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Iron, the King of All Materials

Iron, this fascinating metal that holds one of the secrets of creation, is by many standards the most important material known to humans.



No wonder the Iron Age that described few thousand years of human history bears its name and its introduction made dramatic changes to whole civilizations. The Iron Age started between 1200 BC and 1800 BC in present day Turkey and here in the Eastern Mediterranean region¹. Until today the Damascus steel is still famous among metal enthusiasts and the sword made in Damascus during a period of the Roman Empire was said to be sharp enough to cut a feather in midair.

Earlier encounter of humans with Iron came from heavens.

Archeologists were dazzled at first when they realized that the dagger in Tutankhamun tomb was made of Iron (Figure 1) since his reign was well within the Bronze Age.



Figure 1. Tutankhamun's dagger

Later research concluded that not only King Tutankhamun's dagger but also virtually all iron made materials dating to the Bronze Age came from the skies above us. Both Sumerian and Egyptian translation of iron means 'metal from heaven'. The quality of this alloy was not to be matched until after late 19th century with the beginning of the industrial revolution.

In this short paper we will discuss some of iron's characteristics and discover what makes this metal an essential part of our life on earth.

Iron in Nature

Like most metals, Iron is found in nature in what is called ores which means it is combined with other elements. Iron ores come as rocks and soils containing impurities like sulfur, silica, phosphorous, and carbon. Iron ores come in a variety of colors like dark grey, bright yellow, deep purple or rusty red (Figure 2).



Figure 2. Iron ores in nature

Iron is the second most abundant metal on the surface of earth after Aluminum. However, in terms of production it sits by far on top of the list. Almost Two billion tons of steel are produced every year. It is no wonder steel is seen in every aspect of our lives. From houses to cars and ships and to every household appliance in our homes, iron in the form of Steel is there. It is hard to imagine living without iron but it is also harder to imagine that humanity actually lived without it for millions or perhaps billions of years.

The countries with highest iron production and iron reserves are Australia, Brazil, China, Russia and Ukraine ². Luckily for humans is that most iron is produced by surface mining making it a cheaper commodity. In some places such as this site in Brazil shown in Figure 3, mountains of

iron ores are given as gifts and ready for processing without going underground ³



Figure 3. Vale's mammoth S11D iron ore mine in Brazil

From Iron to Steel

Iron by itself is a very soft and malleable metal but when combined with very small amounts of carbon it can become very hard. What is interesting is that the process of melting Iron to purify it and make it workable is accidentally the same process needed to add carbon. Ancient people thought they melted iron by heating to get pure iron but what they were getting sometimes when charcoal was used was actually steel (Figure 4).

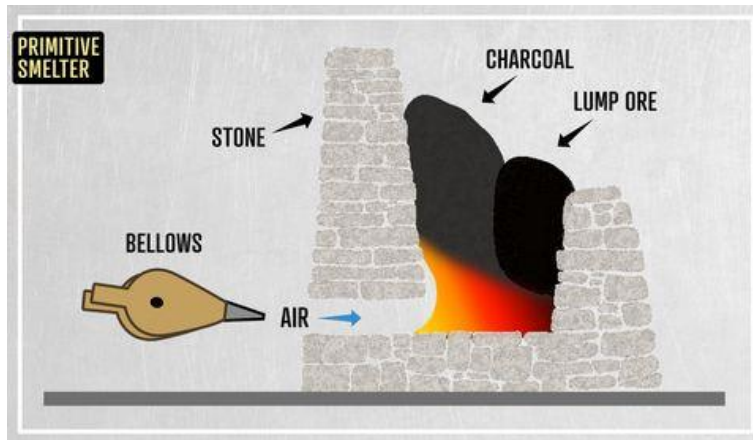


Figure 4. Ancient way of melting Iron

We know now that Steel is basically iron with percentages of carbon that varies between 0.5% and 2%. The process of adding and removing carbon to create the right mix for the right applications under controlled and repeatable conditions was developed in the late 18th century by factories in the UK. The first prize of this new development was the first steel bridge over the River Severn in the United Kingdom's town of Telford and it is still being used today after almost two hundred and fifty years (Figure 5).

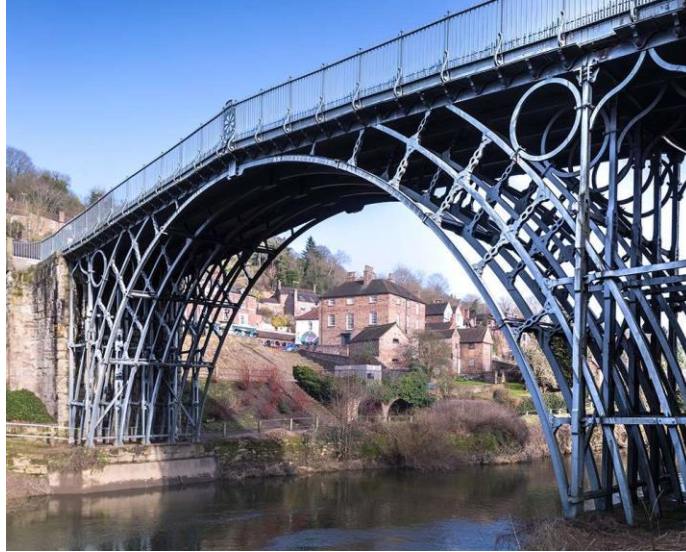


Figure 5. The Abraham Darby III Bridge in the UK

The same technology that was used to build the first bridge is still being applied today in many countries but certainly with more advanced adaptations. Today, China is by far the on top of the list producing Steel almost as much as the whole world together ⁴.

