

Mining the Fourth Industrial Revolution

Chemical elements for South Africa's future – Rare elements for new technologies
 #elements4tech #IYPT_za #4IRsciZA #IYPT2019

There is a lot of controversy around mining. At the same time, people use products and materials from mines just to live... from housing to technology. This tension ramps up further when we face the near future. As we look to reduce carbon output and environmental impact, we focus on green energy sources and the Fourth Industrial Revolution (4IR). The latter needs minerals from the earth to operate. It seems we have much to investigate.

This is the [International Year of the Periodic Table of Chemical Elements 2019](#) (#IYPT2019) as declared by the United Nations.

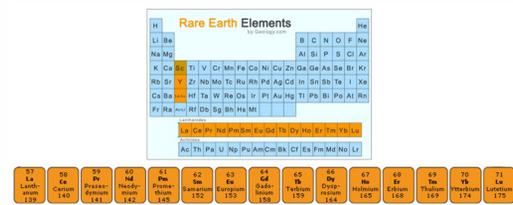
The [National Science and Technology Forum](#) (NSTF) held an NSTF Discussion Forum on ['Chemical elements for South Africa's future'](#) (#elements4tech #IYPT_za) from 18-19 March 2019. The first day focused on "Rare elements for new technologies". The event was held in partnership with the [South African National Convention Bureau](#) (SANCB), SA Tourism.

What are rare earth elements?

Rare earth elements (REE) are elements on the periodic table that range from the atomic numbers 57 to 71.

The NSTF provides neutral collaborative platforms where issues and sectors meet

- One of the National Science and Technology Forum (NSTF) functions is to hold [discussion forums](#), bringing the private and public sector together to address important issues and engage with government policy.
- Feedback from these discussion forums is given to stakeholders.
- Recommendations are put forward to government as part of the [SET community's](#) lobbying efforts.



The REE are the 15 lanthanide series elements, plus yttrium. Scandium is found in most REE deposits and is sometimes classified as a REE. (Source: [Geology.com](#))

REE are called 'rare' not because of scarcity. Dr Leon Kruger, Manager of the Hydrometallurgy Division: Mintek, explains that REE are found spread across the globe but in relatively low concentrations. Further to that, REEs are very difficult to separate from each other when processing. (Dr Kruger presented on ['REE processing – A South African perspective'](#).)

The REE are also all metals, and are often referred to as 'rare earth metals'.

REE and the Fourth Industrial Revolution

The Fourth Industrial Revolution (4IR) moves beyond the digital sphere. It's defined in the Department of Science and Technology's White Paper on Science, Technology and Innovation as technological developments that blur the lines between the physical, digital, and biological spheres.

Our current technologies are already the basis for 4IR technologies. 4IR is not a break from the past but an evolution – and mined elements are critical to both existing and new technologies.

Take the cell phone. There are about 40 elements in phones that are mined, says Mr Sietse van der Woude, Senior Executive: Modernisation and Safety, Minerals Council South Africa. "When you look at the periodic table, it's easier to say what's not relevant to 4IR because so many are relevant." Mr van der Woude spoke on ['Challenges in Mining for the Fourth Industrial Revolution'](#).

Mr van der Woude says that for green energy technology, even more elements are needed. As the demand for green technologies rises, so will the demand for rare metals. Other examples for REE uses include: batteries, glass, fuel cells, hybrid and electric vehicles, wind turbines, and air conditioning. Is 4IR even possible without mining?

South Africa's mineral resources

Beyond REE, South Africa's mineral resources for 4IR rank within top 10 in the world (except for iron ore), notes Mr van der Woude.

Dr Annelize Botes, Principal Researcher: Materials Science and Manufacturing, Council for Scientific and Industrial Research (CSIR), explains that titanium is considered a 'rare' metal because it's a difficult metal to produce. She presented in her own capacity on ['Rare Metals in New Technologies'](#). Titanium is used in many industries including aerospace, automotive, and medical. The CSIR hosts the Titanium Centre of Competence.

Dr Botes notes that rare metals are understood as part of something – such as a cell phone. They also form part of a larger ecosystem: "Materials (including metals) are the pillar upon which most manufacturing is built..." She advocates more work with design engineers who predominantly use steel when so many other materials are available.

REE are used in batteries and Dr Mesfin Kibede focused on lithium ion batteries (LIBs). Dr Kibede is a Principal Researcher: Energy Centre, CSIR. He spoke on ['The Transition Metals \(Manganese, Titanium, etc\) for Energy Storage Application'](#). There is a high availability of these minerals in South Africa. LIBs are used in the automotive industry (consider electric vehicles) and for renewable battery storage, among other things.

