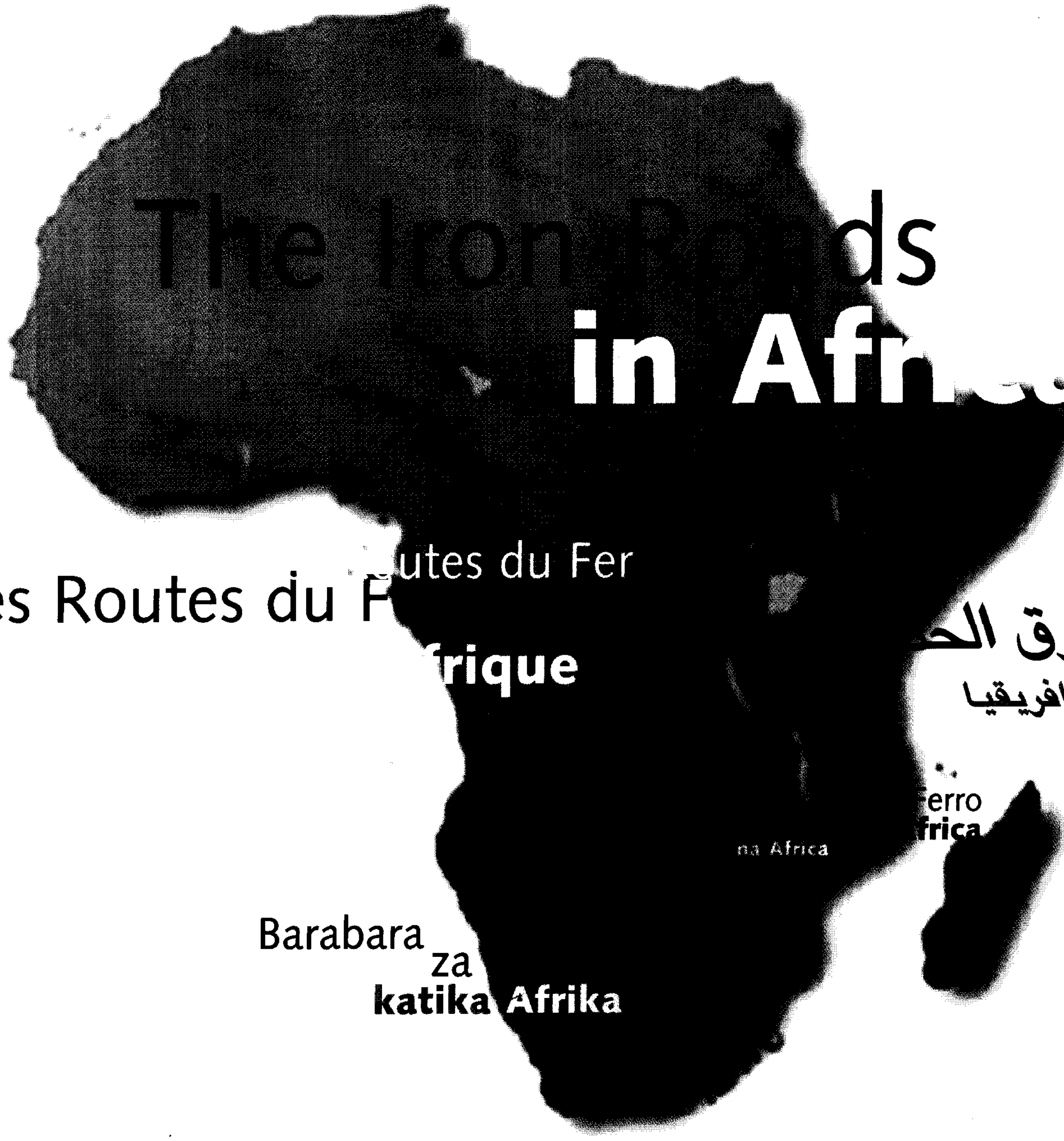
Department of Intercultural Dialogue and Pluralism for a Culture of Peace



The Iron Roads in Afri

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EXHIBITION • The Iron Roads in Africa

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- Musée de l'Homme, Paris
- Metallurgy and Cultures Laboratory, UMR 5060, Centre national de la recherche scientifique (CNRS), Université de Technologie of Belfort-Montbéliard

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SUPPORT

USINOR, SNIM, Musée de l'Homme, Royal Museum of Central Africa (Tervuren), National Museum of Mali, National Museum of Ethnology (Leiden), Présence Africaine Editions, Logostyle

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A preliminary version of the travelling exhibition was first presented at UNESCO Headquarters, Paris, from 26 October to 17 November 1999
with the support of the Permanent Delegations to UNESCO of Nigeria, Benin and Angola, and with the collaboration of the Priority Africa Department, the Histories and Culture of Peace Unit and the Unit for Handicrafts

CLT-2000/WS/3

When I heard that the Department of Intercultural Dialogue and Pluralism for a Culture of Peace, in partnership with the Musée de l'homme, was preparing a travelling exhibition as part of the Iron Roads in Africa project, it was a most welcome piece of news. As director for 25 years of the archaeological museum and the art galleries of the Central Bank of Ecuador, I was, and still am, particularly interested in museum activities.

This exhibition is in fact unique of its kind. As we see in this illustrated brochure – an introduction to the major travelling exhibition now being prepared – UNESCO decided to mount an exhibition for its Member States and the general public on the ironworking wealth of the African continent.

Few people know that thousands of years before the Christian era, the Africans had mastered the techniques of transforming iron ore into metal. Few people know that long before the colonial period the Africans had dug deep underground tunnels to mine iron ore on a near-industrial scale. Few people know that before colonization – that is, before the industrial revolution in Europe – Africans were building ore-reduction ovens up to more than six metres high.

Similarly, little is known about the role played by the blacksmith in African societies, or the role of iron as a valuable commodity in the development of metropolises in ancient Africa. Little is known of the virtuosity of these artists, who designed and worked tools, jewellery and ornaments in iron. Today, we should be encouraging African artists and artisans who use recycled iron to create utilitarian objects and works of art.

In UNESCO's approach to promoting cultural development, that is to say economic development which has a cultural basis, it is clear that these objectives are fully incorporated in the Iron Roads in Africa project, launched in the framework of the World Decade for Cultural Development. The aim of the exhibition is not simply to present the more or less distant past of Africa. While it will certainly enhance the continent's image in the eyes of the world, its aim is also and above all, thanks to the Iron Roads in Africa project, to link up a revitalized technological heritage with the needs of the modern world. Metallurgy laboratories, such as the one directed by Philippe Fluzin in Belfort, France, are taking a close look at these vestiges of the past, since by studying the internal structure of objects discovered during archaeological digs, specialists can learn about the ore-fusion techniques used to produce ancient metals, and also how to manufacture the steel of the future.

It is therefore with great pleasure that I pay tribute to the efforts of those responsible for this project, which furthers the aims of the Stockholm and Florence Conferences and fully reflects the concerns raised by the ministers of culture at the round table held on 2 November 1999.

On behalf of the Director-General, I would like to thank the partners supporting this project – the Usinor group, the Société Nationale Industrielle et Minière of Mauritania, the publishing house Présence Africaine, Logostyle, all the exhibition organizers, led jointly by Hamady Bocoum and Pierre de Maret, and the UNESCO staff in the Priority Africa Department, the Unit for Handicrafts and the Histories and Culture of Peace Unit, who voluntarily offered their services, alongside the Division of Intercultural and Interreligious Projects, to enrich the substance of this exhibition and ensure its success.

Hernan Crespo-Toral
Assistant Director-General for Culture

12 November 1999

UNESCO

Iron in Africa

The aim of this exhibition presented at UNESCO Headquarters from 26 October to 17 November 1999 was to give Member States a general idea of the multidisciplinary travelling exhibition that the Department of Intercultural Dialogue and Pluralism for a Culture of Peace is preparing with the assistance of eminent archaeologists, anthropologists, historians, geographers, metallographers and palaeometallurgists from Africa, Europe and America, and two industrial groups – USINOR and SNIM.

The exhibition is expected to be on display first in a major Paris museum, where it will stay for three months before beginning its long circuit across the African continent.

It will be divided into five major sections, focusing on the importance of iron in people's lives, the antiquity of its manufacture in Africa, the virtuosity of African iron founders, smiths and artists working in iron, past and present, the cultural significance of ironmasters in African societies, and the importance of studying the ageing of iron for the preservation of our heritage and the development of new materials.

Gou, copper alloy
Porto-Novo, Benin (private collection)
Photos: Cyril Bailleul

This statue stood as if welcoming visitors at the entrance to the UNESCO exhibition. It is reminiscent of the celebrated god Gou, an exhibit at the Musée de l'Homme in Paris.

The god Gou of the Musée de l'Homme, which has influenced a number of sculptors, stands 165 cm high. That statue was fashioned in the nineteenth century from scrap iron from Europe.

The god of metal, Gou ensures success in battle. He is traditionally the god of blacksmiths and, more recently, of mechanics.

Iron

The Tunisian man of letters Mohamed El Tounsy, who travelled to Darfur (Chad) and Oudaï (Sudan) between 1803 and 1813, praised "the really marvellous skill" of the people making iron and wooden objects, which had "a finish one would think the work of skilled European craftsmen".

He recorded that a "speciality of Fertit is the manufacture of arms from the abundant iron ore in the region". He described lances bought from the Banda and Kara, fine javelins made by the Goula, and daggers fashioned "with, as it were, English skill".

He admired the stems of iron pipes "worked with amazing purity and beauty. The stems are curved and twisted like some European pipes, but they are more elegant, more graceful, and have such a flawless, brilliant polish, they seem to be made of silver".

P. Kalck,
Histoire de la République centrafricaine, 1974, Paris – éd. Berger-Levrault.

Votive head-rest in Tellem iron (eleventh to twelfth century),
from a burial cave, Bandiagara cliffs (Mali)
H: 9.4 cm L: 12.2 cm. *(Excavations: R. Bedaux, National Museum of Mali)*

Ankle bracelet in iron,
from an iron excavation site at Nyeme in the province of Bougouriba (Burkina Faso). The interlacing twisted threads are another example of the high degree of precision of ironworking techniques in Africa.
Diam.: 12.1 cm; weight: 893.1 g.
(Excavations: J. B. Kiethega)

What is important in a salvaged object is not its beauty or its rarity but the flash of insight it produces as the observer realizes the possibility of its transformation. Creation is therefore the product of the convergence of ingenuity and skill in a variety of forms, of a talent for tinkering that by soldering and glueing succeeds in fashioning an ideal object.