Iron: Our Planet Defender from Solar Wind

The real importance of iron, the one that has to do with our own existence lies beneath the surface of earth. The earth if we simplify it as a sphere of radius 6378 km has an innermost core with a radius of 1220 km made of mostly iron and some Nickel (Figure 6). This inner core is in a solid state at a temperature of 5200° Celsius which is higher than the

melting point of iron of 1538° Celsius but remains solid due to the 3.6 million atmosphere (atm) pressure ⁵. An outer core bigger than the inner one and extending to more than half the distance from Earth center outward is also made of mostly molten iron. Due to the existence of these quantities of relatively heavy iron in the core and what lies on the crust, scientists estimate that one third of the total earth's mass is made of iron.

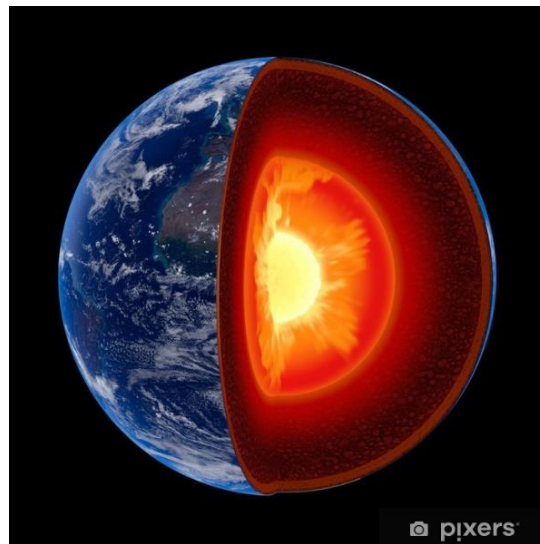
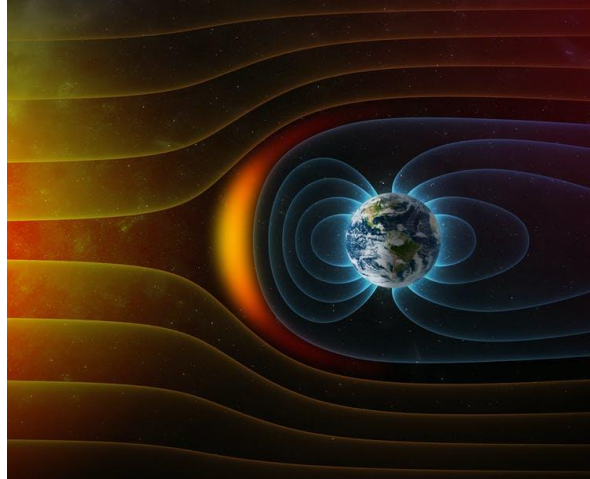


Figure 6. Earth Layers as depicted by science

As much as we depend on iron for everyday life, its job in the core of earth is much more interesting. Scientists believe that the whole iron core was molten at the beginning of the creation few billion years ago. Based

on the laws of Thermodynamics Earth is cooling down since it is hotter than the space around it. The inner solid core is growing bigger as it solidifies causing molten iron to flow and swirl fast as heat is transported outward to eventually exit Earth almost as if it is breathing. This phenomenon creates the magnetic field that surrounds Earth. Interestingly, this magnetic field is what protects our planet from solar winds.

Solar winds are currents of particles charged with energy originating from the sun at speeds exceeding one million kilometers per hour and emitting radiation. When they approach our planet, the magnetic field wrapped around Earth deflects them and protect us (Figure 7). It is a wonder that the events of earth cooling then iron swirling then magnetic field forming all work to defend life on earth from imminent and deadly threats ⁶.



**Figure 7. The Earth's magnetic field (blue) diverting harmful solar radiations
(Yellow)**

Iron in our body

Iron serves many vital functions in the human body. The most important role of iron has to do with our basic existence” The human cell”. Iron serves as a carrier of oxygen in the blood to every cell in our body via red blood cell called hemoglobin. It is almost like a taxi that takes oxygen from the lungs to all tissues of the body. The red color of blood comes from the iron rich Hemoglobin cell (Figure 8). Iron is also essential for muscle cells and proper immune system function. The few grams of Iron in the human body which is mostly in the blood is detrimental to our survival ⁷.



Figure 8. Iron rich Hemoglobin cells

The Mystery about Iron

We know that Iron runs through our veins delivering oxygen to our cells so it can function, it is spread around in many places on Earth for us to transform into hard steel, and it sits right in the core of our planet creating a magnetic field protecting us from harmful sun storms. This metal then deserves to be called the king of all metals as this paper claims by its title. Science has allowed us to understand some facts about Iron and other metals but there are certainly much more to be discovered in the future. The mystery and secrets of our own creation and the universe around us always point to this metal as an essential player from the tiny molecular level to universal dimensions.

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