IRON SMELTING IN NORTHERN GHANA

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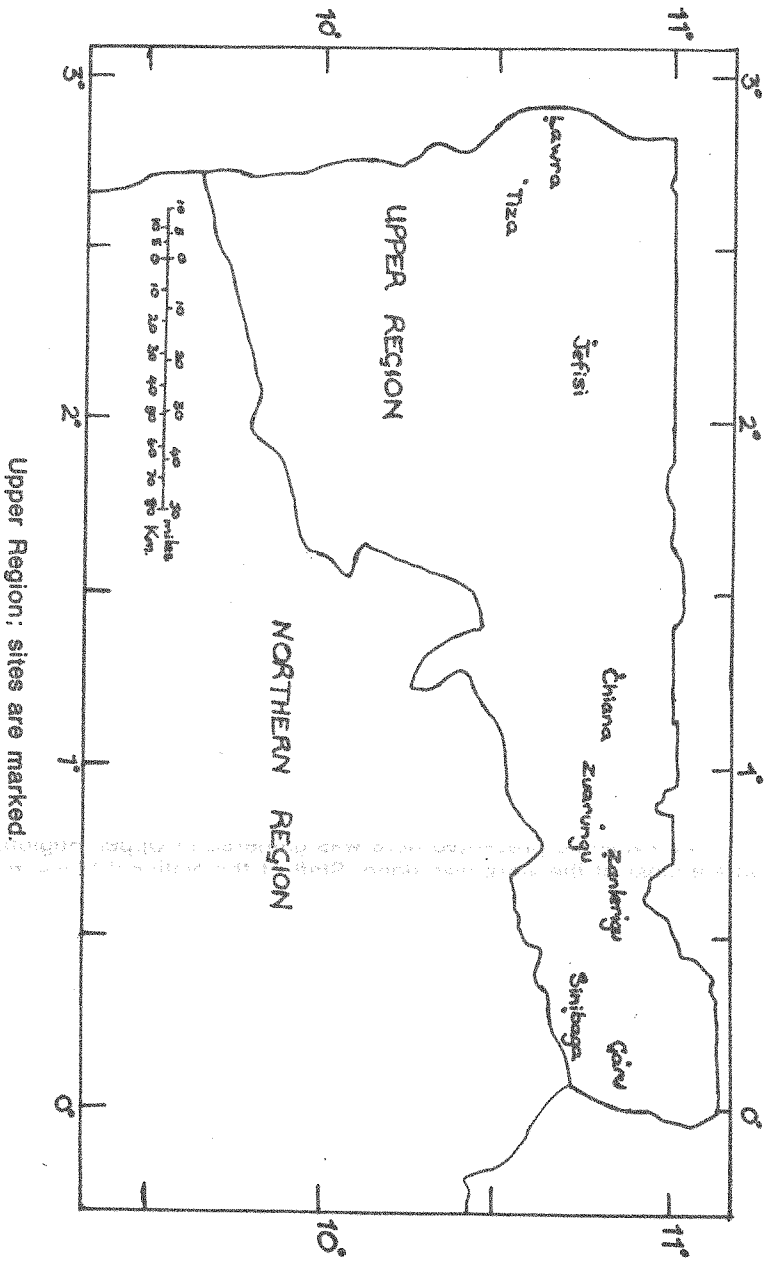
INTRODUCTION

There is an increasing amount of archaeological evidence coming to light each year to demonstrate that iron-smelting was formerly practised by blacksmiths in most parts of that area of West Africa now known as Ghana. Yet today there are no communities supporting blacksmiths in the execution of this craft. The complete demise of iron-smelting in this country has been due primarily to the introduction of ready-made iron objects and bars of iron by Europeans at the coast. There is evidence that the local smelting of iron became unnecessary for this reason in the Cape Coast–Elmina area as early as the seventeenth century. The technique appears to have existed until the late eighteenth century in the Accra Region, and in parts of Western, Ashanti and Brong-Ahafo Regions until the mid-nineteenth century. In what is now Volta Region iron-smelting ceased soon after the arrival of the Germans in the area in the 1880's. Fieldwork recently carried out by members of staff of the National Museum has revealed that the work continued as a regular feature of the economic life of the people of Upper Region until well into the twentieth century; indeed at Jefisi, one of the villages visited in 1971, the blacksmiths there indicated that they were smelting iron in the early 1950s.

Up to now, little has been written about iron-smelting in Ghana. Rattray noted..... 'the Ashanti do not now work iron ore, nor are there obvious traces of their ever having done so.' (Ashanti, page 325). Nevertheless, he reported elsewhere in the same book that iron-smelting tuyeres had been found in the region of Obuasi, supposedly used by communities living in the area before the existence of the Ashanti nation; unfortunately these finds, in common with most isolated iron-smelting sites, cannot be dated. Rattray also described in 1916 the remains of an iron-smelting furnace at Akpafu Todzie in Volta Region. Although he does not indicate it in his article, furnaces such as he mentioned had been more fully described in operation by Hupfeld in 1899, who managed to witness what must have been one of the last smelts in the area; of the hundreds of furnaces formerly in use in the Akpafu–Lolobi–Santrokofi area only six were functioning at that time. Hupfeld also gave an account of a smel-



Upper Region; sites are marked.

ting operation at Banyeri, a village now on the Ghana–Togo border east of Yendi. Cline, in a survey of the literature on African metallurgy, mentions the Ewe, but only to say that their iron is worked by the original inhabitants (i.e. the Akpafu etc.), and the Lobi, in what is now Upper Region. Written descriptions of the Lobi method come mostly from French speaking territories, by Charles (1911), Ruelle (1904) and Labouret (1931). These writers all witnessed smelting operations in the area between the present Ghana border west of Lawra (i.e. the Black Volta) and Bobo-Dioulasso, in Upper Volta. A short report by Junner (1936) indicates that he and his colleagues in the Gold Coast Geological Survey witnessed several smeltings of a similar type in the Lawra district in the 1920's and 1930's. This is the only first hand account we have of smelting in Upper Region.

Elsewhere, there have been several archaeological reports (Wild (1931), Geological Survey Annual Report 1931-1932, Nunoo (1957, 1970), Shaw (1969) and Penfold (1972) and oral traditions collected from the Accra region, Fumesua near Kumasi (contradicting Rattray) and around Nsawkaw in Brong-Ahafo Region. Oliver Davies (1971-3) reports surface iron slag deposits and tuyere remains from all regions; a useful map appears in his 'West Africa Before the Europeans' (page 242).

It is not the intention of this paper to trace the history and development of iron-smelting practices. Such a study will have to await the publication of a good many more field reports on early sites. Its task is to present a summary of what has recently been found out about the processes involved in the smelting of iron in some Ghanaian communities. The fieldwork that has generated this paper is still in progress and will, it is hoped, uncover more information as other areas are visited.

The evidence presented here was gathered in Upper Region, where most of the work was done. Staff of the National Museum visited six communities in 1971, 1972 and 1973 (Zanlerigu, Jefisi, Tiza, Lawra, Chiana and Garu) where the process was recreated, and obtained reports from other places of a more fragmentary nature (see Map). In each of the villages the blacksmiths built a furnace, collected ore and charcoal and smelted the ore. In four of these places, Lawra, Jefisi, Garu, and Chiana, the furnaces remained standing and are now protected with shelters in order that they may be used again to demonstrate to local people and visitors the blacksmiths' techniques. A furnace built at Tiza, but not used, has been transported to Accra where, it is planned, it will be re-erected and put to use. A film of the blacksmiths at work at Jefisi has been made by a GBCtv team, with aid from the Friedrich Ebert Foundation, and has been televised several times

In each case the blacksmiths were recreating a process they had either themselves learned as young men or had seen performed by their fathers. It was therefore unlikely that recall of the details of the process was total. This is supported by the fact that three of the thirteen smelts witnessed or reported were unsuccessful in producing iron. The picture of the process built up in the following pages seeks to make allowances for these lapses and to account for them wherever possible. It is never possible in an area where there are no local pre-colonial written records to say exactly when iron-smelting was last performed; however, from what various persons have reported it appears that in Zanlerigu the last smelt occured at least 50 years ago, in Tiza between 40-50 years ago, in Chiana and Garu 30-40 years ago, in Lawra about 30 years ago and in Jefisi apparently no more than 20 years ago.

TECHNICAL BACKGROUND

Before describing the various furnace designs and smelting procedures it will be useful to outline the chemistry of the process. Iron does not occur naturally in West Africa. It readily combines with other substances to form iron compounds. In the natural state these compounds are associated with non-metallic materials and other metals in rocks known as ores. The processes of separating the iron-bearing material from the other substances and extracting the iron from the former are known as smelting.

