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Chemical hazards in the mining sector: An industry case study

Session objectives

At the end of the session, you will be able to:

1. Describe the global mining sector and the role of the world of work.
2. Distinguish between large-scale mines (LSM) and artisanal and small-scale mines (ASM).
3. Understand how mine workers are exposed to chemicals.
4. Identify the key chemical hazards in mines and know their main health impacts.

Introduction

Mining is one of the most hazardous jobs in the world.

- Hazards include explosions, **toxic gases and vapours**, rockfalls, flooding and extreme temperatures.
- Although the industry only employs one per cent of the global workforce, it is responsible for about **eight per cent of fatal accidents at work** *(ILO 2015)*.
- **Toxic chemicals** pose a major risk to the health of miners globally.
- Chemicals can severely impact body systems and organs, leading to **disability, life-long illness and even death.**
- Mine workers in **Low- and Middle-Income Countries** (LMICs) and in **informal settings** are particularly at risk.
- Health effects are often undiagnosed or misattributed, unrecorded and unaddressed.

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Question:

Can you name any chemicals used in mining?

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Answer: Key chemical hazards in mines

- Mercury
- Cyanide
- Sulfuric acid
- Solvents
- Silica dust
- Explosives
- Diesel particulate matter (DPM)

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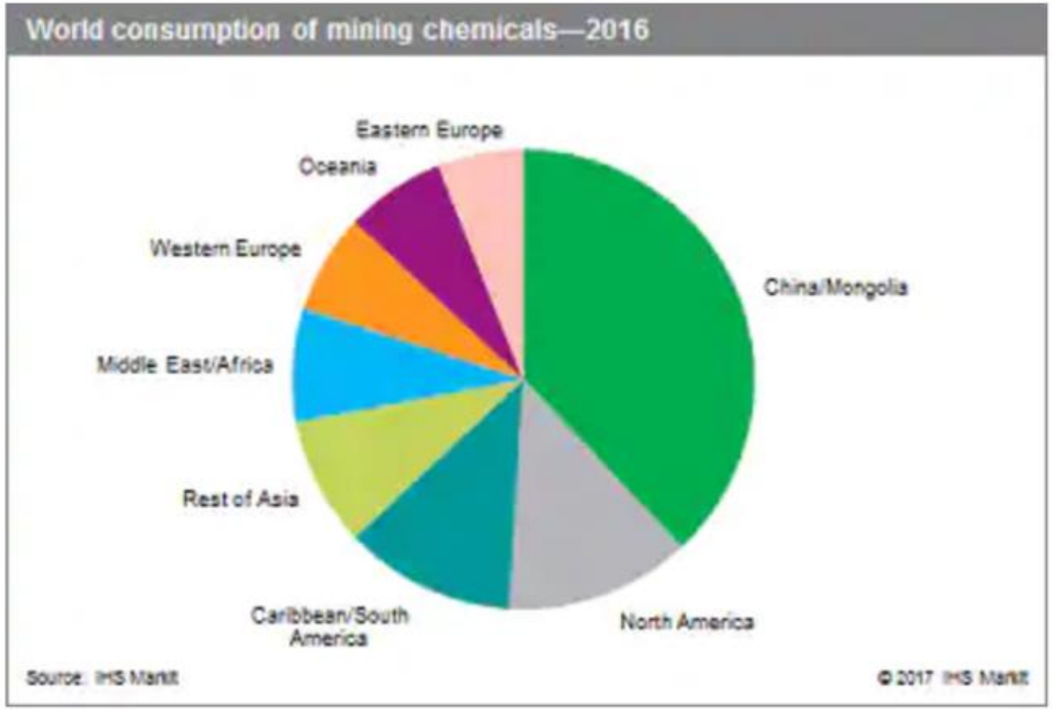
The mining sector

The mining sector

The mining sector is pivotal to the world's economy.

- The revenue of the top 40 global mining companies was **US$656 billion** in 2020 *(Garside 2021).*
- The mining chemicals market is set to be worth **US$38 billion** by 2024 *(Grand View Research 2018).*
- Most exploited commodities worldwide are iron ore, coal, postash and copper.
- The mining industry's leading five companies based on market capitalisation are: BHP, Rio Tinto, Anglo America, Glencore and Newmont.



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Large-scale mining (LSM)

One of the world's most safety conscious and strictly-regulated industries.

- Considerably **improved fatality rates** in recent years.
- Sound occupational safety and health (OSH) systems to **protect workers.**
- Use little or no chemicals due to **advanced mechanised technologies.**

Case study: Brumadinho Dam disaster in Brazil

- The dam collapse in Brumadinho was one of Brazil's **worst environmental disasters**.
- In January 2019, Dam I at the Córrego do Feijão iron ore mine collapsed, releasing a **torrent of toxic iron ore waste**.
- The mudflow overwhelmed mine buildings and engulfed nearby houses, farms and roads.
- **270 people died** as a result of the collapse.
- Forests were devastated and nearby rivers were polluted.
- Agricultural lands were destroyed and the public water supply was contaminated in numerous municipalities.

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Case study: Garpenberg Mine

- Located in Sweden, 200km northwest of Stockholm.
- **One of the world’s most modern mines**.
- Mine depth of 1,250 metres.
- Produces nearly one per cent of the world’s zinc and more than one per cent of its silver.
- **Remote-controlled equipment** and **control monitors** keep miners away from hazards.
- **46 rescue chambers** with enough air to keep **239 people alive for eight hours**.

