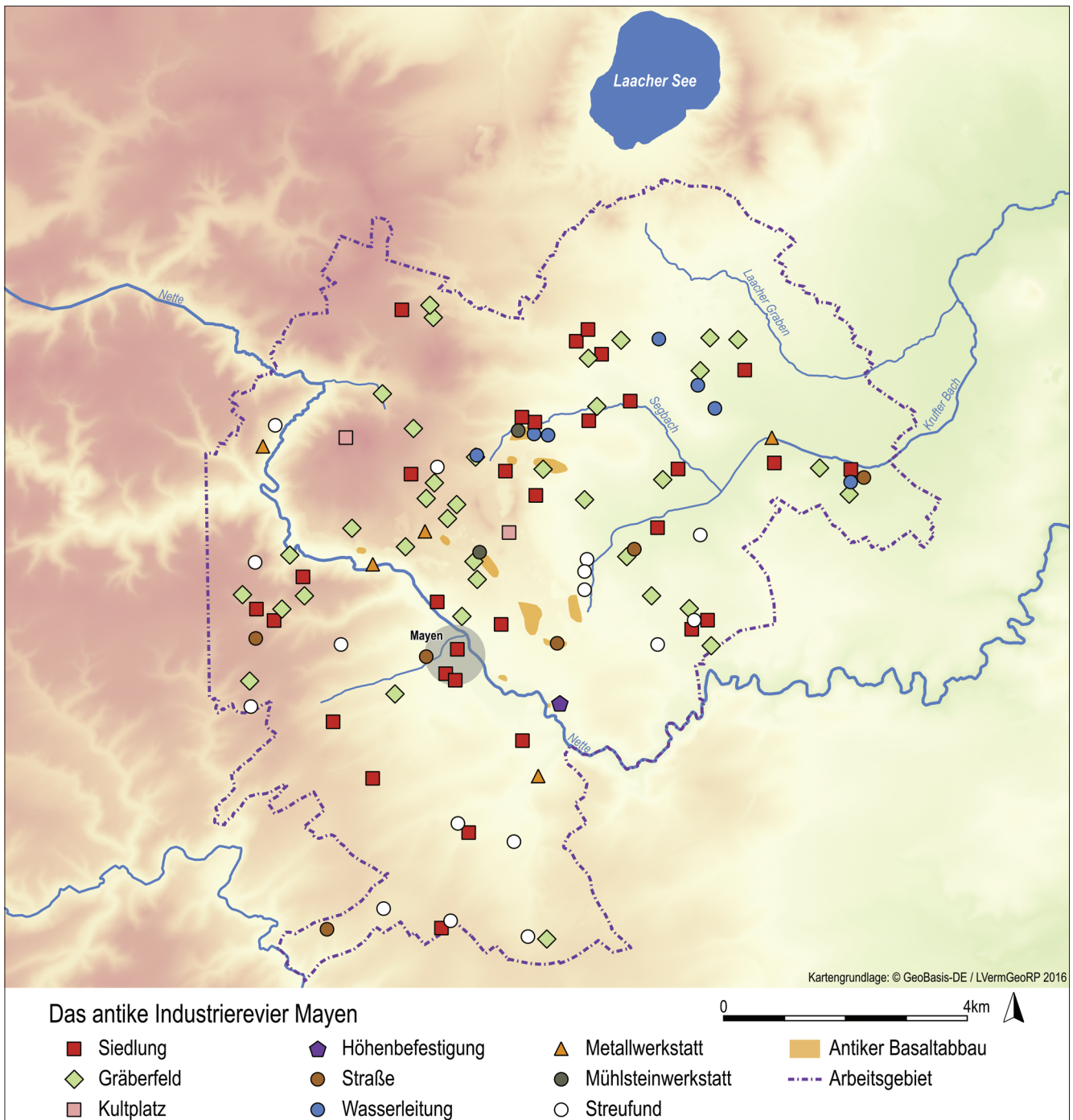


Fig. 7. Rural settlement around Mayen in the Roman period, after V. Baur (Illustration B. Streubel, RGZM).

V. Baur found that the architecture and the grave finds indicate remarkable prosperity around Mayen. In all, 116 sites are known in this area, most of them *villae* and graves (fig. 7 – Baur 2012; Baur 2014). Thirteen *villa* sites have been confirmed, 37 more sites are probable *villae rusticae*. The main and adjoining *villa* buildings were built of stone with tile or slate roofs. Their interiors were fashioned with mural paintings, mosaics, and plasterwork. The estates were equipped with wells, water pipes, and hypocausts. The sites are located mostly on rivers or streams as well as along roads, but less often on hillslopes although they are often supposed to be the typical site for a Roman *villa rustica*. The connection with the road and waterway network seems to have been more important for the choice of site. Only a few sites are found on the basalt rock. One reason for this may be the lack of watercourses for transport; another reason could be that these areas are unsuitable for cultivation because the water seeps into the rock.

The structures of four *villae* can be determined. Among them the so far unexcavated axial *villa* of “Fraukirch” (fig. 8) is outstanding. Known exclusively from aerial views, it has a walled courtyard area of 5.7 ha. The main building faces at least 12 adjoining buildings arranged in two rows. Four of them seem to be granaries, four others could be living quarters. Two graveyards, which have been investigated in detail, belong to the *villa*. The bigger one includes three funerary gardens and was established in La Tène D2a. Some 350 m to the south-west, two square tower foundations and a wall have been observed, possibly indicative of a fortified complex. Roman pottery and millstone roughouts were unearthed there.

In general, the rural settlement grew continuously from the Late La Tène period to the second century AD. Continuity from the Celtic to the Roman eras can be clearly seen. Evidence comes from the *villa* sites but even more from the graves. There are at least 36 known rural burial grounds, the largest of which contains 44 graves. Most of the graveyards were already established in the La Tène D2 period and used throughout the first two centuries AD. Traditional behaviour can be observed in the burial rites until the second century, for example, by interring weapons, indigenous pottery, or remarkably extensive tableware sets. On the other hand, there is no indication of any considerable immigration of strangers during the first century. The predominant funerary form was cremation, mostly in urns. In the vicinity of Mayen, cremation remained the predominant burial form even in the third and fourth centuries; only four inhumations are known in total. In the Early Roman period, soldiers or veterans may have counted among the *villa* owners, judging from the burial of an equestrian soldier in Thür.

A particularly striking connection arises between the *villae rusticae* and the millstone quarries. Waste from millstone production is found at the “Lungenkärchen” and “Im Winkel” sites (see below). Millstone roughouts occur at the well investigated sites of “Narrenborn”, “Steinrutsch”, and “Fraukirch” where they are used partly in the buildings’ foundations. This suggests that the more wealthy estates especially were inhabited by the quarry owners or quarry administrators.

Some *villae* seem to have engaged in other special economic activities as well, such as “Steinrutsch”, which was probably connected with mineral water springs. Several metal workshops were related to the *villae* by reason of their proximity. On the other hand, there is no evidence that the owners of the *villae rusticae* were involved in the production of “Mayen ware”. Despite these peculiarities, agriculture remained an important source of income, as findings of agricultural equipment demonstrate.



Fig. 8. The axial *villa* of “Fraukirch” near Thür (Photo A. Schmicler).

During the crisis in the third century, the rural area around Mayen appears to have been only marginally affected by destructions. It was not until the end of the fourth century that some sites were abandoned, while other sites exhibit fire strata. Still there was no wholesale destruction of the area. The number of burial grounds remained the same until the end of the fourth century. Only in the first half of the fifth century did their number decline but without collapsing completely. For the first time, a general decline in settlement can be observed, which may have been accentuated by deteriorating climatic conditions.

As in the Mayen *vicus*, there are indications of continuous development into the Early Middle Ages. The “Narrenborn” *villa* site with its burial ground was inhabited from Augustan times to the late fifth century. A hilltop sanctuary on the Hochsimmer volcano was used continuously from the Late La Tène or Early Roman period to the sixth century. The burial ground of Thür was used continuously up until the ninth century even (Baur 2014, 145). However, after AD 500, a restructuring of the region with newly established settlements is noticeable.

RURAL SETTLEMENT IN THE VICINITY OF THE TUFFSTONE QUARRIES

In the fertile basin landscape between Mayen and Andernach, 181 Roman sites are known (fig. 1). Most are burial grounds but there were 40 settlements too. This area was continuously inhabited from the Late La Tène to the fifth century. In addition to agriculture, which was mainly concerned with the cultivation of grain and possibly wine, tuffstone was quarried out in an 2.3 km² large area (fig. 3). Tuffstone was used extensively as a building material during the Roman period. Urbanization projects in Cologne and Xanten and the construction of the *limes* in the first and second centuries, along with the forts and city walls in Late Antiquity, saw the arrival of numerous quarry workers from the ranks of the military and personnel in the logistics sector (Schaaff 2015). The doctoral thesis written by R. Giljohann (Giljohann 2012; Giljohann 2013) examines the effects of the stone industry on the pattern and development of rural settlements in Roman times. This PhD thesis will be published in the RGZM Monographien in 2017.

