Recent discoveries and excavations of 6th–2nd century BC furnaces in SW Germany

Guntram Gassmann

ABSTRACT: Fieldwork and excavation have given new evidence for Celtic iron production in southwest Germany. Two types of furnace have been recognised, both new to the upper Rhine region. Examples of each type of furnace have been excavated and dated. The later type, of the 3rd–2nd century BC, had a conical shaft over a slag pit, in which blocks of slag accumulated. The earlier type, of 6th–4th century BC date, had a large diameter cupola-shaped chamber, topped by a narrower shaft. It is suggested that this type may have been operated by natural draught. These cupola furnaces may have been a prototype for the large diameter domed furnaces which occur in several regions of Europe in Celtic and Roman times.

Introduction

In connection with the main focus of research of the Volkswagenwerk Foundation, since 1989 the Landesdenkmalamt Baden-Württemberg has investigated the early production of iron in southwest Germany. Two projects on early and high Middle Ages iron production have been successfully concluded, in co-operation with the Deutsches Bergbau Museum, Bochum. One result is that the start of local cast iron production can now be assumed to date to the 11th/12th century AD (Yalcin 1992).

In April 1995 a new project was started, dealing exclusively with remains of the pre-Roman Iron Age. The aim of this project is to improve our understanding of Celtic iron production, to gain reliable results for dating and to establish relationships with other Celtic regions.

Celtic iron exists not only in the form of arms, tools or implements, but in its extended distribution in the form of trade iron, as flat bars or as bipyramidal pointed bars (Kurz 1995). The questions are: Where does the iron come from? Can the discovery of trade iron deposits lead to the production centres? What are the techniques of smelting? How does the iron go from its place of production to the end-user? Are there a few central production centres or is iron produced only for a regional market or even domestic requirements, dependent on local ore deposits?

Southwest Germany served as an example to locate Celtic smelting places and to examine them archaeologically (Fig 1). This task required a large region of investigation, which was examined on a random basis. According to the geographic structure of southwest Germany three areas were chosen within the most important ore regions. They are two *Bohnerz* deposits, one in the central Swabian Mountains, the other in the southern upper Rhine region, and a vein ore mine in the northern Black Forest.

The main emphasis of this project is on the prospecting and archaeological investigation of Celtic smelting places. Starting out from potential ore deposits and the known settlement pattern, the fields and forests around the potential areas have been searched for remains of archaeometallurgical activities, mainly slags. By means of detailed typological studies it was possible to