The blacksmiths of Northern Ghana obtain their iron from laterite which contains an iron compound known as haematite. The oxygen is removed from the haematite by the action of carbon monoxide. This is an unstable gas produced by the combustion of charcoal in a reduced flow of air, which reaction produces heat. The carbon monoxide combines with the oxygen in the ore to form carbon dioxide. This reaction occurs at temperatures in excess of 450°C. Heat is also essential in separating the non-metallic elements, known as gangue, from the iron compounds. This occurs when the gangue melts away from the rest of the ore at about 850°C. In order to achieve a reasonable degree of efficiency in the smelting process, temperatures in excess of 900°C are therefore needed. It appears that temperatures of up to 1200°C can be obtained in the furnaces described below. The iron bloom at these temperatures is a pasty mass, with the texture of a sponge. Iron in a pure state melts at 1535°C but its melting point is reduced by about 300°C if it is mixed with other materials, particularly carbon. If the iron has been allowed to melt and mix with carbon, it loses its malleability when it solidifies and is unworkable in the forge. Thus the ideal temperature for iron-smelting in this part of West Africa lies between 1000°C—1200°C.

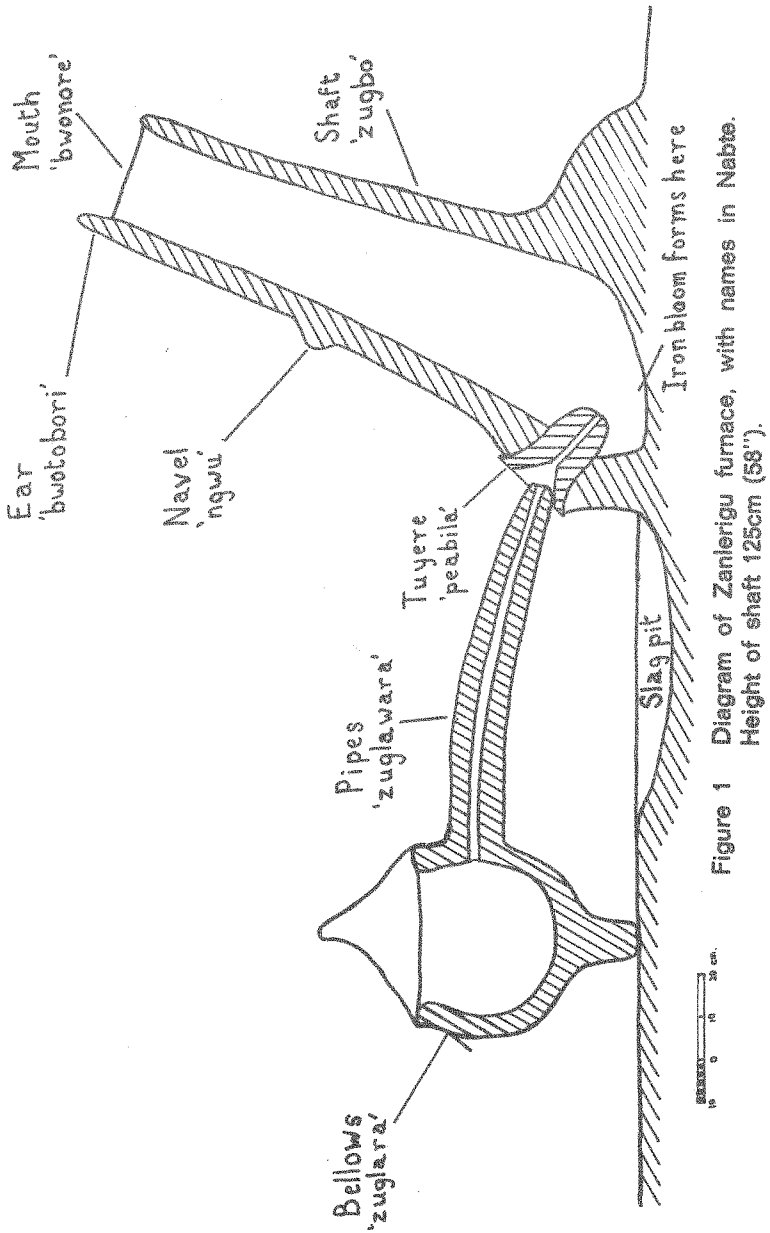


Figure 1 Diagram of Zanlerigu furnace, with names in Nabte. Height of shaft 125cm (58").

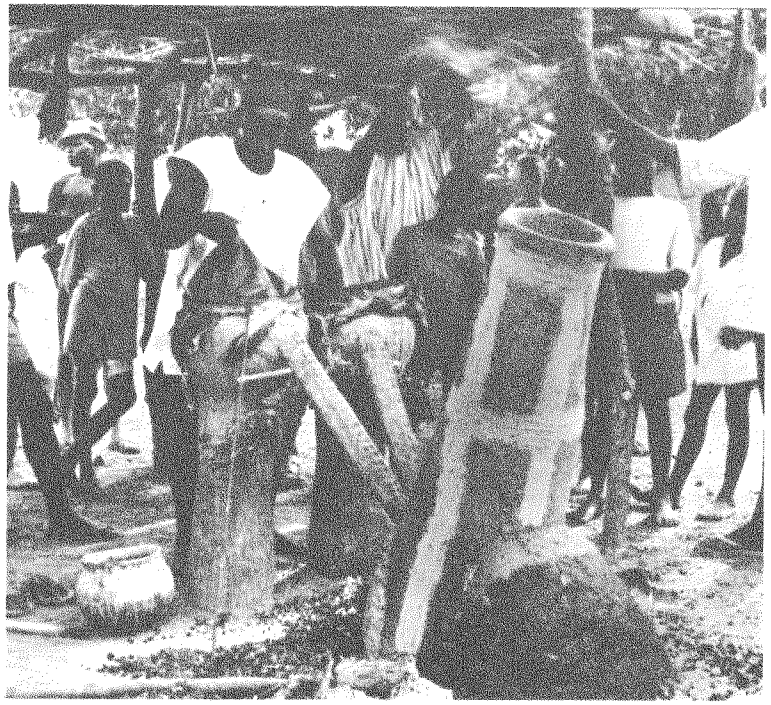


Plate I Furnace at Jefisi; height of shaft 130cm (61").

Plate II Furnace at Lawra; note remains of sacrifice on 'navel' and chicken roasting above tuyere. Height of shaft 135cm (63").

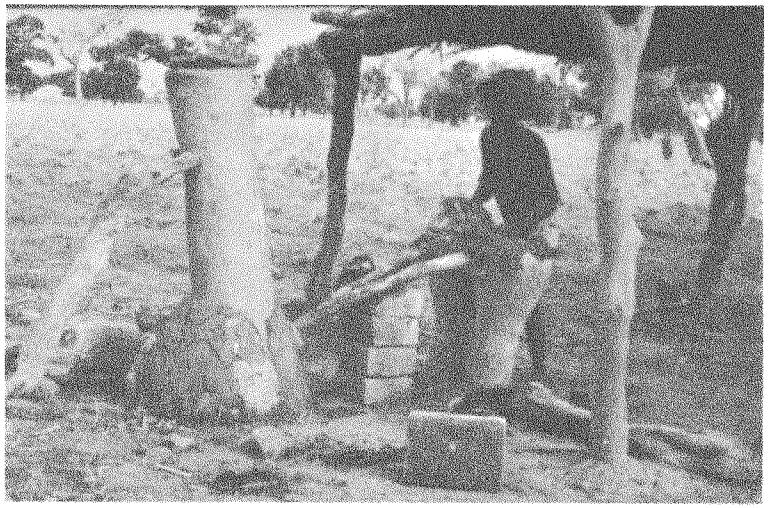


Plate III Furnace at Tiza; height of shaft 155cm (73").

Plate IV Furnace at Chiana; note upright shaft, two low pairs of bellows. Height of shaft 122cm (57").

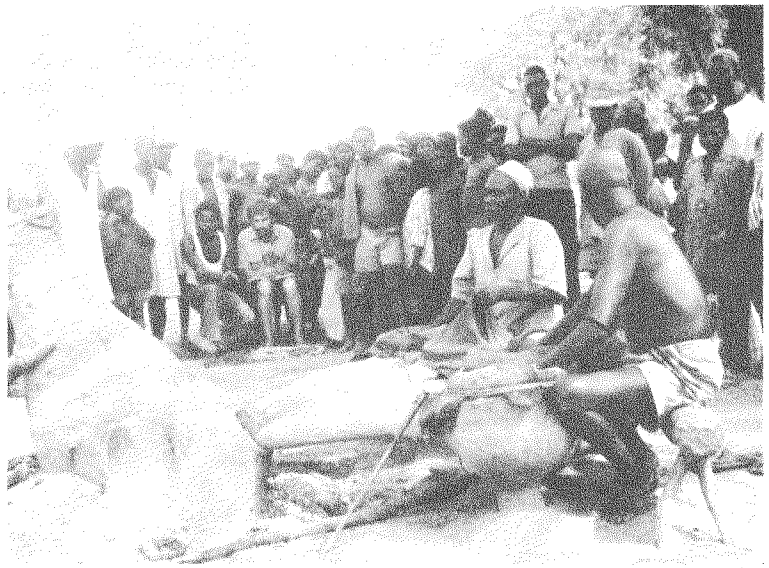


Plate V Furnace at Garu; note two low pairs of bellows. Height of shaft 113cm. (53").

