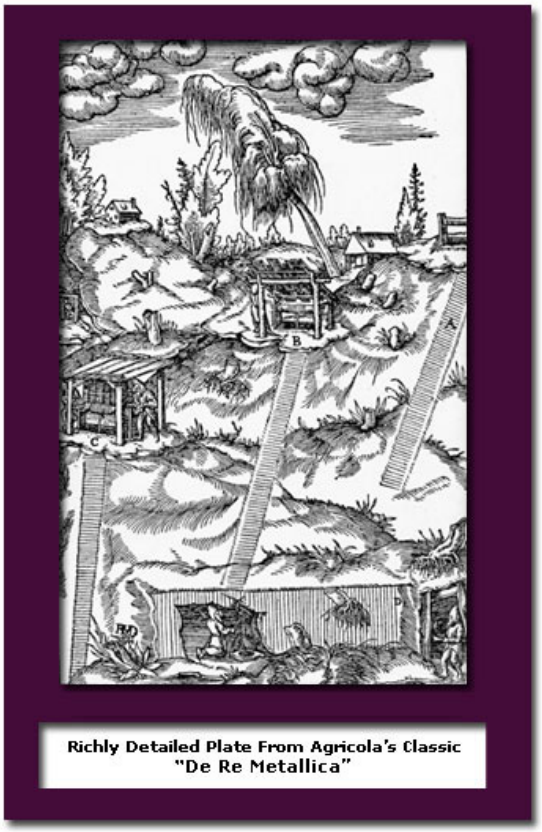

Richly Detailed Plate From Agricola's Classic "De Re Metallica"

MAN, METALS AND MAGIC:

A WALK ALONG THE METALS ROAD OF ANCIENT METALLURGICAL HISTORY.

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Man, Metals and Magic: The Ancient History of Metallurgy

"The Beginning of Metallurgy"

Chapter I

Over the years, it has often pointed out that man existed for a very long time. While indisputable, that is hardly remarkable because due to lack of experience, man's development came slowly. However, we can take as our starting point, the first Ice Age. About 500,000 years ago, there was a creature on earth that we recognize as being something like a man, which could stand upon his hind legs, and thus was able to use his front limbs for other, more interesting purposes. His physical change resulted in mental development, and as he was obliged to think, his brain grew.

Direct evidence of these primitive man-like creatures is rare. There were probably few of them and their remains were rarely preserved. Anything edible, including bones, was likely eaten by animals that, like the younger generation, had bellies but no palates. Primitive man left more abundant evidence of his development in the implements that he made for himself from flints, which altered in form and improved as the millennia went by.

The idea of making a tool by chipping and shaping a flint must have taken thousands of years to mature, for it involved the animal intelligence that prompts a monkey to throw a coconut, and logical reasoning that allows an end to be achieved by first performing a seemingly unconnected operation. In this case, the aim was to kill, and the intermediate action was to make a weapon. This dawn of thinking -- crude though it was -- marks the beginning of the Stone Age, and the improvements in the way flints were fashioned.

About 100,000 years ago, Piltdown man was once supposed to have existed. Although the scant evidence offered by remains of a creature found in Sussex was later written off as a hoax, the flint implements found in the vicinity indicate advances had been made in working stone. Flints were no longer just crudely chipped, and could be distinguished as tools for specific uses (knives, axes, borers.)

Then came the precursor to Homo sapiens -- the Neanderthal -- so similar to man, as we know him, he might be regarded as human. He made fires, which was an extremely important advance, sheltered him self in caves and was right-handed.

Following the worst of the last Ice Age, approximately 35,000 years ago, Neanderthal man was displaced from his dominant position by another creature – our first ancestor. The Homo sapiens were similar in many respects to the Neanderthal. However, they could talk, were more intelligent, and the skull and digits were very like our own.