Creation is also a game – the game of building with random components. It not only involves necessity and thought but is also a challenge presented to imagination by a somewhat drab or lifeless reality: it is the way the intellect and fantasy can take revenge against the heaping up of objects destined for annihilation but that can be incessantly resuscitated, a gleeful bonus being the fact that they come free of charge.

J. Etienne-Nugue

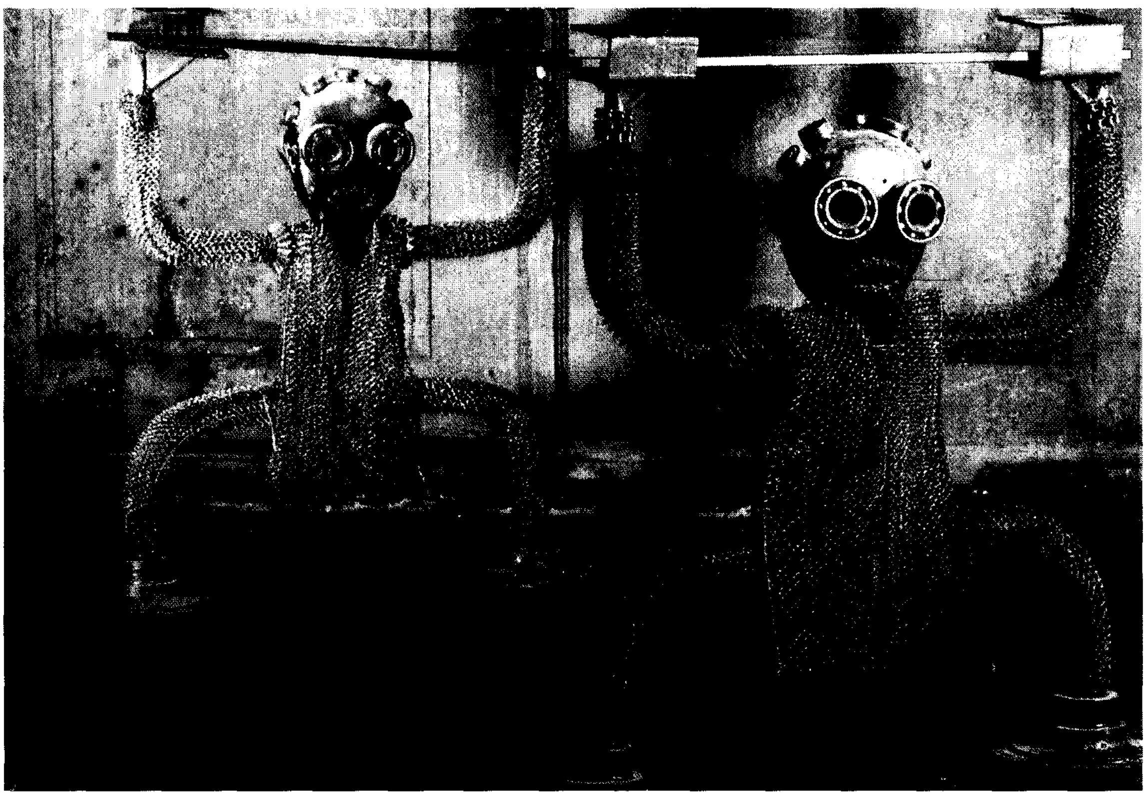
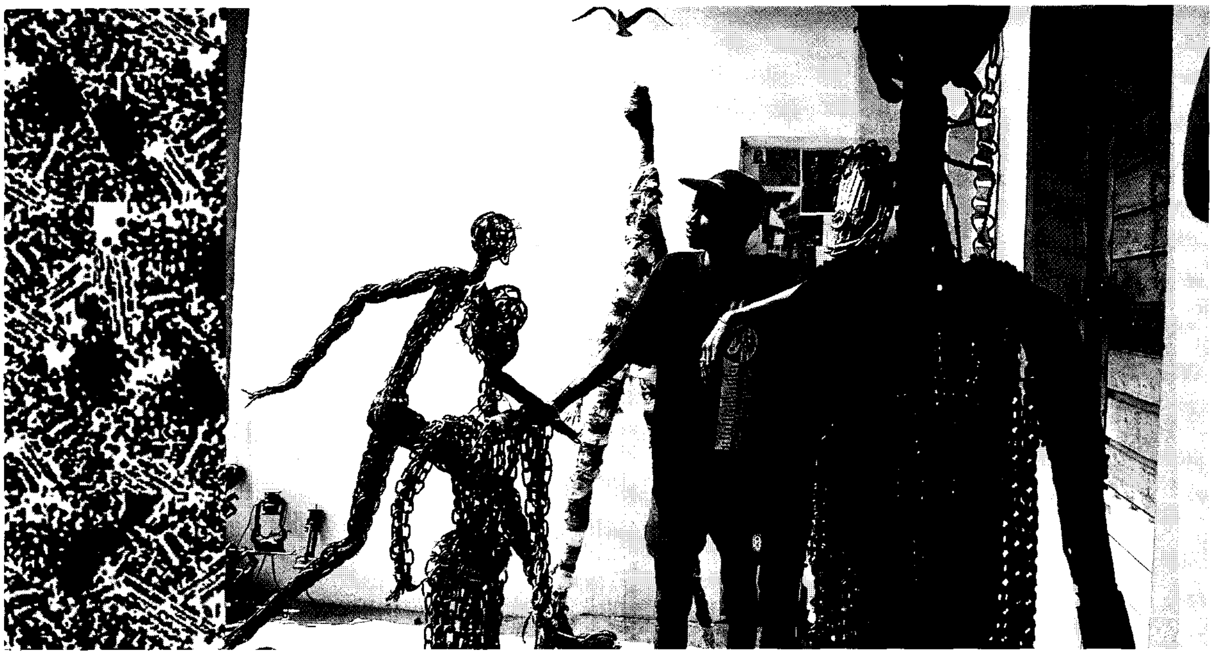


Table-top on a base of two iron figures created from recycled car parts
Design: Ouedraogo-Burkina Faso 1987/Collection Alcantara

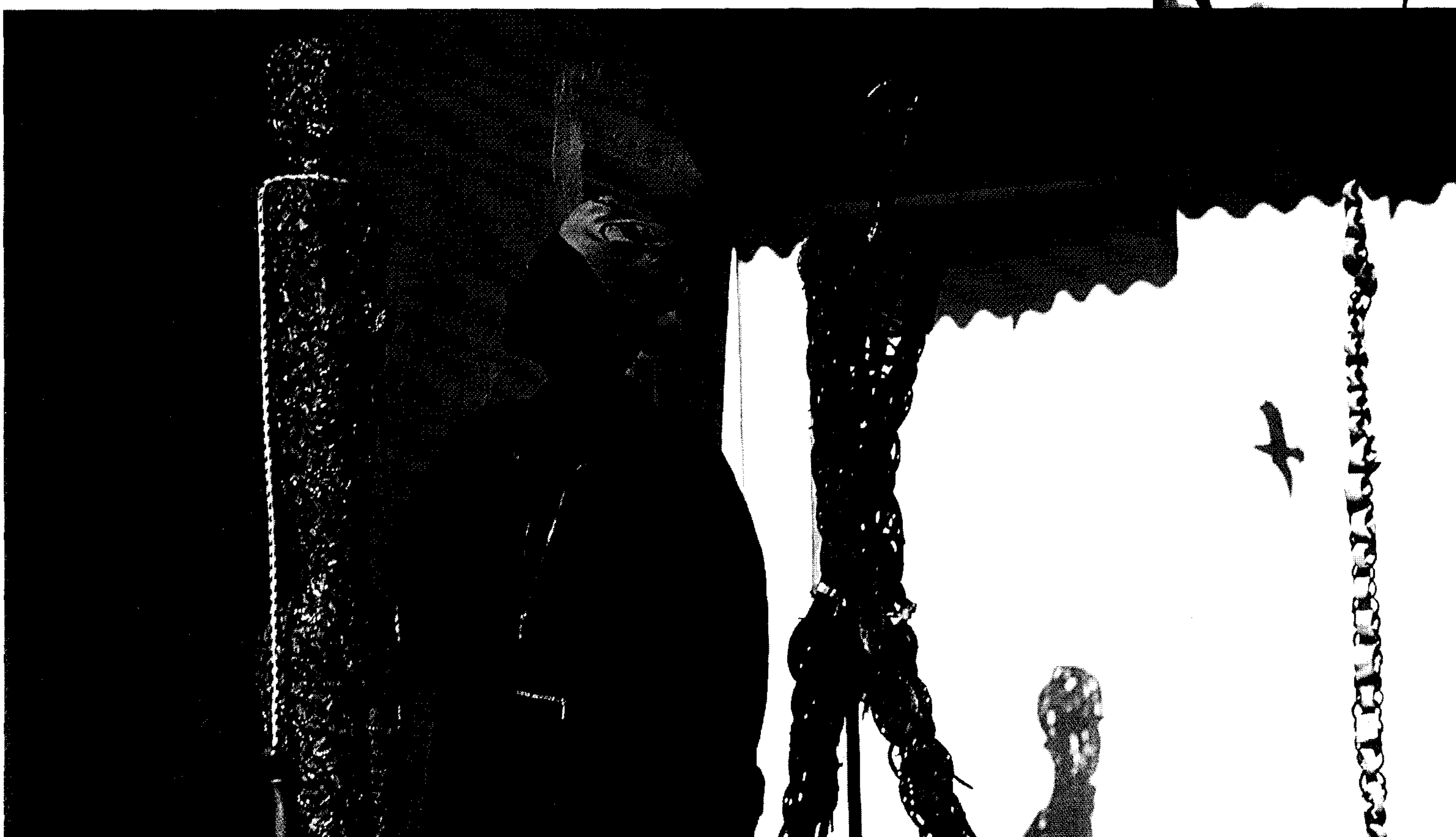


Ndary Lo in his workshop in Dakar
Photos: Francine Vormese

Elsa Despiney tells how in August 1997 Ndary Lo went to the Francophone Games in Madagascar, attended by artists from various countries.

They all gathered in a large clearing to create a work which would symbolize the cultural aspect of the games. As Ndary Lo could not work in metal because there was no electricity, he used wood instead, nailing Coca-Cola bottle caps into it. And so the "daptaist" movement was born.

For Ndary Lo, "Daptaism" is working with what the environment has to offer. It also means respect and tolerance for other cultures and, quite simply, for the Other.



