MINING LEARNING SERIES

Mining Basics & Why Mining Matters

A learner-friendly introduction with a South African focus

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LEARNING OUTCOMES

After studying these notes, you should be able to define mining, distinguish key mining methods, describe the mine life cycle, explain mining's benefits and costs, identify major South African minerals, and discuss safety, sustainability and career opportunities.

How to Use This Study Note

This guide introduces mining in clear language. It is designed for school learners, first-time mining students and anyone exploring a career in the minerals sector.

A simple study method

Step	What to do
1. Preview	Read the headings, tables and key-point boxes before reading the details.
2. Learn	Study one section at a time and write down unfamiliar words.
3. Connect	Link each mineral to a product you use, such as a phone, building, vehicle or electrical cable.
4. Recall	Close the note and explain the main idea in your own words.
5. Test	Complete the revision questions without looking at the answers.

The big idea

REMEMBER

Mining is not only “digging.” It is a complete system of science, engineering, finance, law, community engagement, safety, processing, transport, rehabilitation and environmental management.

Responsible learning

Mining brings important materials and economic activity, but it can also create serious safety, environmental and social impacts. A balanced understanding recognises both sides and asks how benefits can be shared while harm is prevented or reduced.

1. What Is Mining?

Mining is the process of locating, extracting and preparing naturally occurring mineral resources from the Earth so that they can be used. The resource may be a metal-bearing ore, coal, diamonds, industrial minerals, stone, sand or other geological material.

Mining and quarrying

The word mining is often used broadly. Quarrying usually refers to extracting construction materials such as stone, aggregate, limestone or sand from a surface excavation. Both activities remove geological materials, but the products, methods and regulations may differ.

Why deposits are not mined automatically

A mineral occurrence becomes a mine only when evidence shows that it can be extracted legally, safely, technically and economically, with environmental and social responsibilities addressed. A rich deposit may still be unsuitable if it is too deep, too small, unsafe, environmentally sensitive or too expensive to develop.

Four questions behind every mine

Question	Meaning
What is there?	Geologists identify the mineral, grade, size, shape and location of the deposit.
Can it be mined?	Engineers choose a safe and practical extraction method.
Will it be worthwhile?	Economists compare expected revenue with capital, operating and closure costs.
Can it be responsible?	The project must meet legal, safety, environmental and social requirements.

KEY POINT

A mineral resource is a geological concentration with reasonable prospects for eventual economic extraction. An ore reserve is the economically mineable part demonstrated through detailed studies and modifying factors. The terms are related, but they are not interchangeable.

2. Minerals, Ores and Rocks

A mineral is a naturally occurring substance with characteristic chemical and physical properties. A rock is a natural mixture of one or more minerals. Ore is rock or mineralised material that contains a valuable component at a concentration and under conditions that make extraction potentially worthwhile.

Important terms

Term	Plain-language meaning
Deposit	A natural concentration of mineral material.
Grade	The amount or concentration of the valuable material in the ore.
Gangue	Unwanted minerals or rock mixed with the valuable mineral.
Overburden	Soil and rock covering a near-surface deposit.
Waste rock	Rock removed during mining that is not processed as ore.
Commodity	A mineral or material traded in markets, such as gold, coal or iron ore.

Mineral groups and uses

Group	Examples	Common uses
Metallic	Gold, iron, copper, manganese, chromium	Electronics, steel, wiring, machinery and transport
Energy minerals	Coal and uranium	Electricity generation and energy systems
Industrial minerals	Limestone, phosphate, salt, silica	Cement, fertiliser, chemicals and glass
Gemstones	Diamonds and other gems	Jewellery, cutting, drilling and specialist tools
Construction materials	Sand, stone and aggregate	Roads, houses, bridges and concrete

CHECK YOUR UNDERSTANDING

High grade usually means more valuable material per tonne of ore, but grade alone does not determine profitability. Depth, processing difficulty, recovery, prices, energy, water, transport, safety and closure costs also matter.