In the vicinity of the tuff quarries, all the Augustan-Tiberian settlements were continuations of Late La Tène sites (fig. 9-10). The successions of timber houses and stone buildings as well as ceramics in the La Tène tradition are indicative of continuity also in two settlements in the tuff area. The continuity of the local upper class in the research area was detected in a burial field in Trimbs (Oesterwind 2012; fig. 10, Triz). Beside the road from Mayen to Andernach, in the tuff mining area, expensive tomb monuments made of Lorraine limestone indicate extraordinary wealth and a high degree of Romanization already in the middle of the 1st century AD (Scholz 2012, 39). Furthermore large cremation ashes boxes made of tuff with extensive additions, including valuable imported products have been found dating from the first and second centuries. Significant compaction of settlement occurred during the early Roman Empire until AD 70/80, so that until AD 150 all fertile areas were populated with farms (fig. 11).

Only a few settlement structures are known in the mining area. Most were probably destroyed by pumice mining in the twentieth century. But these settlements often had subterranean water conduits using qanat construction methods – vertical access shafts and horizontal tunnels (fig. 12). The qanats channeled large quantities of clean spring water to settlements that possibly resembled the large axial farms with water basins and thermal springs in the area of basalt quarries (see above). For the most part, the water pipelines were found near the mining area and the rich graves were found directly within the mining area, so it is obvious that the extraction of and trade in tuffstone was the basis of the economy alongside agriculture. What Peter Henrich calls type 2 mansions are recognizable by the presence of tomb monuments, Jupiter’s giant columns, or *tumuli* with *dromos* (Henrich & Mischka 2012, 328-329). In this research area, the rich mansions are recognizable also from qanat water conduits, partly with monolithic linear connections made of tuffstone, whose complex design required not only know-how but also substantial investment. Information gaps in the mining area mean that no reliable figures can be calculated for the extent of the associated farmland.

In the southeastern part of the Neuwied basin, *villae* have been discovered at regular intervals, which may have managed over 50 ha of cultivated land and slate quarries. Here, too, some water pipelines and tomb monuments are found, but are invariably simpler versions than in the tuff mining area. The juxtaposition of small compound settlements and large *villae*, or *villae* characterized as superior by their facilities, can be clearly seen. According to calculations for the Mayen countryside, the distribution of type 2 *villae* is five times denser than in the western Volcanic Eifel.

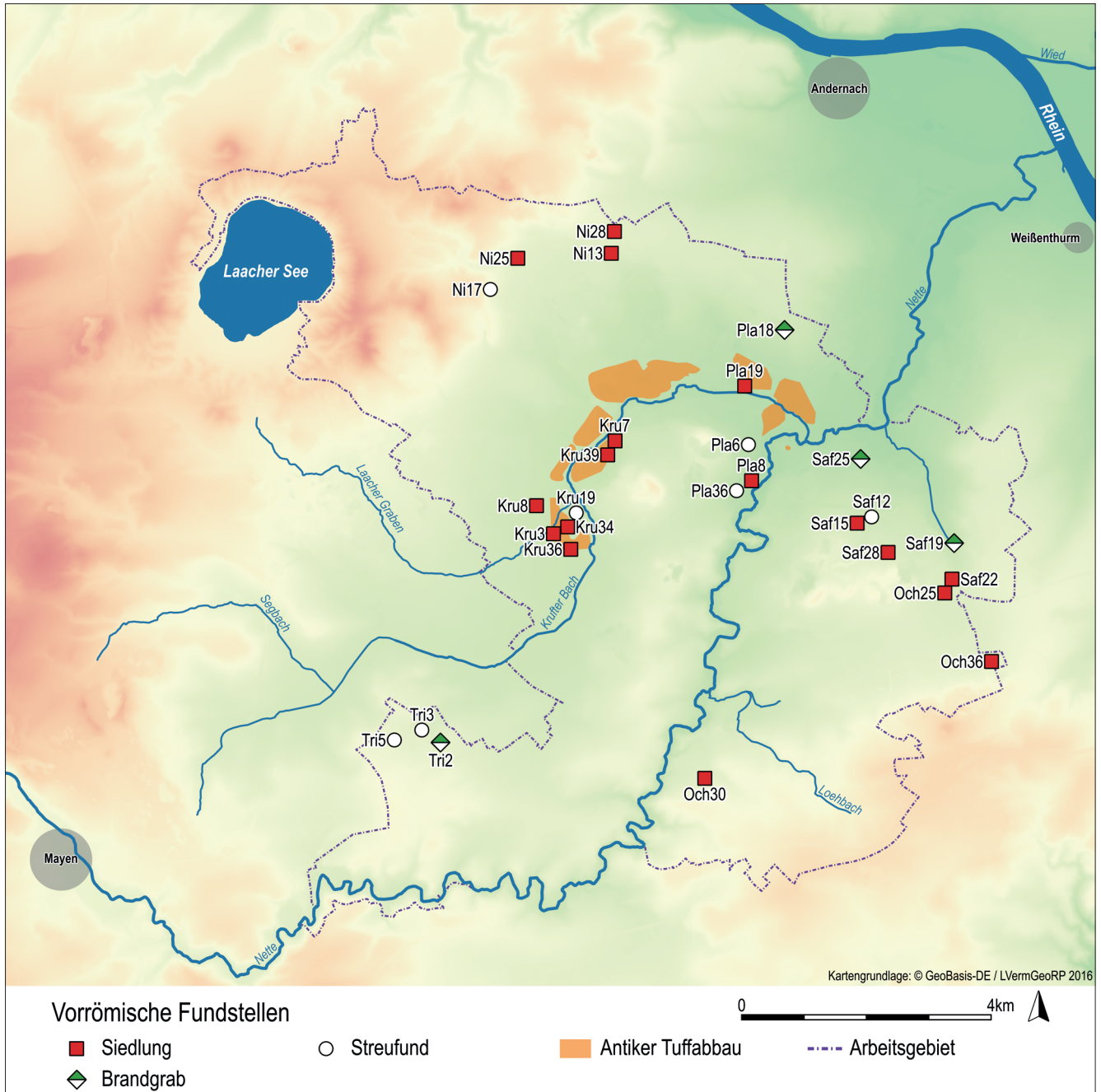


Fig. 9. Late La Tène sites (Illustration R. Giljohann & B. Streubel, RGZM; Map. ©GeoBasis-DE/LVermGeoRP 2016).

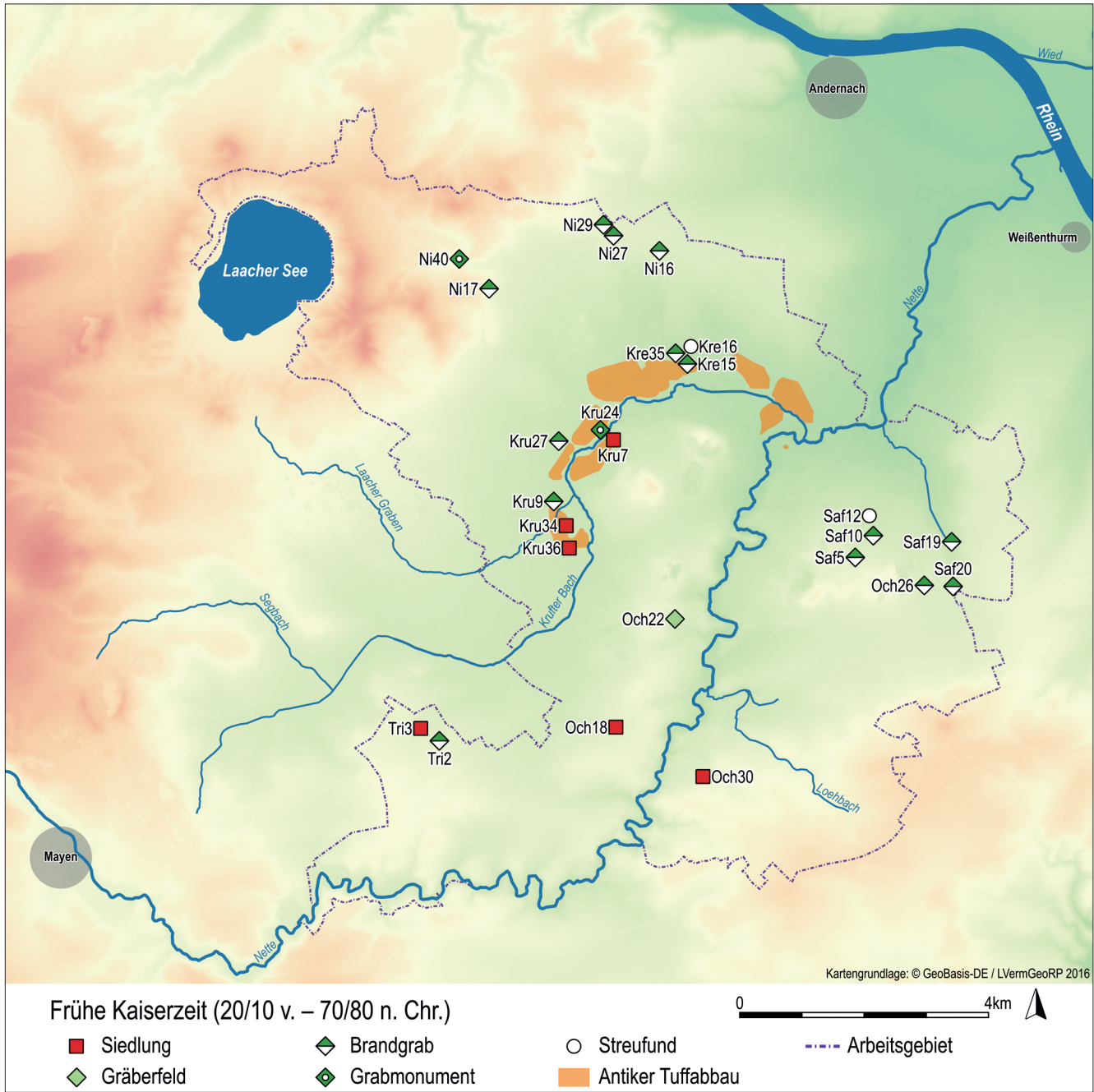


Fig. 10. Early Roman sites (20/10 BC - AD 70/80) (Illustration R. Giljohann & B. Streubel, RGZM; Map. ©GeoBasis-DE/LVermGeoRP 2016).