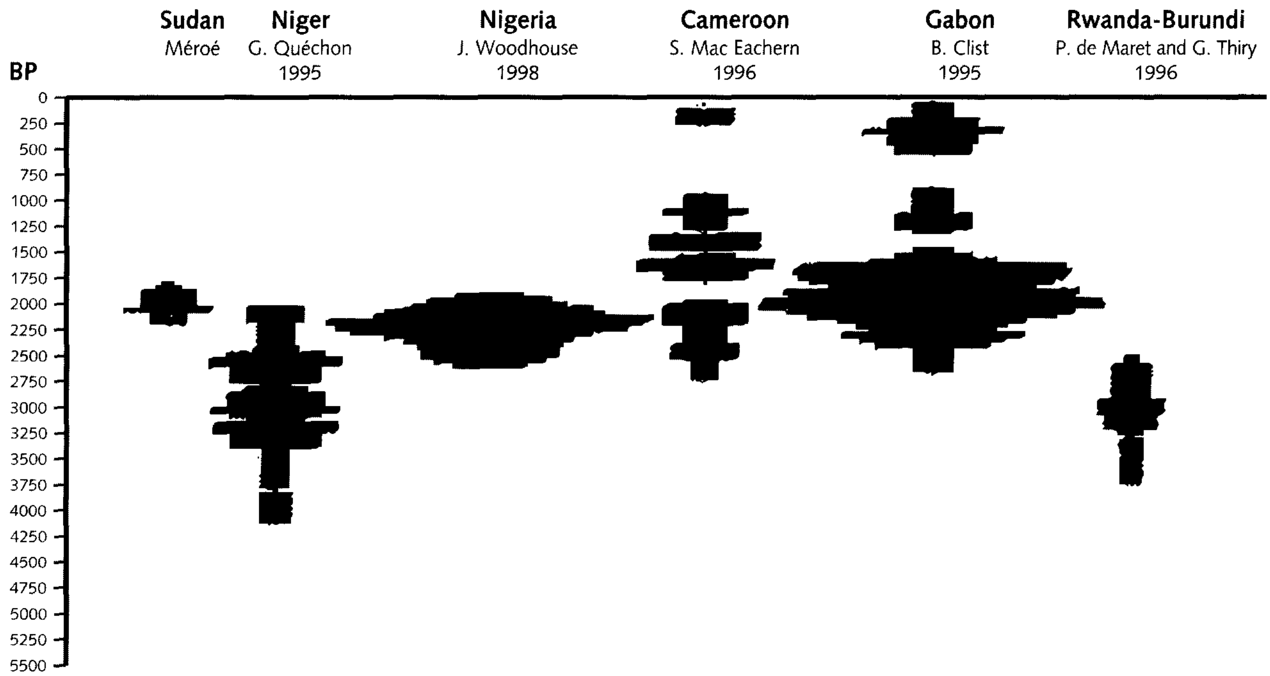
Iron

Africa

Assuming that there had been a single centre from which the iron metallurgy spread, most historians thought that ironworking had been introduced into Africa from western Asia, first into ancient Egypt and then into West Africa in the third century B.C., either via Carthage or from Nubia.

Between 1969 and 1974, some dating suggested the ninth to tenth centuries B.C. for the relics in Taruga-Nok (Nigeria), the seventh to tenth centuries B.C. for the iron in Termit (eastern Niger), while iron did not appear in Tunisia until the seventh century B.C. The reliability of this dating nevertheless remained a matter for debate. There was evidence that there had been iron in Napata in Nubia in the late eighth century B.C., while the age of the slag in Meroe was still a matter for conjecture.

Further research revealed both that the Meroe iron dated only from the sixth century B.C. and that ironworking in Termit certainly dated back to at least 1500 B.C. Some dates of around 1200 B.C. have been obtained near Lake Victoria-Nyanza and in Cameroon. West of Termit, in Egaro, the dates go back to 2500 B.C. and beyond. If they are confirmed, the antiquity of sub-Saharan ironworking will be similar to that of the Middle East. Its endogenous nature is in any case clear. Many sites await excavation and dating. Some of them may well conceal evidence of even more ancient ironworking.

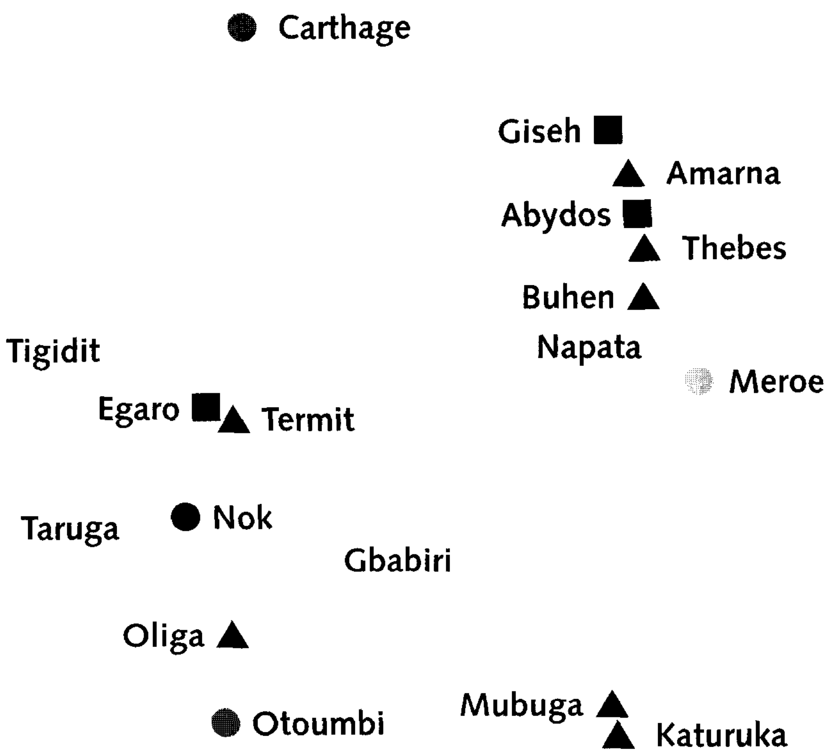


Based on archaeological studies published over the last five years, this table presents a comparative chronology of ironworking in Africa using statistical treatment of carbon-14 dates.

The dates are expressed in years BP (Before the Present) whereby convention zero represents the year 1950. The surface of the histograms is proportional to the number of dates taken into account.

The table shows that iron appeared in Africa a long time ago, a fact that is not compatible, in terms of present knowledge, with the notion of borrowing from the Mediterranean world, still less from the Meroe region. It also shows that the initial dates are not isolated, since they have been confirmed by findings obtained subsequently in other regions.

Gérard Quéchon/Alain Person



Iron metallurgy in Africa from the third millennium to the fifth century B.C.

■ Third millennium B.C.
- Egaro, eastern Niger, -2 900/2 300 -2 520/1 675 *(G. Quéchon et al., 1992)*
- Giseh, Egypt, -2700 *(C.A. Diop, 1973)* -2 565/2440 *(J.P. Mohen, 1990)*
- Abydos, Egypt, -2 345/2 181 *(J.P. Mohen, 1990)*

▲ Second millennium B.C.
- Buhan, Egyptian Nubia, -1991/1786? *(J.P. Mohen, 1990, 1996)*
- Termit, eastern Niger, -1870/1130 *(G. Quéchon, et al., 1992)*
- Amarna, Thebes, Egypt, - Fourteenth century Eighteenth/Nineteenth dynasties *(C.A. Diop, 1973; J.P. Mohen, 1996)*
- Mubuga, Burundi, -1230/1210 Kuturuka, Tanzania, -1470/1030 *(M.Cl. Van Grunderbeek, 1982)*
- Oliga, Cameroon, -1300/800 *(J.M. Essomba, 1999)*

● Tenth century B.C.
- Nok, Nigeria, -925/±70 *(A. Fagg, 1972)*

Ninth century B.C.
- Oliga, Cameroon, -1256/500 *(J.M. Essomba, 1999)*
- Taruga, Nigeria, -880/400 *(R. Vernet, 1993)*
- Gbabiri, Central African Republic, -903/796 *(E. Zangato, 1999)*

Eighth century B.C.
- Napata, Sudan, end eighth century Piankhy (-713) *(J.P. Mohen, 1990 and 1996)*
- Tigidit, Niger *(D. Grébénart, 1988)*

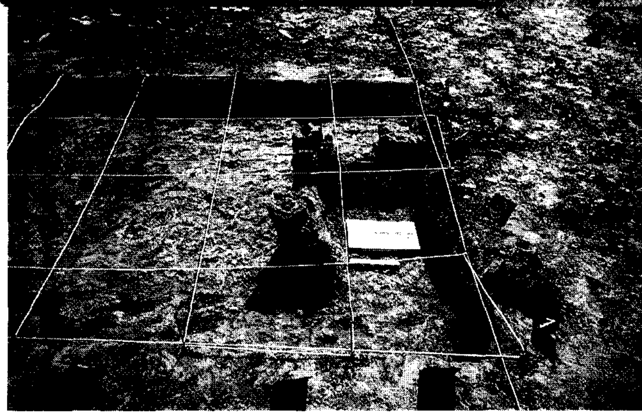
● Seventh century B.C.
- Otoumbi, Gabon *(R. Oslisly et al., 1992)*
- Carthage, Tunisia *(H. Niemeyer, 1995)*

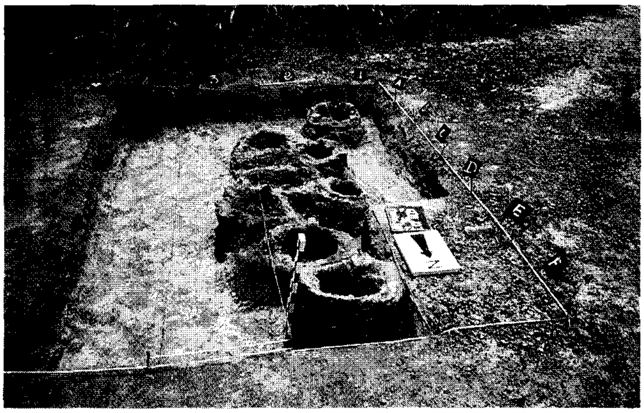
Sixth century B.C.
- Meroe, Sudan *(P.L. Shinnie et al., 1982)*

L. M. Maes Diop

Sites and archaeological excavations

Giraffe in harness with a bent object
Cave painting, Adrar des Iforas (Mali)
Photo: Christian Dupuy

