

ore used is a siliceous hematite occurring in shale. It is roasted, and then pulverised in a wooden mortar. The pounded ore is then washed by women. A hole is dug in the ground about 2 feet deep and filled with water. In this a woman stands, and washes the ore in a tray about 18 inches in diameter. It is then subjected to a further and more careful washing by a second woman, seated on the ground near by. The ore is then conveyed to the furnace in a smelting shed, of which there are eleven in the village. Each shed is about 25 feet long and 16 feet wide, with a doorway at each end. The walls are built of clay, and are from 4 to 6 feet high. They are not carried up to the roof, but a space is left all round for light and ventilation. From the ground to the ridge of the roof the height is 25 feet. The furnace is in the centre of the shed. It is built of clay, and occupies a circular space 7 feet in diameter. Its height is 3 feet 9 inches. Opposite one of the doorways, a depression in the floor gives access to the furnace. The dome of the furnace is bound round by a rope of twisted vines. In the centre of the bottom of the furnace is an aperture 3 inches in diameter which communicates with a short tunnel below the floor of the shed, to which access is obtained by a pit inside the shed. The shed also contains a small kiln for firing the earthenware tuyeres, and an ore-bin; both being made of clay. The process of smelting occupies 36 hours; draught being supplied by nine pairs of earthenware pipes. These are only rudely shaped by hand around a stick, and but partly baked. The average diameter of each pipe is 1.4 inches. Selected slag from each successive smelting is used as flux. It is run off by opening the orifice in the bottom of the furnace. For removing the bloom, the clay seals over the six apertures are broken up, the earthenware pipes removed and thrown aside, and the doorway of the furnace opened. The contents of live charcoal are raked out, and the 70-lb. bloom removed in a red-hot state by a loop of green creeper. Subsequently it is broken up, with the aid of a stone, into convenient sizes, and sold to smiths. The metal produced in this way is a natural forged steel, which by reheating by the native smith is brought down to a tool steel with 1 per cent. of carbon. It is difficult to realize that in a part of the world which is within twenty days of the great European manufacturing centres, the smelting methods practised by the earliest ironworkers can still be seen in operation.

From western Asia and Egypt civilisation came to Greece. Cyprus and Crete were the oldest Phœnician settlements; and these islands were the starting-points of Greek metallurgy. Hephaestus (Vulcan) was, according to tradition, the first to work in iron; and he is often represented forging the bolts of Zeus. References to "iron wrought with much toil" are frequent in the poems of Homer (B.C. 850). Hardening steel by quenching is adopted as a simile in the description of the blinding of Polyphemus (Od. ix. 391). Iron is referred to as a treasure, and a bloom of iron is the valuable prize offered by Achilles at games (Ib. xxiii. 826). Evidently a considerable degree of skill in working iron had been attained. But the heroes used copper or bronze; metallurgy and mining being still in Phœnician hands. The silver mines at Laurium, in Attica, were even then being worked with slave labour by the Phœnicians. An iron knife and an iron dagger were found by Schliemann in his excavations on the site of Troy. The oldest mines worked by the Greeks were the iron mines of Eubœa (Chalcis). From the earliest times the Spartans wore iron rings, and used iron bars as currency—a practice that was not abandoned until B.C. 320.

Little is known of the methods of iron smelting used by the Greeks, as the metallurgical treatises written by Aristotle (B.C. 384-322), and his pupil Theophrastus (B.C. 372-287), have not been preserved. Somewhat obscure passages in the latter author's book on stones indicate that the Greeks were acquainted with the coking of coal, with the use of coal, in iron smelting, and with the tinning of iron. Aristarchus, however, in the second century B.C., says definitely that iron cannot be melted or cast. Although written records are sparse, the numerous sculptures and painted vases that have been preserved throw some light on the metallurgical methods of the ancient Greeks.

Passing on to Italy and the Romans, we find that mining and metallurgy were early practised by the Etruscans. Copper and iron were mined in their own land, notably in Elba and in the Tuscan hills. Diodorus Siculus (a contemporary of Julius Caesar) and Aristotle refer to the great antiquity of the Elba iron mines, which were originally started to work a copper vein. Among the Romans iron appears to have been used earlier than bronze. One of the oldest customs of the Romans was to wear iron rings on the right hand. Even the statues of the kings Numa Pompilius and Servius Tullius bear these rings. Pliny (A.D. 23-79) refers at length to the custom (xxxiii. 4, 5, 6). In the early days of Rome there was little scope for metallurgy; but with the Punic wars, culminating in the sack of Carthage, the foundation of the world's empire of Rome began. All the mines in Europe gradually fell into the hands of the Roman State, and were worked by slaves. The details of metallurgical practice supplied us by Latin authors are as sparse as those of the Greeks. Most information is supplied by Pliny's Natural History. Iron he describes as the best and at the same time the worst help to man, and, as the metal of foolhardiness, better suited than gold for war and murder. He gives interesting details of the manufacture of iron. He notes that the differences in iron are remarkable, and that on smelting the ore the iron becomes liquid like water ("mirumque cum excoquatur vena aquae modo liquari ferrum"). He describes the Bilbao iron-ore deposits, and refers to the medicinal value of iron. Next to the Elba iron, the Styrian (Norium) iron is mentioned by him as the most celebrated at this epoch.

The wonderful mechanical skill of the Greeks and Romans is well shown in the works of Vitruvius (B.C. 46) and of Hero of Alexandria (B.C. 285-222). The water level of Vitruvius is a surveying instrument of great accuracy; and the automatic coin-in-the-slot machine and the toy steam turbine of Hero of Alexandria suggest how rapid might have been technical progress had not thirst for conquest on the one hand, and envy and revenge on the other, given rise to wars and massacres that caused the inventions and progress made to be swept away and ignored for five hundred years.

It is difficult to realise the mass of artistic treasures that were destroyed when the Asiatic barbarian Huns burst across the Volga in the year 374 A.D. Manufactories were also destroyed. The iron trade suffered; but iron weapons were needed, and the primitive furnaces in the forests remained untouched. There are no written records of these furnaces of prehistoric time; and all we have to guide us are the archaeological discoveries which year by year add to our knowledge of the metallurgical practice of the ancient inhabitants of Europe.

Numerous iron objects of prehistoric date have been found in northern Europe, where iron was undoubtedly the first metal to be used. Iron weapons,