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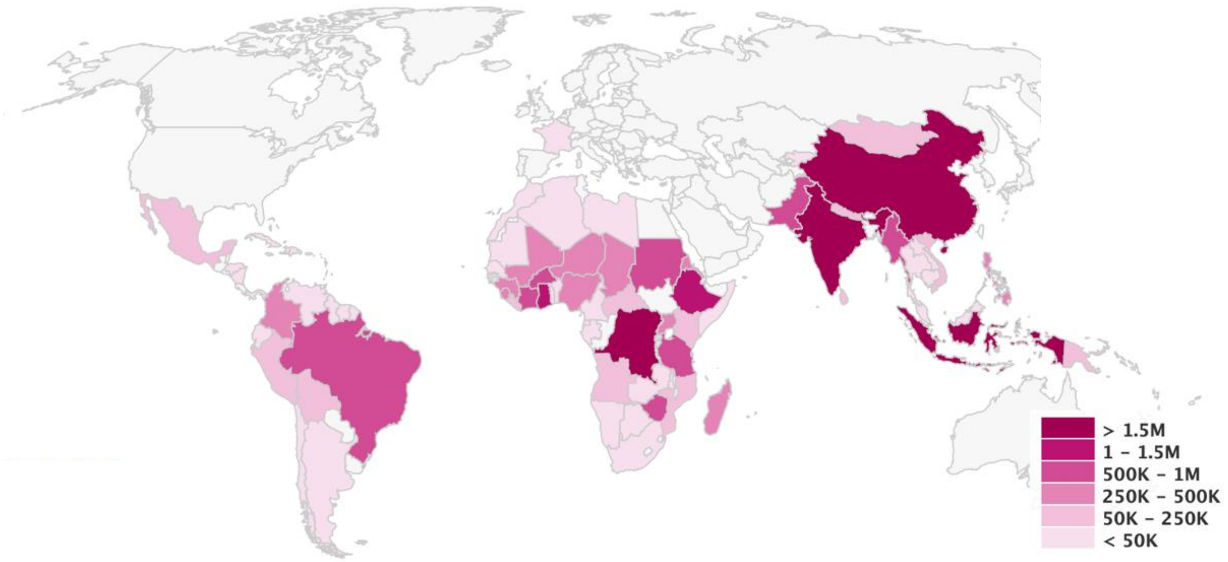
Artisanal and small-scale mining (ASM) operations

Primary source of employment for over 44 million people across 80 countries worldwide *(Delve 2020).*

- 30% of the ASM workforce are women *(Delve 2020).*
- **80-90 per cent of ASM activity operates informally** *(Perks and McQuilken 2020).*
- **Accident rates** in ASM are routinely **six or seven times higher** than in larger operations, even in industrialised countries *(ILO 2015).*
- Produces 15-20% of global minerals, including 80% of sapphires, 20% of gold and 20% of diamonds *(EU Science Hub n.d.).*
- A major producer of raw materials for electronic manufacturing *(EU Science Hub n.d.).*

Number of people working in ASM globally



- Over 44 million people across 80 countries worldwide are employed in ASM *(Delve 2020).*

Top 10 ASM countries by number of people working in ASM

Country	No. working in ASM
India	15,000,000
China	9,000,000
Indonesia	3,600,000
Democratic Republic of Congo	2,000,000
Ethiopia	1,260,000
Ghana	1,100,000
Burkina Faso	1,000,000
Zimbabwe	1,000,000
Sudan	1,000,000
Tanzania	1,000,000

Source: Delve 2020

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Key characteristics of ASM

Frequently operate outside of health, safety and environmental legislation and standards.

- Often occurs in **rural communities** with **limited other employment.**
- The work is **labour intensive**, **low paying** and **extremely hazardous.**
- Frequently **operate illegally** and receive **little support** from authorities.
- **Children** as young as ten years old are frequently used in mines.

Women in ASM

Women make up approximately 30 per cent of the total workforce, and up to 50 per cent in Africa *(IGF 2018)*.

- Participate sluicing, panning, mercury-gold amalgamation, amalgam decomposition, cleaning and food provision *(IGF 2018)*.
- Are at increased risk of **adverse health impacts**, as they often perform ore purification using mercury or cyanide *(Eftimie et al 2009)*.
- Frequently encounter **financial exploitation**, **workplace discrimination**, **unequal pay**, **sexual harassment** and have **limited power**, as they are unable to own land and mining titles *(ILO 2021)*.

Children in ASM

More than one million children are engaged in child labour in mines and quarries *(ILO 2019)*.

- ASM has a **poor reputation** when it comes to child labour.
- Children engage in a wide range of **hazardous activities**, from working in underground shafts with **poor ventilation**, to handling mercury to amalgamate gold with **bare hands** *(ILO 2019)*.
- ILO considers mining as a **worst form of child labour** due to:
  - The harsh working conditions.
  - Handling and exposure to toxic chemicals.
  - The vulnerability of young women and girls to sexual and gender-based violence.

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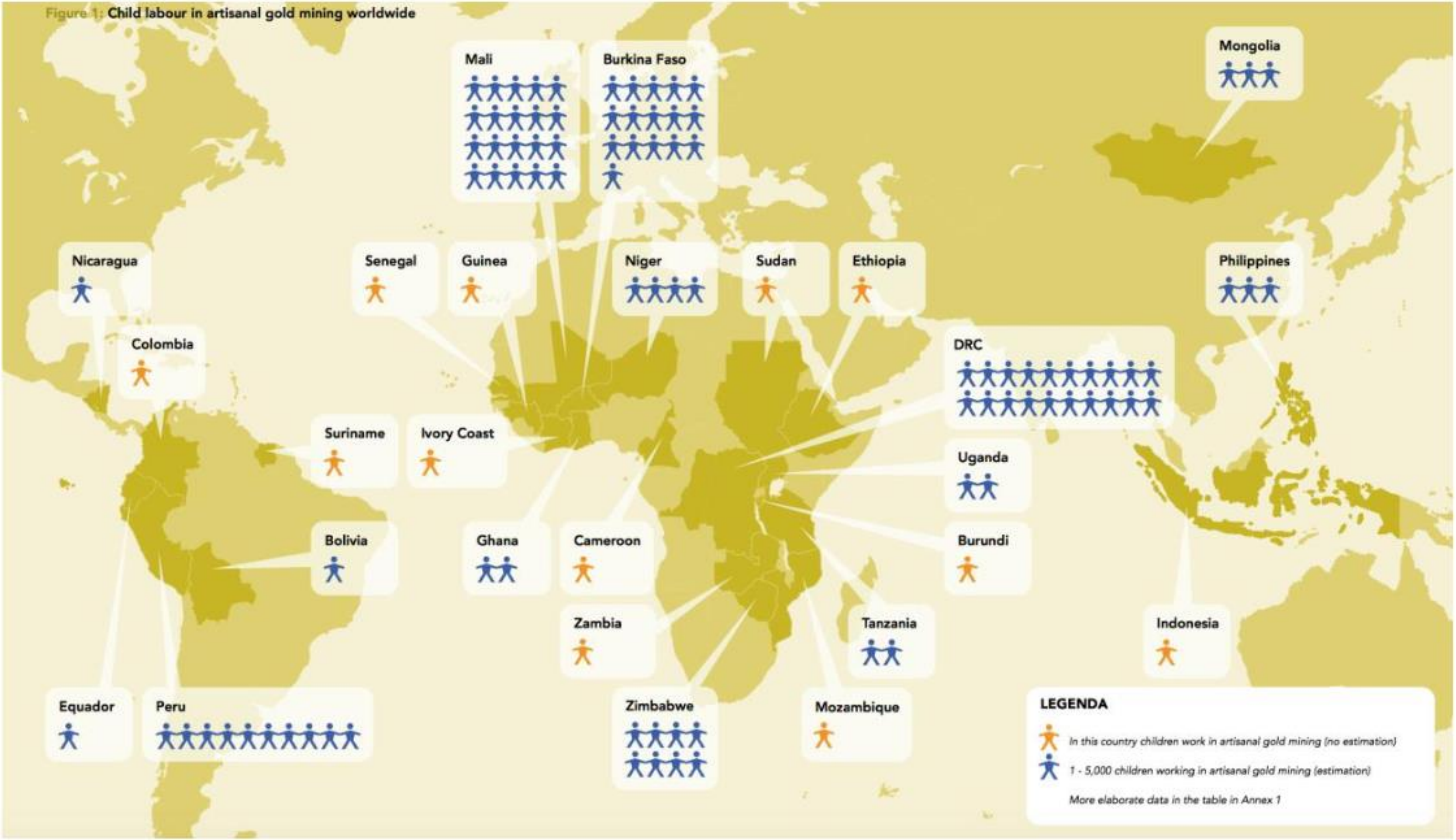
Children in ASM