3. The Mining Life Cycle

A mine is temporary, even when it operates for decades. Good planning therefore begins before construction and continues after extraction ends.

Stage	Main activities	Typical decision
1. Exploration	Mapping, sampling, geophysics, drilling and resource modelling	Is there a deposit worth studying?
2. Evaluation	Technical studies, environmental assessment, consultation and financial analysis	Can the project be viable and responsible?
3. Development	Permits, detailed design, shafts or pits, roads, power, water and plant construction	Can construction proceed?
4. Operation	Drilling, blasting, loading, hauling, processing, maintenance and monitoring	Is production safe and controlled?
5. Closure	Dismantling, sealing, reshaping land, treating water and rehabilitating disturbed areas	Are closure objectives being met?
6. Post-closure	Long-term monitoring, maintenance and agreed future land use	Is the site stable and safe?

Exploration is evidence-building

Exploration reduces uncertainty. Surface clues are followed by increasingly detailed work. Drill core and samples help geologists estimate the geometry, grade and continuity of mineralisation. Not every exploration project becomes a mine.

Closure must not be an afterthought

RESPONSIBLE PRACTICE

Progressive rehabilitation restores disturbed areas during the operating life where practical. It reduces the amount of work left for final closure and allows methods to be tested and improved.

4. Main Mining Methods

The method depends on the deposit's depth, shape, size, strength, grade, surrounding rock, water conditions, safety risks, environmental setting and economics.

Method	How it works	Best suited to	Main considerations
Open-pit / opencast	Benches are excavated from the surface; ore and waste are loaded and hauled.	Large deposits close to the surface	Large surface footprint, slope stability, dust and hauling
Underground	Shafts, declines and tunnels provide access below ground.	Deeper deposits or limited surface exposure	Ground control, ventilation, heat, gas, fires and escape routes
Placer / alluvial	Water and gravity methods separate dense minerals from loose sediment.	Minerals in river, beach or ancient channel deposits	Water and sediment control
Solution / in-situ	A fluid dissolves the target mineral underground and the solution is recovered.	Specific soluble deposits and suitable geology	Groundwater protection and process control
Quarrying	Surface extraction of stone, limestone, sand or aggregate.	Construction and industrial materials	Blasting, noise, dust and rehabilitation

Surface versus underground

Surface mining generally allows larger equipment and high production rates, but disturbs a wider surface area. Underground mining can reach deep deposits with a smaller surface excavation, but creates complex risks involving rock falls, machinery, ventilation, heat, fire and emergency access.

NO SINGLE "BEST" METHOD

The correct method is the one that safely and efficiently matches the deposit and site conditions while meeting legal, environmental and social requirements.



Open-pit mining uses benches and haul roads to reach near-surface deposits. | Source: 911 Metallurgist

5. From Ore to a Useful Product

Mining removes material from the Earth; mineral processing separates and concentrates the valuable part. Further treatment may produce a metal, mineral product or fuel suitable for customers.

Typical value chain

Step	Purpose
1. Break the rock	Drilling and blasting, cutting or digging frees material from the rock mass.
2. Load and transport	Loaders, shovels, conveyors, locomotives or trucks move ore to the plant.
3. Crush and grind	The material is reduced in size to help release valuable minerals.
4. Separate and concentrate	Methods may use gravity, flotation, magnetism, screening or chemical treatment.
5. Dewater and manage residues	Water is recovered where possible; tailings and waste require engineered management.
6. Smelt, refine or finish	Depending on the commodity, additional treatment produces a marketable material.
7. Transport and manufacture	Products move to factories and customers through road, rail, ports and pipelines.

Recovery and waste

Recovery is the percentage of valuable material captured by the process. Perfect recovery is rarely possible. Engineers aim to increase recovery and product quality without creating unacceptable cost, energy use, water use, emissions or safety risks.

