Challenges in mining for the Fourth Industrial Revolution

Sietse van der Woude
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Meet … citizen of …?
My story

- We live in the 4IR
- Africa should be a leader in mining for 4IR
- There are ‘VUCA’ challenges to mining for 4IR
- We are working together to find people-centred solutions
- 4IR is impossible without mining, so please join us
DEFINING 4IR

• The Fourth Industrial Revolution (4IR) has been defined as technological developments that **blur the lines between the physical, digital and biological spheres.**

• It integrates cyber-physical systems and the Internet of Things, big data and cloud computing, robotics, artificial intelligence-based systems and additive manufacturing.

• Compared to previous industrial revolutions, this one is **evolving at an exponential rather than a linear pace**, with potentially significant impacts on work, services, education and leisure.

Source: Department of Science and Technology, Draft White Paper on Science, Technology and Innovation
SOME ELEMENTS RELEVANT TO 4IR
RECYCLING RATES OF SMARTPHONE METALS

Colour coding:
- Red: <1% recycle rate
- Orange: <1-10% recycle rate
- Blue: <10-25% recycle rate
- Brown: <25-50% recycle rate
- Green: <50% recycle rate
- Black: Non-metal (or recycle rate unknown)

**SCREEN**
- Touch: Indium Tin Oxide
  - Indium (In)
  - Tin (Sn)
  - Oxygen (O)
- Glass: Alumina and Silica
  - Aluminium (Al)
  - Silicon (Si)
  - Oxygen (O)
  - Potassium (K)
- Colours: Rare Earth Metals
  - Yttrium (Y)
  - Lanthanum (La)
  - Terbium (Tb)
  - Praseodymium (Pr)
  - Europium (Eu)
  - Dysprosium (Dy)
  - Gadolinium (Gd)

**BATTERY**
- Lithium (Li)
- Carbon (C)
- Cobalt (Co)
- Aluminium (Al)
- Oxygen (O)

**ELECTRONICS**
- Wiring & Microelectronics
  - Copper (Cu)
  - Silver (Ag)
  - Gold (Au)
  - Tantalum (Ta)
- Microphones & Vibrations
  - Nickel (Ni)
  - Dysprosium (Dy)
  - Praseodymium (Pr)
  - Terbium (Tb)
  - Neodymium (Nd)
  - Gadolinium (Gd)

**CASING**
- Copper (Cu)
- Magnesium (Mg)
- Br (Bromine)
- Nickel (Ni)

**CONNECTING ELECTRONICS**
- Tin (Sn)
- Lead (Pb)
MINERALS REQUIRED FOR GREEN ENERGY TECHNOLOGIES

SOLAR TECHNOLOGY
- Al: Aluminium
- Ge: Germanium
- Ni: Nickel
- Te: Tellurium
- Cd: Cadmium
- In: Indium
- Se: Selenium
- Sn: Tin
- Cu: Copper
- Fe: Iron
- Si: Silicon
- Zn: Tellurium
- Ga: Gallium
- Pb: Lead
- Ag: Silver

WIND TECHNOLOGY
- Al: Aluminium
- Fe: Iron
- Mo: Molybdenum
- Cd: Cadmium
- Pb: Lead
- Mn: Manganese
- Zn: Zinc
- Co: Cobalt
- Mn: Manganese
- Zn: Zinc
- Cu: Copper
- Pb: Lead
- Ni: Nickel
- Ti: Titanium

ELECTRIC VEHICLES AND ENERGY STORAGE
- Al: Aluminium
- C: Carbon
- Li: Lithium
- Rare Earths
- Co: Cobalt
- Fe: Iron
- Mn: Manganese
- Si: Silicon
- Cu: Copper
- Pb: Lead
- Ni: Nickel
- Ti: Titanium

The “Rare Earths” designation refers to 17 different elements, including dysprosium and neodymium (critical for wind technologies and energy storage), as well as praseodymium (critical for electric vehicles and energy storage).
AFRICA’S MINERAL RESOURCES

Source: SEMS Exploration, The African Geological Consultancy Group
AFRICA’S MINERAL RESOURCES FOR THE 4IR

• World Bank: Minerals for Low Carbon Future
  • Southern Africa and Guinea vital for growing demand in platinum, manganese, bauxite and chromium

• TheEastAfrican: Minerals in Your Phone
  • Micro-electrical components – copper, gold and silver from DRC and Zambia
  • Electrical units’ micro-capacitors – tantalum extracted from coltan ores in DRC, Rwanda and Uganda
  • Mircophone and speaker magnets – arsenic minerals from SA
  • Vibrating motors weights – tungsten from Rwanda, Burundi and Uganda
### SOUTH AFRICA’S MINERAL RESOURCES FOR 4IR

<table>
<thead>
<tr>
<th>MINERALS</th>
<th>RESOURCES</th>
<th>Mass</th>
<th>% World</th>
<th>Rank</th>
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SOUTH AFRICA’S MINERAL RESOURCES

• PGM metals
  • Highly resistant to wear and tear
  • Resistant to chemical attack
  • Excellent high temperature characteristics
  • Stable electrical properties
RARE EARTHS – EXCITING FUTURE POTENTIAL...