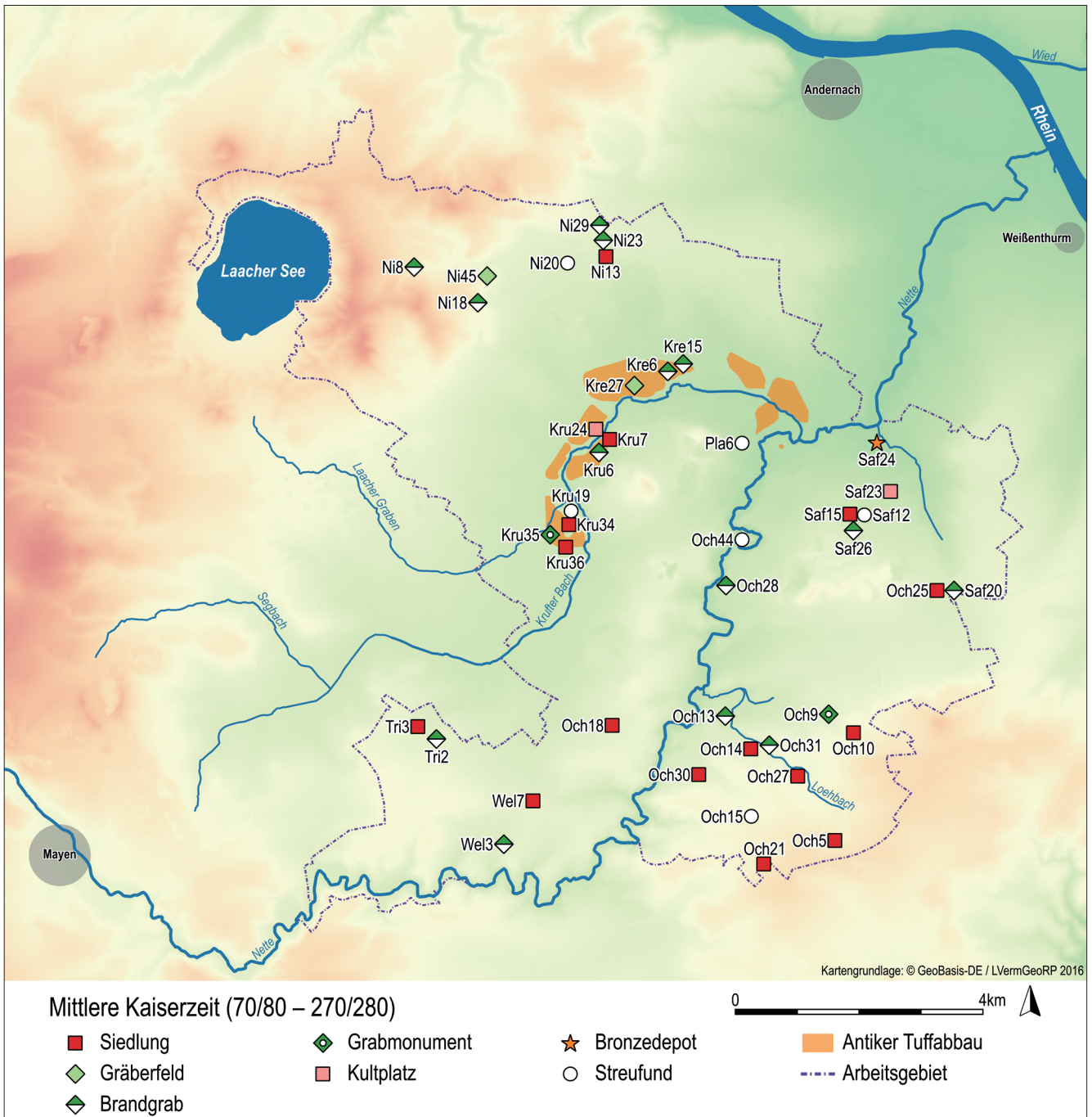


Fig. 11. Roman sites between AD 70/80 and 270/280 (Illustration R. Giljohann & B. Streubel, RGZM; Map. ©GeoBasis-DE/LVermGeoRP 2016).

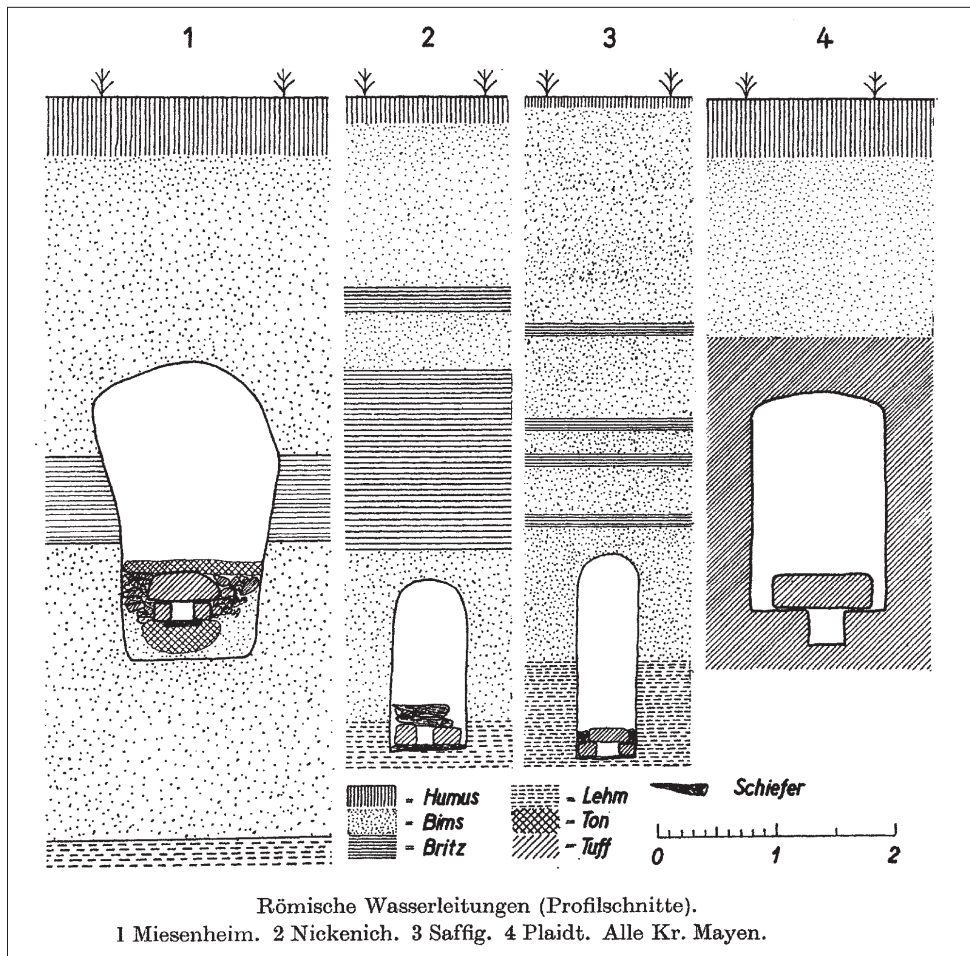


Fig. 12. Water conduits (Nito; Pla31; Saf9) (Röder 1961, 119-120 Fig. 1).

The region was affected by the political crisis and the Germanic invasions of the third century, as attested to by fire strata and repairs in several villas. But there was no final break-up of settlements. In many cases, reconstruction is visible in the same place, only in individual cases is there any record of temporary abandonment between the middle of the third and late fourth centuries (fig. 13). In the times of crisis triggered by recurring attacks by Germanic tribes and in years with crop failures, which were also associated with climatic deterioration, grain had to be imported from Britain. In the middle of the fourth century, large storage buildings were erected in Andernach, which ensured the continuity of the ceramic and stone industry (Brückner 1999, 131). The rural settlement returned to prosperity from Valentinian times onwards. Border protection by the construction and expansion of forts on the Rhine managed to halt Germanic raids at least until the middle of the fifth century. The richest sarcophagus burials are found again in the grave fields in the mining area (fig. 13, Kre15; Giljohann 2013, 208-209; Grunwald 2007).

