The mining and processing of minerals provides us with the building blocks required to form much of the infrastructure needed to support modern societies. In 2020, the top 40 mining companies had together accumulated a total revenue of USD$544 billion, which was up 4% on the previous year. Whilst demand for some resources such as coal is falling, other resources such as copper are seeing increasing demand as new products and technologies require different materials. For example, a single lithium-ion electric vehicle battery pack (a type known as NMC111) uses around 16kg of lithium, 46kg of nickel, 46kg of cobalt and 43kg of manganese.

However, the process of mining remains intense and invasive, and operations often leave large environmental impacts on the local surroundings as well as having wider implications for the environmental health of the planet.

Water Use in Mining

Mining and mineral processing operations often have high water footprints as many stages require the use of water. Examples include dust mitigation, removing soluble particles, sieving and separation processes, and in creating tailings dams for waste management. Although some stages, such as the separation of minerals, can reuse and recycle the water, other stages such as spraying to remove airborne dust will lead to pollution of the water, preventing water from being recycled. High water use in mining operations can lead to reduced access for local people to uncontaminated freshwater supplies and can result in a local area suffering from water stress.

However, compared to other industries, mining has a relatively small water usage and often a large fraction of the water used is saline so does not have much use in other industries or domestically. For example, the **US** has one of the highest rates of mineral production in the world after China and Australia; however, the water used for mining only makes up about 1% of the total national water use with 47% of this water being low quality saline water.

Mining Pollution

There have been many documented instances of **environmental pollution** caused by mining operations, which are often caused by leakages of mining tailings. Mining tailings are the materials left behind after the economically valuable fraction of material has been extracted. These materials are often stored in large tailings dams to prevent environmental damage as tailings are often radioactive, toxic or acidic. Tailings consist of valuable substances used in the extraction process such as cyanide, mercury or arsenic; therefore, modern mining programmes often aim to remove these harmful but valuable chemicals to reuse for further mineral separation. In addition to improving efficiency and cutting costs, this minimises the risk of environmental damage by reducing the toxicity of the tailings.

As a result of strict international regulations, pollution caused by mining has been dramatically reduced; however, it is still an ongoing problem in many developing countries where illegal small-scale operations known as ‘artisanal mining’ occur. These low-tech, subsistence mining operations are often unsafe, and the poor management of sites leads to environmental pollution in the region. The problems associated with artisanal mining remain complex as it is difficult to identify and shut down all of these small operations. Furthermore, although artisanal mining can result in dangerous environmental pollution, it does help to alleviate the estimated 40 million people who participate in this industry from poverty.

How Does Mining Impact the Land?

Another key environmental problem associated with mining projects is the **land** use change that occurs, not only from drilling and excavating open pit mines but also the changes that occur as result of the development of surrounding infrastructure. The latter can include camps to provide accommodation for the miners as well as the railways and roads needed to transport the mined materials. The infrastructure created by mining operations in remote, untouched landscapes can lead to improved access to these regions which may result in further human-caused disturbance to the local ecological systems.

The impact of mining operations on the surrounding land is also closely linked to the ecological setting of the mining sites. For example, the deforestation of primary forests caused by mining for iron ore in the tropical rainforests of Gabon is likely to leave more devastating and longer term ecological damage compared to mining iron ore in the deserts of northern Australia.

However, compared to many other industries such as agriculture, mining uses relatively small pockets of land, and the future of mining could move to using techniques that are arguably even less invasive on the environment by using less land and emitting less pollution. Methods could include underground mining where ore is extracted below the surface with little waste and minimal ecological scarring of the Earth’s surface; phytomining where plants accumulate high concentrations of metals which can then be processed; or even asteroid mining where materials from asteroids could be harvested for their use on Earth.

Greenhouse Gas Emissions from Mining

It is also important to consider the impact of land use change in the context of greenhouse gas emissions. The destruction of vegetation and soils when land is cleared for mining results in the release of carbon dioxide and other greenhouse gases. Another important consideration relates to the quantity of greenhouse gases released per unit mass of mined

material, as some less concentrated mineral deposits require proportionally higher energy usage. For example, mining a kilogram of diamond produces around 800,000 kg CO2e compared to a kilogram of a highly abundant mineral such as iron which produces only about 2 kg CO2e.

The creation of products from mined materials uses high amounts of energy throughout the different stages of the production chain and most of this energy is currently sourced from the burning of fossil fuels.

Looking Ahead

Overall, when considering the environmental ramifications of mining, it is important to weigh up the social and environmental damages caused by extracting the minerals against the benefits gained from the use of the final product. As consumers, it is important that we are aware that our personal decisions to purchase new products containing finite mined materials are associated with high water use, land use, pollution, and the release of greenhouse gases.

Mining of further resources is required to support the growing global population and allow for the creation of green infrastructure and renewable energy generation. It is vital that governments and companies continue to innovate to create clean mining technologies with strict environmental regulations which will enable the mining industry to pave the way for a sustainable and hopeful future.

Source: Earth