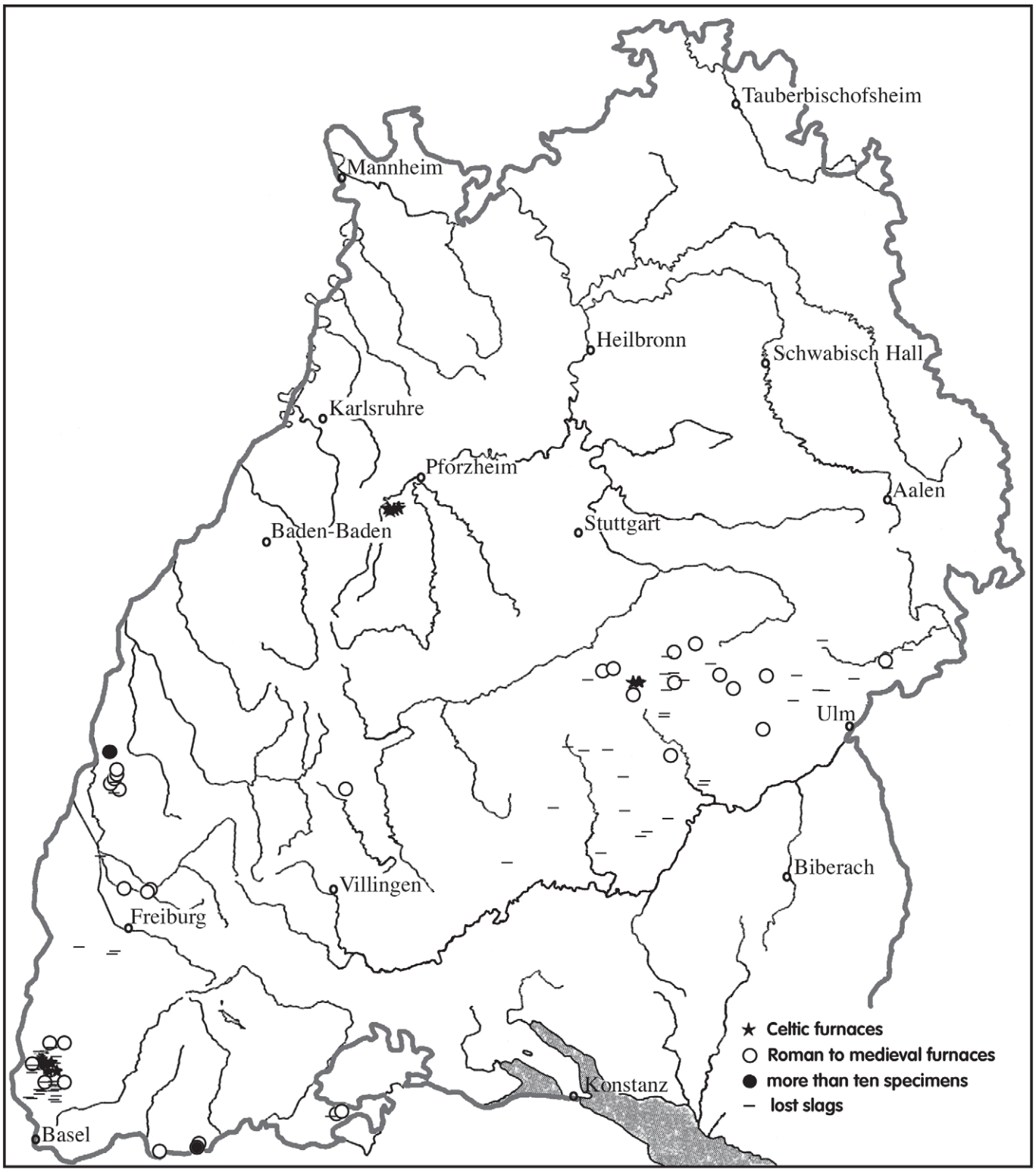

Figure 1: Map of slag deposits and smelting sites in Baden-Württemberg, southwest Germany.

distinguish different types of medieval and modern slag within the area of investigation. Those types of slag which could not be placed within the known spectrum have been registered systematically and samples have been examined. Two types of slag have been defined which seem to be characteristic of the pre-Roman Iron Age in southwest Germany. These are the massive slag blocks on the one hand and porous slags, rich in charcoal on the other. So far, slag blocks have been found exclusively in the upper Rhine region, whereas porous

slags have been found in the Black Forest and the Swabian Mountains.

Those Celtic smelting places, which were found by means of prospecting, are all in the vicinity of iron ore deposits. Accompanying settlements could not always be identified. It is remarkable, however, that the furnaces are always near springs or small streams.

Slag pit furnaces

Besides a couple of medieval or Roman smelting places, six sites have been found in the upper Rhine region, between Basel and Freiburg, with remains of slag typical of shaft furnaces with a slag pit (Fig 2). Archaeological excavations on one of the sites found two blocks of slag in their original position, each about one metre in diameter, 0.4m high and weighing 150kg. The remains of at least 20 more broken specimens were found. Presumably the furnaces were slightly cut into a slope but not dug in completely. At the front a small channel at a shallow angle connects with the slag pit; this channel was presumably constructed from the outside at an advanced stage of the smelting process. The reasons for this are not yet known, but may have been to lower the slag content in the furnace before removing the sponge iron (bloom). These channels seem to be similar to examples from the Polish slag-pit furnaces, reported by Bielenin (1975a, 141f).