The Steenkampskraal mine the highest grade rare earths mine in the world.

Relative economic value of the rare earths at the Steenkampskraal mine at present market prices
Batteries

Elements used in the manufacture of batteries:
- Cerium (Ce)
- Lanthanum (La)
- Neodymium (Nd)

Rechargeable batteries are used in:
- Cellular phones
- Computers
- Digital cameras
- MP3 players
- Hybrid and electric vehicles

Metal Alloys

Rare earths form a part of the many super alloys that are used to make components for gas turbines, electric generators and many other items.

Phosphors

The rare earths used in phosphors are used for the production of television sets and energy-efficient lamps. (europium (Eu) and terbium (Tb))

Glass

Cerium (Ce) is used in ultra-violet light filtering

Catalysts

Automotive catalytic converters use cerium (Ce) to facilitate the oxidation of carbon monoxide (CO) and significantly reduce vehicle CO emissions.

Hybrid and electric cars and trucks

Each hybrid vehicle uses an average of 2kg of neodymium magnets in sensor and motor applications.

Wind Turbines

Between 200kg (hybrid) and 500-600kg (direct drive) neodymium magnets are used for each MW of output.

Air Conditioning

The use of neodymium magnets improves efficiency by 20%.

Source: www.steenkampskraal.com/rare-earth-uses
 Vedanta Zinc’s Gamsberg…The Future, Today

When developed it will be one of the world’s top 5 zinc mines…

Future uses of zinc
- New market: Agriculture
- 60% of soils in China and India depleted of zinc
- China mandated fertiliser should include zinc
POTENTIAL FUTURES OF MINING FOR 4IR…

• Finding and mining new deposits of ‘exotics’

• Finding new uses of ‘ordinaries’
‘VUCA’ CHALLENGES

Human and social change
Individualism and inequality will drive increasingly fraught social relations over time

Business and organisational change
Organisations are increasingly active in driving a more inclusive performance outcome

Political, economic and environmental change
The operating context will become increasingly volatile and unpredictable

Technological change
Technology will be invisible, augment human action, and be artificially intelligent
HIGHEST IMPACT MACRO TRENDS TO 2030

In SA context, people trends matter more than technological...

ACCELERATED DIGITALISATION…

Source: Deloitte, Future of Mining
HISTORICAL
Reporting and analysis of historical data and insight gained from analysing trends, patterns and opportunities for improvement learned from experience.

DIGITAL MINE NERVE CENTRE
Data driven insights drive improved planning, control and decision support across the mining value chain.

FUTURE
Future insight derived from historical analysis to improve planning, simulate the integrated supply chain, and predict future outcomes, using analytics and AI tools.

INTEGRATED ENTERPRISE PLANNING AND SUPPORT PROCESSES

- MAINTENANCE
- SUPPLY
- ENERGY MANAGEMENT
- HSE & COMMUNITY
- FINANCE
- HR
- IT
- MARKETING

- Reimagined core systems on cloud platforms
- RPA for support process
- IT/OT convergence
- Integrated communications network with cyber security
- Diverse & Inclusive workforce
- Shared Services & COEs

Source: Deloitte, Future of Mining
The new frontiers…

- **Circular economy: Recover, recycle and reuse**
  - How do you recover 7 mg of gold from a throw-away mobile phone?

- **The rise of rare earths**
  - Global consumption expected to increase by 5% pa

- **Deep impact: subsea mining**
  - 1st deep sea (1600M) mining lease granted in 2011

- **Watch this space: ET riches**
  - Asteroidal supplies could meet earth’s needs for next 400 million years
Mining R&D and Innovation are firmly back on the national agenda as evidenced by the following:

- R&D and Innovation back in Minerals Council’s Strategic Plan

- The 2018 White Paper on Science, Technology and Innovation, emphasises importance of ‘modernising existing industries like agriculture and mining’ has eight references to mining. The 1996 White Paper had none.

- Institutions like the CSIR, University of Pretoria and University of Witwatersrand have or are in the process re-creating their roles in mining modernisation.

