THE METALLURGIST

Aluminum and iron are the third and fourth most abundant elements in the Earth's crust, after oxygen and silicon. Yet finding either near our planet's surface as a metal is extremely rare. Both are almost exclusively found combined with other elements as mineral ores. In the case of iron, magnetite and hematite are the most useful while the most important aluminum ore is bauxite. There is however non-native metallic iron on the surface.

The earliest iron artifacts that archeologists have found are small beads that date to around 3200 BC. We can tell by their high nickel content that this iron fell to Earth as metallic meteorites and was simply hammered into shape. Obviously, such meteoric iron was extremely rare and consequently was available only to the rich and powerful. King Tutankhamun's burial dagger, dating to the mid-1300s BC, is one such extraterrestrial artifact.

Mars Owes Its Redish Color to Iron Rich Rock on The Surface

Hematite

Magnetite

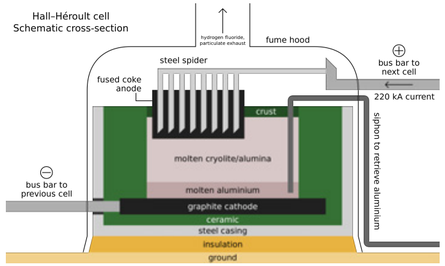
RUBIES & SAPPHIRES ARE PRIMARILY ALUMINUM OXIDE- IMPURITIES ACCOUNT FOR THEIR COLOR DIFFERENCE

Bauxite

While we are not certain exactly when humans learned to refine iron from ore, it is widely believed to have been somewhere between 1100 and 750 BC. Aluminum however, would have to wait.

In time, metal smiths learned techniques that introduced just the right amounts of carbon into the iron they were working. The resulting alloy, steel, is as much as 1000 times stronger than pure iron. The development of this technology marked the end of the Bronze Age, the beginning of the Iron Age, and laid the groundwork that led to the Industrial Revolution and the modern world. Even today we extract, refine and use more iron than any other element, by far.

Extracting metallic iron from ore, at its most primitive, only requires throwing the right rocks into a very hot fire. Aluminum is not so simple, and it does not fall to Earth in meteors. Legend has it, by way of Pliny the Elder's *Naturalis Historia*, that a goldsmith once presented a cup to the first century Roman Emperor Tiberius. This cup, made from an unknown metal, looked like silver, but was far too light to be silver. Tiberius was apparently so impressed that he had the goldsmith put to death to protect the prices of gold and silver from this new metal. No one knows what this cup was made of, but based on Pliny's description some have speculated that the cup was made of Aluminum. The cup, if it ever existed, has been lost to history, and no one produced metallic aluminum (again?) until modern chemistry and electricity could be brought to bear the 1800s.



- Once refined both steel and aluminum can be used again and again.
- Recycling existing metal is cheaper than mining and refining new ore.
- Over 70% of the aluminum ever produced is still in use.
- The USS New York incorporates 24 tons of steel from the World Trade Center.

Each of these metals has its advantages. Steel is incredibly versatile and is often the first choice when a low-cost, structural material is required. But steel has two major limitations: it is heavy and it rusts. Aluminum overcomes these shortcomings. Because it is lighter and softer than steel, it is generally cheaper and easier to transport, cut, drill and shape and because it doesn't rust corrosion is not a significant issue.

The production of these two metals, iron and aluminum, are foundational to the world we live in today. Very few of the products and structures that make up our lives could exist without them. Even the few products that do not actually contain iron or aluminum are built, grown or extracted, and brought to market, by technologies made possible by these two metals.

In 1808 English chemist Humphry Davy devised an electrochemical method of refining aluminum from its oxide, alumina. He never succeeded in actually doing it though. It wasn't until 1827 that the German chemist Friedrich Wöhler finally succeeded in refining pure aluminum. Nineteen years later, in 1846, French chemist Henri Étienne Sainte-Claire Deville significantly improved on Wöhler's technique, but the aluminum precursor, alumina, was relatively scarce, the process involved was difficult, and in the end it produced such tiny quantities of metal, that the price of aluminum far exceeded that of gold. And so it remained for over 40 more years.

In 1886 the American chemist Charles Martin Hall, and Frenchman Paul Héroult independently discovered a new electrochemical process for refining alumina into metallic aluminum. The method, now called the Hall/Héroult process (Shown Above in Schematic Form) could be scaled up to industrial levels, if one had enough alumina. In 1888 Carl Josef Bayer, an Austrian chemist working in Saint Petersburg, developed a method to extract alumina from the common mineral bauxite. These two processes finally made large-scale production of aluminum possible. That same year Hall founded the Pittsburgh Reduction Company, now called Alcoa, and the modern world's newest metal was no longer a precious metal. Almost overnight the price of aluminum dropped to less than a dollar per pound. The Bayer and Hall/Héroult processes are still used today to make the transition from mineral to metal.