Potential futures of mining for 4IR

Mr van der Woude notes that mining's future lies in new deposits of 'exotics' (such as REE where the global demand is expected to rise) and finding new uses for general mining materials. Other areas include:

- The circular economy with the 3Rs: recover, recycle and reuse
- Subsea mining
- Mining of asteroids

It is also of use to look at the report commissioned by the German Mineral Resources Agency at the Federal Institute for Geosciences and Natural Resources, Berlin. Dr Botes says that with Germany depending on metal imports, they examined key and emerging technologies (across industries) and the potential demand for associated raw materials. This assists with estimating long-term price and supply risks. Dr Botes says this can be used as a guideline for South Africa. (See [slide 25](#).)

Impact of 4IR on the mining industry

Accelerated digitalisation heralds exciting changes in mining. Mr van der Woude sees a move to where a great number of activities are driven from inside an office. According to Deloitte, future mining technologies include:

- Digital capturing of information
- Autonomous equipment such as driverless trucks
- Internet of Things (IoT) wearables for capturing real-time data
- Drones (which help with surveying in all types of temperatures)
- Diverse mobile workforce with integrated remote operations
- A digital mine nerve centre with controlled, safe and healthy conditions and data-driven insights for improved planning control and decision support

Dr Botes says there are also new manufacturing technologies. These include: additive manufacturing, collaborative robots (robots designed to work alongside humans), and smart manufacturing (to improve productivity and efficiency).

New frontiers – a centralised refinery for South Africa?

Dr Kruger says that, currently, China possesses 40% of global REE reserves and produces over 80% of the global REE. China's dominance has an overriding impact on prices, for example, just by changing export quotas.

Because of this, Dr Kruger says that the world is looking for alternative sources of supply. Currently there are two non-Chinese world-class REE refineries: Lynas and Molycorp. Dr Kruger believes there is a gap for South Africa. The real value of REEs lies in physically separating these elements from each other. REEs are found in mixed deposits and not individually and concentrated like gold ore. The REE deposits typically include radioactive elements.

He proposes a centralised refinery where South Africa takes deposits from other countries for processing. (South Africa does not have enough deposits to sustain the refinery and to make it globally competitive.) He says that South Africa has the ability to transport, dispose and store radioactive waste. Not every country can do this. Further to this, South Africa has the expertise as Mintek has been conducting commercial work and R&D on every REE project on the globe (except China).

Governance around mining

Mr Sahlulele Luzipo, then-Chair of the Parliamentary Portfolio Committee (PPC) on Mineral Resources, presented on ['Benefits to the economy vs harm to communities and environment? Stimulating beneficiation?'](#). The PPC role is to lead public oversight of the Minister of Mineral Resources and the Department. This looks at whether laws are being implemented and budget spent responsibly.

Mining is seen as the cornerstone of the economy of South Africa, contributing R400-billion. South Africa needs to make the most of its mineral resources – for the benefit of all South Africans.

There is also a need to look at the harm around mining regarding communities and the environment. Mr Luzipo says that South Africa needs a clear proactive strategy and risk qualifications on mine closures. We should not be dealing with disasters as they happen.

One of the issues is that mines often change hands at different phases and this leads to a lack of responsibility. Furthermore, there should be increased legislation or enforcement around management and process (as has been done with diamonds).

The above links to illegal mining and its lack of safety and impact on ground stability. Illegal mining and the 'zamazamas' (illegal miners) have grown in criminality, as well as supporting industries such as food trucks. This is just one of the issues showing the need for collaboration between government entities. For example, beyond the Department of Mineral Resources (DMR), the Department of Water and Sanitation and police should be involved.

Mining is an extraction industry. This means it's impossible to bring back to the soil exactly what was taken out. However, says Mr Luzipo, we need to see what can work with the soil. Mines range from very neglected to those running effectively – with ongoing rehabilitation and a mining area returned to productive agriculture.

He says, in his experience, Social and Labour Plans are not implemented. This results in appalling conditions where communities are left in poverty and there has been no environmental rehabilitation. According to the South African Human Rights Commission, neither the environmental nor the community/public benefit aspects of the laws that apply to mines are being effectively enforced by government.

Mr Luzipo says that the system around mining rights and permits could be redesigned – where businesses with the best motivations around community beneficiaries and socio-economic development plans are given the rights.

South Africa also needs to consider the limits to parliamentary oversight. There is limited manpower and capacity, as well as limited time assigned to meetings. Furthermore, the parliament budget is determined by the institutions that are monitored ie the DMR.

Speakers can be contacted through the spokesperson, [Ms Jansie Niehaus](#). [Video clips](#) with the [full presentations](#) can be found on the [NSTF website](#).

About the NSTF
 The National Science and Technology Forum (NSTF), established in 1995, is a broadly-representative stakeholder body for all SET and innovation organisations in South Africa, which seeks to influence policy formulation and delivery.

The NSTF Awards are unique in SA, recognising the outstanding contributions of individuals and groups to SET and innovation.

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