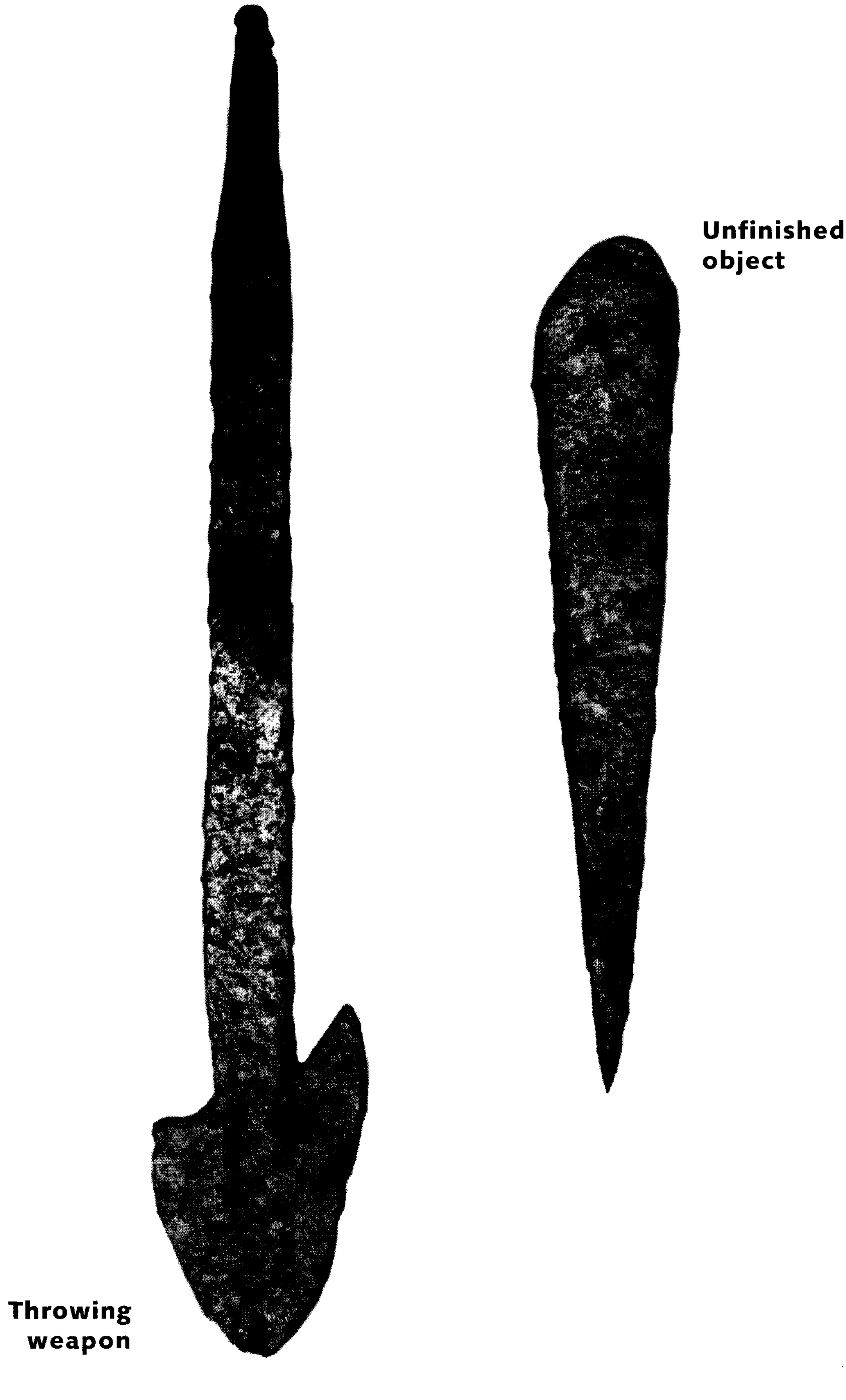




Small open furnaces
Lilboure site (Burkina Faso) (+1440-1683)
Photo: H. Kienon

Oboui site
Bouar region, Ndio, north-western Central African Republic
Photo: E. Zangato

Gbabiri site (village site)
Bouar region, Ndio, north-western Central African Republic
Photos: E. Zangato, excavations 1996



Objects from layer 2 of a forge, Oboui site
(Central African Republic) - 1880±40 BP (Ly. 9007)
(Excavations: Etienne Zangato)

Bell from layer 2 of a village site.
Gbabiri, Central African Republic - dating from second century B.C.
(Excavations and photos: Etienne Zangato)

Needle from layer 4 of a village site.
Gbabiri, Central African Republic
(2680 ± 40 BP) (Pa. 1451)
(Excavations and photos: Etienne Zangato)

iron

The Earth's core consists of over 80% iron, a material that is also found in the Earth's crust (of which it forms about 7%) in the form of ore, very seldom in the form of metal (meteorites). The major iron deposits were all formed more than two billion years ago.

Iron is the most commonly used metal because of the abundance of the ore, the comparative ease of its extraction and its remarkable mechanical properties (particularly when associated with carbon to produce steel).

The capabilities of iron tools not only made possible the conquest and development of huge tracts of land, but also revolutionized the military arts and led to profound socio-economic upheavals.

In Africa, however, the technology of iron required large quantities of charcoal, and this was a real threat to the plant cover and the environmental balance. Hence the arrival of the iron ingot from Europe in return for slaves ended Africa's technological independence in iron production and destroyed the prestige of the iron founders, who had to redirect their activities towards ironworking instead.

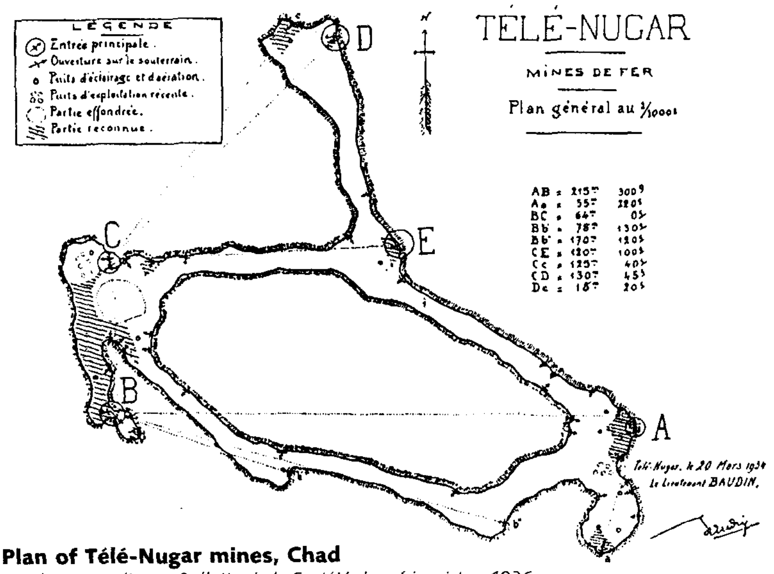
Prospecting for iron ore

Iron ore extraction in Mauritania
Société nationale industrielle et minière
Photos: SNIM

African metalworkers extracted all kinds of ores, using every possible type of technique.

Women of the Murgur tribe in northern Cameroon separated out non-cohesive ore from the sandy waters of streams. In Gabon stone chips consisting of iron and manganese (pisoliths) were gathered from dry waterbeds. African miners also used iron-bearing rocks which were either found on hilltops or reached by mine shafts and tunnels following the ore veins.
Throughout Africa laterite chips gathered on the ground served as raw material. In many regions mining could not begin without the blessing of the sacred powers that reigned over the mining sites. The task of mining was preceded by propitiatory rites and accompanied by ritualized behaviour. Landowners had to make offerings; men had to be sexually abstinent for several days before mining. Sometimes the "harvesting" was done by women and children who were thought to be closer to the spirits that owned the earth and its resources.

Blacksmiths
recreating the search for iron ore, using a five-metre-long iron probe, Paradé (Burkina Faso)
Photo: Elisée Coulibaly, 1995

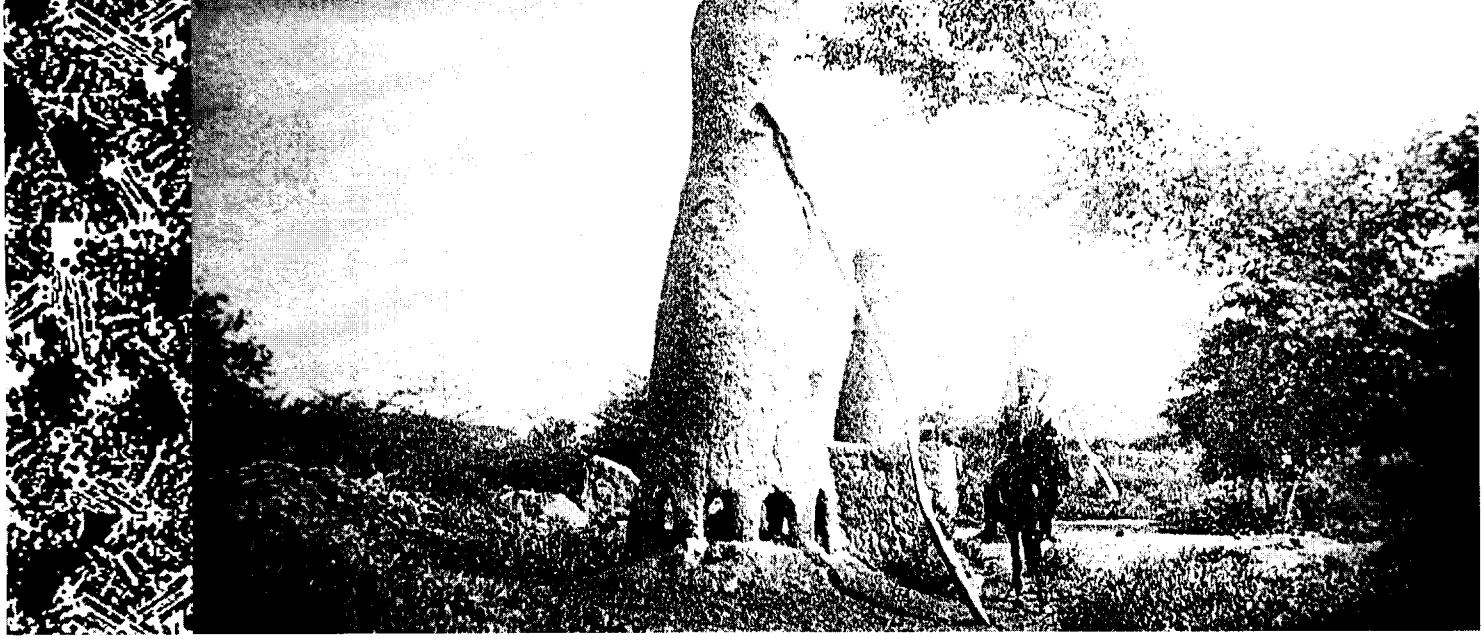


Plan of Télé-Nugar mines, Chad
Baudin/Dérendinger, Bulletin de la Société des africanistes, 1936

(Sketch by General Dérendinger, *Journal des africanistes*, Vol. VI, Fasc. 2, 1936, p. 199)

The abandoned iron mines of Télé-Nugar were discovered by General Dérendinger in 1911.