In some areas the issue of child labour in mining is particularly acute.

- In Burkina Faso and Niger, some 30 to 50 per cent of the gold mine workforce is comprised of children, predominantly under the age of 15 *(ILO 2006)*.
- 20 per cent of artisanal gold miners in Mali are children *(Schipper et al. 2015)*.

Child labour in ASM worldwide *(Schipper et al. 2015)*



Case study: Children in cobalt mines in the Democratic Republic of Congo

- Child labour is used in cobalt and coltran mines.
- These minerals are used in portable electronic devices and rechargeable batteries, including the batteries of electric cars.
- More than half of the world's supply of cobalt comes from the Democratic Republic of Congo *(Statista 2020)*.
- **Children as young as seven years** old work in **life-threatening conditions**, subject to **violence**, **extortion** and *intimidation (ILO 2019)*.
- This cobalt has been traced to lithium batteries sold by **major multinational companies** *(Amnesty International 2016)*.

Case study: Children in ASGM in Uganda

- Approximately 12,000 children under 14 years old are engaged in ASGM in Uganda *(Schipper et al. 2015).*
- Children undertake tasks such as digging in deep open pits, carrying stones, operating grinding machines and washing the ground ore *(NRDO 2017).*
- Working children often come from large families and have **limited access to education** *(Rivera 2020).*
- Factors such as **existing norms**, **beliefs**, **quality of education**, **insufficient income**, and **lack of policy enforcement** at community and mine level, play a major role in driving or stopping child labour *(DELVE 2020).*

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How are miners exposed to hazardous chemicals?

Sources of chemical exposure in mining

- A chemical substance is an **element**, **compound** or **mixture** which may be present in the workplace in the form of a **liquid**, **solid** or **gas**.
- Mine workers may be exposed to hazardous chemicals which are:
  - used as part of a production process
  - generated by a process e.g. tailings
  - used in maintenance activities
- Absorption can occur through **inhalation**, **ingestion** or **dermal contact**.
- Chemical substances may also pose a **fire** or **explosive** hazard in the workplace.

Chemical absorption/exposures – key facts

Inhalation	▶ Main route of exposure for some chemicals e.g. 80 per cent of inhaled mercury vapour is absorbed in the lungs ▶ Poorly ventilated, warm, indoor spaces are of particular concern in cases of airborne mercury vapours
Dermal absorption	▶ If chemicals are handled inappropriately or if they are spilled and not cleaned properly
Ingestion	▶ When hygiene practices are limited e.g. from unwashed hands ▶ Also from chemical-contaminated food sources e.g. if workers live near work
Explosions	▶ Combustible or explosive chemicals build up in unventilated areas ▶ Explosive gases (e.g. methane, carbon monoxide and hydrogen sulfide) may be released during mining operations such as drilling and blasting

Health impacts of chemical exposures

- **Numerous health impacts** have been associated with the different chemicals used in mining.
- Prevalence and severity of occupational diseases dependent on:
  - the type of ore mined
  - the contaminants present
  - the levels and duration of exposure
- Chemicals can have **acute** and/or **chronic** health effects, with or without a **latency period**.

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Question:

Which characteristics of ASM put workers at risk of chemical exposures?

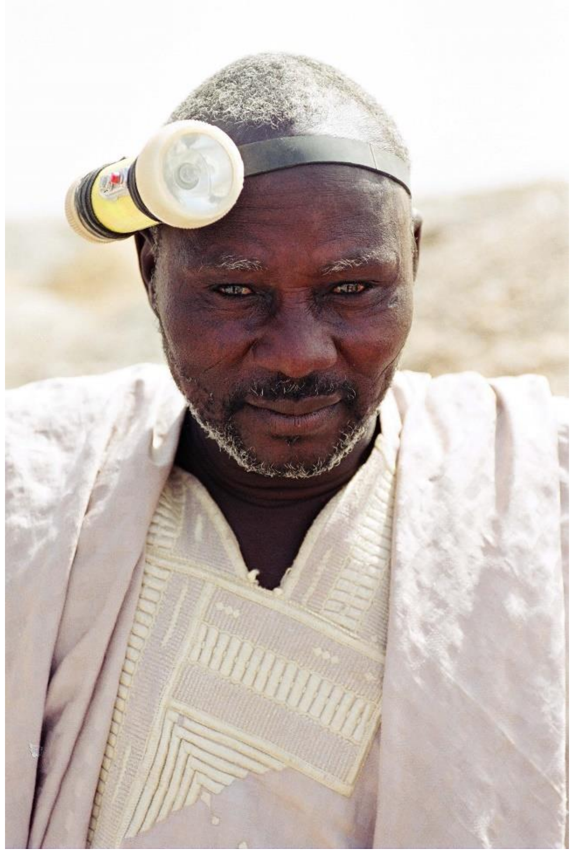
Child working as a gold searcher, Niger

Spotlight on artisanal and small-scale goldmining (ASGM)