The question of how and where the miners lived in the tuff area during the Roman period cannot be answered in full. Where the soldiers' lodgings were and what they looked like, is unsolved. They probably lived in quarters in the tuffstone area and not in the *vicus* of Andernach 10 km away. A fragmented building inscription may be associated with this soldiers' accommodation (fig. 14 – Giljohann 2013, Kre23). The site is located above a Roman mine, only 150 m from the main road between Mayen and Andernach. The fragmented three-line inscription is 50 cm high and wide, which indicates a building of not inconspicuous size. The formula "*sub cura*" indicates an official dedication, which was often used by officials or the military (Giljohann 2013, 56-57).

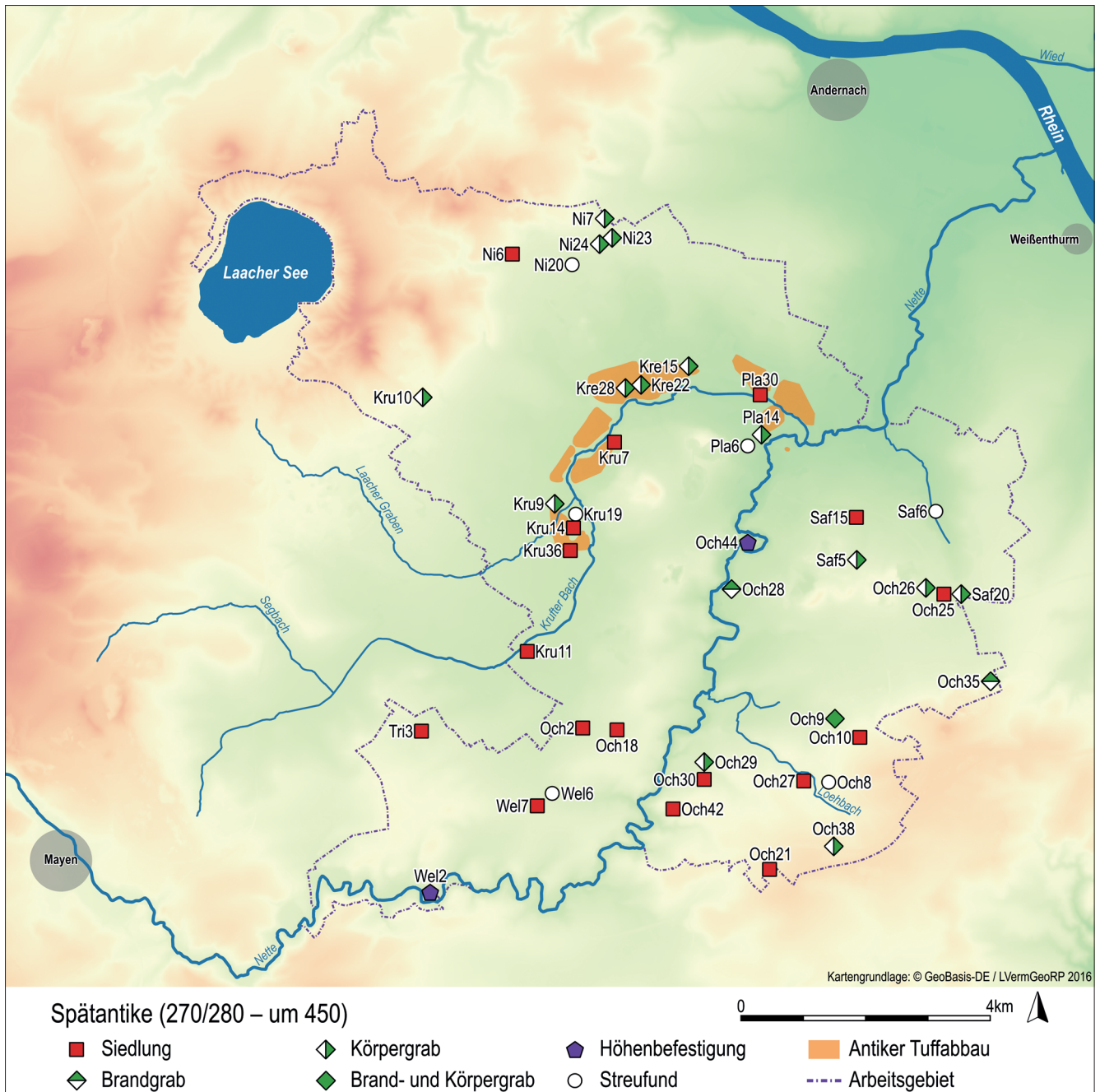


Fig. 13. Late Antiquity sites (270/280 - 450) (Illustration R. Giljohann & B. Streubel, RGZM; Map. ©GeoBasis-DE/LVermGeoRP 2016).

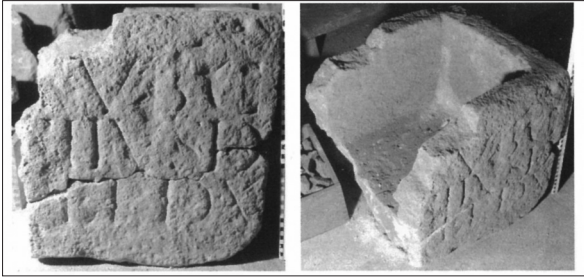
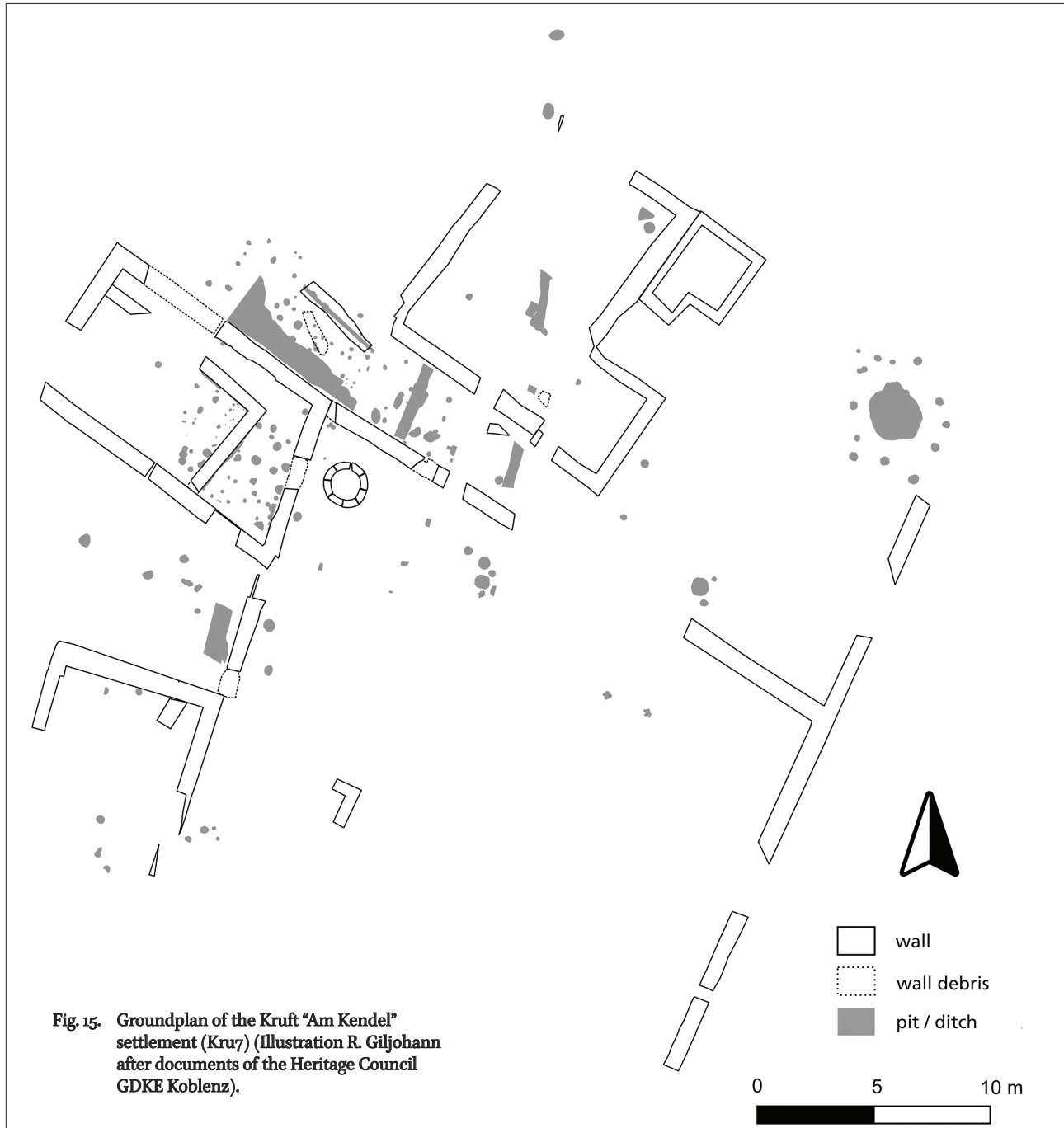


Fig. 14. Sarcophagus with inscription (Kre28) (Wiegels 2010, 490 Fig. I34a-b).