The mines have more than a kilometre of tunnels leading to large chambers (22.10 m) with several entrances. They were dug during the pre-colonial era, but have not been dated precisely.



Metallurgy ovens of the Yatenga (relative scale from soldier on horseback).
J. Meniaud, *Haut Sénégal-Niger-Soudan français.* Paris, Emile Larose, 1912.

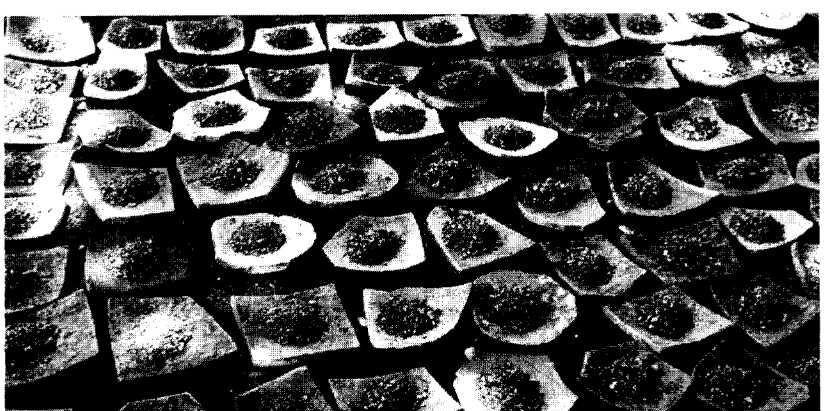
The wood of the acacia tree is highly prized by blacksmiths for making charcoal.
While the iron ore and the furnace are usually located in proximity to one another, it would be unusual to find at the same location a sufficient quantity of the kind of trees that are needed. At Fouta, for example, blacksmiths usually entrust the young people of the caste with the task of seeking wood and transforming it into charcoal. First, they kill an animal (Teli) in front of the furnaces and then, before dawn, leave the village to look for wood, returning only when they have cut enough for all the furnaces.

Wood combustion techniques vary from one region to another. The Senufo, for example, place the tree branches in layers alternately pointing in opposite directions, forming a hemispherical pile two metres high and four metres wide. The branches, covered with grass and clumps of earth, are lit from below and burn slowly. As there are no air vents the smoke escapes through the layer of grass and earth.

Ovens of southern Mali and Burkina Faso
Cap. Binger, *Du Niger au golfe de Guinée*, Paris Hachette, 1892

Direct reduction
Direct reduction, which yields useable iron in a single operation, was the earliest technology used for the production of iron. Ironworkers constructed small furnaces and loaded them with alternate layers of charcoal and iron ore. At approximately 1200°C the iron separates out. The remaining impurities, known as slag, contain some residual iron ore which was recycled to make the walls of new furnances. The reduced metal is purified by heating and hammering and shaped into objects. The direct reduction technique was used until the twentieh century in Africa.

Indirect reduction
The other technique for producing iron - indirect reduction – has been less wide-spread in Africa. It is a two-stage process. First, foundry workers produce pig iron by melting iron ore into liquid form in blast furnaces at temperatures starting at 1535°C. Once the excess carbon has been eliminated from it, the iron can be turned into steel. This more productive technique was introduced around the fourteenth century in Europe,where it became one of the pillars of the industrials revolution.



Iron filings on sale at a market in Côte d'Ivoire
(Photo: Jocelyne Etienne-Nugue)

1 - Using the base of the anvil as a workbench,
this blacksmith files the head of a sugar hammer (Mali)
(Photography archives, Musée de l'homme) (C 42 800 301)

2 - Blacksmiths at the Ambatolampy market (Madagascar)
The blower cylinders are made of sheet metal. An assistant operates the two pistons while in the foreground the blacksmith works at the anvil and dips the spade into a small metallic pan. All the equipment can be dismantled and moved from one market to another.
Photo: E. Vernier/Photography archives, Musée de l'homme (F 66 876 722)

3 - Forging
Hammering on the tool held in his left hand, the blacksmith decorates a flat piece that will become part of a lock. The anvil serves as a workbench (Mali).
Photo: Olivier Schultz/Photography archives, Musée de l'homme (C 42 788 301)

4 - A blacksmith,
Lassana Kante, forging an axe (Senegal)
Photo: M. Garcia, 1985, Photography archives, Musée de l'homme (85 503 865)

5 - At the souk
A blacksmith uses small "toothpicks" to clean old sickle blades. Note his prehensile use of his toes, and the anvil made from a dromedary femur (Morocco).
Photo: D. Champault/Photography archives, Musée de l'homme (E 74 1567 703)

6 - Ambohibory market
Small portable forge with bellows made from old tin cans. The craftsman makes the rounds of the markets, where he solders household objects and makes new ones.
Photo: E. Vernier/Photography archives, Musée de l'homme (F 66 875 722)

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Foot bellows
Egyptian bas-relief

Working at the forge
Photo Source: Tony Care, TFSR Cymru. Tools for self-reliance

Msori Hango, blacksmith,
Singida region (Central Tanzania)
Photo Source: Tony Care, TFSR Cymru. Tools for self-reliance

Iron

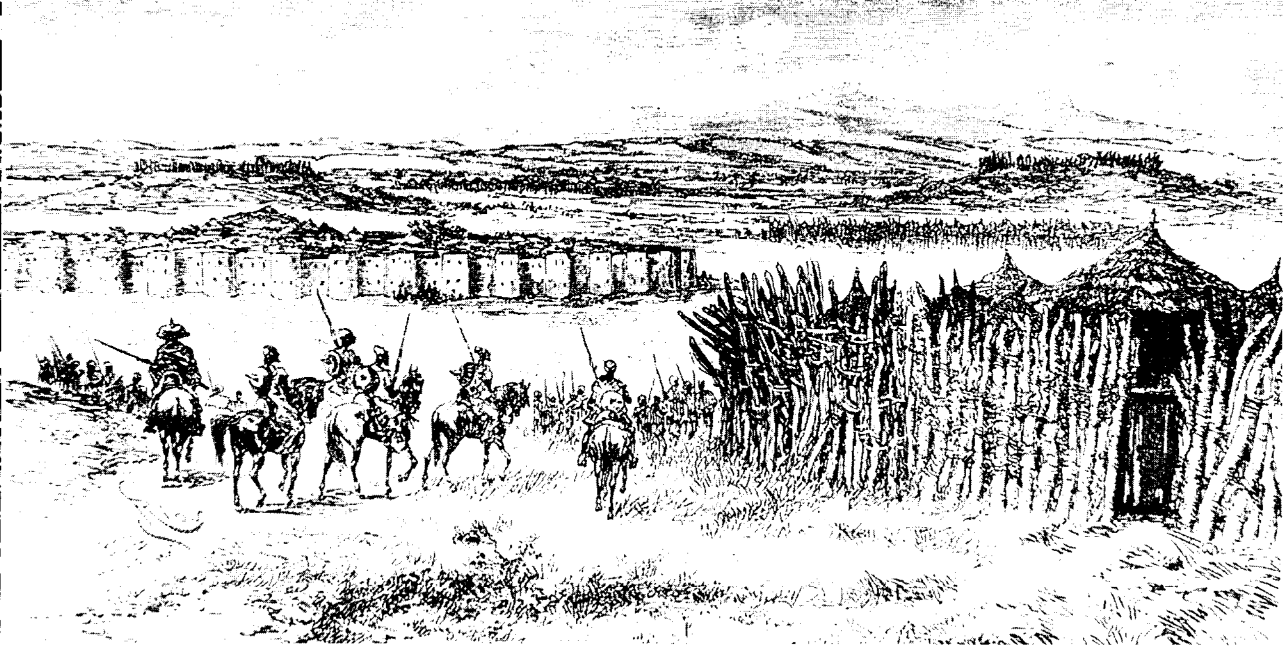
Iron had a profound effect on African societies.

Firstly, it permitted the clearing of more land for cultivation.

Above all, it was the foundation on which strong states were constructed. Takrur, for example, a state in the valley of the River Senegal (third to thirteenth centuries) was founded by a dynasty of forge masters, the Jaa-Ogo, who introduced flooded-plain crops and established political power based on the control of iron. The Sosso empire, whose most famous forge master king, Soumaouro Kanté, dominated Mandé (Mali) in the early thirteenth century, is another example. The working of iron was stimulated by the demand for weapons in empires and kingdoms (Ghana, Mali, Songhai, Mossi, etc.).

The spread of iron in Africa did not follow linear routes, with a point of departure and precise destinations. It was more a process of osmosis during which the technology was assimilated by some peoples, profoundly changing their history. Hence African societies gave special status to the "iron masters", who were the linchpins of traditional religions and socio-economic life. In the Islamicized societies of the Sudan-Sahel region, they were a group apart, wrongly seen as a caste by modern sociology. In the forest regions they can be regarded as superior beings exercising economic, political and moral ascendancy over society.

H. Bocoum, IFAN/CAD, Dakar



Stronghold, Mali (former French Sudan)
Capt. Binger, *Du Niger au Golfe de Guinée*. Paris, Hachette, 1892

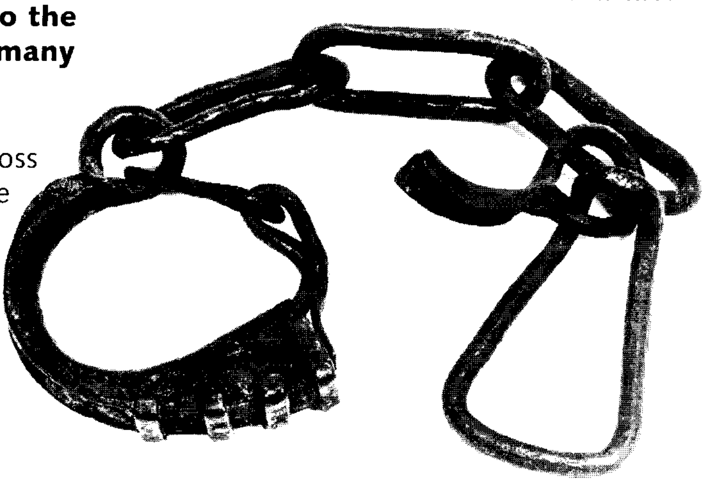
The Iron roads in West Africa

In the nineteenth century a plentiful supply of iron led to noteworthy changes in the tools used for land clearing and farming. We are just beginning to measure the impact of the supply of tools on ecosystems and the evolution of plants cultivated in close association with the development of economic circuits. The supply of iron and tools was also a determining factor in regional differentiation. All the pre-colonial states in West Africa sought to administer, protect and attract blacksmiths, who were often fiercely independent and highly mobile. Many myths and historical legends attest the importance of the forge and the blacksmith in ancient societies. *(B. Martinelli).*

The encounter with Europe spelled the decline of the iron roads, which intersected with the slave routes. Iron rapidly became an almost conventional currency and was massively exported by the slave traders; this led to the progressive disappearance of many production sites.