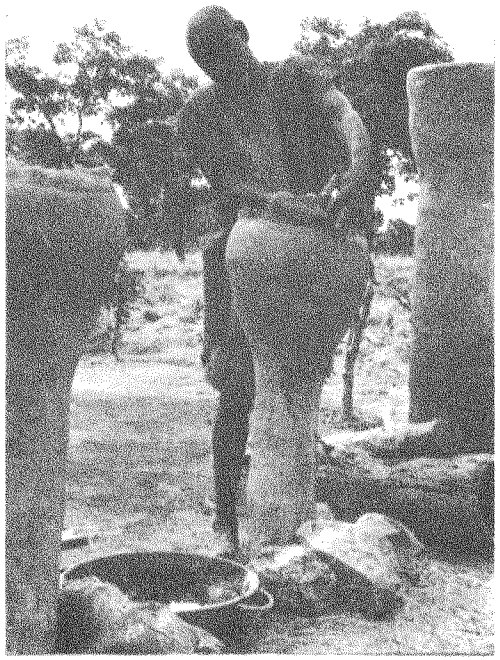


Plate VII Tiza; bellows being moulded.

BUILDING THE FURNACES AND OTHER APPARATUS

The furnaces of Upper Region are all of the same basic design. This comprises a shaft which is usually inclined and has openings at the top and bottom (see figure 1).The lower opening is provided with two holes; a nozzle called a 'tuyere', which directs the flow of air from the bellows into the centre of the shaft, and below it at the very base of the shaft, a space for the removal of the slag during the smelt. The air is forced through the tuyere by the action of a pair of bellows. A skin of a goat is tied onto each of a pair of clay bowls; each of the bowls is connected via a pipe to the tuyere. The skin is tied over the bowl so that it can be rhythmically raised and lowered. Each down-stroke forces some of the air contained in the bowl down the pipe and into the furnace shaft. Air is drawn into the bowl on the upstroke of the skin in two ways; through the pipe by means of a small gap between the end of the pipe and the tuyere; and also through a flap in the skin itself, which is worked by the pumper's wrist (see figure 2).

As would be expected, there are individual differences in the construction and shape of these furnaces (see figure 1; plates I-V). The furnace at Chiana has an upright shaft which widens near the base, and uses two sets of bellows, with two tuyeres; the hole through which the slag is tapped is opposite the holes into which the tuyeres are placed. The bellows bowls and the pipes leading from them into the tuyeres are made in one piece, the bowls being on a short pedestal. The bellows are operated in a seated position. The same is true of the furnaces at Zanlerigu, Garu and, to judge from a photograph in the archives of the National Museum, at Sinibaga. At Jefisi, Lawra and Tiza the pumpers stand, the bellows bowls being made on a high pedestal; occasionally the pumper may stand in a shallow pit. In those three places the pipes are made separately from the bowls and with a different kind of clay.

The building of a furnace and the making of the charcoal will be described as it was observed in the village of Tiza, about 15 miles from Lawra in the extreme West of Upper Region (see map). Other parts of the process will be described from different sites, references to techniques used elsewhere being made when they differ.

The clay for the furnace is the same clay as is used in making granaries. It is dug from a pit and soaked for two days in water. Since there are a number of those granaries in each compound the pits are commonly situated near them. It is puddled after two days and mixed with dried chopped grass on a wooden board which is also covered in chopped grass. The main structure of the furnace, the shaft, is built around a core of bound guinea-

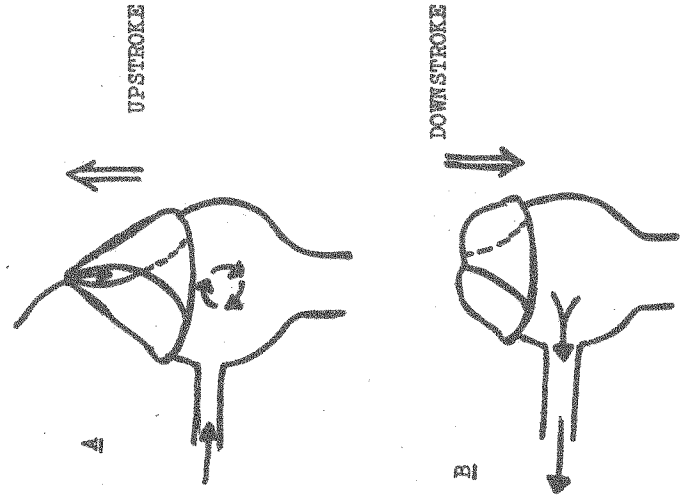


Figure 2 Schematic diagram showing valve action of bellows skins.

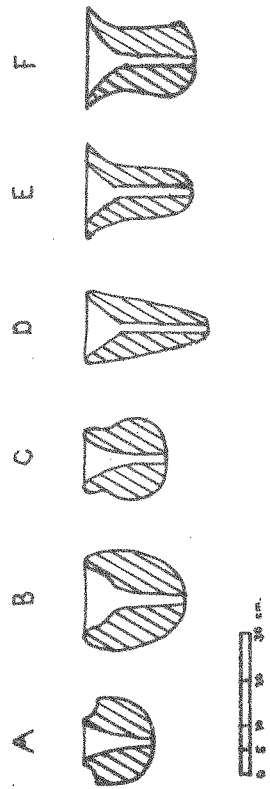


Figure 3 Sections through tuyeres

corn stalks. This core is about six feet in height and is put vertically into the ground to a depth of four inches so that it will stand without support. Work begins on building the shaft at about 7 a.m. Slabs of moist clay with added grass are put around the core and pressed into place (plate VI). When the walls have been built up to a height of about three feet the outside surface is smoothed with the hands, covered with more chopped grass and left to dry for an hour; this allows the clay to shrink before work is continued. If the whole shaft were made at once the structure would be too weak to withstand the intense heat of the smelting process. Because of the care needed in manufacture of the furnace parts the blacksmith builds them himself.

Later the shaft is brought to its full height, smoothed and again covered in a layer of chopped grass. It is then left to dry. In the meantime work on the two bellows begins. The pedestals on which the two bowls will sit are made in the same way as the shaft, with a bundle of guinea-corn stalks in the middle; this makes the bellows lighter, which is necessary since they are usually carried into the compound overnight during a session of smelting operations. When the stems have dried adequately the bowl is shaped on top with thick sausages of clay, in the way a pot is normally made. The surfaces of the bowls are moistened with water in which the bark of the **'dawadawa'** tree has been soaking. This is said to strengthen the clay. The bowls are left to dry (plate VII). The length of time these structures are allowed to dry is dependent on the weather conditions. In 1971 the operation was witnessed towards the end of the dry season when there was a threat of sporadic but heavy thunderstorms. Furnace-building would normally have taken place at the beginning of the dry season when the harmattan is blowing and the humidity may be as low as 10%. The drying process at this time is much quicker and has to be overseen with great care.

If the furnace shaft is left to dry overnight in an unfinished state, three short pieces of grass are stuck in the ground at the base of the shaft. These act as 'night-watchmen', warding off evil spirits which might otherwise interfere with the manufacture of the furnace (plate VIII). When the fabric of the bowls is sufficiently dry the top layer and the rim of each is completed.

The blacksmith then carves a hole in the side of each bowl into which the bellows pipes will eventually fit. Later, the bellows are upturned and the cores removed; the base of each is smoothed and both are left until needed. When the shaft is ready to be worked on, its core is removed and the rim is added. The hole at the lower part into which the tuyere will be put and from which the slag will be tapped is also cut at this stage; by allowing the passage of air inside the shaft, it assists in the drying process.

Plate VI Tiza; shaft being moulded around a core of guinea-corn stalks.

Plate VIII Tiza; shaft after one day's work. Note protective sticks in position.

