PART I

Explorers

1 The Age of Metals in the Ancient Near East

Although the early stages of mankind are defined by the materials from which tools and other objects are made (stone, copper and its alloy, bronze, and iron), all derived from the earth's surface, we do not always think sufficiently about the effects that these materials have had on human life, especially metals in their distribution and in the technology of their production, let alone in their uses.[1] We speak of the Bronze Age which arose fully around 3000 BCE without giving sufficient thought to where that material came from – there was little enough metal on the riverain sites of the Near East where the 'age' originated. Nor do we think that, in speaking of the Iron Age, it was not the discovery of iron, which was known long before, but its widespread use by the Hittites and urban societies of Crete, Greece and Rome that marked the beginning of its effective influence. And even then there was all the difference between the simple iron-making found earlier on and which diffused throughout Africa, and that which developed in Eurasia, especially in India, in China and later on in modern Europe.[2]

The Bronze Age in most cases was preceded by the Chalcolithic, the Copper Age, which used the same metal but mostly in its 'raw' state, often without any casting, but worked by hammering. The question of the origins of metallurgy in the Old World (see Appendix 1) has been much discussed and a recent study concludes that this began around the eleventh to ninth millennium BCE in South West Asia due to 'a desire to adorn the human body ... using colourful ores and naturally-occurring metals'.[3] That may well be the case; experimentation with coloured stones was certainly important. But what is more important for human history is the deliberate use, the casting or manufacturing of metal tools and weapons, which had so many implications for the creation of complex cultures. That aspect seems more closely linked to the use of kilns for pottery and eventually to the control of fire. Not that beads were without such implications but if they could be said to have 'developed' at all, it was not in the same way or with such important results for the human race.

[1] See Thomsen 1848. [2] Fagan 1965. [3] Roberts *et al.* 2009: 1012.

However, this was a very significant period in human history, as a prehistorian notes: 'During the thousand odd years of the Chalcolithic', he declares, people made 'many discoveries pregnant with revolutionary consequences – the metallurgy of copper and bronze, the harnessing of animal motor power, wheeled vehicles, the potters' wheel, bricks, the seal.'[4] These achievements were not technical alone but also intellectual and cognitive. Even before 3000 BCE they were spreading from the Near East not only to the Aegean but to India: 'In a thousand years they would reach China and Britain.' In this chapter I want to look at the great extension of metal-working from its beginning in the Near East and the search for metals in Europe, as well as with some of the many consequences, one of the major transformations in the history of humanity.

The first food producing societies were to be found earlier in the Near East but they lacked the control of heat for pottery, being known as the pre-pottery Neolithic. In East Asia, pottery long preceded settled agriculture and in the west permanent human settlement had begun even before food production. Sedentarism was seen at Ohalo in Israel about 20,000 years ago but the first permanent settlement was in sites like Jarmo in Kurdistan, an agricultural village where the change to the new way of living took place around 8500–6500 BCE. The production in place of the collection of food by humans also meant the gathering together of animals that lived on their detritus or under their protection, that is, not only domestic animals like cats and dogs that were deliberately fed by them but also rats and in parts foxes and rabbits that consumed the droppings, as well as birds like gulls and sparrows that profited from what they cultivated or collected. The production of food also produced a surplus for gleaners and crop thieves.

Only in the later period did some pottery, including painted ware, appear in that area. A Neolithic pre-pottery stage existed at Jericho up to 5000 BCE. Grain was cultivated using stone sickles and stored in granaries, located in a town-like settlement. Pots were then produced with the clay dried in the sun or baked over an open fire. However painted pottery responds better to being fired in a closed container or kiln, and this pyrotechnology would later be a key for metallurgy.[5] Kilns were widely found in ancient Persia, one of the main areas that developed in the early Neolithic.

Some use of metals had already occurred in the Stone Age with the employment of natural gold for its 'glitter' and even copper as a form of

[4] Childe 1942: 83. [5] Aitchison 1960: 69.

malleable stone, largely for decorative purposes. Their further use began in the Near East around 8000 BCE. What then changed things was the employment of heat to work the metal by annealing in order to prevent cracking. It is the melting and smelting of copper from ore that marks the beginning of the Bronze Age,[6] and for this a forced draught was necessary to raise the temperature to 1084.5 degrees Celsius. 'The melting and smelting of copper', it has been rightly said, 'was probably a result of the development of kilns for firing pottery'.[7] This controlled the fire for intensive heating.