The findings indicate an unorganised bloomery site, according to Bielenin (1976). Samples of charcoal from five of the slag blocks were dated by radiocarbon to the 3rd/2nd centuries BC. There is no certain knowledge of the superstructure of the furnaces, as there is only one example with a preserved wall some centimetres high. For the reconstruction of the furnace structure, the findings from northern and eastern Europe (*eg* Bielenin 1964 and 1996, Jöns 1993, Pleiner 1964, Voss 1989 and many more) can be used to suggest a furnace with a tapering shaft. Until the problem of structure is solved, the term shaft furnace with slag pit will be kept. Maybe

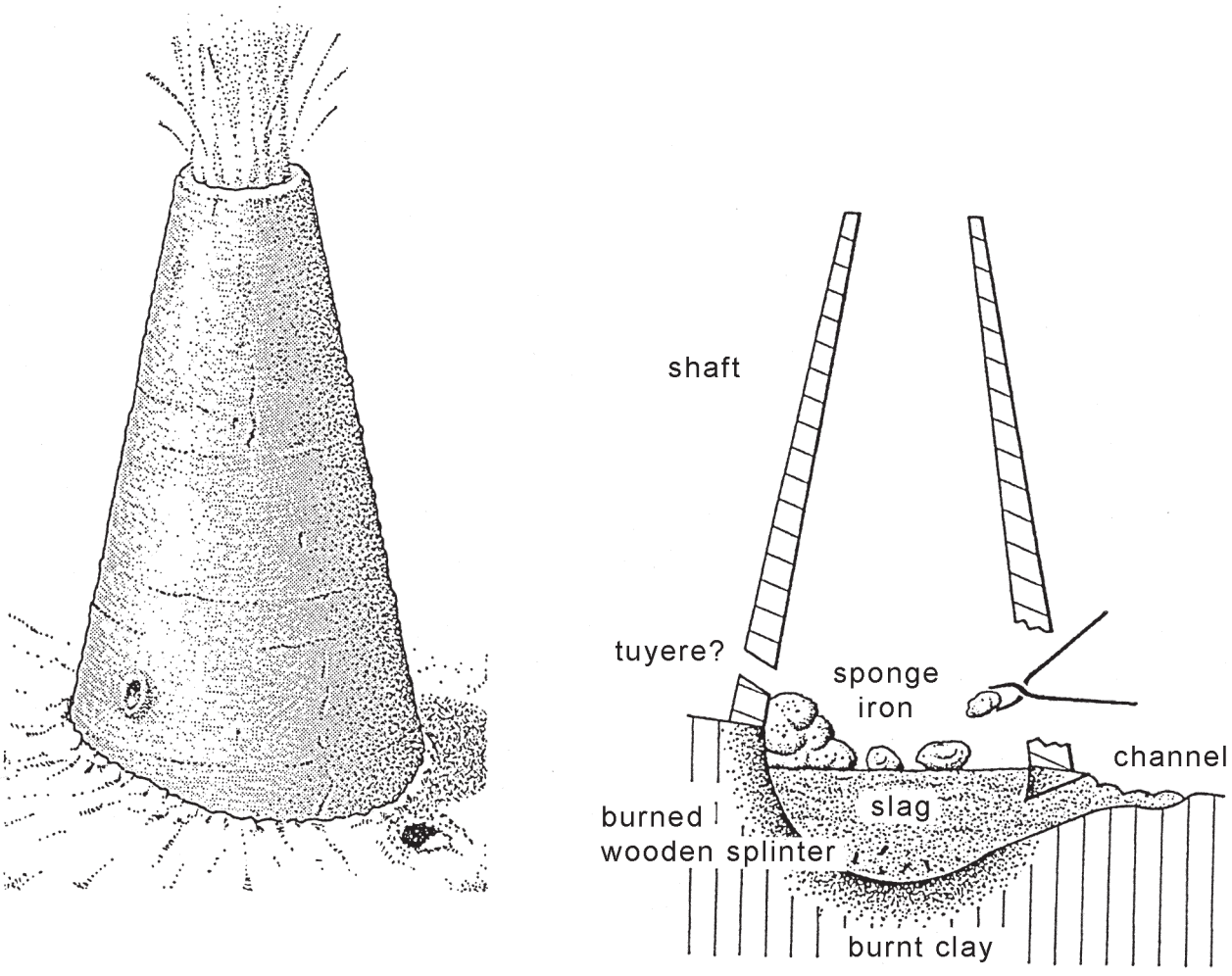

Figure 2: Reconstruction of a shaft furnace with slag pit from the upper Rhine region.

the top of the furnace was movable and could be used several times? Maybe at an unorganised bloomery site there was only one movable shaft? This could be an explanation why the top part is found quite rarely, in comparison to the slag blocks which remained in the ground.