The blacksmith works from the top with an axe-head on a wood pole, smoothing the inside surface. When the shaft is sufficiently dry, it is laid on the ground and further work on the inside is done. It is essential for the inside to be without protrusions of any kind; these hinder the downward passage of the charcoal and ore during smelting, resulting in blockage and failure of the smelt. To finish making the shaft a small hole is made in the side with a piece of millet stalk, about halfway up the shaft, above the hole for the tuyere. In addition, three more holes are made in triangular pattern above the first hole and immediately below the rim. All four holes will be used as guides during the smelting operations; when light can be seen through the upper three holes it indicates that the level inside the shaft has fallen sufficiently to require a refill of charcoal or ore. At the end of the smelt the level is allowed to fall until light can be seen through the lower hole; after which the bottom of the shaft is opened.

The tuyeres are made from the same type of clay as the shaft. A solid lump of clay mixed with grass is shaped into a paraboloid with a flattened base. A straight piece of guinea-corn is pushed through in line with the main axis; the hole thus created is filled with ash, to aid in drying and to prevent the clay filling it again. The tuyere is left for a day, then the hole is cleared of ash, and a rim of clay put on the flattened base. The hole is widened at this end so that its section is conical and smooth (plate IX and figure 3).

In 1971, the bellows pipes were made by a man other than a blacksmith, who formerly made them as a means of livelihood. His wife was a potter, but there was no indication that the wives of bellows-pipe-makers are usually potters; the pipes are, however, made of pottery clay. The clay is obtained from a place some ten miles from the compound. It is mixed with some water, carefully inspected for stones and other extraneous materials. Kapok and chopped rice-stalks are used as temper; they serve to absorb moisture from the clay without causing cracking both during the air-drying period and during the firing itself. Two tapering cores of bush grass are made. The clay is daubed onto the cores and carefully smoothed (plate X). After each addition of clay the core is turned on the wetted area of floor. Formation of the pipes is completed in one session; after the smoothing is finished a slip is formed by moistening the surface with water. The pipes are left in a cool, dark room to dry. It is essential that the clay dries at the slowest rate possible as some shrinkage is inevitable, and it must be allowed to take place uniformly throughout the length of the pipes. They are left until the clay is leather hard when they are burnished with a smooth river-worn pebble much as women use on the pots. After they have further dried out they are fired on an open bonfire of small branches of wood and farm refuse.

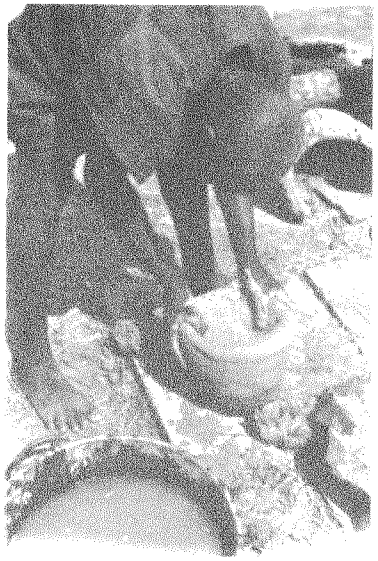


Plate IX Tiza; tuyere being moulded.

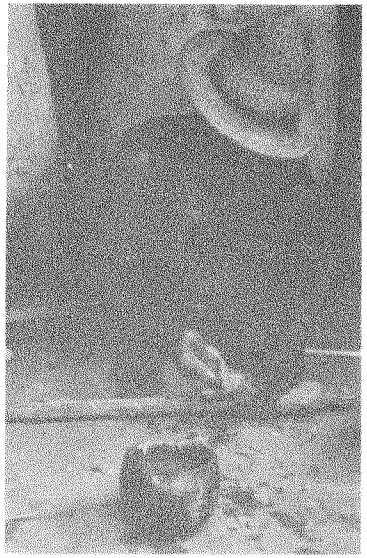


Plate X Tiza; bellows pipes being moulded around a core of grass stalks.

Plate XI Jefisi; shaft being built up with slabs of clay.

The firing usually lasts for about two hours. The pipes are removed when they are still hot and sprinkled with an infusion of dawadawa pods. They are put on the roof of the compound to cool. It is not necessary to remove the cores as they have been burnt out in the firing.

As will be seen from the photographs, the furnace structures from the other villages differ to a lesser or greater extent in appearance from the one at Tiza. They also differ in mode of construction. The shaft at Zanlerigu and those at Garu, Jefisi and Chiana are all made without cores. The process at Zanlerigu begins with the collection of clay from an old termite hill, which is mixed with chopped grass, water and an infusion of a certain root which when pounded exudes a slimy juice. Three rectangular slabs of clay are made on a bed of chopped grass; they are fitted together vertically on a patch of cleared ground to form a ring about ten inches high; this is the base of the shaft. Its height is increased by additions of sausages of clay. Care is taken to ensure that the walls taper slightly, by the use of a measuring stick. (In Jefisi, where the method of construction is the same (see plate XI), the blacksmith's foot is used to measure the diameter of the base.) The outer surface is washed with the root infusion. Chopped grass is worked into the clay until the exterior is smooth. The shaft is built up to its full height of about four feet at one session, and is decorated with a shape at the top called an 'ear' and a knob situated half-way down the shaft in the same position as the small lower hole in the Tiza shaft; this is called a 'navel' (see figure 1). Similar addition is made to the shaft at Jefisi but the name is not the same. The tuyeres are made at the same time as the shaft, in a paraboloid form with a flaring flat base (see figure 3). The bellows bowls are made the next day. They are built up of sausages of clay. The pipes are made separately, of the same kind of clay, but are joined to the bowls immediately, and the completed bellows are smoothed and left to dry.

Additions to the furnace conform to the symbolism attached to the smelting process that operates in some of the villages. In Zanlerigu it was stated that the shaft was thought of as a woman from whom the iron would be born as a result of impregnation with air from the bellows, which are seen as male genitalia. At Jefisi, where the design is very similar, such symbolism was explicitly disavowed by the blacksmiths. At Lawra, where the shape is also similar to that at Zanlerigu, the symbolic details are also different. The shaft and bellows are together thought to be a person with some male characteristics. The bellow pedestals are legs, the bowls are the lungs; the pipes are together thought of as the penis, the tuyere and the slag tapping hole are together seen as the urinary tract. The support for the shaft when it is in the smelting position is called the buttocks. There is also

a knob at the front which is called the navel, and a design at the top of the shaft which represents a male hair pattern, above a protrusion called a chin. The shaft as a whole is thought of as a body. It would be incorrect to attach much significance to these attributions, however; they appear to be no more than metaphorical names for these parts of the furnace, and on a par with the word 'mouth' when used in connection with a cave.

CHARCOAL MAKING

The charcoal used in the smelting process is in every case a special type said to produce greater heat than charcoal used for domestic purposes. In Zanlerigu, the charcoal was obtained from brewers of millet-beer, who require a lot of heat for a long time; it was understood that although this was not exactly the same as the charcoal formerly used in smelting, the similarity was close. Information from Zuarungu, a Nankansi town 6 miles away, indicates that smelting charcoal was made from three types of trees, none of which were specifically associated with the brewing of millet-beer ('pito'). In Jefisi the blacksmiths made their own charcoal, from wood other than that associated with pito-brewing. It is, however, the same as that used in the blacksmiths' forge. In Tiza, the charcoal is made from four or five species of tree, none of which can be identified with trees used in the other places. The wood of the shea-butter tree is mentioned as being unsuitable for smelting since it burns too quickly and produces insufficient heat. The same was said of shea-butter wood in Zuarungu. At Lawra, however, only 12 miles from Tiza, this tree was specifically mentioned as being the best for smelting purposes. During our first visit there the blacksmiths regretted they could not obtain charcoal from this tree, as they would formerly have been able to do, since its fruit is now a cash crop. However, when we returned they were pleased to have found some shea-butter trees that were no longer producing fruit.

The process of charcoal-making in Tiza takes two days. It requires wood at two different stages in one firing. A pit is dug and lined with dried grass on which are laid freshly cut logs (plate XII): these are covered with charred logs from a previous firing. Layers of green leaves are put over the charred logs. The grass is lit and when it is seen that the logs have caught alight, the pile is covered with earth from the pit and left for 24 hours or more (plate XIII). The charred logs have been totally carbonized; the fresh logs have been charred and will be used in the following firing. At Chiana, there was no evidence that wood at two stages was used, but the wood was burned in an earth-covered fire and left to smoulder for four days. The same comments apply to the time the fire is left as applied to the time the shafts were allowed to dry out; in the beginning of the dry sea-

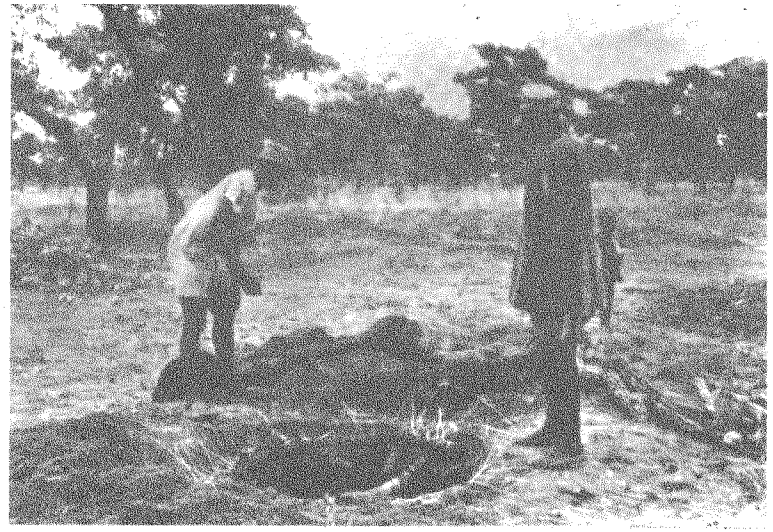


Plate XII Tiza; charcoal-making. Logs being placed in a pit.