However, fire was certainly not first used for pottery but for light (in caves), for heat, for defence and for cooking. Its importance in early human life has been emphasised by many commentators.[8] It was already used in the Palaeolithic for cooking the meat of wild animals and in the Neolithic for preparing that of domestic ones as well as for bread and other grain-based products, and subsequently in kilns for pottery; the ovens for smelting metal were a subsequent development.

This use was not discovered in the highly fertile valleys where the Bronze Age flourished but by the dwellers in the hills nearby. In the Chalcolithic period, say from about 6000 to 4000 BCE, the lowlanders exchanged their surplus Neolithic grain from the richer valleys with the products of highland metal-workers. During this long period they learnt to work 'stone' by hammering free copper. Shallow mining for coloured ores (and paints) occurred in Hungary and Poland as early as about 35000 BCE, and for flints in Palaeolithic France and later in Belgium and Poland.[9] Copper could have been found this way and smelted as the result of heating colourful stones. As Charles,[10] the historian of metallurgy, spells out, arsenic could have been added to make a stronger material, leading eventually to its replacement by tin, perhaps because of the poisonous nature of the former, perhaps because of the gold colour of the latter. Finally there was the slow shift to iron in the Near East. However, in South East Asia, there was no shift from bronze to iron, for they were worked and used jointly, and the Iron Age saw a huge growth in the employment of bronze for ornaments. Save for two localised centres of bronze-working in Mexico and Peru, there was no equivalent development in the New World, Oceania nor, in most cases, Africa south of the Sahara until historic times, although simple iron-working spread widely from the Mediterranean.

[6] Greene 1986: 143. [7] Renfrew 1969: 36.
[8] Lévi-Strauss 1970; Goudsblom 1992. On the role of cooked food in an evolutionary perspective, see Wrangham 2009.
[9] Clarke 1979: 285. [10] Charles 1994.

The Chalcolithic, then, saw the development of smelting which was dependent on the furnace or kiln used for the pottery of the upper Neolithic. The smelting of copper took place in double-tiered kilns which could raise the temperature for reducing blue malachite to red copper – and was also employed to make the glazes that required a greater heat than that needed for making plain earthenware. The process of smelting seems to have been first carried out in Susa in Persia south of the Caspian Sea where, then situated on the drier plateau above the Mesopotamian valley, farming had earlier been developed. At an early period farming cultures stretched from the Balkans to southern Afghanistan using similar forms of plastic art and the decoration of prestige pottery.[11] Before 3500 BCE most of the early metal objects themselves made from local supplies of copper were exported from there into the lowlands. From these drier areas metallurgy was transmitted not only to Sumer in Mesopotamia but to Harappa in the Indus Valley.

Both in Mesopotamia and in India recent research suggests that the classical Bronze Age cultures were preceded by a period of developing urbanisation – in Uruk in the Susiana plains of Khazakhstan[12] and in the pre-Harappan phase of the Indus Valley.[13] This work has emphasised the role of long-distance trade routes in this early period, linking up the alluvial valleys with the surrounding resource-rich areas, the Zagros–Luristan highlands in the first case, and those of Baluchistan, Afghanistan and Pakistan in the second. Exchange was nothing new, but with metals the increase was immense, and hence the communication between groups.

In Late Chalcolithic times we find a series of Uruk sites developed from southern Mesopotamia scattered along the trade routes in the northern Syrian–Mesopotamian plains that indicate exchanges between those sites and the local societies.[14] The position of some of their outposts, especially in the Zagros hills, 'strongly suggests that highland resources were being exploited for the alluvial market'.[15] These resources comprised metals, especially copper in the Taurus highlands of Anatolia where the traces of smelting have been uncovered at this time,[16] near to the Ergani copper mines which possibly predated the Uruk enclaves in the north. The area south of the Taurus was very rich in copper and still is. That around Diyārbakir may have been 'the home of metallurgy'; it is on the banks of the Tigris that the earliest copper objects, hammered out of natural metal, have been discovered coming from the late ninth or early eighth

[11] Chernykh 1992: 29. [12] Algaze 2005. [13] Allchin and Allchin 1997.
[14] Algaze 2005: 53. [15] Algaze 2005: 63. [16] Algaze 2005: 69.