The Real History of Mankind Begins

Here, too, is where metals make their appearance, for during the latter part of the Stone Age metals were known and appreciated both for their ornamental and utilitarian value. Gold, silver and copper are the metals that most commonly occur in the native form. That is, they occur *as* metal and not in the usual guise of chemical compound. The most important sources of metals (except gold) do not occur in this convenient way, but as complex minerals whose treatment to yield metal may be intricate and expensive.

Of these three native metals, it is likely that gold was the first to be discovered, for it is the most widely distributed. As it is very resistant to corrosion, the bright surface of a gold nugget would attract the attention of an observant primitive man, and no doubt kindle his disgust when it would not chip or break, as did other stones. However, its appearance was pleasing, and the metal was so ductile that although it was not a first-rate material for armament, it made a pretty ornament and might even be temporarily sharpened into a blade. When the Spanish invaded the American country in the 15th or 16th centuries, the Incas were found to have almost no metallurgical knowledge; yet they used native metals very largely. Incredible as it may seem

today, many of their axes and knives were of gold, which they valued much as we value iron – for its utility, not because of its scarce.

But native gold and, more particularly, native silver could not be used a great deal, for their rarity and their softness precluded wide application. Copper, however, was found much more commonly. Although fairly easily corroded, the shining metal surface might be revealed by stream erosion, or by fortuitous inquisitive scrapings. Once discovered, and once some significance had been attached to the discovery, the locality would be searched for more. Whereas the widely distributed metal gold was found as small nuggets or disseminated in quartz rocks, native copper might be discovered as very large masses, probably too big to be moved. A lump of copper hacked off would be beaten and hammered until it became a suitable shape, and during this process it became harder.

This phenomenon of work hardening occurs in all metals but only below a characteristic temperature, which for some metals is somewhat below atmospheric. Fortunately for primitive man, copper hardens at ordinary air temperatures. After hammering, it could be sharpened to make a blade, or pointed to make a spike. By our standards, of course, the metal would still be fairly soft, but it was hard enough for many purposes; and it had the advantage over stone and flint that it was much more easily worked into shape. It is doubtful whether prehistoric copper weapons were hardened by any other process; as far as it is possible to tell, both native copper and smelted copper (which will be described later) were hardened only by this means.

The period was a very long one during which man used stone and metal by manhandling them into shape. In the most civilized localities it ended only about 6500 years ago; in some restricted areas it continued into the last century. As recently as about 550 years ago, there were vast parts of the world where the inhabitants had not been introduced to more advanced techniques. Before the Metal Age began there were two vital discoveries to be made: (1) that metals could be melted and cast to form the impression of a mold, and (2) that metals could be produced from mineral-bearing rocks.

Before we can satisfactorily follow the early history of metals, it will be necessary to define some of the terms that have to be used. Thus, for the moment continuity will be laid aside and we will digress to include some necessary definitions.

Terms Used to Describe the Early History of Metals

A mineral is any metallic compound that occurs in the earth's crust. A fairly broad interpretation, it means virtually anything in the earth's crust that is not vegetable is mineral. If a particular mineral deposit occurs in sufficient abundance to be profitably mined and treated to extract its metallic component, then it is called an ore. The worthless material that somehow or other has to be expelled during the process of extracting the metal from its ore is called "gangue." For example, ironstone may occur as a siliceous deposit of which, say, half is iron compounds and the remaining half are silicates of calcium, magnesium, aluminum (as well as many others) that make up the gangue.

The metal is usually produced from the ore by smelting. Broadly speaking, this involves heating the ore with carbon (as coke) and fluxes to a high temperature, so that the metallic compounds will be reduced to form liquid metal and the fluxes will combine with the gangue to produce a slag. Slag and metal form two distinct liquid layers, and can be separated. Usually the metal is the heavier, lower layer. The nature of the ore and a suitably arranged smelting process allow only the desired metal to be produced, although, of course, fairly heavy contamination may occur.

It may be economic to re-treat the slag to recover any valuable constituents; and it may also be advisable to refine the metal, producing a more marketable product, and perhaps incidentally recovering some valuable metallic impurities. In this way, much of the silver, gold and platinum of the world is produced during the refining of copper.