Cupola furnaces

In the Swabian Mountains south of Stuttgart two sites with remains of cupola-shaped shaft furnaces were located, near a settlement of the Hallstatt and early La Tène period. In their near vicinity was found slag, rich in charcoal. This slag has thin liquidated flows, but it seems not to have been tapped, indicating a different sort of furnace. On one site the remains of eight cupola shaft furnaces have been located by means of magnetic surveys; three of them have been excavated.

These are the lower parts of cupola-shaped furnaces with front pits, ascending towards the outside. The slags accumulated, together with a lot of charcoal, in the furnace and the front pit during the process of smelting. The actual combustion chamber is about 0.6m in diameter at its base and the connected front pit has similar dimensions. One of the furnaces showed places where the furnace wall had been repaired. To one of the damaged places a second furnace wall had been applied from the inside, which shows that the furnace was operated several times. One furnace had been prepared for another smelting, which, for unknown reasons, was not carried out. Samples of charcoal from the remains of the furnaces are dated to the 4th century BC by radiocarbon. The second slag deposit has not yet been investigated.

In the northern Black Forest there are 71 veins of brown iron ore in the surroundings of the Schlossberg von Neuenbürg near Pforzheim, which was populated during the early La Tène period (Jensen 1986). The archaeological prospecting of the area discovered five sites where the same type of slag was found as in the Swabian Mountains. One of the sites has been partly investigated archaeologically, exposing the remains of seven cupola furnaces with upper shafts and front pits. Other examples have been found by magnetic surveying.

In cross-section one of the furnaces shows details of the construction. The pit has been partially dug into the slope and a layer of charcoal has been scattered into it. The cupola wall only starts above the charcoal layer at the side of the pit and the walls become thicker towards the top. A section has been taken of another, mainly collapsed, domed shaft furnace. Here too a basal layer of charcoal appears, which leads as a continuous layer from the combustion chamber into the front pit, and again the dome only starts above the charcoal.

One of the furnaces was in such a good condition that it could be recovered completely (Fig 3). It is preserved about 0.5m high. The external dimension of the base of the dome is 1.2m x 0.8m, and the cupola is 0.4m high. Above this is a shaft, preserved only 0.1m high and it is 0.4m in external diameter. The original height of the shaft is estimated as 0.5-1.0m. The wall of the cupola is 0.1m thick, the shaft wall is a bit thicker. At the base of the front side, slightly off-centre, a 0.2m diameter channel leads from the combustion chamber towards the front pit (Fig 4). No hole for the air supply was found other than this channel, nor were there any parts of a tuyère found in the waste material. Maybe the furnace was operated with natural draught, as Gilles (1958) suggested for the Siegerland furnaces. The good

Figure 3: A domed shaft furnace from the northern Black Forest.

preservation can be explained by the fact that the furnace was dug into the slope. During smelting it was only accessible from the frontal working pit and from the top. The advantage of this in comparison to free-standing furnaces was a smaller loss of temperature, though the design would have caused some difficulties in operating the furnace as all the elements for operation had to be placed at the front. Similar to those from the Swabian Mountain sites, the slags contain a lot of charcoal, which was dated to the 6th/5th century BC by radiocarbon. This is the earliest evidence for the production of iron in the investigation area and is one of the oldest sites known in Central Europe.