- Employs over **19 million workers** in **70 countries** *(Steckling et al. 2017)*.
- Approximately **4.5 million** of these workers are women and **600,000 are children**.
- Typically consists of small groups or individuals.
- Gold is extracted using **semi-mechanised** and **low-tech methods**.
- Mining sites tend to have **poor occupational safety standards** and practices.
- Chemical risks include mercury, cyanide and silica dust.

Image source: BBC

Spotlight on artisanal and small-scale goldmining (ASGM)



There are also positives associated with ASGM, however:

- However, can represent an **economic opportunity** when alternative livelihoods are scarce or where people are employed in seasonal work *(Haundi et al. 2021)*.
- Has the potential to **alleviate poverty** in rural populations and contribute to economic development *(Neumann et al. 2019)*.

The ILO and mining

- The ILO has been dealing with labour and social problems in the mining industry since its early days.
- **Hours of Work (Coal Mines) Convention** (No. 31),1931.
- **Safety and Health in Mines Convention** (No. 176), 1995.
- In particular, the ILO has long recognised that the **protection of workers** from hazardous chemicals is essential for **ensuring health populations**, as well as **sustainable environments**.
- **Chemicals Convention** (No.170), 1990.
- Improving OSH in mines is also paramount to achieving **Sustainable Development Goal (SDG) 8**: “Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all”.

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The chemicals

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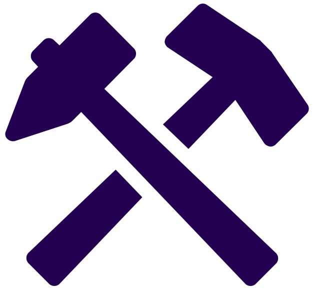
Question:

What are chemicals used for in mines?



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Answer:

- To separate ore from rock e.g. mercury and cyanide
- To create tunnels and excavation areas e.g. explosives
- To power equipment e.g. diesel
- Leaching e.g. sulfuric acid

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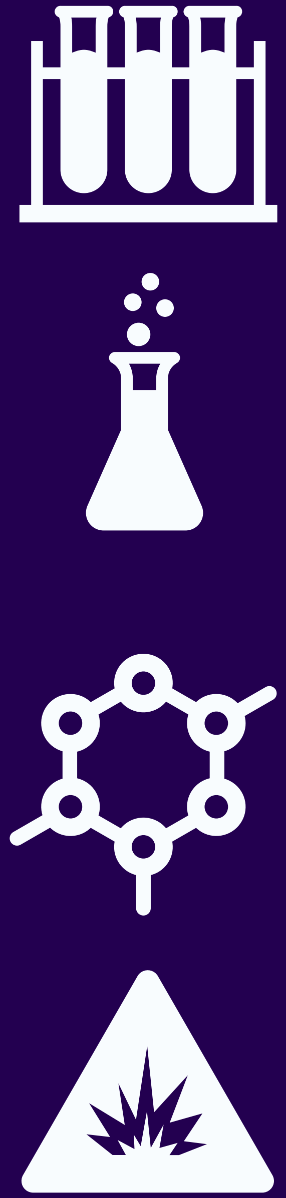
Overview of key chemicals

- Mercury
- Cyanide
- Sulfuric acid
- Solvents
- Silica
- Diesel particulate matter (DPM)
- Explosives



Mercury

Mercury is a highly dangerous heavy metal that cannot be destroyed and persists in the environment.

- Elemental mercury is **highly volatile** and can transform to **toxic vapour** even at room temperature.
- The World Health Organization (WHO) has identified mercury as **one of the top ten chemicals of major public health concern** *(WHO 2017)*.
- Used in ASGM, primary mercury mining and the mining of non-ferrous ores.
- **ASGM continues to be the largest user of mercury globally**.
- East and Southeast Asia regions predominate in overall mercury consumption.

Mercury: Use in ASGM

- Workers exposed during amalgamation, squeezing, vaporization, melting and refining of raw gold doré.
- Most direct route of exposure is via **inhalation of mercury vapour** from heated amalgam e.g. during open burning or smelting *(WHO 2016)*.
- Mercury vapours in the air around amalgam burning sites can be **alarmingly high** and **usually exceed the WHO limit for public exposure** of 1.0 μg/m^3 *(UNEP 2012)*.
- Workers can also be exposed if liquid mercury is not properly stored, if surfaces are soiled or they are in contact with contaminated waste material *(WHO 2016)*.
- Food sources may also be **contaminated**.