With hindsight, it seems that the loss of technological leadership in the area of ore mining and the decay of the iron roads are the keys to understanding how Africa began to lag behind Europe, starting in the fifteenth century.
(H. Bocoum)

Irons used to attach slaves
Alibert collection



Mbaye Thiam, born in 1924, peerless blacksmith, has earned a reputation for rigour and honesty in his craft. Despite his modest social circumstances and the caste to which he belongs – looked on as one of the lowest – he is admired by all and considered to be a "distinguished" person.

(Text by Sheik El Hadj Amadou, photos by Ibrahima Mbodj, for UNESCO Sources, June 1995)

Mbaye Thiam's faith is kept up by his son Amadou, who will succeed his father and is content to take sales orders, assign the tasks and coordinate the group's work. "Besides Amadou, three of his younger brothers are with me. They give me a hand after school." In fact, it is hard to have other apprentices who are not part of the blacksmith caste. As Mbaye Thiam insists, "The forge is reserved for the initiated".

(Text by Sheik El Hadj Amadou, photos by Ibrahima Mbodj)

The blacksmith can also be a healer

Among the Moose people, L. Calderoli says that the blacksmith performs rites to help cure illnesses, promote fertility in women and prevent child mortality. He is also called on in cases of depression or attempted suicide. Various parts of the forge play a role in the rites, including the hammer, the tongs, the hearth and the blower nozzle – i.e. the end of the bellows, where the air is collected and directed into the hearth.

The hearth, bridge, tongs and blower nozzle of the Moose blacksmiths, Burkina Faso, Oubritenga province, 1992
Photo: Lidia Calderoli

Two Moose blacksmiths forging a hoe Burkina Faso, Oubritenga province, 1992
Photo: Lidia Calderoli

Marko Deu
Tanzanian blacksmith
Photo source: Tony Care, TFSR Cymru, Tools for self-reliance

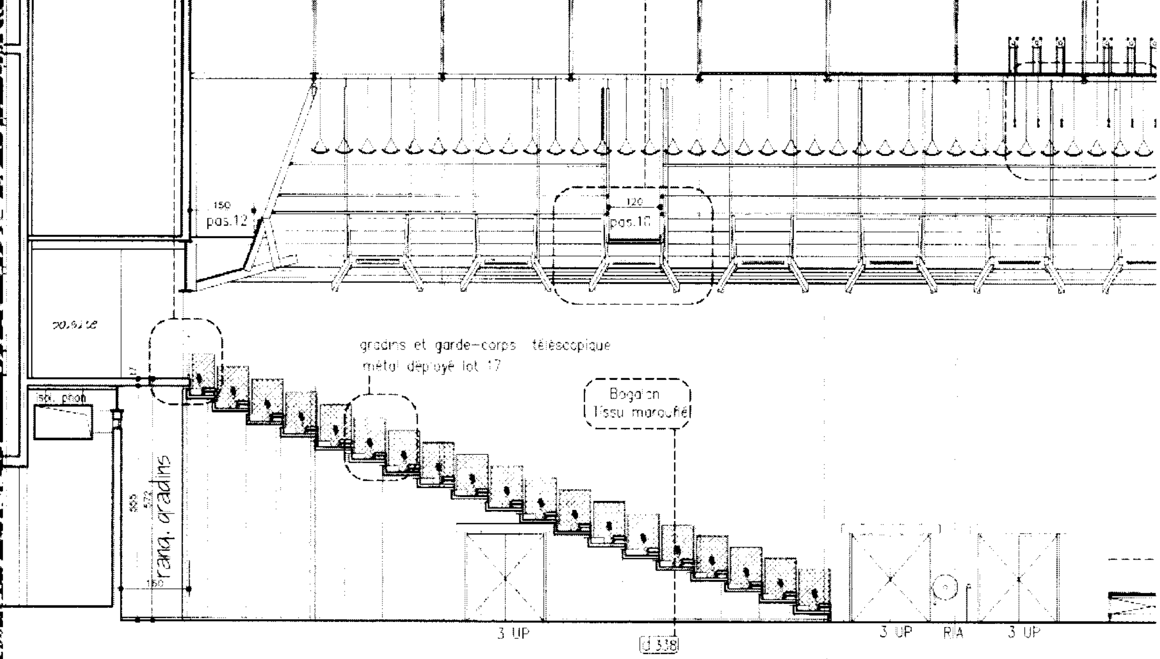
The economic crisis in the early 1980s and the various structural adjustment programmes led to the collapse of rural management policies in most African countries, and brought equipment projects to an abrupt halt.

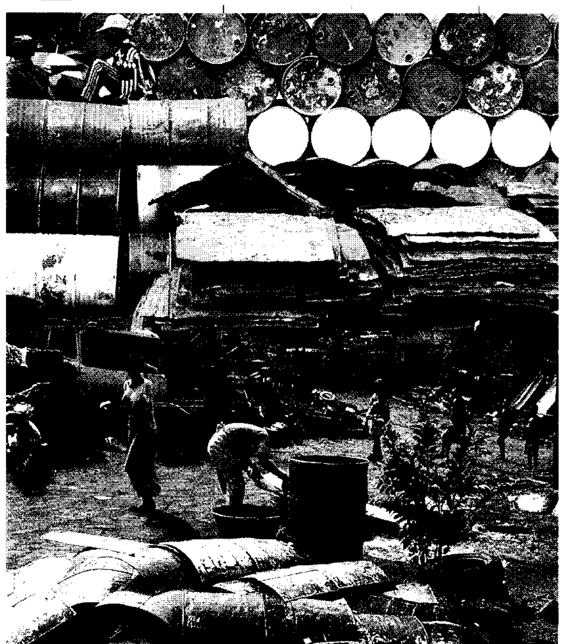
Photo Source: Tony Care, TFSR Cymru. Tools for self-reliance

In response to the rising costs of maintaining an ageing stock of equipment, African peasants, in addition to more and more city dwellers, have turned to local artisans to meet their most pressing needs in terms of equipment and tools. This development is revitalizing African ironworking, which is now making incursions into numerous sectors of activity, including agriculture and industry.

"A whole population cannot work with its bare hands. If millions of artisans, men and women alike, are to find long-term employment, then basic hand tools must become massively available to ordinary working people. Today, tools for the craftsman – the builder, the motor mechanic, the tailor – are almost a 'luxury commodity' in much of Africa. Young artisans finish their training courses, but have neither a hammer nor a saw to start work with. A jack plane can cost a carpenter six months' earnings..."

(Tools for self-reliance)





LU-Nantes-Africa Project

Association ARGILE
By kind permission of the Malian National Commission for UNESCO

Conversion of the LU factory in Nantes to a production and exchange site for the Centre de Recherche et de Développement Culturel (CRDC).

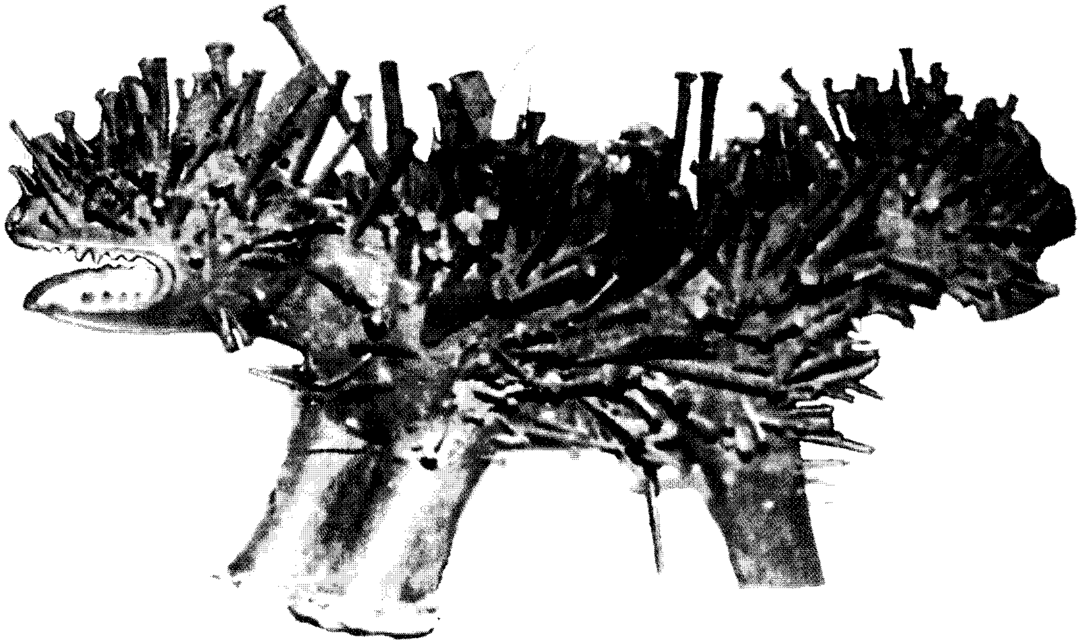
Directors of the ARGILE project:
Jean Lautrey and Camille Virot,
in collaboration with Patrick Bouchain, architect, the blacksmiths of Médine (Bamako), the canoe-makers of Ségou and women fabric-painters in the Ségou region.

The blacksmith/recyclers of Médine (Bamako)
There are about 500 blacksmiths in Médine (outskirts of Bamako), grouped into 40 workshops of 10 to 15 persons each, under the leadership of the elder Mamourou Kane. The blacksmiths work mainly with recycled metals, from which they produce all kinds of useful everyday objects.

The blacksmiths of Médine (Association Coopérative Diamazigi and Ousmane Samessecou) were chosen to construct the ceiling of the *Grand Atelier* (a 400 m^2 auditorium), using sheet metal made from recycled metal drums.

Technical specifications
Large open metallic-band ceiling (assemblage of sheet metal and colours) from which technical equipment can be lowered – high-performance acoustics.