millennium.[17] But copper was also obtained from elsewhere; in the Iranian plateau, for example, where Uruk pottery has been found near an important metallurgical centre dating from the fifth millennium. Significant copper sources long existed at Sialk before the Uruk contacts. But while Uruk enclaves later controlled the flow of goods to the lowlands, the actual sources of the materials and the nearby access routes were held by 'indigenous communities that were willing to trade'.[18] Indeed the exploitation of copper took place 'well before the Uruk period',[19] although in a less complex context. In the valleys, copper was later imported to be transformed into bronze and used for weapons, for tools and for the plough; these were all products of an asymmetrical exchange with the metal producing areas which showed the advantage of the 'literate expansion' over the local Al Ubaid populations of 'barbarians'. But this was not only a one-way transmission. It is also important to emphasise that one of the difficulties with discussions of 'exchange' is that they often neglect this reverse process but even the content of the transaction in favour of an abstraction privileging a notional symmetry, as suggested by Marcel Mauss.[20] An exchange is not simply equal. The trade in pottery, so esteemed by archaeologists because of its preservation, has very different implications from the exchange of metals, which in the case of early iron may leave little trace. Nevertheless the implications are quite different. With iron one can conquer, with pottery one cannot. The importation of most metals, like the contemporary importation of oil, operated in a different way; these materials had little 'value' unless used in a more complex economy when they were highly dependent upon the technological developments of the latter which in fact created their original 'value' in the first place. The exchange is automatically asymmetrical but produces the wherewithal of growth.

Before the Chalcolithic the farming culture of the Neolithic had already spread westwards from the Near East to the Mediterranean, and from the Lebanon and Palestine north to Greece, the Balkans and the Pontic region, and south to the Nile delta (as well of course as going eastwards to India and to China). Some migrated to mainland Europe from Greece and the Black Sea, or travelled along the North African coast and eventually crossed into Iberia. Those that remained in that delta later developed the Chalcolithic culture of the Badarians, which was followed by that of the Amratians and then in about 3500 BCE of the Gerzeans. The latter smelted

[17] Fehérvári 1977: 14. [18] Algaze 2005: 71. [19] Algaze 2005: 75. [20] Mauss 1954.

copper, built kilns for painted pottery and voyaged in the Mediterranean by sea, all practices that seem to have come from Mesopotamia. The following pre-dynastic period of 3250 to 3000 BCE used copper more extensively for both weapons and tools, and led directly to the dynastic Egyptians and to their construction of the Pyramids.

The use of copper for tools and ornaments instead of stone (and sometimes of clay) involved the discovery of, first, its malleability, second, its fusibility, then, third, the possibility of its reduction from ore, and later, fourth, of its combination with alloys.[21] Copper itself may have first appeared as a superior sort of stone which could be sharpened to cut like flint but could also be bent, shaped by hammering or beaten out into sheets, as it was in early Mesopotamia, in Egypt and in recent times by the Columbian Indians of North America. When heated, it becomes as plastic as clay, even becoming liquid, so that it could be cast into a mould whose shape it took on when cooled; with working it then becomes as hard as stone, giving a good cutting edge. You did not simply 'sculpt' copper, as you did with some of the early metals, but like clay you could join pieces together, or more usually mould in a clay container, itself perhaps built around wax which the molten copper replaces, as in the process known as *cire perdue* or 'lost wax'. That method can produce objects in an unlimited number of intricate shapes, but so too could the ordinary moulding in China.

In the Old World copper was rarely found as a raw metal, but it can be readily produced by heating the ores called oxides, carbonates, silicates and sulphides, usually by means of charcoal made by burning wood in an insufficiency of air as in the covered heap of the *carbonier* or charcoal-maker. These ores do not look like copper but are brightly coloured and so would attract man's attention; and their preparation by heat would eventually lead to the reduction of other metals, silver, lead and tin. A further development was the combination of copper with another material to make it harder or more pleasing to the eye; the advantages of an alloy such as bronze were well understood. The Mesopotamian smiths were clearly experimenting with this and with a number of combinations.

The metallurgist, Charles, sees copper being formed 'by the weathering and breakdown of originally sulfitic materials'[22] which were oxidized in an arid climate such as existed in the Pontic and Zagros areas, thereby producing conditions 'conducive to the formation of [metallic, "native"] copper'.

[21] Childe 1942. [22] Charles 1980: 159.