Besides the military mines, civilian enterprises were producing not only building materials but also cremation ashes boxes made of tuff at the latest in Tiberian era. Two settlement sites, which are surely related to the processing of tuffstone, were excavated between 1986 and 1994 (fig. 11, No. Kru7; Kru36). The comprehensive processing of the excavations is still in progress, but the unpublished documentation of the Archaeological Heritage Service in Koblenz provides clear indications. The two settlements were close to shafts into tuffstone mines. At the “Am Kendel” settlement, substantial stone waste is proof that at that place tuff was processed for building materials, such as column bases. The floor plan has characteristics of a *villa*, such as a court wall and a small main building with a basement (approx. 12 × 12 m – fig. 15). This is separated by a wall of strip shaped buildings (max. 7.9 × 11.3 m) in the yard area, which is reminiscent of *vicus* architecture. It was probably a farm that developed during the Roman period into a stone-working enterprise (Wegner 2007, 423). Even more like a *vicus* are the wall traces of the other settlement at Kruft “Neuwiese” (Overall plan: Heritage Council GDKE Koblenz). Both sites display at least two stone building phases and pole marks of earlier framehouses. The settlements and workshops of civilian tuff companies are here discovered.

CROP PRODUCTION MODELS

One of the most important research tasks concerning the relationship between the stone industries of Mayen and their rural surroundings is to examine whether regional crop production was sufficient to sustain the economic centre of Mayen. The economic areas of the single estates cannot be determined exactly but, by comparison with other regions, dimensions of about 100 ha seem to be realistic.

V. Baur drew up a model for crop production which is based on the spatial extent of the Mayen district (Baur 2014, 20-21). That district, defined by E. Köstner, covers 220 km² (Köstner 2015). Comparing the past and present situation, Baur assumes that 40% of this area could have been used for agriculture. That is to say about 9000 ha of farmland were available for crop production. Yields in this region, which offers less favourable climatic and soil conditions than southern *Germania inferior*, for example, are estimated at 0.4 t per/ha. Under better conditions, an average of 2 t/ha could be achieved (Rothenhöfer 2005, 56). So the annual harvest in the Mayen district totalled 3600 t minimum and 18,000 t maximum. Deducting 30% for seeds, tax levies, and perhaps fodder would have left 2500 t minimum and 12,600 t maximum. Accordingly, 7 to 35 tonnes of grain per day were available.

Assuming an adult consumed 1 kg a day (Rothenhöfer 2005, 56), 7000 to 35,000 people could be fed with the cereal produced in the Mayen district. This means that the region was in a position to supply not only the rural population (see below) but also the economic centre of Mayen. In the event of a good harvest, it could even have exported crops.

For the region around the tuffstone mines, the model calculation of crop production assumes that about 65 km² were used here in Roman times, a figure similar to that of the early nineteenth century (Tranchot / von Müffling 1803-1820). Half of this value has to be deducted as the soil had to regenerate. Assuming that between 0.4 and 2 t/ha of grain were produced, this resulted in a harvest of 1300 to 6500 t of grain. Again, 30% were retained for sowing the next crop. Estimating consumption of 1 kg of grain per person per day, it was possible to provide between 2400 and 12,000 people with grain. On average, 15 people lived in a *villa rustica* with 50 ha of associated farmland (Rothenhöfer 2005, 48-49). On this basis, almost 2000 people were employed in agriculture in the middle of the second century, when all the fertile land was used and a surplus could be generated. Approximately 7000 to 8000 inhabitants lived in the countryside at this time on the whole, in the *vici* of Andernach and Mayen, including workers in the basalt quarries and tuffstone mines (Hunold 2011b, 274-275; Mangartz 2012, 16-18; Schaaff 2015, 196-197).

STONE INDUSTRY AND AGRICULTURE – THE CASE STUDY OF SEGBACHTAL

In order to find out how Roman agriculture enabled the booms in the millstone, tuff, and ceramics industries (Mangartz 2008, 55-57, fig. 29; Mangartz 2012, 2; Friedrich 2015; Schaaff 2015, 201-211; Grunwald 2016, 348) since the early Imperial age and what the effects on the environment were, the small Segbachtal valley north of Mayen was explored. Segbachtal lies on the northern edge of the millstone quarry area amid the lava flows of the Bellerberg volcano. Already before the beginning of the investigation, an extraordinary concentration of rich *villae* was known there (fig. 16), including the axial Thür “Fraukirch” *villa*,

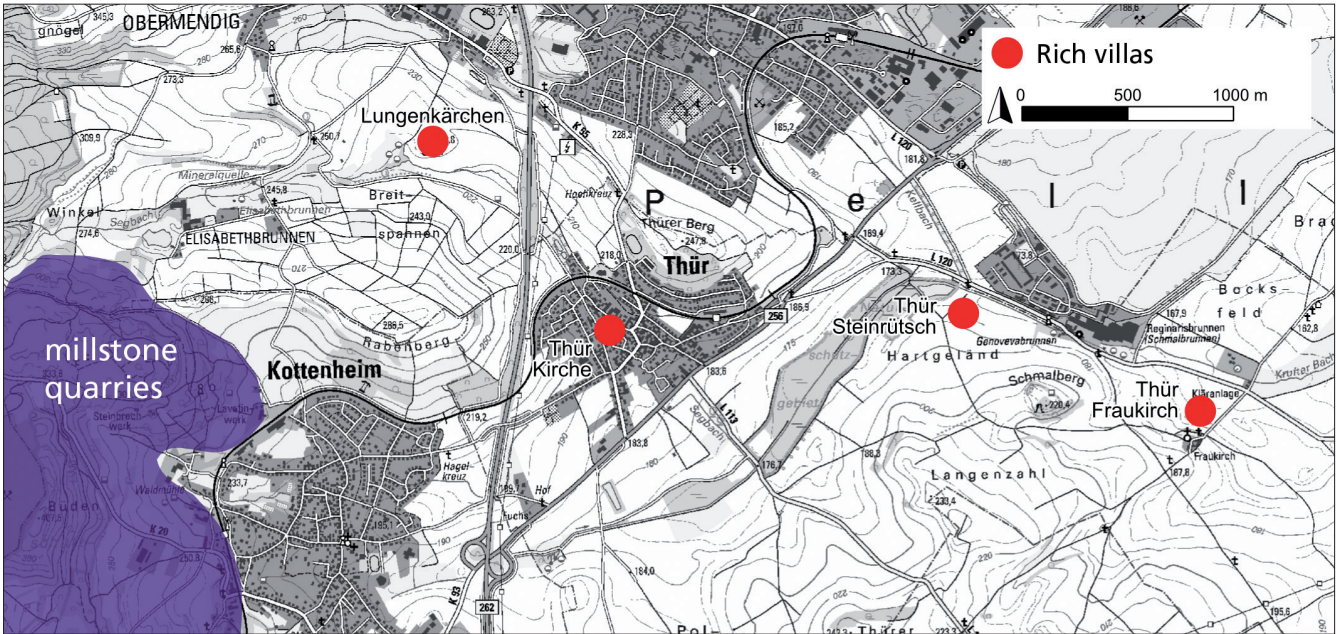


Fig. 16. Concentration of rich villas along Segbach stream (Illustration M. Grünewald & B. Streubel, RGZM; Map. ©GeoBasis-DE/LVermGeoRP 2016).