- The Mining Charter and the most recently signed Leadership Compact on Competitiveness and Growth both include commitments related to mining RDI.
MINERALS COUNCIL SA POLICY: PEOPLE-CENTRED MODERNISATION

Modernising the mining industry involves:

- Turning to account South Africa’s mineral resources in the safest, healthiest, most efficient, cost-effective and sustainable manner possible
- Recognising that people are at the heart of our industry with focus on improving skills, health, quality of life and fulfilment of employees
- Conservation of natural resources, preservation and restoration of the environment
- Contributing to the development of local and labour-sending communities
- Recognising that metals and minerals are valuable, useful and necessary
- Transformation and growth as key imperatives of the mining industry and the nation
MODERNISATION FRAMEWORK

MINING Objectives:
- Zero harm for people and the environment
- Investment in more resources for longer
- Job retention

SHARED VALUE* in modernising the mining industry:
- Improved mining equipment and systems = improved health, safety and well-being
- Skills development = better pay and improved opportunities for growth and development
- Widespread industrialisation = more jobs associated with mining and beyond
- Sustainability through effective community development and protection of natural resources

NATIONAL Objectives:
- Higher growth, employment, exports and government revenue
- Better use of South Africa's mineral wealth
- Improved talent pool of portable skills

* Shared value = simultaneous advancement of social and economic goals

RESEARCH AND DEVELOPMENT
Narrow reef, hard-rock mining equipment and systems

MANUFACTURING
Globally competitive environment. Employment opportunities in factories and service industries

SUSTAINABILITY
Upskilling of employees and communities, job retention

LEGISLATIVE CERTAINTY
For long-term investment
MINERALS COUNCIL PLANS AND PROGRAMMES

Leadership
Build a cluster-wide consensus on the importance of people-centric modernization, to contribute towards SA’s development trajectory

Building Leadership Consensus
Establish a common vision across the mining cluster about how the modernization of the mining industry can uplift South Africa

Development through modernisation framework
Improve the ability of the mining cluster to understand the implications of its modernisation journey on society

Mining cluster acceleration
Advance the organisational and cultural capabilities of the SA mining cluster to foster a people-centred modernisation, and inclusive, competitive growth

Create new value
Establish a Mining Cluster Startup Accelerator that will create new business, products, services, jobs in the industry, and change views on modernisation

Support Cluster Partners
Develop and transfer leading innovation practices across the mining cluster, both through direct involvement, as well as through knowledge transfer

Enhance Catalytic Capabilities
Empower the SA Mining Cluster to act as an accelerator for talent, skills and employment into secondary industries, even outside of mining

Modernisation Processes and Tools
Define and socialize various collaborative mechanisms, via which people-centric innovation can be effected within the mining cluster

Inclusive and Human-Centred Innovation
Demonstrate the value of inclusive innovation practices, such as Human Centred Design, in building modern products and businesses

Facilitated Relationship Building
Demonstrate-by-doing how facilitated dialogues with key stakeholders can improve modernization outcomes, by bringing people with from the start

Modernisation Skills Transfer
Establish the systems to allow knowledge / skills development that takes advantage of the modernisation process, and the 4th I.R.

Enabling elements
The underlying resources, relationships and knowledge that will lead to success

Collaboration
The willingness of local firms to work together to solve problems

Resources
The availability of financial and other resources required to undertake modernisation

Institutional factors
The organizational and institutional systems that will sustain successful change

SA Policy
The overarching SA innovation and R&D policy environment

Governance
The institutional controls that allow transparency and accountability
MANDELA MINING PRECINCT: PPP
SA MINING EXTRACTION RDI (SamerDI)

- Increasing the life of current mining
- Accessing orebodies that will not be accessed using current conventional methods
- Accessing orebodies even deeper orebodies

CROSS CUTTING INITIATIVES

- Advance Orebody – the ability to “see” ahead of the rock
- Real-time Information Management Systems - converting information to knowledge and wisdom
- Successful Applications of Technology Centred Around People - understanding why technologies either work or fail and its impact on people

BENEFIT

- Increase safety
- Increase efficiency by knowing where the reef is
- Information is collected, processed and managed to allow for proactive and predictive decision
- Understanding the pitfalls when technology is implemented
- Change management principles
IS 4IR POSSIBLE WITHOUT MINING?

- Fibreglass roofing (Feldspar)
- Air conditioner (Copper)
- Solar panels (cadmium, gallium, germanium, indium, selenium, and tellurium)
- Bricks (Clay)
- Glass (Quartz)
- Cement (Coal)
- Steel (Iron ore)
- Computer monitor (Lead, titanium, iron, and copper)
- Metal furniture (Aluminium and steel)
- Air conditioner (Copper)
- Power cells (Platinum)
- Television sets (Gallium)
- Detergent (Phosphate)
- Jewellery (Gold, platinum, silver and diamonds)
- Water filtration (Silver)
- Stainless steel (Hematite)
- Pots and pans (Silver)
- Lightbulbs (Molybdenum)
- Cellphones (Gold, lithium and platinum)
Thank you

18 March 2019
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