Neolithic humans started to work this ductile material around 8000 BCE and the copper could then be given a work-hardening by cold hammering to make the edges sharper, and even shaped more readily by annealing in a mild heat. A greater heat could be obtained by using the kilns for making pottery or for the baking of stones for flaking. With those higher heats, the ore could not simply be annealed but smelted, thus adding to the supply of natural copper. This reduction of copper ore was facilitated by the use of a flux, such as an iron oxide, to help separate the liquid copper from the earthy gangue that produced a slag. Such a procedure may indeed have been the origin of the production of metallic iron, which was easier to obtain and therefore cheaper.[23] For, as the Bronze Age developed, 'the effort to obtain better copper smelting led to improved furnace operations. More efficient use of fluxes and greater control of combustion and heat consumption meant there was an increased incidence of metallic iron occurring in the spent charge material',[24] which may have led to an upsurge of interest in iron for its own sake.

Copper appeared early in Anatolia, at Çatal Hüyük even before the first ceramics, but there was a very slow development until the mid fourth millennium; its use was low from archaeological finds.[25] There was an explosion in the Middle Bronze Age and in the Late Bronze Age there was a heavy use by the Hittite Empire, possibly as a result of the coming of iron.

In the Near East bronze began to replace copper to obtain hardened instruments between 3300 and 3000 BCE, in India soon after, but in Italy not until 1800 BCE. Different metals including silver, lead and tin could by then be cast in moulds of various shapes rather than simply treated by cold-working. Alloys could be made, especially of copper and arsenic or tin, and these non-ferrous ores were found in the volcanic rocks in some highland areas. A metal tool made of bronze is more durable than one of stone or bone because, when it is worn or broken, it can be repaired and even recast to produce a new one. It is stronger too than copper. To make it required the use of a furnace to heat the metal, where one could enhance the draught by means of a chimney; the use of a pair of bellows would later do the same but more intensively. The process also required a container for the liquid metal known as a crucible, as well as a mould to produce the desired shape.

In the Near East copper was at first alloyed with arsenic, apparently deliberately,[26] in order to make a bronze, and only later combined with

[23] Charles 1980: 116–25. [24] Charles 1980: 169. [25] Chernykh 1992: 168.
[26] According to Renfrew 1967: 14 and Charles 1974.

tin. Copper–arsenic alloys have many advantages over pure copper both in terms of casting and in the resultant properties,[27] and these would have led to their conscious selection. The arsenic was eventually replaced by tin which was normally traded as cassiterite. However tin was rare in the early Mediterranean and often had to be brought from some distance.[28] It is possible that tin as metal or as cassiterite was imported from Central Europe to the northern Black Sea region during the Late Bronze Age. There were very important tin deposits in the Bohemian Erzgebirge as well as some in Yugoslavia. It has been suggested that the adoption of tin–bronze as an alloy may not have been for metallurgical reasons, since arsenic or nickel–bronze was nearly as effective, and in some cases occurred naturally, but rather for aesthetic ones as it was golden in colour and often first used for jewellery. Moreover as a metal, tin was prestigious, being rare and coming from afar. Chernykh[29] writes of a 1,000 km tin trade route extending westward from the Altai in the Late Bronze Age of Central Asia. The latter had been strongly influenced by the transfer of eastern European skills, possibly by migration, to Kazakhstan and the Altai, which became the main mining culture for the province because of their easily accessible copper and tin deposits. That development led to the westward advance of the significant Seima–Turbino people with the predominance of tin–bronze (and some jade and thin-bladed tools) rather than the arsenic variety, coming from the Altai and Tien Shan. These horsed nomads spread very rapidly to Eastern Europe in the sixteenth century BCE through the forest-steppe zone.

The distant origin also applied to other metals. Indeed one of the features of their coming to the Aegean, for instance, was the 'marked increase in trade and in contact', providing 'an international spirit'[30] to the Early Bronze Age which distinguishes it from previous periods. Metal-working had arrived in the Aegean from the Troad or from elsewhere in Anatolia. The archaeologist, Renfrew, writes that the 'idea of metallurgy *may* have been brought to the Aegean from outside',[31] indicating doubt. He emphasises, quite rightly, 'the essential autonomy' of the new culture it produced; nevertheless metal-working itself apparently did arrive from abroad. But that is not to deny the role of invention in this or in other activities, for instance, in the decoration of pots, though not in the introduction of pottery itself; one has to distinguish different elements and not be too enmeshed in a holistic 'anthropological' view. A recognition of this

[27] Charles 1980: 168. [28] Renfrew 1967: 13. [29] Chernykh 1992: 194.
[30] Renfrew 1967: 15. [31] Renfrew 1967: 15, my italics.