Impact of mercury use on health and the environment

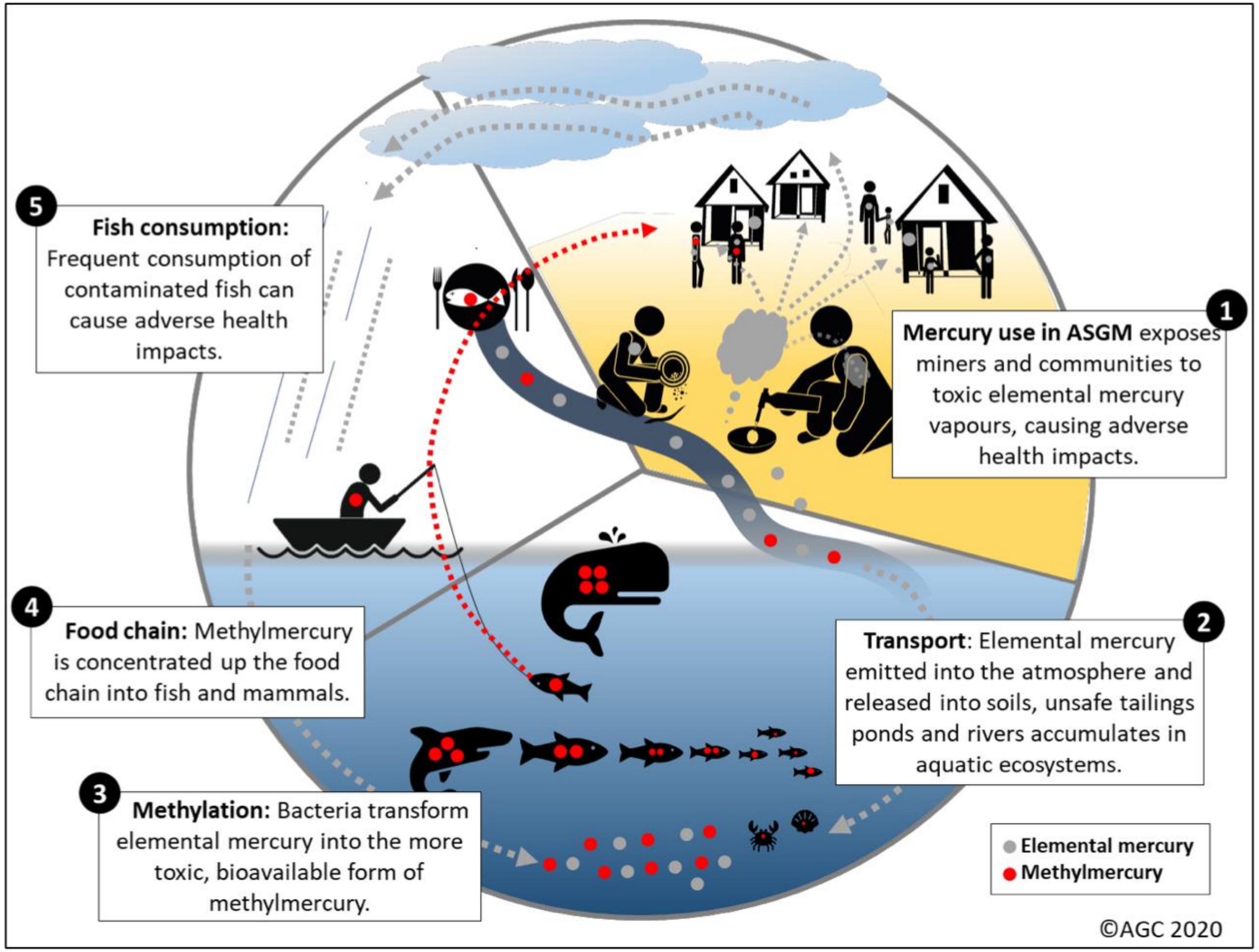


Figure 3: Impacts of mercury use in ASGM on human health and the environment: Mercury persists and travels in the environment, affecting not only miners and their communities locally but also the global environment

Mercury: Biological matrices

Biological matrices using urine, blood and hair can be used to measure mercury exposure

- Urinary mercury can be hugely elevated for those involved in both amalgamation and heating/burning processes
- Studies report urinary mercury concentrations well above:
  - 50 µg mercury/g-creatinine - a urinary concentration where renal tubular effects are believed to occur, and
  - 100 µg mercury/g-creatinine - a urinary concentration where the probability of developing the classical neurological signs of mercury intoxication is “high” *(WHO 2013)*

Case study: ASGM communities in Colombia

- A study of 238 ASGM miners in Colombia assessed total mercury in blood, urine and hair samples, as well as methylmercury in hair
- Approximately 40 per cent of miners showed mercury concentrations in blood, urine and/or hair above WHO thresholds
- Miners burning amalgams showed significantly higher concentrations then miners not involved in this process, with values 7-, 7- and 8-fold higher in blood, urine and hair respectively *(Calao-Ramos et al. 2021)*

Image source: GEF

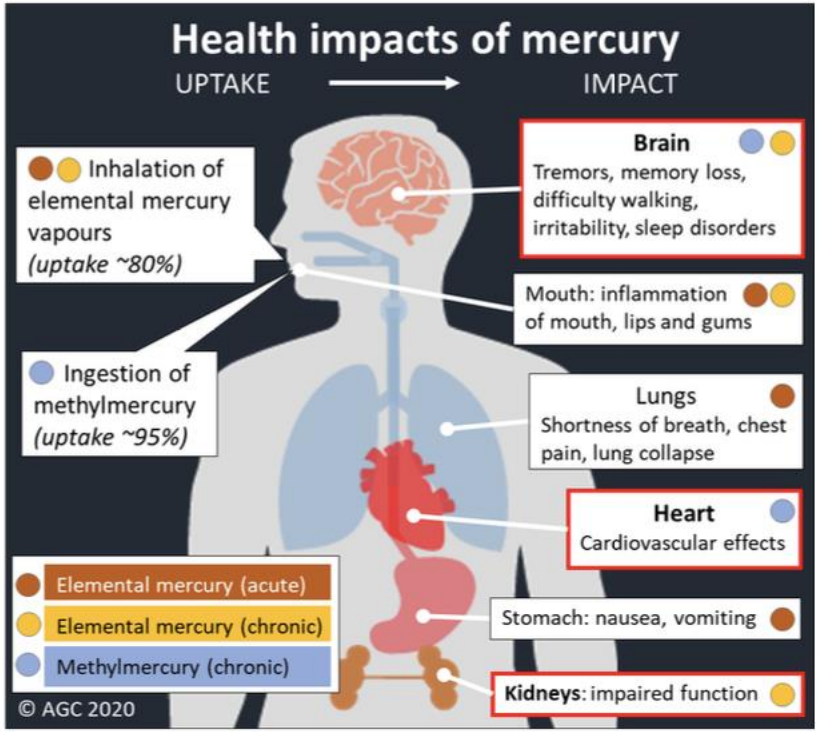
Mercury: Use in other mining industries

- **Primary mercury mining**:
  - In China, Mexico, Indonesia and the Kyrgyz Republic only *(UNEP 2017)*.
  - In 2019, the world mercury production from mining was 4,000 metric tonnes and the leading global producer was China (3,500 metric tons) *(USGS 2020)*.
  - Both China and Mexico have ratified the Minamata Convention.
- **Other non-ferrous ores**:
  - Mercury is a trace contaminant in other non-ferrous ores e.g. zinc, gold, lead and copper.
  - By-product mercury is generated from non-ferrous mining operations.
  - Most of this mercury goes to disposal or is released into the environment *(AMAP/UNEP 2013)*.