Plate XIII Tiza; charcoal-making. Logs burning and covered with earth.

son, when the harmattan wind is blowing and the humidity is very low, the fire tends to burn more quickly, but towards the end of the dry season it is necessary to leave the fire for a longer time before uncovering it. The process used in Lawra for making charcoal is more elaborate. It occupies 25 days, during which time the blacksmiths involved in the work camp in the bush near where the charcoal trees are standing, without returning to their compounds. The trees are cut down and chopped into manageable pieces. This takes two weeks, during which time the wood is of course drying out. The logs are heaped and set in fire on the open, until their volume is reduced by half, when the piles are covered in earth, without airholes, and left for about five days until the covering is cool. At the end of this time most of the wood has been turned into charcoal, but that which is left awaits the next time that charcoal is needed.

OBTAINING THE ORE

The iron-ore is in every case obtained from shallow pits dug in areas which are recognised as being rich in that material. The iron-ore site at Chiana is about ten miles away from the village and five miles from the former smelting site. At Tiza there are various areas within a radius of about four miles of the smelting site where the stone is suitable. The blacksmith collected small amounts of ore from each place since he was not sure which would yield the highest grade of iron. The blacksmith remarked that the same procedure would have been used in former times until the location of the ore that yielded the best iron was established, when that site would have been used exclusively. At Jefisi the ore was gathered from a ridge four miles from the smelting site which during our visit was situated in the village itself, although it appears that the former iron-smelting sites were scattered around the outskirts of the village. At Lawra the blacksmiths come together after the end of the rainy season to decide when to start digging at a place two miles from the blacksmiths' quarter of the town. They together dig enough iron-ore for each of them to smelt for at least twelve days continuously. They use a large lump of granite, which has had to be brought to the site from a place seven miles distant, and has a distinctive name. It is hurled at the ground to break up the surface laterite, which contains iron, but not at a sufficient degree of concentration to be useful in smelting. Below, at a depth of three to four feet, iron-ore is found (plate XIV); it is detected by close inspection of the lumps thrown up by the granite boulder. At Zanlerigu the iron ore is not far from the former smelting site. The surface laterite is broken with a pick; the usable ore is obtained from a depth of only 18 inches below the surface. The same is true at Garu, where small nodular lumps are dug from a pit a foot deep 300 yards east of the village.

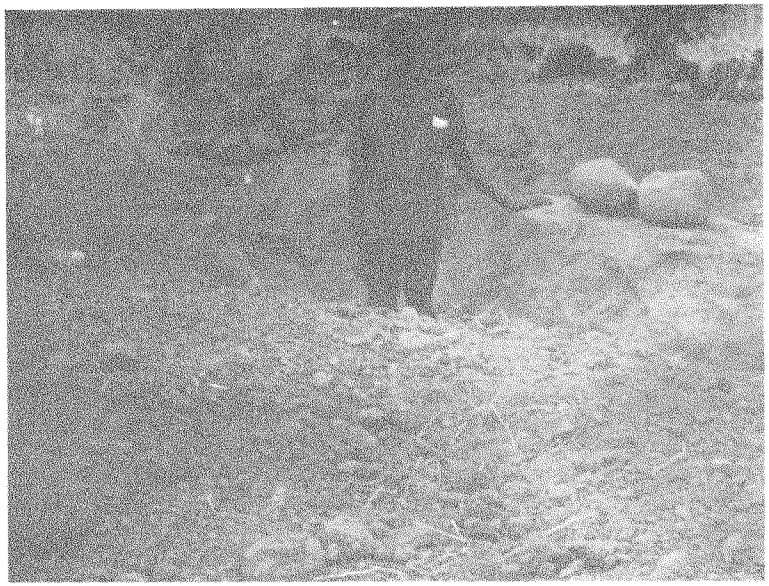


Plate XIV Lawra; blacksmith standing in pit from which ore has been dug. Lumps of ore on the left, lumps of granite used in breaking up the ground by blacksmith's left hand.

Plate XV Lawra; ore being broken into small lumps at smeltingsite.

RITUAL ACTIVITIES

Before work can begin at the iron ore site near Zanlerigu, a fowl has to be sacrificed, as part of a divination procedure, to establish whether the occasion is a propitious one for such work. The fowl's throat is cut and it is thrown on the ground. If the fowl turns onto its back as it dies, it is a good sign. On the occasion of our visit, the local custodian of the earth shrine ('tendaana') was informed of the work and of our purpose in coming to the area. In any matter in which the earth is involved, the 'tendaana' normally has to be consulted. It is a measure of the special position vis-a-vis the earth that the blacksmith holds that it is not necessary to approach the earth through the intermediary of the tendaana. It is merely a courtesy to inform him of the blacksmiths' activities. The earth itself is not supplicated in any way; the killing of the fowl is a divinatory act only. The relation between the blacksmith and the tendaana is the same in Lawra, and appears to have similar elements in all the other villages except Chiana. At Lawra, however, the blacksmiths were said formerly to have begged the earth to allow them to remove the ore, although this was not done while we were there.

When the ore is moved to the smelting site it may be protected from the effects of evil spirits. A sprig of acacia is put on top of the pile of ore at Zanlerigu. A ring of wood ash is also put round it on the ground, marking a barrier both for the spirits outside and those inside that may cause harm if they get out. The same ring of ash is also put around the shaft when it is completed and before it is inclined, in preparation for the smelting operation; this protects pregnant women passing near the shaft from the harmful effects of the structure, which may cause them to have a miscarriage. The iron ore at Jefisi is protected with some of the feathers of a fowl sacrificed on the shaft to ensure the success of the smelt. No precautions were taken at the smelting site at Chiana, but the whole area of the iron-ore site is regarded as sacred ground by the people of Chiana, and was forbidden to those who were not blacksmiths. No precautions were taken at Lawra or Tiza specifically to protect the ore. However, in the former place a piece of grass stalk was put on top of the pile of charcoal at the smelting site to protect it and the area in general from the ill-effects of menstruating women. At Tiza, neither the iron ore nor the charcoal was protected during the smelting operations themselves, but during the charcoal-making process, the mound was surmounted by a bunch of leaves of the same type as was used inside. In addition, the forked stick that had been used to manoeuvre the hot logs was put on the mound. These objects showed the blacksmiths now dead that they had not been forgotten, and thereby dissuaded them from interfering with any aspect of the work.

The smelting operation itself is usually preceded by sacrifices of fowls to ensure its success although at Jefisi and Garu this was done using a dog. This is necessary because the iron comes from stones in the earth, disturbing which is ritually dangerous. Throughout West Africa the earth is approached with care because it is the source of food and livehood. Thus the iron-smelters have to propitiate the earth before they begin to smelt. In addition there are malevolent spirits which are ready to contribute to the downfall of any enterprise; these too have to be guarded against. Divination to find the time when these influences will be least harmful is either done with a fowl as at Zanlerigu, or with white cowries, which was done at Jefisi. Where there are many sacrifices of fowls which are not divinatory, as at Chiana and Lawra, they may each seek to propitiate a different supernatural entity. An alternative explanation is that the fowls and dogs are opening gambits offered before permission is sought to proceed, or as a prelude to giving the information that the work is about to start. The pouring of libation also serves the same function. Another element in the sacrifice may be a technical one. Blacksmiths always say that sacrifices are necessary; without them the iron could not be produced. While this is in part no doubt a way of accounting for the sacrifice without giving away secret information, there may be some significance in it. The sacrifice is as much a part of the process as pounding the clay or shaping the rim of the shaft, and has for the blacksmith the same functional position.