Conclusion

The findings in the Swabian Mountains and especially those of the northern Black Forest can be compared to the domed furnaces with a front pit which appear in a similar form all over the Celtic-influenced regions, for example in the Siegerland (Behagel 1939), in Austria (Bielenin 1975b), in France (Dunikowski and Cabboi 1995) and in Great Britain (Jackson and Tylecote 1988, Crew 1998). The only difference seems to be the smaller size of German furnaces, perhaps because they are earlier in date. The other type of furnace — the shaft furnace with a slag pit — is mainly known from northern and eastern Europe, but its distribution can now be extended to the upper Rhine region.

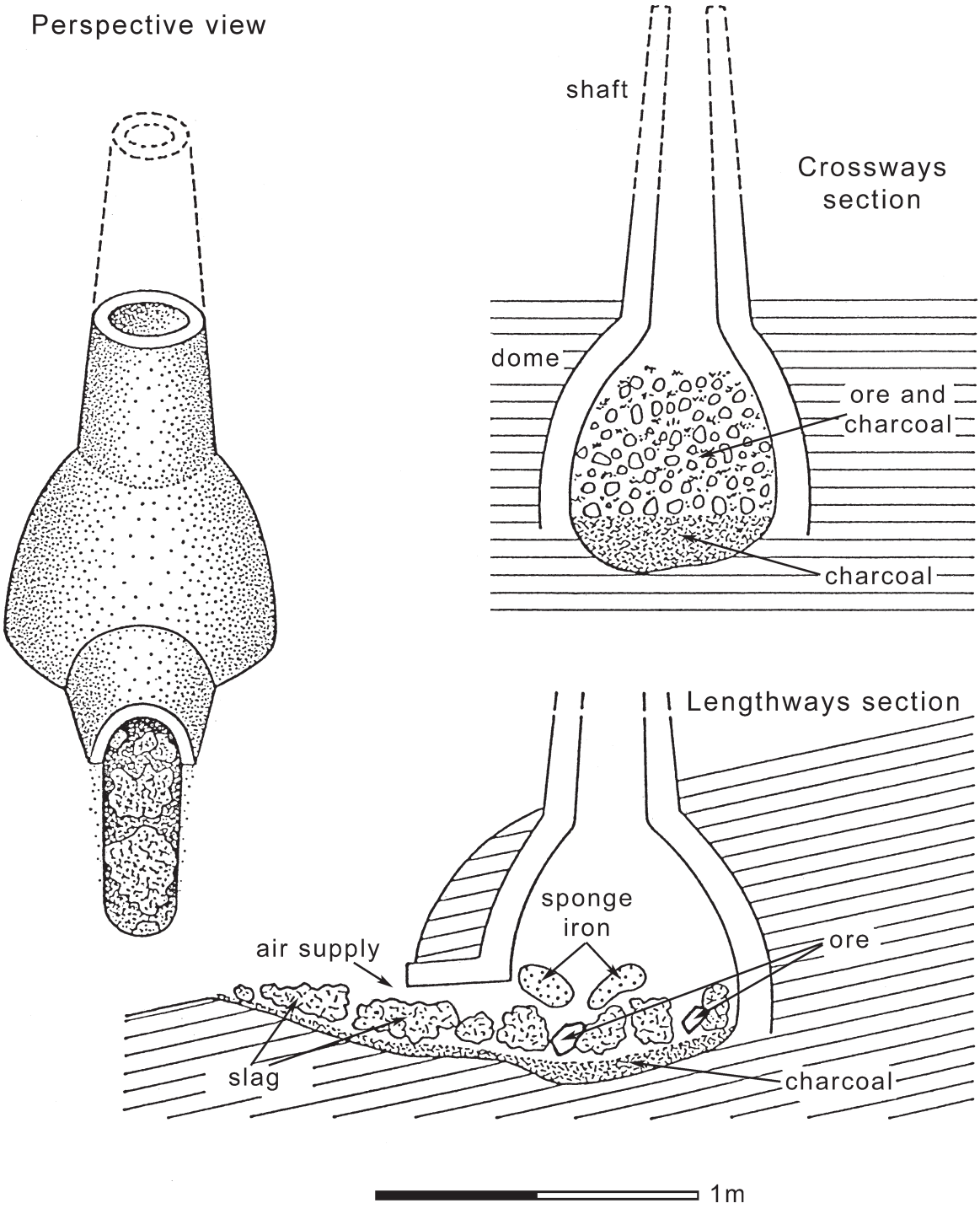

Figure 4: Reconstruction of a domed shaft furnace from south-west Germany.