Mercury: Health impacts

Exposure to mercury, may adversely impact the nervous, digestive and immune systems, as well as specific organs, such as the heart, brain, lungs, kidneys and skin *(WHO 2021)*.

- **Central nervous system** (CNS) is the most sensitive target for elemental mercury.
- **Neurotoxic symptoms** include tremors, insomnia, memory loss, neuromuscular effects, headaches and cognitive and motor dysfunction *(WHO 2021)*.
- **Respiratory tract infection**, **renal damage** and **cardiac effects** may also occur.
- **Methylmercury from contaminated food sources** can also damage the CNS.



Mercury: Health impacts

- Between **25 and 33 per cent of miners** are estimated to suffer from **chronic metallic mercury vapour intoxication (CMMVI)** *(Steckling et al. 2017)*.
- ASGM workers frequently have urinary mercury concentrations **above the WHO threshold**, beyond which there is a high probability of developing classic neurological signs of mercury poisoning.
- **Global burden of mercury exposure for ASGM alone was estimated to be over 19 million** *(Steckling et al. 2017)*.
- The Global Burden of Disease (GBD) from ASGM alone was estimated to be over **2 million disability-adjusted life years** (DALYs) *(Steckling et al. 2017)*.

Mercury: Vulnerable worker groups

- **Females** are at high risk during **child-bearing years** and **pregnancy**. Mercury can cross the placental barrier to cause **irreversible neurodevelopmental damage** to the foetus.
- **Children** are especially vulnerable due to their developing physiology, anatomy, metabolism and health behaviours. Exposure to very high mercury levels can cause **irreversible damage to children's brain function** including attention span, language, visual-spatial skills, and coordination.
- **Migrants** may not speak the local language, making it difficult to understand chemical labels, safe handling procedures and training materials.
- **People with disabilities** face **unique risks** depending on their disability.

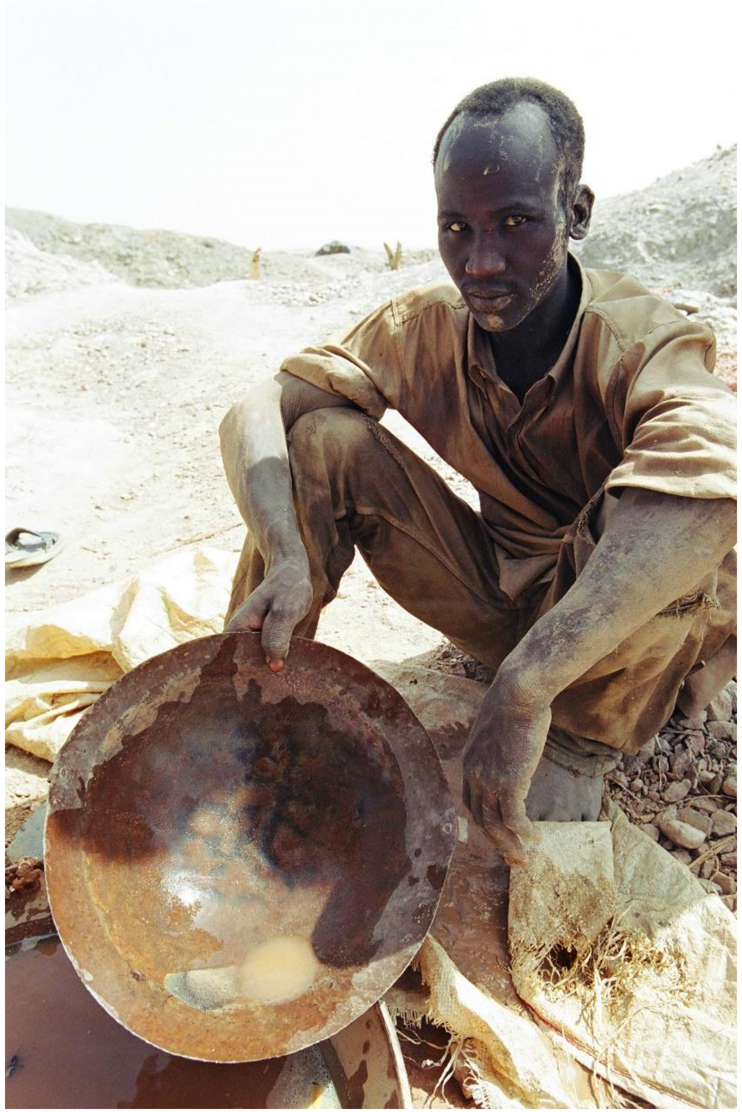
Case study: Children in ASGM

- A study carried out in Indonesia and Zimbabwe looked at mercury exposure in 80 children aged between 9 and 17 working in ASGM *(Bose-O'Reilly et al. 2008)*.
- Children working with mercury showed symptoms of **mercury intoxication**, including **ataxia** and **dysdiadochokinesia**, as well, as high levels of urinary mercury compared to non-exposed children.
- When considering the numbers of children involved in ASGM, the **potential burden of disease in adulthood** for former ASGM child labours is likely to be considerable.

Cyanide

Highly toxic sodium cyanide is used in mining to separate gold from ore.

- Used for gold extraction in many **LSM operations** worldwide.
- **Increasingly used in ASGM**, as it can recover more gold than mercury amalgamation *(EPA 2017)*.
- However **generally costlier** and requires more knowledge and **technical training** *(Veiga et al. 2009)*.
- If adequately handled, risks to human health and the environment can be minimised.