Having cleared away enough of this undergrowth to see the path once again, we can continue with the affairs of primitive man, who, by dint of groping and floundering, eventually found these things out. There is some doubt whether he first discovered that ores could be smelted to produce metals, or that the native metal he had known so long could be melted. It does seem, however, in light of the metal articles he left behind, that smelting was first known;

and this is not surprising in view of the accidental way in which the discovery must almost certainly have been made.

Copper was the first metal to be extracted from its ores. And the most popular of the current theories of primitive man's discovery is that by pure chance he built his hearth of rocks containing a copper mineral, which was reduced to metal by the charcoal produced in the fire. Now, it is unlikely that such an occurrence would be noticed immediately; and if it were, there is little chance that much significance would have been attached to the phenomenon. But in a copper-rich region it would inevitably happen many times, and eventually some association would be made – it is supposed – between fire and the fused copper produced from rock of a particular kind. In this manner, by the way, lies the strength of the theory, as opposed to rival theories, for it is more than unlikely that a single chance production of metallic copper would have attracted much attention. The pretty story – and it is one of a number – of the Egyptian lady who accidentally dropped her cosmetic, which was made of malachite (copper carbonate), into a charcoal fire and observed its reduction to metallic copper is doubtful on that score alone. What is more, one cannot easily believe that an Egyptian lady so intent on obscuring the work of nature would be so capable of revealing it. The campfire theory seems far more plausible.

The repeated production of copper under these conditions made its mark on the brain of primitive man; metal could be extracted from its ores. Such a happy accident could hardly be responsible for leading him to melt native metal. A man, however primitive, could not be expected to throw his valuable copper weapons or his wife's equally treasured gold ornaments on his campfire, nor be credited with the intelligence of noticing what happened if he did. Most likely he would not repeat the operation so many times that it would make any impression upon him.

Thus far, we have avoided dates and locations -- the former, because of the recognized difficulty of dating prehistoric events, and the latter, because the absence of evidence of metal-workings in certain parts of the world is not conclusive of metallurgical inactivity. There may well have come a time when man was so hard-pressed for materials that he melted and recast his earlier weapons and tools; we do it today, without giving a thought to the difficulties we are making for posterity.

Earliest Copper Workings

The earliest copper workings, which may be dated about 6000 B.C., have been discovered in parts of the Middle East, particularly around Ur in the Fertile Crescent, where like agriculture, it seems likely that the art of metallurgy was first practiced. Here, probably at Sumer in Mesopotamia, the land of Shinar mentioned in Genesis, the first civilized community existed, for the silt deposited from the Tigris and the Euphrates as they entered the Persian Gulf produced a fertile land that attracted the peoples of the northern reaches of the rivers. As more immigrants settled it became necessary to organize a scheme of irrigation, and an agricultural community developed, which, in addition to growing crops could spin, weave and make pottery. It had its wars too; but the weapons were made of stone.

Then came the Great Flood, supposedly about 4000 B.C., destroying all the low-lying farms and villages, exterminating the inhabitants, and laying waste to all that had been built. After the waters had subsided and the face of the ground was dry, the fertile land again attracted inhabitants of the north, who in addition to reviving the agriculture of the Delta introduced new arts. Among these were those of melting and casting copper, silver and gold, and of making copper from its ores.

The ornaments and weapons found during the excavations at Ur imply that the casting of metal had begun about 3500 B.C. And it seems that in this locality there was an interval of about 2000 years between the first crudely hammered metal article and the earliest cast one. Remains of primitive copper workings have been found at the sites of other early civilizations – in the Nile valley in Egypt; and at Mohenjo-daro, which appears to have been the center of an early Indian culture at Sind. A complete survey of this subject would fill several books, but there seems to be no evidence to suggest that in any of these places metallurgy was more advanced than in Sumer. The general progress of the art of producing and using metals followed much the same sequence. It is only the speed of the advance and the time over which each state of development lasted that differed very greatly.