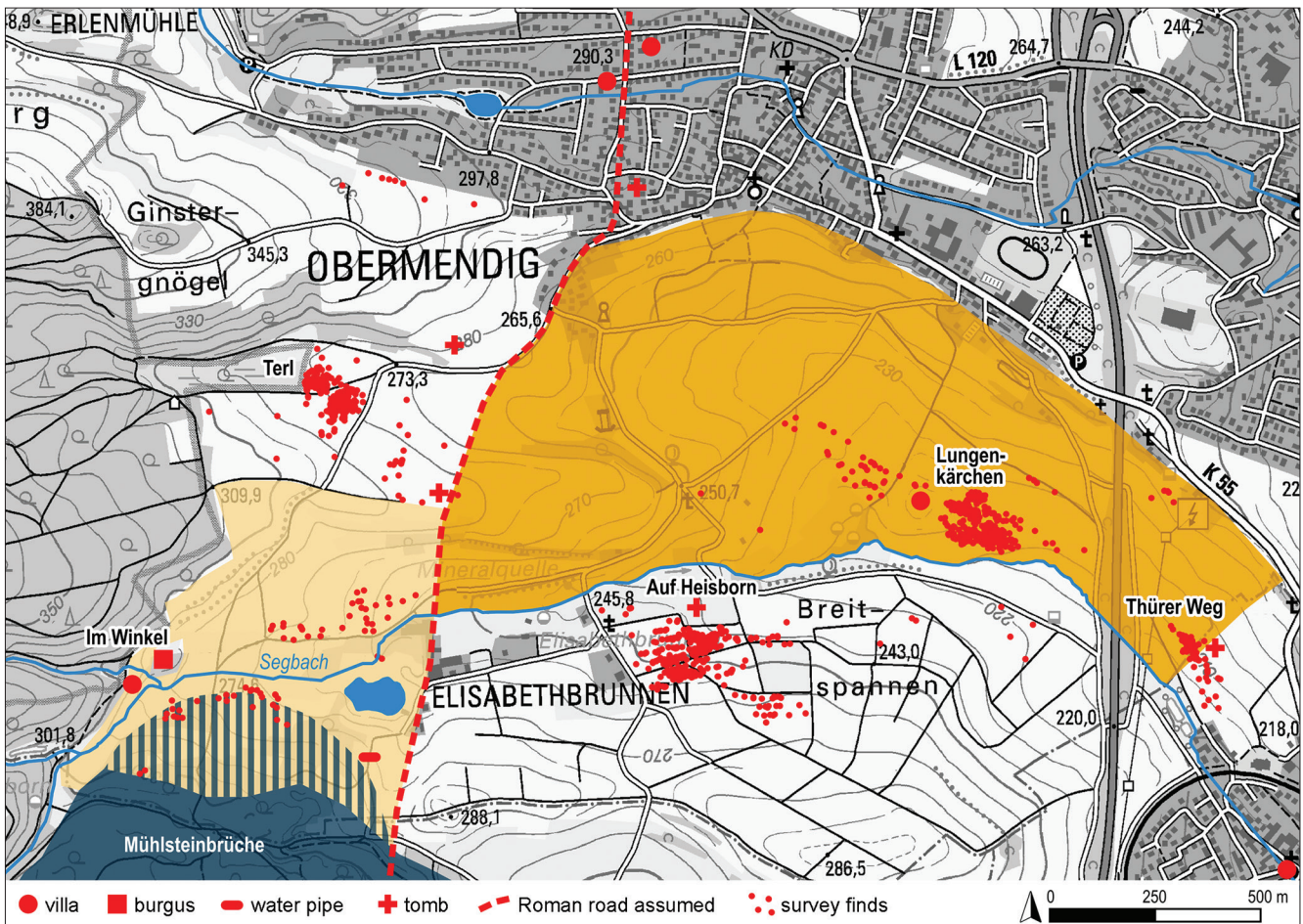


Fig. 17. The Roman “Im Winkel” (bright yellow) and “Lungenkärchen” (dark yellow) villae with their reconstructed farmland areas as well as other Roman sites in the Segbachtal near Obermendig, after M. Grünewald & S. Wenzel (Illustration B. Streubel, RGZM; Map. ©GeoBasis-DE/LVermGeoRP 2016).

(fig. 8; Baur 2012) and the large Thür “Steinrüttsch” *villa* (von Berg & Wegner 1990, 336-343). Prospecting and excavation focused on the “Lungenkärchen” and “Im Winkel” *villae* (fig. 17), and the surroundings of these sites were surveyed too. The project was carried out in collaboration with the Archaeological Institute of the University of Cologne and the Landesarchäologie Koblenz of the Generaldirektion Kulturelles Erbe Rheinland-Pfalz, and was supported by the Deutsche Forschungsgemeinschaft (FI 805/6-1, FI 805/6-3).

Mendig, “Lungenkärchen”

Due to geophysical investigations, the well-known settlement site of “Lungenkärchen” has surprisingly been recognized as an axial *villa* that attests to considerable prosperity. The complex consisted of a 73 m-long main building (fig. 18, 1) with a 40 m-long water basin (fig. 18, 2) in front and six outbuildings (fig. 18, 3-8) arranged symmetrically about the centre line of the main building, including a probable granary (fig. 18, 4). A further building (fig. 18, 9) is located at the south-east end of the

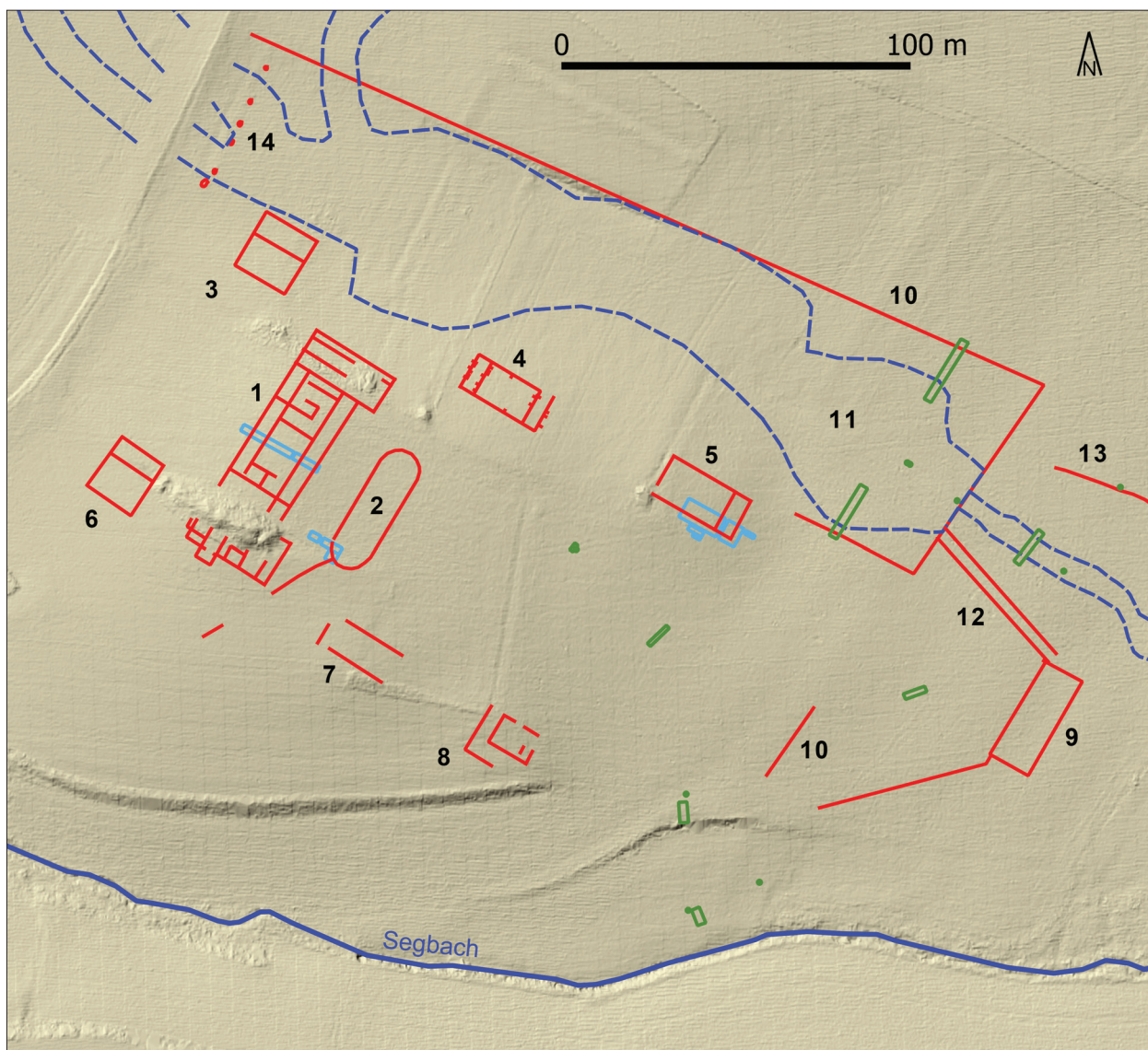


Fig. 18. Mendig, “Lungenkärchen”, plan. Archaeological trenches (blue), geoarchaeological trenches (green). 1. Main building; 2. Ornamental pool; 3-8. Annex buildings; 4. *Horreum* (?); 5. Stabling; 9. Mill (?); 10. Courtyard border; 11. Reservoir (?); 12-13. Mill channels (?); 14. Aqueduct (?). Archaeological structures after Grünewald 2012, fig. 6; Geophysics S. Seren, ZAMG as well as Arbeitsgruppe ArchäoGeophysik, Archäologisches Institut der Universität zu Köln (Illustration S. Wenzel, RGZM; LiDAR. ©GeoBasis-DE/LvermGeoRP 2017; Processing A. Cramer, RGZM).

courtyard, which was bordered by walls as shown by linear structures in the geophysical surveys and conspicuous steps in the terrain. Beyond the buildings, the border of the courtyard can be located to the east and north (fig. 18, 10), where it runs approximately parallel to the buildings. Whether water was dammed up north of the *villa* buildings in a natural depression (fig. 18, 11) to operate a mill or even to collect additional water in the manner described by Pliny the Elder (Plin., *Nat.*, 3.53) for navigation on the Segbach still needs clarification (Grünewald 2012, 169-170; Wenzel 2014, 243-245).

The courtyard measured a minimum of 4.5 ha. From the surrounding settlements and graves, it can be concluded that the *villa* worked an area of 100-120 ha (fig. 17; Grünewald 2012, 171-172). Surface finds from the courtyard range from pottery of the Late La Tène period or Early Imperial times to late variants of Alzei 33 pots from the second half of the fifth century.



Fig. 19. Architectural decoration made of Lorraine limestone from the “Lungenkärchen” *villa* (Photo B. Streubel, RGZM).