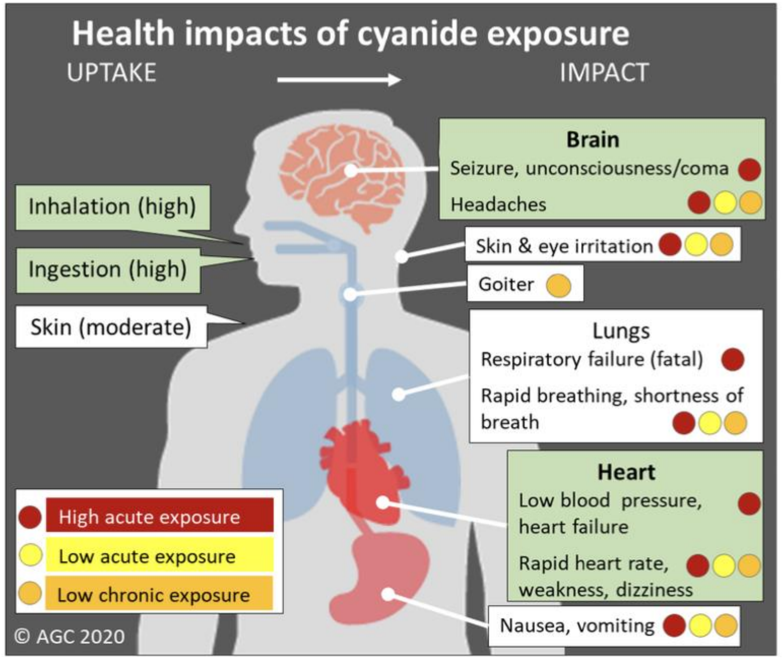
Cyanide: Exposure

- If cyanide is properly handled risks can be minimised, however **inadequate OSH procedures** put mine workers in **danger**.
- Workers may be at risk from **direct exposure** or from **cyanide spills** (can contaminate water supplies and agricultural lands).
- Exposures from:
  - **Ingestion** (deadly when swallowed, even in minute doses).
  - **Inhalation** of hydrogen cyanide gas.
  - **Skin contact** e.g. walking with bare feet in cyanidation ponds.
  - **Contaminated food and water**.

Cyanide: Health impacts

Fast-acting poison that prevents oxygen from being used by the cells, resulting in tissue hypoxia and death *(Utembe et al 2015)*.

- High amounts absorbed by lungs and gastrointestinal system; absorption through skin exposure is moderate.
- A small dose of ingested cyanide salts may be **deadly** within a short time.
- The inhalation of 120 mg/m^3 can cause **life-threatening injuries** and may lead to death after 30 to 60 minutes; exposure to over 300 mg/m^3 is immediately fatal.



Cyanide: Health impacts

- Low dose acute exposure symptoms include dizziness, headache, vomiting, rapid breathing, rapid heart rate, restlessness, weakness, hypoxia and skin and eye irritation.
- High dose acute exposure can also lead to **seizures, loss of consciousness, respiratory failure and death**.
- Low dose chronic exposure can **damage the central nervous system** (causing headaches, dizziness, numbness, tremors, loss of visual acuity), the **cardiovascular system** (causing rapid heart rate) and the **respiratory system** (breathing difficulties, chest pain).
- Child show similar symptoms to adults, however smaller doses can be more harmful. Cyanide can pass the placental barrier and impact the developing foetus.

Case study: Cyanide use in Burkina Faso

- Cross-sectional study of 279 workers at three ASGM sites in Burkina Faso *(Knoblauch et al. 2020)*.
- Comparison of cyanide using miners with non-cyanide using miners and community members not involved with mining.
- Long term exposure at AGSM sites was associated with high blood lactate levels (a proxy indicator for cyanide exposure) and short-term memory loss.

Image sources: UNIDO and Artisanal Gold Council

Sulfuric acid

Sulfuric acid is strong acid used in copper mining to leach copper oxide minerals.

- Other uses include metal cleaning, explosive production, processing bauxite and metallurgy.
- It is also a by-product of many kinds of mining, mixing with water and heavy metals to form **acid mine drainage**.
- Contact with sulfuric acid can cause irritation of the eyes, nose and throat, as well as burns, blindness and death.
- Long-term exposure can cause **chronic inflammation** of the respiratory tract.

Sulfuric acid: Acid mine drainage

- Acid mine drainage is the formation and movement of highly acidic water rich in heavy metals.
- Released anywhere where sulfides are exposed to air and water e.g. waste rock piles, tailings, open pits and underground tunnels.
- Often marked by ‘yellow boy’, an orange-yellow substance that occurs when the pH of acidic mine-polluted water raises above 3.
- Can have severe impacts on fish, animals and plants.
- Many impacted streams have a pH of 4 or lower (like battery acid).
- Food sources may be contaminated.

Solvents

- The term ‘solvent’ is generic and may include **hundreds of different chemical compounds**.
- Used in mining to separate minerals from ore.
- Occupational exposure generally occurs through vapour inhalation.
- Dermal exposure may also occur.
- Blood absorption occurs quickly after exposure.
- Blood levels depend on solvent concentration in the air, room ventilation and duration of exposure *(Hurley and Taber 2015)*.

Tangshan Qianjiaying Mine, China

Solvents: Health impacts

- May be retained in organs with high lipid content e.g. the brain.
- Acute, high-level exposures can lead to **delirium, respirator depression and death**.
- Chronic, low-level exposures are **solvent-specific** and have been associated with **cancer, reproductive concerns and neurotoxic effects**.
- Reproductive concerns include infertility, cleft palates, miscarriage, newborn infection and childhood cancer *(Rim 2017)*.
- **Chronic solvent induced encephalopathy (CSE)** can occur after long-term exposure to solvents.
- Symptoms of CSE include fatigue, irritability and neurobehavioural deficits.

Silica dust

Copious amounts of silica dust is produced during mining processes, such as rock drilling, mineral extraction, ore crushing and milling.

- Causes fine silica to be **deposited in the lungs**.
- Data on silica exposure in ASM is limited, but field observations suggests it is extensive, especially in hard rock mining *(AGC 2020)*.
- A study in Tanzania found average concentrations of 0.19mg/m^3, in above ground operations, **exceeding the NIOSH recommended exposure limit by four times** *(Gottesfeld et al. 2015)*.