At Lawra, one male fowl was sacrificed on the 'navel' of the shaft (see plate II). This is the repository of the agent through which the iron is smelted; it is as a result of this sacrifice that the necessary goodwill is released to allow the smelting to proceed. Another fowl is sacrificed on a small stone inset into the support at the back of the shaft in order to propitiate the earth. A third fowl is sacrificed next to the bellows pumps in order to bring the attention of the elders to the work that is about to start. A fowl and a guinea-fowl are sacrificed at the shrines of the ancestors; their permission is being sought for the work to begin. Four small fowls are sacrificed at the four cardinal points, some way away from the site; the blacksmith in charge of the smelt was unsure of the purpose of these, but carried them out because he remembered his father doing the same. They may be 'general purpose' precautions to keep harmful spirits, of whatever nature, away from the smelting area. At Zanlerigu, Jefisi and Tiza sacrifices are also made at the 'navel' or equivalent place on each shaft; it is essential for the efficient working of the furnace in each case. The shafts at these four places are each marked with a cross in white ash, the bars of which converge at the place of sacrifice. The chief blacksmith at Lawra said by way of explanation for these marks that they served the same function

as the label on a tin of pilchards: they indicated what was inside. Elsewhere it was merely said that they were essential to the process. At Lawra and Jefisi the sacrificed fowl are roasted by the heat of the furnace and eaten by those taking part in the smelt. At Garu, a libation of millet gruel is made on each side of the shaft, over an iron stake set in the ground. At Chiana no sacrifices are made on or near the furnace itself, but eight fowls are sacrificed to individual ancestors by individuals among their descendants. They are sacrificed at the house shrine of the first compound to be built in the blacksmiths' quarter of the town. The incantations accompanying the sacrifices indicate that the ancestors are being propitiated on the occasion of the visit of strangers who are interested in witnessing the iron-smelting process. The sacrifices therefore had in this instance nothing to do with the smelting itself.

THE SMELTING PROCESS

Smelting is usually done between dawn and dusk on one day. The only exception noted was in a report from Zuarungu, a place where no reconstruction took place; here the operation starts at dusk and continues until dawn of the next day. If the shaft has been used the day before, it is cleared through the hole where the new tuyere will be inserted. At Chiana it is cleared through the slag-tapping hole. The shaft is then filled with guinea-corn stalks which are lit at the base (plate XVI). At Zanlerigu the flame for the lighting is taken from a specially-lit fire by the local Tendaana, who seeks the help of 'unseen powers' in the undertaking; in other places, however, this is done by one of the blacksmiths without ceremony. When the blaze has died down the embers are flattened in the base of the shaft, and left to smoulder. The tuyere is fitted into the hole with slabs of fresh clay (plate XVII). The blacksmith with the greatest knowledge is entrusted with this work since the positioning of the tuyere in the hole and especially the angle its axis makes with that of the shaft is crucial. At Chiana the two tuyeres are fitted into their holes, and wedged in place with clay. At Lawra, Tiza, Jefisi and Garu some provision is made for the slag-tapping orifice beneath the tuyere. During the preparations for the first smelt at Lawra only perfunctory measures were taken to make such a hole, but on the second day, more sustained efforts were made to provide a workable hole since this made slag-tapping easier throughout the smelt. At Jefisi and Garu a distinct arch was formed in the fresh clay; this was plugged at first with clay, and during the smelt itself with charcoal and ash. At each place except Chiana and Tiza a depression in the ground in front of the tuyere is made to take the slag outflow; at Garu this takes the form of a definite pit into one end of which the shaft is fitted. At Chiana the slag

Plate XVI **Jefisi; guinea-corn stalks lit in the shaft at start of smelt.**

tapping hole opens onto a gulley which extends 33 inches (84cm.) radially from the shaft. A branch of wood is put into the hole and packed around with termite-hill clay; after a few minutes the branch is removed, leaving a hole through which the slag flows out. It is left open at the beginning of the smelt and later is blocked up with the slag itself.

When the tuyeres have been fitted, the bellows bowls and pipes are put into position. At Lawra, Tiza and Jefisi the bellows on their pedestals are placed in front of the shaft, then the pipes are fitted into the holes in the bowls, clay being used to seal the joint. The further ends of the pipes rest on the tuyere lip. Care is taken to align the axis of the tuyere hole with that of the pipes so that there is the least impediment to the flow of air. Once the pipes are fitted the skins are lashed onto the top of the bowls with vegetable fibre string. In Zanlerigu and Chiana the fitting of the bowls and pipes is done in one operation, the bowls being kept in position by large stones wedged against the short pedestals. At Garu the two pairs of bellows are simply leant against each other.

At the same time as the pumps are being placed, some charcoal is put into the shaft. This keeps the embers in the bottom of the shaft alight. As soon as the skins are fitted the bellows are blown a few times to test them and to make sure the fire is alive. The shaft is filled with more charcoal and iron ore (plate XVIII). At Lawra, Tiza and Jefisi the ore has been broken up into pieces about 1½ inches by one inch (4cm x 2.5cm) (plate XV); at Zanlerigu larger lumps are used. At Chiana the ore is dug up in pea-sized lumps which do not need to be broken up; the ore is merely winnowed to remove lighter particles. At Garu similarly the ore is in small lumps; nevertheless most of these are split in half with a wood stick. The same kind of ore was said to have been used at Zuarungu. At Chiana the ore is put in the shaft after a small amount of charcoal; half the total amount of ore is used up at this time, and is covered with charcoal which fills the shaft. At the other places the ore is put in a handful at a time, always at the very top of the shaft, when it has been filled with charcoal.

Pumping begins as soon as the shaft has been filled. At Lawra, Zanlerigu and Jefisi there are conventions about the length of time the first pumper should stay at his post. At Lawra it was said before the demonstration was put on that the first pumper must continue until noon without a break or any food or drink. After he has handed over to another person the bottom of the shaft would be opened to let out the slag. When we witnessed the demonstration at Lawra slag was tapped for the first time 109 minutes after the pumping began; the first pumper was not relieved until 43 minutes later, at 9.10 a.m. Because this

Plate XVII Zanlerigu: tuyere is fitted in place with clay

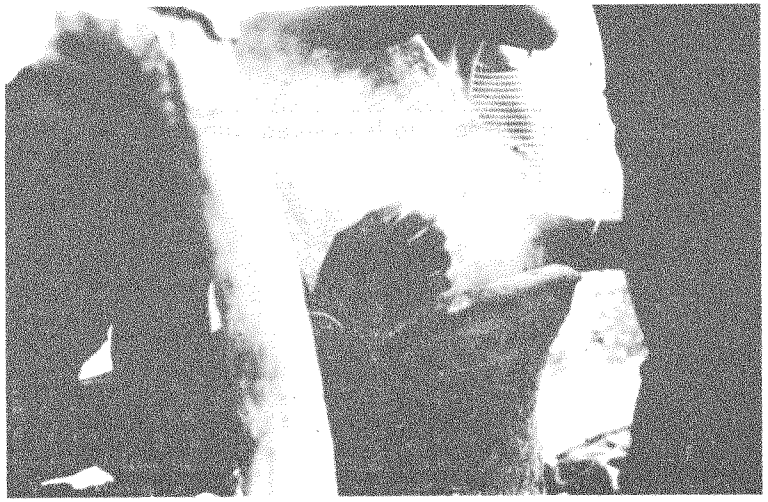


Plate XVIII Chiana: shaft being loaded with charcoal.

man was also one of those who had experience of the smelting process, he had momentarily stopped pumping during this period to clear the tuyere hole of slag (and also to blow his nose) four times. He did not take the millet porridge that was being handed round to the other workers until he was relieved at the pumps. The first calabash of pito was not taken until after 9.10 a.m. At Jefisi the first pumper was changed after the slag was first tapped, which occured 78 minutes after pumping began. At Zanlerigu, the first pumper had a rest after the first refill of iron ore, 71 minutes after the start. Here the shaft was not refilled with ore until the level in the shaft had fallen halfway down it. At neither Chiana, Garu nor Tiza did there appear to be any special rule about the length of the first pumper's stint. In all places the changes of pumpers became more frequent as the day progressed. Women are not debarred by their status from pumping, but the blacksmiths are of the opinion that few women have the necessary strength for the work; at Zanlerigu, however, three women, all related to the blacksmith in charge, pumped for short periods during the day. At Garu it was said that formerly the whole iron-making operation could be performed by a blacksmith and his wife or wives and children.

Preparations are made to tap the slag when it is judged that the lower part of the shaft is full of the molten material (plate XIX). At Jefisi the slag was to have burst through the thin membrane of crushed charcoal and ash when sufficient pressure had built up, but in the event some help from an iron spike was required. Here also one blacksmith was in charge of keeping the tuyere hole free of slag with the same iron spike. It is by keeping constant watch on the condition of the fire that he knows when to open the bottom of the shaft. At Zanlerigu the slag even at the beginning was a very dull red colour and flowed sluggishly; later it had to be pulled out. At the first smelt at Tiza the slag soon became dull after the first few tappings. In each case this was the first indication that the smelt was unsuccessful. At Lawra, Jefisi and Garu slag flowed in all smelts and in Lawra the furnace was almost self-tapping. At both smelts in Chiana the slag had not flowed, but was gouged out with an iron spike, it was black and in small particles. The first smelt was successful, the second was not. Although elsewhere the holes were given constant attention, at Chiana they were not touched. This may have been because the slag was of a different consistency. This was also the only furnace where the inlets of the tuyeres in which the ends of the pipes were placed were blocked with shaped slabs of clay.