IMPORTANT DISTINCTION

Tailings are fine residues left after mineral processing. Waste rock is removed during mining and is not treated as ore. Both must be characterised and managed because their physical and chemical behaviour can create long-term risks.

6. Why Mining Matters

Modern societies use mined materials every day. Buildings, roads, electricity networks, mobile phones, vehicles, medicines, fertilisers, tools and renewable-energy technologies all depend on mineral inputs.

Major contributions

- Materials: mining supplies the raw materials used by construction, manufacturing, agriculture, communication and energy systems.
- Employment and skills: mines and suppliers employ artisans, operators, scientists, engineers, health professionals, administrators and many others.
- Economic activity: mineral sales, exports, taxes, royalties, procurement and investment can support national and local economies.
- Infrastructure: some projects support roads, rail, power, water and communication systems, although access and long-term value must be planned carefully.
- Technology transition: copper, manganese, nickel, lithium, rare-earth elements and platinum-group metals are among the inputs used in various low-carbon and digital technologies.

Benefits are not automatic

Mining can also cause injury, displacement, pollution, land disturbance, conflict, unequal benefit-sharing and dependence on volatile commodity prices. The presence of minerals does not guarantee broad development. Governance, accountability, worker protection, community participation, local capability, transparent revenue use and responsible closure influence the final outcome.

BALANCED CONCLUSION

Mining matters because minerals are essential, but the way they are produced matters just as much. Responsible mining aims to create lasting value while preventing harm and respecting workers, communities and the environment.

7. Mining in South Africa

South Africa has a long mining history and a diverse mineral endowment. Government sources describe the sector as important to socio-economic development and regulate it through mineral, environmental and mine health and safety laws. Mining's share of the economy has changed over time, but the industry remains linked to exports, employment, infrastructure, manufacturing and regional supply chains.

Selected commodities

Commodity	Important uses	South African context
Platinum-group metals (PGMs)	Vehicle emission-control catalysts, jewellery, industrial catalysts and some hydrogen technologies	Major deposits occur in the Bushveld Complex, including parts of Limpopo and North West.
Gold	Jewellery, investment, electronics and specialised technology	Historically central to mining development; many operations exploit deep deposits.
Coal	Electricity, industrial heat and metallurgical applications	Important to the energy system, with significant environmental and transition challenges.
Iron ore	Main feedstock for steel	Supports steel and export value chains.
Manganese and chromium	Alloys that improve steel properties	South Africa has important resources and export industries.
Diamonds	Jewellery and industrial cutting or drilling	Mined from kimberlite, alluvial and marine deposits.
Copper, phosphate and other minerals	Electrical systems, fertiliser and diverse industrial uses	Contribute to regional mining and manufacturing activity.

Law and institutions

The Department of Mineral and Petroleum Resources regulates the sector. Key frameworks include the Mineral and Petroleum Resources Development Act and the Mine Health and Safety Act. Environmental authorisation, water requirements, labour law, community commitments and other rules also apply. Laws and institutional names can change, so learners should consult current official sources.

LOCAL CONNECTION

Limpopo is closely linked to PGMs, chrome, coal, copper, phosphate and other minerals. For learners near mining communities, this creates career opportunities but also makes knowledge of safety, water, land use, community rights and closure especially important.

8. Mining Safety and Health

Mining hazards can cause immediate injury or long-term disease. Safety is therefore a core operating requirement, not an optional extra. Everyone at a mine has responsibilities, and work should be performed only by trained, authorised and competent people using approved procedures.

