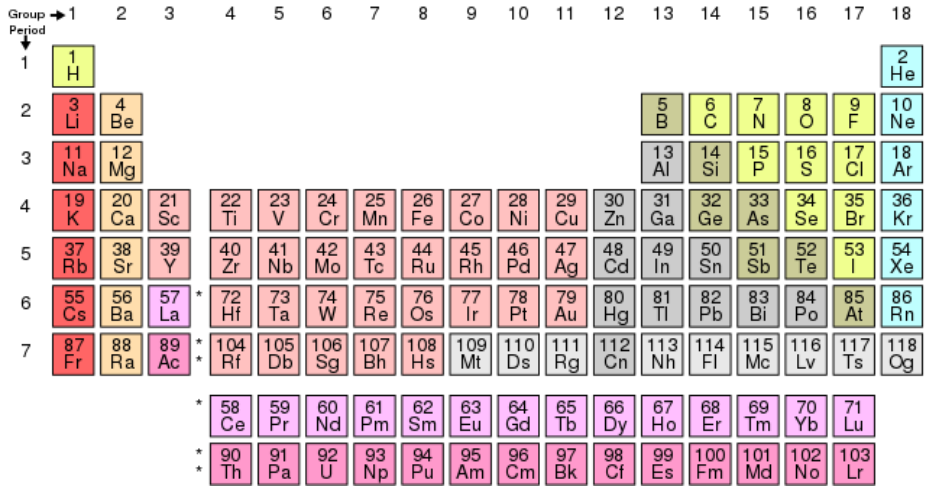
Minerals and Elements in the Democratic Republic of Congo*

The Periodic Table of the Elements is an amazing thing. On a single, highly structured page, it summarizes the identity and properties of all of the atoms that make up Planet Earth. These are grouped into specific entities called “elements” which are typically referred to by scientists as simple, one- or two-letter chemical symbols.



Some of these elements are well known to us:
- carbon (C)—the building blocks of humans and all life-forms on Earth,
- nitrogen (N)—the most abundant gas in the Earth’s atmosphere,
- oxygen (O)—less abundant than nitrogen, but the gas in the atmosphere which fuels human life.

Just as nitrogen is more abundant in air than oxygen, so the various elements in the Periodic Table differ in their abundance in the Earth’s crust — the outer skin of the planet on which we all live. Ten elements, topped by oxygen, silicon, aluminum, iron and calcium, make up 99.2% of the weight of the crust.

All of the other elements on the Periodic Table make up less than 1% of the weight of the crust. Many of these elements have critical uses in our high-technology advanced industrial society. But in order to be economically extracted from the crust, we need to find rocks where the concentrations of these desired elements greatly exceeds this average crustal concentration.

There are places where these rare elements are concentrated by geologic processes.
The rocks here constitute *ores* — rocks that can be mined and processed for a profit.
In the DRC, there are ores of the following elements: copper, cobalt, niobium, tantalum, tin, tungsten, and gold.

element	ores (minerals) occurring in the DRC	selected uses of element
copper (Cu)	a variety of copper sulfide minerals	electrical wire and cable; electric motors; integrated circuits
cobalt (Co)	heterogenite, a mixed oxide and hydroxide of cobalt (CoOOH)	alloys for gas turbines and jet engines; batteries in cell phones and electric vehicles
niobium (Nb)	columbite (also called niobite), an iron, manganese, niobium oxide mineral [$(Fe,Mn)Nb_2O_6$]	alloys in jet and rocket engines; superconducting magnets in magnetic resonance imaging equipment
tantalum (Ta)	tantalite, an iron, manganese, tantalum oxide mineral [$(Fe,Mn)Ta_2O_6$] Columbite-tantalite ores are typically referred to as *coltan* (see https://friendsofthecongo.org/coltan/)	capacitors in cell phones and personal computers; alloys in jet engines
tin (Sn)	cassiterite, a tin oxide mineral SnO_2	solders for electronic circuits; alloys with zirconium for cladding of nuclear fuel rods
tungsten (W)	wolframite an iron, manganese tungstate mineral $(Fe,Mn)WO_4$	tungsten carbide for cutting tools; alloys for use in armor- piercing ammunition
gold (Au)	native metal, Au	monetary use; jewelry; electrical contacts in personal computers

Much of the world's attention with respect to *conflict minerals* in the DRC (see full report available at https://www.globalwitness.org/en/campaigns/democratic-republic-congo/time-dig-deeper/) has focused on tin, tantalum, tungsten and gold, often referred to as the *3TG*.

In the United States, regulations are in place to protect the health and safety of miners, and to protect the air, water and soil of the mining regions. Sadly, in the DRC, such protections just don't exist. The processing of ores to extract the economically important elements exposes sulfide minerals to atmospheric oxygen, and thereby generates sulfuric acid. This *acid mine drainage* can mobilize toxic metals and threaten surface and ground water resources.

Tailings from these large-scale copper-cobalt operations can be found in streambeds where they act as continuing sources of toxic metals to water supplies. Besides large-scale commercial mining operations, there are thousands of artisanal miners—small-scale, subsistence miners—who are exposed to the danger of tunnel and pit collapses, toxic dusts, and radiation exposure associated with the presence of uranium and thorium in some of these ores.

This has been a glimpse of the science that underlies some of the suffering of the people of the DRC. As end users of many of the high technology products that had their supply-chain origin in the DRC, it is up to all of us to work for the responsible sourcing of raw materials from the DRC.

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