https://doi.org/10.3176/earth.2007.23

Which metals and minerals will be our future resources?

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Received 30 July 2007

WHO NEEDS MINERAL RESOURCES?

Many modern and urbanized persons, often holding influential positions in economy, politics, and culture, are surprisingly unaware of their own needs and consumption patterns of mineral resources. Instead, they often consider exploitation of mineral and energy resources unnecessary. The same people may even consider mining as something that belongs to the past and a threat to the local environment and future development of human cultures. What these people *ought to* know is that the advanced cultures have required, and will continue to require, the exploitation of mineral resources.

This can be exemplifed by some simple statistics on the current patterns for high-intensity consumption countries (EU, North America, Japan, and Australia), where an average person annually consumes 4 tonnes of petroleum, 4 tonnes of coal, and 4 tonnes of sand/gravel, while the per capita need of metals is 500 kg iron/steel, 25 kg alumina, 10 kg copper, and 50 g of uranium. These figures reach astronomical magnitudes if they are multiplied by 950 million, which is the population in those countries. The significance of the above-mentioned per capita figures is further emphasized when low-intensity consumption patterns in less developed countries are replaced by high-intensity patterns as it now happens in China with its 1.3 billion inhabitants.

A wide range of mineral resources are currently exploited globally with good profit due to the current exceptional metal and energy prices. A common discussion topic among experts in resource economy and resource politics is whether we will soon go back to "normal" metal and energy price levels or whether the present mining boom will continue. It is easy to find arguments supporting a continued high demand for many types of mineral and energy resources as long as:

- the consumption patterns in the developed countries remain unchanged;
- new technological products, with "new" metals, will appear on the market;
- the economy in China will continue to expand;
- the political situation in Iraq remains unsolved.

WHAT MINERAL AND ENERGY COMMODITIES WILL WE NEED IN THE FUTURE?

It is always difficult to predict which mineral commodities future generations will need, because it depends on the industrial products that will be required on the future markets. These markets will in turn reflect the technological innovations as well as political and economic climate that will be faced in the future. In any case, if we have a look at the present consumption patterns, we see the following trends:

Classical metals

Some metals, e.g. Fe, Cu, Au, and Ag, have been used by human cultures for several millenia. In spite of this long exploitation history, there is still in 2007 a very strong demand for each of these metals.

"20th-century" metals

Ni, Zn, Mo, Pb, and Al came on the market as a result of the development of specialized industry products during the 20th century. In spite of recent discoveries of large nickel resources, there is no sign of lower prices for nickel or for the other metals of this group.

Post-modern metals

Pt and Pd have had a dramatic price rise during the last ten years, mainly related to environmental regulations in the car industry. Current prices are comparable to, or even higher than, that of gold.

Future metals

In, Ta, Ga, Ge, and Te have come into fashion quite recently. It is generally considered that they will play an increasing role in technological innovations and thus also in exploration. As many of these metals are so new on the market, very little is yet known about appropriate reserves and very small quantities of these metals are recycled. This is particularly true for indium, but all these metals are currently considered as future metals.

Industry minerals and construction materials

This group comprises a variety of mineral resources which have had an expanding market for several decades. *Quartz* for fibre optics and solar cells, *olivine* for the iron metallurgy industry, *ilmenite* for the paint industry, *limestone* for numerous purposes, and *refined dimension stone products* are examples that probably only describe the beginning of a relatively new field in economic geology.

Energy resources

Oil, gas, and uranium are wheel hubs for most of the industrial processes and transports as well as the main energy source for private use. Dramatic political conflicts in the most important oil-producing region of the world have shown how desperately we need these products, which have resulted in the highest energy prices ever.

Water

The access to clean water is a basic need for all biological organisms but it is too often forgotten by human cultures. If we waste or overuse our aquifers, water may become as precious as oil or gold.

WHERE CAN WE FIND THESE RESOURCES?

The above-mentioned summary has demonstrated a high current (and most probably also future) demand for a number of mineral and energy resources. But will Mother Earth have enough supply to cover all these needs? Many densely populated regions in Europe and Japan will have problems to find domestic resources, while this problem is not so critical in North America, Australia, and the Fennoscandian region (and associated offshore regions), which possess potential resources for all these commodities. Mineral resource exploitation in less developed countries offers many options but is also coupled to many ethical questions.

HOW CAN WE FIND THESE RESOURCES?

The most obvious mineral resources have probably already been found. Future discoveries of mineral deposits and hydrocarbon resources will therefore rely on increased skill in resource geology and access to new methods. The only way to meet such a challenge is to:

1) continue educating future generations of geoscientists who must receive a broad and deep understanding of rock-forming and ore-forming processes as well as knowledge on how hydrocarbon and groundwater resources form and
2) improve theories in exploration techniques and resource genesis.