Common hazards and controls

Hazard	Possible harm	Examples of controls
Falls of ground / slope failure	Crushing, entrapment or fatalities	Geotechnical design, support, scaling, inspections and exclusion zones
Mobile machinery	Collision, run-over and vehicle rollover	Traffic plans, separation, visibility aids, alarms, berms and competent operators
Dust and harmful substances	Lung disease, poisoning or irritation	Suppression, extraction ventilation, enclosure, monitoring and correct respiratory protection
Noise and vibration	Hearing loss and physical injury	Engineering controls, maintenance, exposure limits and hearing protection
Fire, gas and explosives	Burns, poisoning, explosion or loss of life	Gas monitoring, ventilation, ignition control, storage rules and emergency plans
Electricity and machinery	Shock, burns, entanglement or crushing	Isolation, lockout, guarding, testing and authorised maintenance
Heat and fatigue	Heat illness, poor decisions and accidents	Ventilation, hydration, work-rest plans, supervision and fitness for work

Hierarchy of controls

The strongest approach is to eliminate the hazard. If that is not possible, substitute a safer option, use engineering controls, then administrative controls, and finally personal protective equipment (PPE). PPE is important, but it is the last line of defence and should not replace better controls.

STOP AND REPORT

Never enter a restricted area, bypass a guard, ignore an alarm or operate equipment without authorisation. Report unsafe conditions, near misses and symptoms early. Emergency procedures and escape routes must be known before work begins.



Underground work requires training, protective equipment, communication and strict controls. | Source: MSHA/AP via Industrial Equipment News

9. Environmental and Social Responsibility

A responsible mine plans for impacts across its full life cycle, including cumulative and long-term effects. It follows the mitigation hierarchy: avoid impacts where possible, minimise those that cannot be avoided, rehabilitate disturbed areas, and address remaining impacts according to law and agreed plans.

Key issues

Issue	What can go wrong	Responsible responses
Water	Contamination, changed flows or competition for scarce water	Water balance, separation of clean/dirty water, treatment, reuse and monitoring
Land and biodiversity	Habitat loss, erosion and unstable landforms	Avoid sensitive areas, limit footprint, store topsoil and progressively rehabilitate
Tailings and waste	Seepage, dust, instability or acid-generating drainage	Characterisation, engineered facilities, monitoring, water control and emergency readiness
Air, noise and vibration	Dust, emissions, disturbance and health effects	Source controls, maintenance, monitoring and community communication
Communities	Loss of land or livelihoods, conflict, unequal benefits and cultural impacts	Early participation, transparent agreements, grievance systems, fair processes and local development
Closure	Abandoned hazards, pollution and economic shock	Funded closure plans, rehabilitation, post-closure monitoring and economic transition planning

Social licence and legal permission

Legal permission is required, but trust also depends on conduct. The phrase social licence to operate describes continuing community and stakeholder acceptance; it is not a substitute for law or formal consent. Trust can be damaged when commitments are unclear, impacts are hidden or benefits are unfairly distributed.

ENVIRONMENTAL JUSTICE

People who receive the least benefit should not carry the greatest risk. Meaningful participation requires understandable information, time to respond and ways to raise concerns without intimidation.



Rehabilitation helps stabilise disturbed land and restore vegetation. | Source: Sierra Rutile

10. Technology and the Future of Mining

Mining is becoming more data-driven, automated and connected. Technology can improve safety, accuracy and efficiency, but it must be introduced with worker participation, training, cybersecurity and clear accountability.

Examples of modern mining technology

Technology	What it does	Potential value
Drones and remote sensing	Map sites, stockpiles and inaccessible areas	Reduces exposure and improves survey speed
Sensors and condition monitoring	Measure vibration, temperature, gas, equipment health and ground movement	Supports early warning and predictive maintenance
Automation and tele-remote operation	Controls machines remotely or with automated functions	Moves people away from some hazardous tasks
Digital mine models	Combines geology, designs, schedules and production data	Improves planning and decision-making
Ore sorting and advanced processing	Identifies and separates material earlier or more precisely	May reduce energy, water and waste per unit of product
Renewable energy and electrification	Uses lower-emission power and electric equipment where feasible	May reduce emissions, heat, noise and fuel exposure

The circular economy

Recycling, repair, reuse and more efficient product design can reduce demand for newly mined material, but they do not remove it completely. Growing infrastructure and clean-energy systems still need primary minerals, while recycling depends on products reaching end of life, being collected and being technically recoverable.