References

Crew P 1998, 'Laxton revisited: a first report on the 1998 excavations', *Historical Metallurgy* 32, 49-53.

Behagel H 1939, 'Eine latènezeitliche Eisenverhüttungsanlage in der Minnerbach bei Siegen', *Germania* 23, 228–237.

Bielenin K 1964, 'Das Hüttenwesen im Altertum im Gebiet der Góry Swietokrzyskie', *Prähistorische Zeitschrift* 42, 79–96.

Bielenin K 1975a, 'Bersicht der Typen von altertümlichen Rennöfen auf dem Gebiet Polens', *Wissenschaftlichte Arbeiten aus dem Burgenland* 59, 49–62.

Bielenin K 1975b, 'Einige Bemerkungen über das altertümliche Eisenhüttenwesen im Burgenland', *Wissenschaftliche Arbeiten aus dem Burgenland* 59, 49–62.

Bielenin K 1976, 'Eingetiefte Renöffen der frühgeschichtlichen Eisenverhüttung in Europa', *Archeologia Austriaca* Beiheft 14 [*Festschrift für Richard Pittioni*] (Vienna),13–28.

Bielenin K 1996, 'Frühgeschichtliche Eisenverhüttung im Heilig-Kreuz-Gebirge', *Ethnographisch-Archäologische Zeitschrift* 3, 293–308.

Dunikowski C and Cabboi S 1995, *La sidérurgie chez les Sénons: les ateliers celtiques et gallo-romains des Clérimois (Yonne)* (Paris).

Gilles W 1958, '25 Jahre Siegerländer Vorgeschichtsforschung durch Grabung auf alten Eisenhüttenplätzen', *Westfälische Forschungen* 11, 113–121.

Jackson D and Tylecote R 1988, 'Two Romano-British iron working sites in Northamptonshire, a new type of furnace?', *Britannia* 19, 275–298.

Jensen I 1986, *Der Schlossberg von Neuenbürg. Eine Siedlung der Frühlatènezeit im Nordschwarzwald* (Stuttgart: Materialhefte des LDA Baden-Württemberg 8).

Jöns H 1993, 'Eisengewinnung im norddeutschen Flachland, Alter Bergbau in Deutschland', *Archäologie in Deutschland Sonderheft*, 63–69.

Kurz G 1995, *Keltische Hort- und Gewässerfunde in Mitteleuropa* (Stuttgart: Materialhefte des LDA Baden-Württemberg 33).

Pleiner R 1964, 'Die Eisenverhüttung in der "Germania Magna" zur römischen Kaiserzeit', *Berichte der Römisch-Germanischen-Kommission* 45, 11–86.

Voss O 1989, 'Iron Furnaces in Denmark', in R Pleiner (ed), *International Symposium of the Comité pour la Sidérurgie ancienne de l'UISSP, Liblice 1987* (Prague), 151–157.

Yalcin Ü 1992, 'Vom Schmiedeeisen zum Roheisen-Frühes Eisen auf der Schwäbischen Alb' *Giesserei* 79, 1029–1033.

The author

Dr Guntram Gassmann works as a freelance geologist and archaeologist. His main interests are archaeometallurgy and the history of mining and smelting, especially in southern Germany. In the last ten years he has been involved in a number of research projects concerned with the production and use of metals from prehistoric times to the middle ages, carrying out both the archaeological fieldwork and the laboratory analyses, with the co-operation of the Deutsclies Bergbau Museum in Bochum. At the moment he is working on a DFG-financed research. project investigating a late Hallstatt-early La Tène period settlement, with evidence for iron smelting, near St Johann in the Swabian Mountains.

Address: Eberhard-Karls Universität, Institut für Ur-und Frühgeschichte, Schloss Hohentübingen, 72070 Tübingen, Germany.
Email: argus.gassmann@t-online.de