Everywhere but Chiana the additions of iron ore were interspersed with additions of charcoal (plate XX). It is made sure that whenever ore is put on top of the shaft, it is covered with a small amount of charcoal in order to reduce the surface ex-

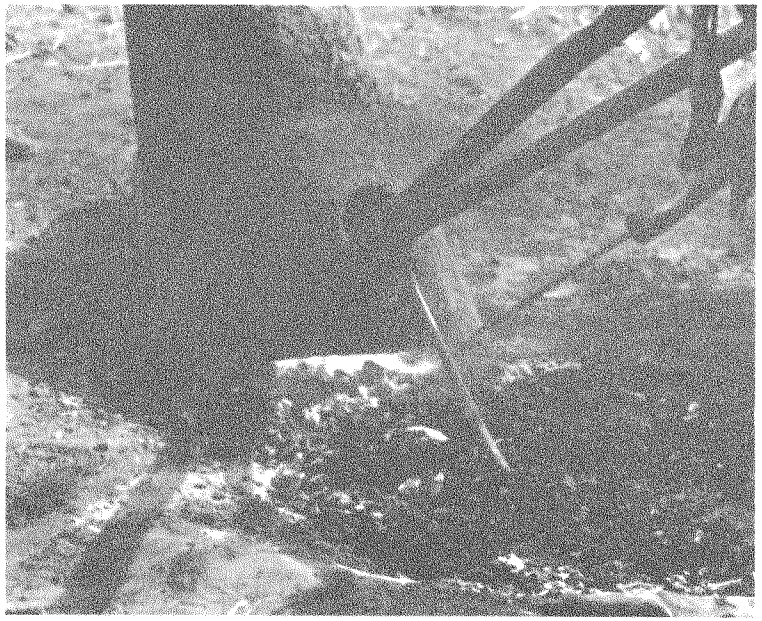


Plate XIX Lawra; slag being tapped.

Plate XX Garu; shaft being charged with basketful of ore.

posed to the air. It is necessary for the particles of ore to mix intimately with the carbon monoxide generated from the carbon in the charcoal. It is usual to add about four times the volume of charcoal to ore, but this varies in detail from place to place and smelt to smelt. At Chiana, ore was put in on two occasions only, at the beginning and after forty minutes. At Tiza and Lawra, other objects were put into the shaft, both through the tuyere opening and in the top. These were chopped roots and stalks of various shrubs, all of which were said to be necessary in the process of separating the iron from the slag. The names for the substances were the same in both localities. It was said that the smelt would not be successful if the substance were not included.

It was only possible to measure the temperatures of the furnace at Lawra. At the base, after one hour's pumping, the thermocouple read 1050° C, rising to 1100° C ten minutes later. The temperature at the top of the shaft was 350° C at this time. The following day when the bloom produced was in a more compact mass, indicating that the temperatures were in excess of those on the first day, it was unfortunately not possible to measure them as the thermocouple had broken.

Smelting is often accompanied by music. In Zanlerigu there was a great deal of singing and dancing, but it occurred as much because the occasion was a special one as because it was a normal part of the smelting operation. However, songs sung on this occasion were all associated with smelting, and would have been sung during smelts in former times. At Lawra and Chiana songs extolling the virtues of the blacksmiths' clan were sung. Although the rhythms kept in time to the pumper's beat, they were not sung to keep him to a certain rhythm. Each pumper has his own rhythm from which he does not deviate more than five strokes per minute on either side. The songs appear to be sung in order to keep the pumper going, since he may be pumping continuously at a rate of 200 strokes to the minute for more than two hours. At Zanlerigu and Gara 2-stringed fiddles were played (plate XXI).

After a certain length of the time, which is either calculated according to the amount of charcoal put into the shaft, or the amount of iron ore added, preparations are made for the final opening of the base of the shaft. The bellows skins are first unlaced and the skins or the complete bellows taken away. At Chiana neither the bellows nor the tuyere need be removed since the shaft can be emptied from the opposite side. Elsewhere the tuyere and clay surround must be taken away, therefore an area in front of the tuyere must be cleared. At Lawra, Tiza and Jefisi the pipes only are removed, but at Zanlerigu and Garu the bellows themselves are taken away. At all these five places the blacksmiths each take a pole which is shot with an adze head

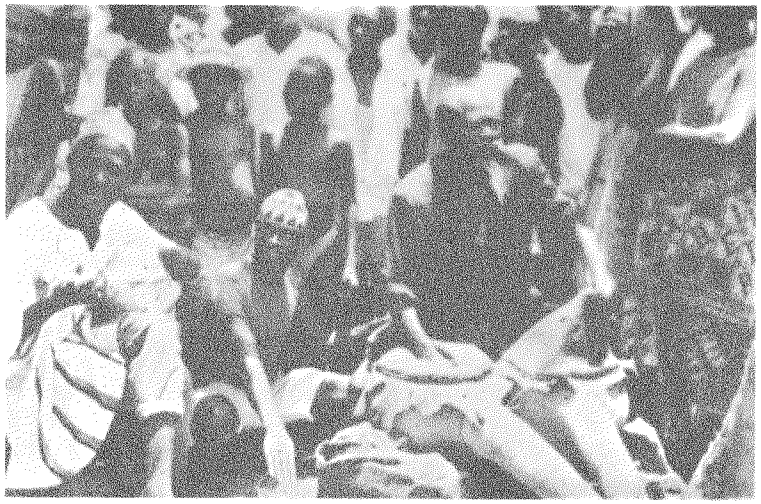


Plate XXI Zanlerigu; music-making.

Plate XXII Lawra; at end of smelt, tuyere is prised away from shaft.

and prise the clay slab in which the tuyere is fitted away from the shaft (plate XII). As soon as the white hot interior of the shaft is exposed, it is splashed with water. The tuyere and surround, together with any adhering slag, is taken to the slag heap which has been forming some way away from the furnace. The remains of the fire are raked and thoroughly doused. There is a black lump of what looks like hard slag seated in the back of the shaft which is pulled out. This is the bloom (plate XXIII). It is doused separately and, with the aid of the mattocks, picked up, to estimate how much iron is in the bloom. At Chiana the furnace as a whole is left overnight and cleared when it is cool the following morning. At the end of the second smelt there the pumps were unlaced at about 6.30 p.m., when it was getting dark, but the fire continued to burn into the night because of the high wind. The following morning the gulley was cleared of slag, the clay plug that had blocked up the hole was removed and the base of the furnace cleaned. The contents were sorted into those that contain iron which is worth consolidating and those lumps which are too low in iron.

Lengths of smelts varied. At Zanlerigu the smelt lasted exactly 12 hours. At Jefisi the smelt witnessed by us lasted 9 hours 10 minutes. At Tiza, the second smelt lasted 9½ hours, the first one having ended prematurely in blockage after 4½ hours. At Lawra, the two smelts took ten hours each. At Garu the first smelt took about 12 hours, the second 8. At Chiana the first smelt was not measured; the second had lasted 11½ hours when the pumping stopped, but it was impossible to estimate how much longer the temperature inside the shaft was maintained by the force of the wind. The smelt at Zanlerigu, the first one at Tiza and the second one at Chiana were unsuccessful. The others produced between one and ten pounds of bloom, of which up to 80% would have been iron (plate XXIV).

In Lawra, where a great deal of charcoal was collected at one time and brought to the smelting site, it was said that smelting would continue day after day until all the charcoal had been used up, even if it meant going back to the iron ore site to dig for more ore. When the charcoal had been exhausted the blooms produced would all be worked into solid iron and made into tools to be sold in the market. At Chiana, on the other hand, each day's bloom was worked the following day at the blacksmiths' forge. It was first consolidated into a solid lump which was then hammered with lumps of granite and iron hammers into the required shape. It was said at Chiana that the furnace would be used two or three times a month for six months between the end of one farming season and the beginning of the next. At Tiza and Jefisi it appears that the furnaces were used consecutively for a number of days before the blooms were converted into solid iron which was then made into tools. The details of

Plate XXIII Jefisi; iron-bloom removed from base of shaft.