FUTURE-READY SKILL

The strongest future mining professionals combine technical knowledge with safety leadership, environmental awareness, digital skills, ethics, communication and respect for communities.

11. Mining Careers and Study Pathways

Mining is multidisciplinary. Not every mining career works underground, and many roles are shared with other industries.

Career families

Career area	Example roles	Useful school subjects / skills
Earth sciences	Geologist, geophysicist, surveyor, GIS technician	Mathematics, Physical Sciences, Geography and data interpretation
Engineering	Mining, electrical, mechanical, chemical, civil and rock engineering	Mathematics, Physical Sciences, design and problem-solving
Operations and trades	Miner, plant operator, electrician, fitter, boilermaker and instrumentation technician	Technical subjects, practical training, safety discipline and teamwork
Processing and laboratories	Metallurgist, process controller, chemist and laboratory technician	Chemistry, Mathematics, Physical Sciences and quality control
Safety, health and environment	Safety officer, occupational hygienist, environmental scientist and ventilation specialist	Life Sciences, Physical Sciences, law, risk assessment and communication
Business and communities	Accountant, procurement specialist, HR practitioner, lawyer and social performance officer	Languages, Business Studies, economics, ethics and stakeholder engagement
Digital and automation	Data analyst, control engineer, software developer and robotics technician	Mathematics, IT, coding, electronics and systems thinking

Typical pathways in South Africa

- University degrees can lead to professional science and engineering careers.
- Universities of technology offer diplomas and degrees with strong applied and work-integrated learning components.
- TVET colleges and apprenticeships can lead to artisan trades such as electrical, fitting, welding and instrumentation.
- Learnerships, bursaries, internships and graduate programmes provide structured workplace development. Always confirm accreditation and entry requirements with the institution or professional body.

FOR FUNDAWAY LEARNERS

Build a strong foundation in Mathematics, Physical Sciences, English communication and digital skills. Keep evidence of projects, practical work, leadership and safety awareness. Research careers early because subject and programme requirements differ.

12. Key Terms and Revision

Quick glossary

Term	Meaning
Beneficiation	Processes that improve a mineral product's value or usefulness.
Concentrate	A product containing a higher proportion of valuable mineral than the original ore.
Cut-off grade	A decision threshold used to classify material for a specific plan and set of assumptions.
Feasibility study	A detailed assessment of technical, economic, legal, environmental and other factors.
Rehabilitation	Actions that return disturbed land to a stable, safe and agreed condition or use.
Tailings	Fine residue remaining after valuable minerals are separated from ore.
Ventilation	Controlled movement of air to provide fresh air and manage heat, dust and gases.
Value chain	Connected activities from exploration and extraction through processing, transport and manufacturing.

Revision questions

- 1. Define mining in your own words.
- 2. Explain the difference between a mineral, a rock and an ore.
- 3. Name the six stages of the mining life cycle.
- 4. Compare open-pit and underground mining.
- 5. Why is crushing and grinding used before separation?
- 6. Give four reasons why mining matters to modern life.
- 7. Name four important South African mineral commodities and one use for each.
- 8. List five mining hazards and one control for each.
- 9. Explain the mitigation hierarchy for environmental impacts.
- 10. Choose one mining career and describe the subjects and skills it needs.

MINI ACTIVITY

Choose one object in your home. Identify at least five mined materials that may be present, where they are used in the object, and what responsible sourcing question you would ask about each one.

13. References

The following sources were used to guide and verify this introductory note. Accessed 17 August 2026. Learners should check the latest official publications when using statistics, legislation or institutional information.

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Editorial note

This study note is an educational overview, not a substitute for site-specific procedures, professional advice, current law or formal training. Mining data and regulations change over time.

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Learn Today, Achieve Tomorrow. Use this note as a starting point, then explore geology, mining engineering, mineral processing, mine safety, environmental management and mining careers in greater depth.