The 200-litre drum is Médine's main raw material. Cut out and hammered, the bottoms are transformed into basins, deep fryers and couscous-pans. What remains is made into plates. For the ceiling of the centre's *Grand Atelier,* 255 drums will be needed, the equivalent of some three tonnes of tiles.



Nail fetish of a dog, *nkonde*
Woyo, Angola, Cabinda
Inv. Musée de l'homme : 01.38.1
Photos: Cyril Bailleul

The *nkonde* in the form of a dog have the special function of detecting *ndoki*, dangerous men who threaten social stability.

The *nganga*, an expert in divination and healing, is responsible for consecrating and handling the *nkonde*: for each request he hammers in a nail, either made locally or in Europe, or fashioned from scrap metal.

iron

Research means trying to understand the present in order to create the future. This cannot be done unless we know as much as possible about our past, if only to avoid repeating mistakes.

In the palaeometallurgy laboratory we study ancient metals in order to have a better understanding of the ageing of today's materials and thus help to develop new materials for tomorrow, at the same time preserving and enhancing our heritage.

In short, we try to reconstruct the "life cycle" of a metal object which, born of the reduction of the ore by human will, is corroded by environmental factors and returns irremediably to its point of departure, ore – and that is the death of the object.

P. Fluzin, CNRS

UNESCO

the reduction process

1. Oolitic ore from Lorraine. During reduction, the metal produced retains the oolitic form. Experimental reduction and refining, Nancy-Belfort, 1995 (P. Fluzin, D. Leclère, M. Leroy, P. Merluzzo) (Photo: P. Fluzin)

2. Concentric iron droplet around a porosity. Archaeological slag, Berthelange site, Franche-Comté (H. Laurent) (Photo: P. Fluzin)

3. Progressive agglomeration of iron droplets during reduction. Experimental bloom, reduction and refining (P. Fluzin, D. Leclère, M. Leroy, P. Merluzzo) (Photo: P. Fluzin)

4. **Agglomeration and densification of the metal in a bloom. Ethno-archaeological material, Ardingi site (Mali), 1995 (E. Huysecom, V. Serneels, P. Fluzin) (Photo: P. Fluzin)**

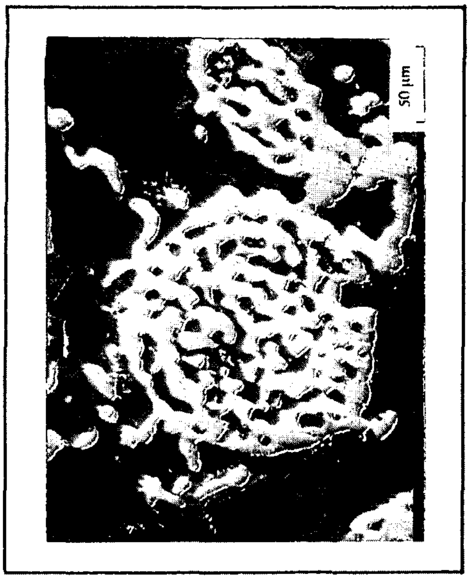
5. **Agglomeration and densification of the metal in a bloom. Ethno-archaeological material, Ardingi site (Mali), 1995 (E. Huysecom, V. Serneels, P. Fluzin) (Photo: P. Fluzin)**

6. Metallic folds during refining of a bloom. Belfort experiments, 1995 (D. Leclère, P. Fluzin) (Photo: P. Fluzin)

7. Metallic folds in an experimental bloom. Belfort-Nancy experiments, 1995 (P. Fluzin, D. Leclère, M. Leroy, P. Merluzzo) (Photo: P. Fluzin)

8. **Metallic folds almost completely welded without deformation (agglomeration) in a bloom. Ethno-archaeological material, Ardingi site (Mali), 1995 (E. Huysecom, V. Serneels, P. Fluzin) (Photo: P. Fluzin)**

9. **Agglomerated iron droplets beside a diffusion vent. Reduction slag, Toungaré site (Burkina Faso), 1994 (Photo: P. Fluzin)**



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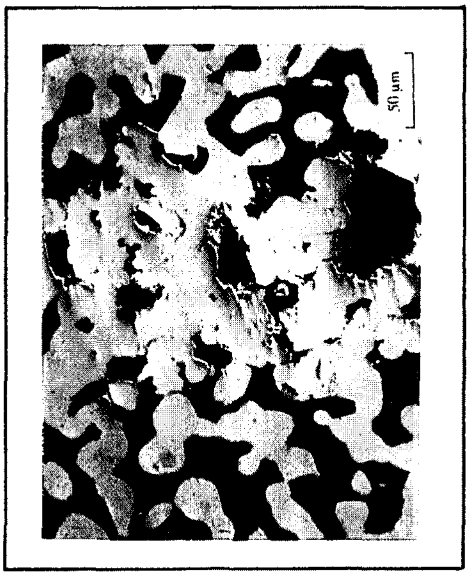

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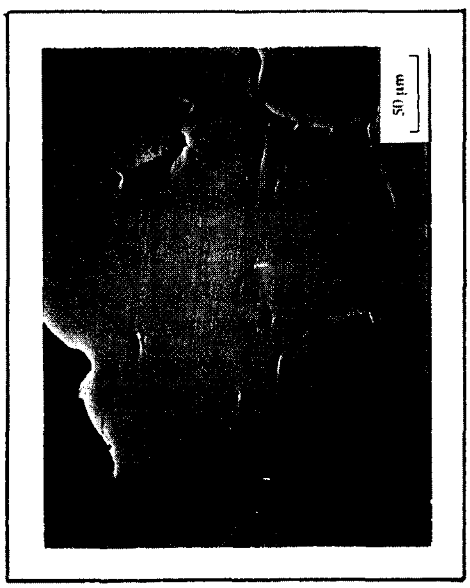

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the refining process

1. Iron fragment in inclusion in a porosity. Gallo-Roman archaeological cake. Touffreville site (Calvados), 1995 (N. Coulthard, P. Fluzin) (Photo: P. Fluzin)

2. Idem. The metal is slightly hardened. (Photo: P. Fluzin)

3. Iron filament with external heat reoxidation (epitaxic). Cake from refining forge. Belfort experiments, 1995 (Photo: P. Fluzin)

4. Iron elements partially heat reoxidized. Cake from refining forge. Belfort experiments, 1995 (Photo: P. Fluzin)

5. **Iron elements fully heat reoxidized. Archaeological slag. Juude-Jaabe site (Senegal), 1995 (H. Bocoum, P. Fluzin) (Photo: P. Fluzin)**

6. Internal heat reoxidation of the metal around a porosity (oxidant). Archaeological cake. Haut-Auxois (Côte-d'Or) (Photo: P. Fluzin)

7. Folds in the process of being flattened, with partial silica filling. Archaeological ingot (centre). Coulmier-le-Sec site (Côte-d'Or) (Photo: P. Fluzin)

8. Folds in the process of being flattened. Archaeological slag. Blessey-Salmaise site (Photo: P. Fluzin)

9. **Hammer-hardened folds in a contemporary bloom. Ethno-archaeological material. Ardingi site (Mali), 1995 (E. Huysecom, V. Serneels, P. Fluzin) (Photo: P. Fluzin)**

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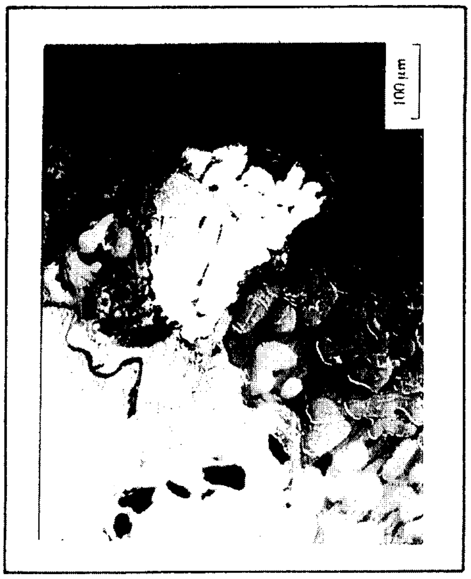

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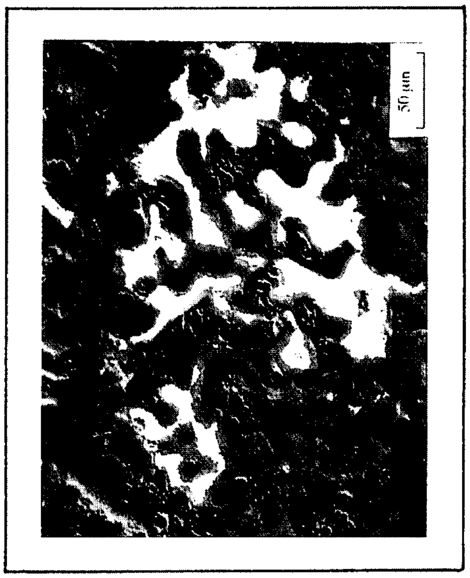

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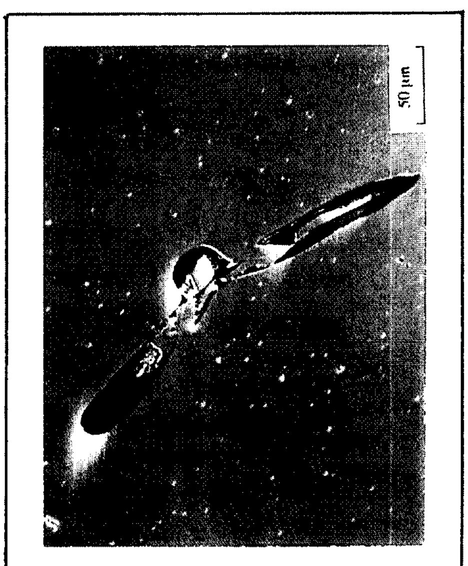

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elaboration of the object

1. Fragment of hammer-hardened iron in a Gallo-Roman archaeological cake. Touffreville site, Calvados, 1995 (N. Coulthard, P. Fluzin) (Photo: P. Fluzin)

2. Idem.

3. Small iron fragment in inclusion in cake from an archaeological forge. (Second Iron Age). Puy-de-Grâce site, Corrèze, 1997 (C. Best, P. Fluzin) (Photo: P. Fluzin)

4. **Small iron fragment in inclusion in cake from an archaeological forge. Sincu-Bara site, Senegal, 1995 (H. Bocoum, P. Fluzin) (Photo: P. Fluzin)**

5. **Fully reoxidized iron filament. Archaeological slag. Juude-Jaabe site (Senegal), 1995. (H. Bocoum, P. Fluzin) (Photo: P. Fluzin)**