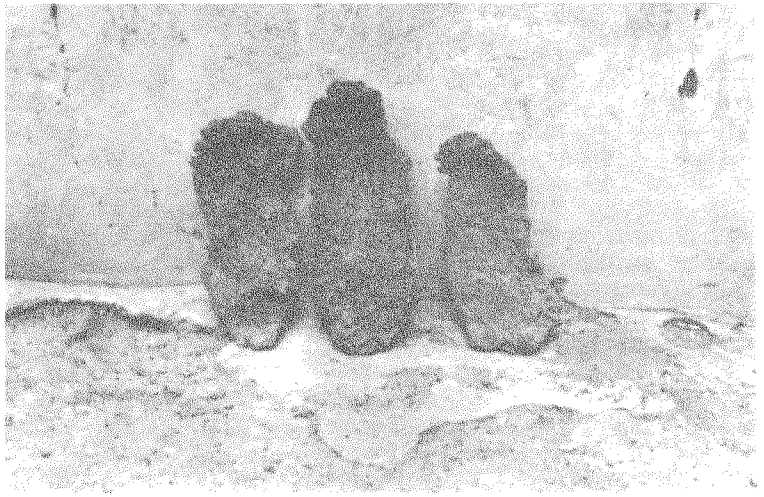


Plate XXIV Lawra; three old blooms kept by chief blacksmith. The length of the middle one is 33cm (13").

this process of forging tools are outside the scope of the present paper.

DISCUSSION.

It can be seen from the above descriptions that the furnaces of this part of Ghana have many features in common, over and above those similarities which are made necessary by technological considerations. However, I believe we are dealing here with two related but distinct technological traditions. One is exemplified at Chiana, the other by the furnaces at the other five places. All of the latter use an inclined shaft. The shaft at Chiana is upright, with tuyere and slag-tapping holes opposed, and uses a kind of ore which produces a less glassy and less voluminous slag. However, comparing the furnaces at Lawra, Tiza and Garu, Jefisi and Zanlerigu, there are also differences. The Zanlerigu and Garu furnaces use low bellows on the pattern of those used at Chiana. The shaft at Tiza is taller and more cylindrical and in use is less inclined to the horizontal than the others. It is moreover made in a different way from those at Jefisi and Zanlerigu. The tuyeres are in each place distinct (figure three). Methods of charcoal making, and the kinds of trees used are also different. As a sub-group, the furnaces at Zanlerigu, Garu and Sinibaga bear closer resemblances to each other than any does to the others. It is therefore too early at this stage to attempt any far-reaching statements about the connections between the similarities and differences in iron-working techniques in parts of Northern Ghana, and the interrelatedness of the communities in which they are found.

However, one preliminary observation can be made about this material. Investigations have been carried out in communities among the Lo-saala, (Lawra), Dagaba (Tiza), Isala (Jefisi), Kasena (Chiana), Namnam (Zanlerigu), and Busanga (Garu) peoples, with additional information from the Nankansi (Zuarungu) and the Kusasi (Sinibaga). Although these groups are distinct to themselves and to each other, their cultures are closely related sociologically. As Rattray says (in the introduction to 'Tribes of the Ashanti Hinterland' p.xi); 'Over the whole area, and embracing the Mole, Gbanya and Kasem-Isal groups we had, it was found, a people who possessed a practically uniform religion, a uniform tribal and totemic organisation and an identical..... system of tribal government, (For tribal distributions see Manoukian (1952) and Goody (1956). In this context it is interesting to note that in addition to the technological differences referred to above, the close relation that exists between the blacksmiths and the spirits of the earth in the Lawra, Tiza, Jefisi, Zanlerigu, Garu group, together with their independence of the sphere of influence of the tendaanas, finds no echo among the blacksmiths of Chiana. In addition, their concern with the ritual aspect of the smelting operation is less marked, although it was very necessary to make sacrifices to the ancestors beforehand, because of the presence of strangers. These distinctions, however, do not exactly reflect the differences in linguistic groupings. The languages of both Kasena and Isala belong to the Gur-Grusi sub-family, whereas the other people speak languages of the Gur-Mossi sub-family except the Busanga whose language belongs to the Mande family. The Busanga of Garu are in any case an intrusive element in a predominantly Kusasi area, and present a number of additional anomalies.

This lack of cohesion between different types of evidence indicates that future research in the area is urgently required, especially in the technological sphere. The blacksmiths among whom the National Museum staff worked are in their 60's and 70's, and cannot be expected to last more than a few years. If they are not contacted within the next decade, their knowledge will die with them.

REFERENCES

Charles,, L.	1911	Les Lobi. Rev. Ethnol & Soc., II, 202-220
Cline, W.	1937	Mining & Metallurgy in Negro Africa. General Series in Anthropology. (Menasha/Wisconsin).
Davies, O.	1967	West Africa Before the Europeans. Methuen/London. Ch. 5
Davies, O.	1971-73	Ghana Field-notes. (U. of Ghana Dept. of Arch./Legon.)
Geological Survey	1931-32	Primitive Iron-smelting furnaces in Wassaw. Gold Coast Geological Survey Annual Report. 1931-2, 16.
Goody, J.R.	1967	The Social Organisation of the Lowiili. (IAI. OUP/London).
Hupfeld, F.	1899	Die Eisenindustrie in Togo. Mitt. a.d. Deutsche Schutzgebieten, XII, 175-194.
Junner, N.R.	1936	Native iron-smelting furnaces in Lawra district. Gold Coast Geological Surv. Ann. Rep., 1935-6, 36-7.
Labouret, H.	1931	Les tribus du rameau Lobi. Trav. et Mem. Inst. Ethnol. Paris, 1931, X
Manoukian, M.	1952	Tribes of the Northern Territories of the Gold Coast. IAI Ethnog. Surv. W. Africa, No. 5.

Nunoo, R.B.	1957	Excavations at Asebu on the Gold Coast. J.W. Afr. Sci. Assoc., v.III, 12-44.
Nunoo, R.B.	1970	Excavations at Beifikrom; in Calvocoressi, D.: Report on 3rd Conference of W. African Archaeologists. W. Africa. Arch. Newsletter, XII, 73-4.
Penfold, D.A.	1972	Excavation of an iron-smelting site at Cape Coast. Trans. Hist. Soc. Ghana, XII, 15.
Rattray, R.S.	1916	The iron-workers of Akpafu, J. Roy. Anth. Inst., XIX (NS) 431-435.
Rattray, R.S.	1923	The Ashanti. (OUP/London.)
Rattray, R.S.	1932	The Tribes of the Ashanti Hinterland. (OUP/London.)
Ruelle, E.	1904	Notes sur quelques noires du 2me territoire militaire de l'AOF. L'Anth., XV, 657-703.
Shaw, T.	1969	An iron-smelting furnace excavated in Ghana. Bull. Hist. Metall. Gp., III, 48-53.
Wild, R.P.	1931	An unusual type of iron-smelting furnace at Abomposu. Gold Coast Rev., V, 144-7.

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POTTERY IN UPPER REGION

by Barbara Priddy
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Pottery is one of the most conservative of crafts. Since the first discovery of pottery over eight thousand years ago in the Near East, the techniques flourished virtually unchanged except in detail until the invention first of the potter's wheel in the same area over five thousand years ago, and then of mass-production, in England in the eighteenth century. There were however large areas of the world which were unaffected by these inventions, and over most of Africa pottery continues to be hand-made in small quantities.

Pottery is still made by the traditional methods in every region in Ghana, but in the face of competition from both imported and locally-made iron and steel, aluminium and enamel, mass-produced china and wheel-turned earthenware and stoneware, it is generally in decline. There are exceptions: among some people, such as the Shai of the Accra plains, it is practically obligatory for every girl to learn the art of pottery-making in order to be accepted as a full member of the community — 'God has given us pottery-making as our work' they say. In other places, special types of pots which have no modern substitutes — vegetable grinders or palm-wine pots, for example — continue to be made to supply a steady demand. Among the most culturally sophisticated people there is a swing away from the idea that European-type goods are the most prestigious, and a demand for a return to the wares of one's forefathers; while among the least sophisticated rural dwellers in the older age groups there is a demand that has never ceased for pottery cooking-pots, serving dishes, food-bowls, water-jars and so on.

In general, the further north one travels the more traditional pottery one finds being made for everyday use. In Upper Region, whose headquarters, Bolgatanga, is about 350 miles almost due north of Accra, the capital, on the coast, no village is without a potter, while in many villages no compound is without a potter. Hand-made pottery is used for every conceivable purpose: there are enormous jars for brewing and storing corn-beer and storing water (Fig. 1); smaller jars for fetching water and keeping corn-beer; measures in which corn-beer is sold; water-coolers (Fig. 2); cooking-pots of different sizes; mixing-bowls, food-bowls and soup-bowls (Fig. 3); colanders (Fig. 4); wash-hand bowls; small jars for storing shea-butter, large bowls for boiling the oil to make shea-butter, and large pots for pounding the nuts to extract