Silica dust: Health impacts

- Crystalline silica (c-silica) is classified by IARC as **carcinogenic to humans (Group 1)**.
- Short-term exposure to respirable dust can cause irritation to the upper respiratory tract.
- Chronic exposure has been linked to **silicosis**, an irreversible and progressive lung disease.
- Silica dust has also been linked to **pulmonary tuberculous (PTB), chronic obstructive lung disease and lung cancer** *(Ross and Murray 2004)*.
- Since the onset of symptoms is usually slow, silicosis often remains undetected and undiagnosed.

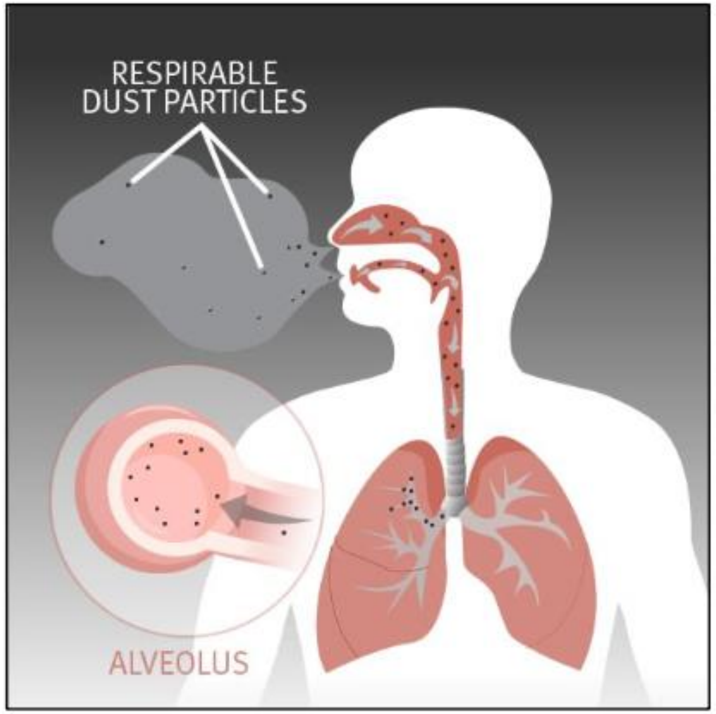


Figure 9: Inflammation and lung obstruction caused by silica dust (© The State of Queensland)

Case study: Silicosis in South African goldminers

- A cross-sectional study of 520 migrant contract workers on a South African goldmine found **silicosis prevalence to be between 18.3 to 19.9 per cent** *(Churchyard et al. 2004)*.
- Significant trends were found between silicosis prevalence and length of service, mean intensity of exposure and cumulative exposure.
- Workers developed silicosis while exposed to a quartz concentration **below South Africa's recommended occupational exposure limit (OEL) of 0.1 mg/m^3**.

Diesel particulate matter (DPM)

- Underground miners may also be exposed to high levels of DPM from the use of diesel-powered mobile equipment.
- Diesel-powered equipment is widely used in ASM, due to its performance, cost-effectiveness, efficiency and durability *(Chang and Xu 2018)*.
- DPM exposure has been linked to **cardiovascular dysfunction, eye and nose irritation, nausea, asthma and neurodegenerative disease** *(Donoghue 2004; Levesque et al. 2011)*.
- DPM is classified as **carcinogenic to humans (IARC Group 1)**.

Explosives

- Mining operations often use explosives, such as ammonium nitrate and fuel oil (ANFO) e.g. to blast tunnels.
- Detonating explosives releases **toxic gases**, primarily oxides of nitrogen and carbon monoxide.
- Nitric oxide and nitrogen dioxide are produced by large surface blasts in which the explosive does not detonate properly.

Explosives

- Even in relatively small concentrations, nitrogen dioxide can produce harmful side effects in underground workers *(Chilton et al. 2005)*.
- Carbon dioxide is a particular problem in underground blasting, where the gas cannot dissipate to safe levels *(NIOSH n.d.)*.
- Mine workers may become ill or die if they remain in an area where toxic fumes levels are high.
- Unmixed ammonium nitrate can decompose explosively and has been responsible for several industrial disasters, including the 2020 Beirut explosion.

Case study: Burkina Faso mine explosion

- At least 59 people died and many more injured following an explosion at an ASGM site in southwestern Burkina Faso.
- It is believed to have been caused by chemicals used to treat gold that were stocked at the site.
- Mine accidents are common in this country, where gold has become the leading product after cotton.
- There are hundreds of small, informal mining sites in the country, that operate without oversight or regulation.

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About 60 killed in explosion at Burkina Faso gold mine site

Published 2 mins ago on February 22, 2022
By **Ariana News**

(Last Updated On: February 22, 2022)

About 60 people were killed and dozens more wounded on Monday (February 21) in an explosion at an informal gold mining site in southwest Burkina Faso, state television reported, citing local officials.

End of session activity

Quiz

Quiz

1. Name some characteristics of ASM.
2. Why is mining considered as a worst form of child labour by the ILO?
3. What influences the severity of health impacts due to chemical exposures from mining?
4. Identify the different mining industries in which mercury exposure can occur.
5. Can you identify what photo on the right is showing?
6. What is the name of the solid waste produced during mining?

Identify the chemical exposure

You are a doctor in a small clinic in a village. An ASM operates nearby. A number of mine workers visit you with different sets of symptoms. Can you identify the possible chemical exposure from the symptoms?

- Patient 1: A 15 year old child who has symptoms of ataxia and dysdiadochokinesia. You suspect he is a child labourer who has been working in the mine for years.
- Patient 2: A 65 year old man who has worked in the mine all his life. He has suffered from a cough, sputum and shortness of breath for a number of years. This has progressively been getting worse. He is involved in excavation work.
- Patient 3: A 40 year old woman who had a seizure earlier in the day and then lost consciousness. Her work involved separating gold from rock.

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Key ILO resources

- Safety and Health in Mines Convention, 1995 (No. 176).
- Safety and Health in Mined Recommendation, 1995 (No. 183).
- Code of practice on safety and health in underground coalmines (2006).
- Code of practice on safety and health in opencast mines (2018).
- Safety and health in small-scale surface mines: A handbook (2001).
- Resource guide on the mining sector.
- Occupational safety and health in the mining (coal and other mining) sector.
- Exposure to hazardous chemicals at work and resulting health impacts: A global review (2021).
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