6. **Fully reoxidized iron filament. Archaeological slag. Juude-Jaabe site (Senegal), 1995. (H. Bocoum, P. Fluzin) (Photo: P. Fluzin)**

7. Iron oxide scales in cake from an archaeological forge (Second Iron Age). Puy-de-Grâce site, Corrèze, 1997 (C. Best, P. Fluzin) (Photo: P. Fluzin)

8. Idem.

9. Primary inclusions deformed in the direction of hammering. Alésia ingot (F-XXIV - 408, 1971), 1996 (M. Mangin. P. Fluzin, P. Dillmann) (Photo: P. Fluzin)

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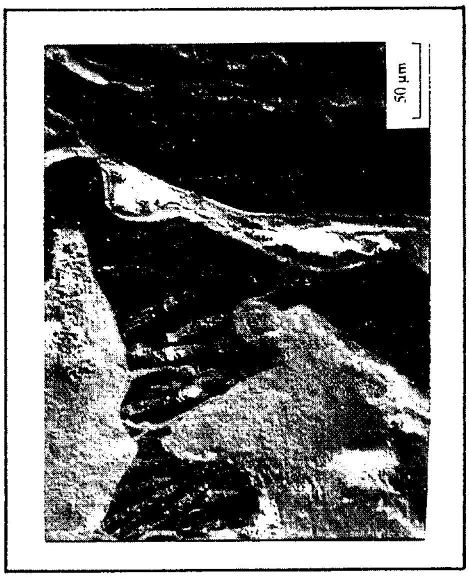

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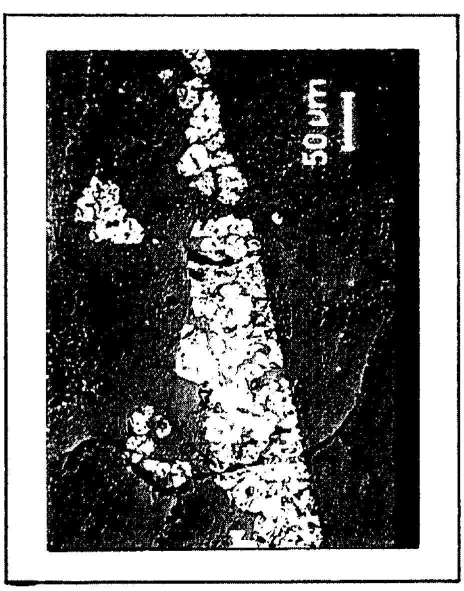

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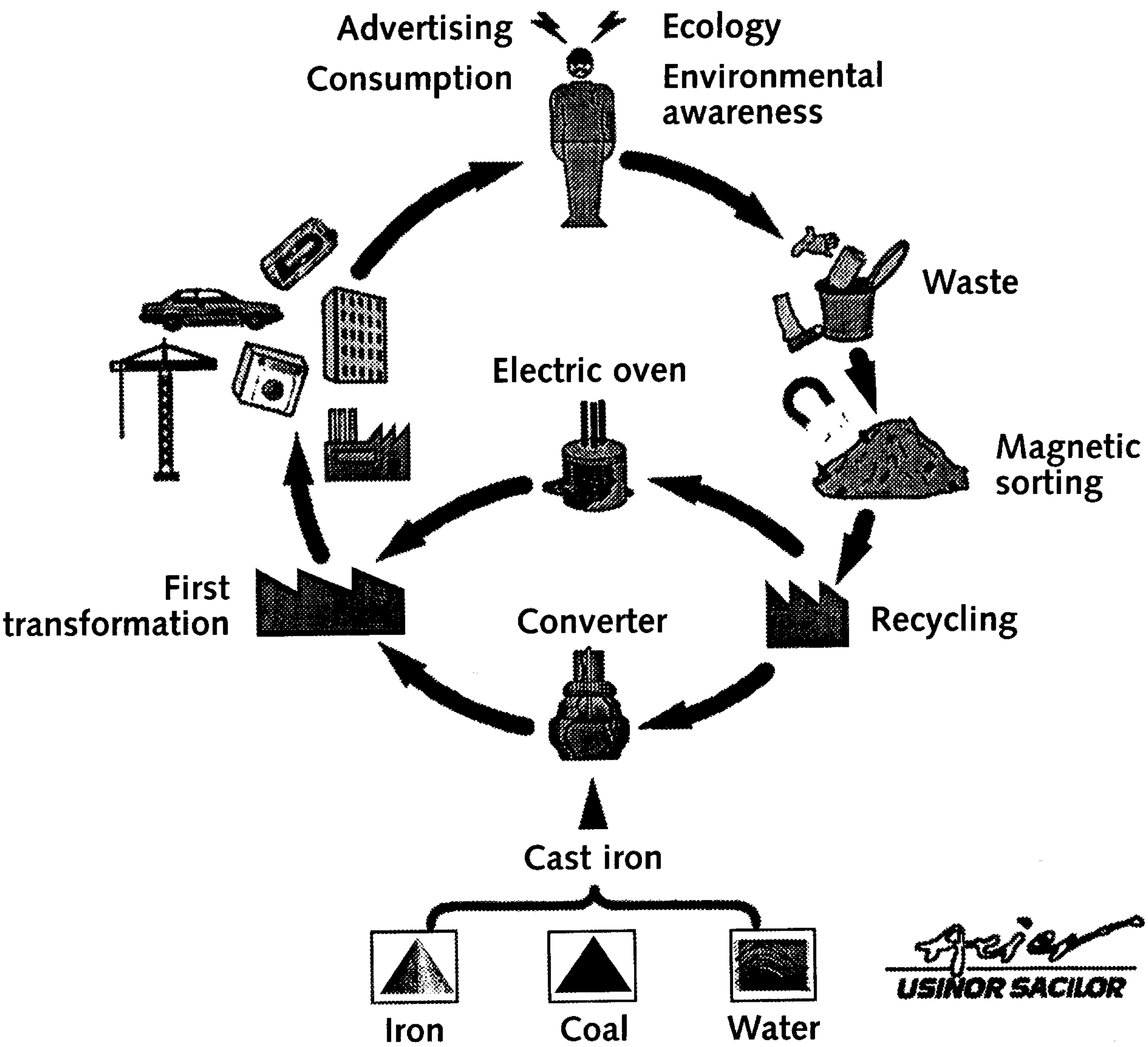
Concentrated iron ore (GMAB) and steel balls (finished product)

Photo: Société Nationale Industrielle et Minière (SNIM)

THE STEEL CYCLE



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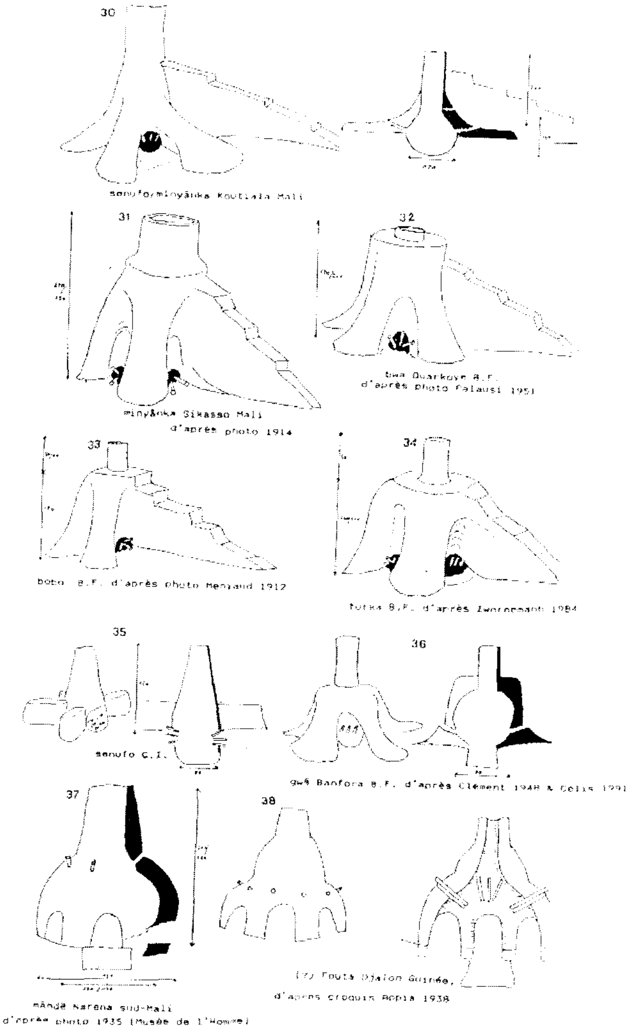
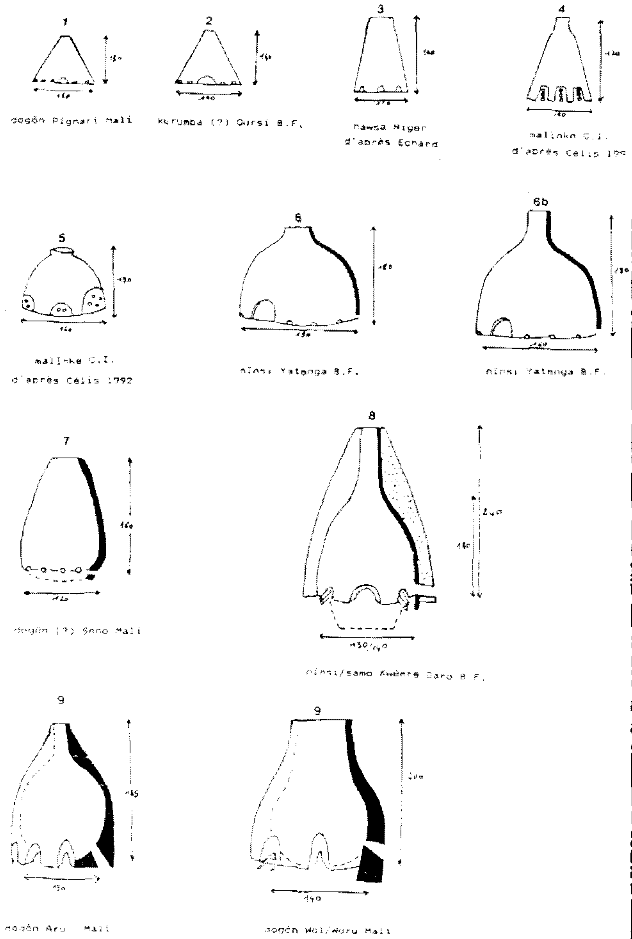
Study by B. Martinelli
"Different ovens used in West African foundries"



Cellular ovens: conical (1-4), hemispheric (5-6), ovoïd (7-9)



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