The main building in its masonry phase was erected in the Flavian-Trajanic period (Grünewald 2012, 165-167; Grünewald in prep.). It had porticos on both long sides, and avant-corps on the narrow sides. The 1600 m² structure had *thermae*, while prestigious rooms were located in the central part of the house. The building was decorated with polychrome wall plaster, with columns and with cornices made of Lorraine limestone (pierre de Norroy) (fig. 19). In the second half of the third century, a simple hearth was placed in the central hall. A large piece of wall plaster features among the building material of this hearth, which makes it clear that the plasterwork was no longer intact and the building in a derelict state at this time. Restoration of the estate in Late Antiquity is indicated indirectly by the re-use of the water basin.

A secondary building of 26 × 13.3 m belonging to the north row (fig. 18, 5) was used at least temporarily as stabling, as attested by high phosphate values (Grünewald 2012, 168-169). Like the main building, this annex was constructed in the late first century or early second century. In the second half of the third century it was destroyed by fire and a pit house was established next to it (Giljohann

& Grünewald in prep.). According to Vitruvius (Vitr., *De arch.*, 6.6.2), cattle needed an area of 15 × 7 Roman feet (4.4 × 2 m) in the cowshed. Columella (Columella, *De re rustica*, 2.12.7) states that a farm with 50 ha of grain cultivation required two teams of oxen (Grünewald 2012, 169). The large room (19 × 11 m) of the annex building would have been sufficient to accommodate more animals than were needed for ploughing on the estate.

Another adjoining building (fig. 18, 4) was possibly a *horreum* of type 2 by A. Ferdière (Ferdrière 2015, 17 No. 62), judging from the buttresses visible in the radar images (Grünewald 2012, 168). The 25 × 11 m building has a total inside space of 215 m² (central room 145 m², lateral rooms 35 m² each). By analogy with early modern times (Blöck 2013), about 100-165 m³ of grain could have been stored there, that is the yield of 114-210 ha of arable land (Grünewald in prep.). Of the 100-120 ha of the holding, 60 to 90 ha could have been sown with crops in a two-field rotation. So the granary of the *villa* was capable of holding slightly more crops than could be produced on the spot.

On the eastern edge of the reconstructed working area of the “Lungenkärchen” *villa*, tomb monuments of the land owners were found in the district of Thür, “Ober dem Thürer Weg” (fig. 17). The debris originate from medium-sized to large pillar monuments from the first-second centuries made of Lorraine limestone (Grünewald 2012, 162; Oesterwind & Wenzel 2012, 358 No. 43; Giljohann & Wenzel 2015, 25-27).

The economic importance of the *villa* is also obvious from the following observations and considerations (Grünewald 2012, 172-173): waste from mill production was found in the foundations of the stone buildings. The owners of the *villa* had connections with the millstone quarries and access to the rubble of the quarries. The main building of the *villa* is huge in proportion to the agricultural land. And the *pars urbana* of the court is surprisingly large in proportion to the *pars rustica* (cf. Roymans & Habermehl 2011, fig. 1). This suggests that agriculture was not the sole economic basis of the *villa*, but that the *villa*

owners were also owners of millstone quarries. The density of large *villae* in the Segbachtal (fig. 16; Grünewald 2012, 170-174; Baur 2012, 242-243), which would be unusual in other regions (e.g. Henrich & Mischka 2012, 334-335, fig. 6), suggests that agriculture or landholding were not the basis of prosperity, but that their wealth was related to the millstone quarries.

Mendig, “Im Winkel”

The “Im Winkel” *villa* was located just north of the millstone quarries. It comprised a main building of medium size (fig. 20, 2) and a side building (fig. 20, 3). In addition, there were several walls around the buildings (fig. 20, 6-9). A *burgus* (fig. 20, 1), a further stone house (fig. 20, 4), and drains (fig. 20, 5) dating from Late Antiquity. Close to the north-west of the settlement is what may have been an artificial lake of unknown date (fig. 20, 11).

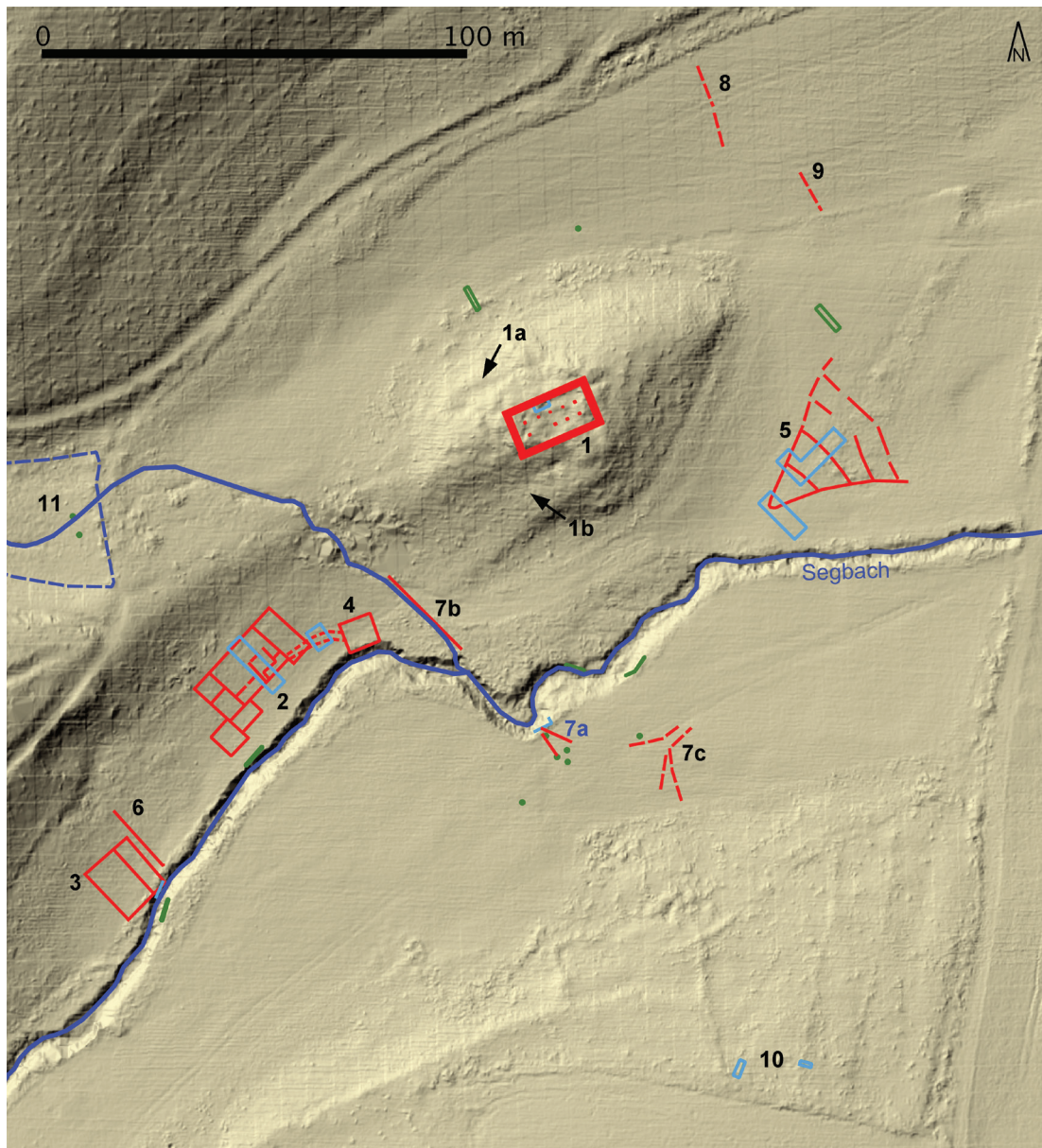


Fig. 20. Mendig, “Im Winkel”, plan. Archaeological trenches (blue), geoarchaeological trenches (green), walls and drains (red) clearly visible on the georadar. 1. *Burgus*; 1a. Step in the terrain; 1b. Possible entrance; 2. Main building; 3. Secondary building; 4. Small stone building; 5. Drains; 6-9. Walls (the findspot of the matrons is at 7a); 10. Linear stone heaps / buried quarry rubble; 11. Possible reservoir of unknown date. Georadar S. Seren, ZAMG (Illustration S. Wenzel, RGZM; LiDAR. ©GeoBasis-DE/LvermGeoRP 2017; Processing A. Cramer, RGZM).

The courtyard of the Early and Middle Imperial period amounted to at least 0.2 ha. The distance to the neighbouring “Terl” and “Auf Heisborn” settlements and the relief suggest an economic area of 46 ha (Wenzel 2012, 145; fig. 17). The settlement existed at least from the Early Imperial period to the first third of the fifth century, but it was also inhabited in the second half of the fifth century.



Fig. 21. Mendig, “Im Winkel”. Cellar of the main building with millstone roughouts (Photo S. Wenzel, RGZM).

The main building is a winged *villa* with a front corridor. It measures 32 × 17 m, with a ground area of 370 m². Window glass, wall tiles, and box flue tiles (*tubuli*) indicate a heated room. The foundations of the construction of double-walled masonry disturb layers with ceramics from the Middle La Tène period and Julio-Claudian times. A cellar built with stones simultaneously with the house was already filled with clay, large stones, and millstone roughouts from basalt as early as AD 100 (fig. 21). The masonry building must have been erected in the course of the first century. The 21 quern roughouts from the small excavated section of the cellar show that the inhabitants of the building had access to the rubble of the quarries outside their front door. Around AD 260-270 the house was destroyed in a fire. More than 43 kg of sherds of wine *amphorae* (mainly of the Gauloise 4 form) from the destruction layer suggest a degree of prosperity. A bronze bell and a billhook (lopping knife) indicate that animals were kept. Post-holes dug through the burnt layer and scarce pottery fragments (Alzei types 30, 28 and 34/29) show the place was inhabited in Late Antiquity.

The adjoining building of 15.5 × 12 m had similar external walls, made of double-walled masonry, to the main building. It corresponds to the annex building of the WW 80-4 *villa* at Weilerswist (Heimberg 2005, fig. 43) and the “secondary house of servants” of the Cologne-Müngersdorf *villa* (Roymans & Zandstra 2011, 174 fig. 9 B). It belongs to a building type with “ambivalent possible uses” (Heimberg 2005, 114) and may have served as very simple accommodation.

Stone waste from the quarries with discarded Late La Tène and Roman quern roughouts were found close to the settlement site (fig. 20, 10) (Dotterweich *et al.* 2012, 198 fig. 12; Wenzel *et al.* in press). Geomagnetic measurement images

suggest that quarry rubble was spread up to 75 m from the main building and up to 50 m from the Segbach (Wenzel 2012, fig. 2).

It is not yet clear whether the stone walls running through the valley were used for water constructions. A wall now intersected by the Segbach might have bounded a kind of basin cut into alluvial clay from the Early to Middle Imperial period. The trenched structure contained pottery of the third century and a group of five terracotta figurines (Cybele and four matrons) (Dotterweich *et al.* 2012, 88-193; Wenzel 2012, 139-142).

The *burgus*, on a hill, is a Type 3 *horreum* according to A. Ferdière (Ferdrière 2015, 25 No. 99), with pillars in the interior. At the same time, the architecture, the topographical position, and hints of a possible enclosure wall (fig. 20, 1a) indicate that the building was a defensive structure. In addition to military equipment, such as ballista bolt-heads (Wenzel 2012, fig. 12, 1-6), the unusually numerous pieces of Argonne ware (Bakker 2012, 220) point to a military occupation of the building. Judging from the small finds and the ceramics, the building came into use in the first third of the fourth century (Wenzel & Zerl 2014, 184),

while the coins indicate occupation only since the reign of Constantine's sons (Chameroy 2012, 227). The building burnt down in the first third of the fifth century.

The *burgus* measures 21.5×11.8 m with an interior area of 160 m^2 . The walls are 1.4 m thick and consist of small basalt blocks set with mortar. Inside the building were two rows of five large basalt blocks, some of which had a mortise. A purified stock of dehusked spelt has been found (Zerl 2012; Wenzel & Zerl 2014, 186-192). After dehusking the spelt was no longer suitable for sowing and was less storable than non-dehusked spelt, but was prepared for consumption as far as possible. Accordingly, stocks of dehusked spelt are known mainly from military contexts (Blöck 2013, 93 note 43). In order to be dehusked, the spelt had to be completely dried (Küster 2013, 184). Therefore for recalculating the capacity of the grain storage, a maximum filling height of 90 cm is assumed, which is known for early modern times in southern Germany (Blöck 2013, 86), and not a filling height of 30 cm (Ferdrière 2015, 19), which may apply to cereals that require further drying. A quarter of the inner surface of the *burgus* is subtracted for free space for turning the grain. The data for the volumetric weight of dehusked spelt range from 73-75 kg/hl (Dubler 1975, 61; Rothenhöfer 2005, 55 note 89) to 78 kg/hl (Schucany 2006, 280 note 643; Lang 2009, 395). At a weight of 0.74 kg/l, approximately 80 t of dehusked spelt could be stored in the *burgus*. If the per capita consumption was 1 kg spelt per person per day, as assumed for wheat (Rothenhöfer 2005, 56; Junkelmann 2006, 66), this stock would have been sufficient for the daily rations of 218 people for one year. With 160 m^2 , the interior of the *burgus* corresponds exactly to that of the granaries of Vindolanda East (160 m^2), Vindolanda West (161 m^2 , with a solid subfloor at the beginning), Birdoswald North (156 m^2), and Birdoswald South (156 m^2), which held the stock of some 500 persons thought to have occupied a military camp on Hadrian's Wall (Collins 2015, 26.28, Tab. 3.1.).

Under crop rotation (Rothenhöfer 2005, 62; Heimberg 2011, 96), 23 of the 46 ha of the *villa* could be sown with cereals. Because the climate was wetter in the north-western provinces than in the Mediterranean area, the quantity of seed per hectare of 164-219 kg, which was determined for the preindustrial period in southern Germany (Blöck 2013, 69), is used for assessing crop yields. For the larger of the two seeding rates, the five-fold yield (Blöck 2013, 94; Habermehl 2013, 143) on 23 ha was 25 t. The *burgus* could store far more cereals than the holding of the former *villa* could produce.

In that context, the drains (fig. 20, 5) become the centre of interest (Wenzel 2012, 146-150). They were contemporaneous with the *burgus* and were obviously constructed to drain a damp space beside the stream (Dotterweich *et al.* 2012, 193-198). So an area immediately beneath the *burgus* was made available as a storage place for either delicate or heavy goods. Here, cereals could be unloaded and stored in the *burgus*, but at the same time millstones could be loaded and transported on the stream. Even very small watercourses like the Segbach could probably have been used for transport (Wenzel 2014). The supposed route led from Segbach to the Krufter Bach and Nette streams and down to the river Rhine. The destination was the trading port of Andernach / Antunnacum (fig. 1), where the goods were transferred to larger vessels.

The inhabitants of the *villa* from the Early to Middle Imperial period were involved in the production of millstones. This is indicated by roughouts of querns from the cellar of the main building, as well as by the occurrence of quarrying debris very close to the settlement site. In Late Antiquity, the *burgus* secured the supplies for more than 200 persons, presumably for the workers of the nearby millstone quarries. Accordingly, supplies for the workers and extracted millstones were stored on the northern edge of the quarry area until the first third of the fifth century. Millstone extraction must have continued at least up to this point in time (cf. Henning *et al.* in press).

Mendig "Terl"

Finds from the older Hunsrück-Eifel culture, the Late La Tène period, and from the first to the fifth centuries have been discovered in an area of 1.5 ha on the settlement site (fig. 17) (Bakker 2012, 216; Oesterwind & Wenzel 2012, 358 No. 37). Geophysical prospecting revealed a settlement plan with several rectangular buildings (fig. 22 – e.g. 18×11 m, 22×9.5 m, 19.5×9.5 m, with interior subdivisions), which differs from usual *villa* development. They are strip houses of a *vicus*. Two buildings whose floor plans are rather reminiscent of granaries (Habermehl 2011, fig. 8, Verneuil-en-Halatte) are orientated vertically to the strip houses. If 80 to 100 people (Rothenhöfer 2005, 26) or 70 to 140 people (Wendt & Zimmermann 2008, 17-19) people lived per hectare *vicus* area, the population would not have been less than 100 people. Since no significant traffic routes have been found there to date, it is more than probable that the millstone quarries were the economic basis of this settlement.



Fig. 22 Mendig, “Terl”, plan. Clearly recognizable walls: solid red lines. Possible walls and rubble: dashed red lines. Presumed ancient path: orange-coloured surface. Possible grave garden enclosure: dashed violet line. The strip houses are located north of the modern and the presumed ancient path, two rectangular buildings south of it. Geophysics S. Seren, ZAMG (Illustration S. Wenzel, RGZM; LiDAR: ©GeoBasis-DE/LvermGeoRP 2017; Processing A. Cramer, RGZM).

CONCLUSIONS

To summarize, special features of the region’s development have been recognized relating to the stone industry and its effects on rural settlement. The Mayen *vicus* saw a considerable economic upswing after Augustus placed major orders for basalt handmills to equip his army. This not only accelerated the development of the *vicus* but soon brought prosperity to the countryside, too. At the same time, tuffstone production transformed the rural area between the towns of Mayen and Andernach. Rich quarry owners lived beside the basalt millstone quarries, but ordinary properties as well indicate that their owners profited from the stone industry. Stone processing of basalt and tuff required special workshops which differ from typical Roman *villae rusticae*. The production of basalt millstones was performed by *vicus* inhabitants as well as by the residents of medium-sized *villae*.

The number of stone workers must have risen considerably in the course of the stone industry boom. Feeding them was a demanding task, which was obviously fulfilled by local agriculture and by imports. In the Late Roman period, the military supported the supply, production, and trade which indicates that the stone industry continued to be regarded as a matter of state interest. The fact that the fort of Cologne-Deutz was erected with local tuffstone underlines this. Not only is the “Im Winkel” *burgus* evidence of military activity, but so is the string of four hillforts along the river Nette, which ended with the Katzenberg near Mayen already mentioned.

All told, we can say that the industrial character of the region between the Eifel and the Rhine created a specific form of settlement that was reflected in the *vicus* of Mayen as well as in its rural surroundings.

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