

Categories

- Definition
- Processing
- Recycling
- Risks
- Pollution
- Disaster

Categories

- Tensions
- Conflicts
- In France
- Geography
- For information
- In pictures

Definition

An **ore** is a rock that is mined in order to obtain metals or other useful minerals, after several stages of processing.

1
1/6

Definition

Waste rock is the rock that needs to be extracted in order to reach the ore.

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2/6

Definition

Mine tailings are the solid or liquid waste produced when processing the ore.

3
3/6

In pictures



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Lac de résidus miniers,
Pérou

4
4/6

Risks

In order to store mine tailings, artificial ponds are created by building dams or embankments.

Dam breaches are one of the causes of mine-related disasters.

5
5/6

In pictures



TV NBR, CC BY 3.0, via Wikimedia Commons

Rupture de digue,
Brésil 2019

6
6/6



Processing

Once the ore has been excavated, it is crushed, ground and sorted in order to separate out the desired minerals.

This processing stage consumes a lot of energy and water, and generates tailings.

7

3+

Processing

When the ore has been reduced to powder, it undergoes various chemical and physical treatments to eliminate impurities until the desired metal is obtained.

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Risks

Mining waste (tailings and waste rock) often contains heavy metals, which occur naturally in the mine and represent a danger to health and to the environment: lead, mercury, arsenic, etc.

9

3+

Risks

Mine tailings contain dangerous chemicals that are used during ore-processing operations.

For example, cyanide is used in the processing of gold.

10

3+

Pollution

Ore extraction and the initial processing operations (crushing and grinding) generate dust, which is a major source of water and soil pollution.

11

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Pollution

Mining waste (tailings and waste rock) often contains sulfur, which reacts chemically with air and water, and then with other pollutants (lead, arsenic, etc.), thus causing serious water pollution.

12

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Pollution

Cleaning up pollution in former mining sites is difficult, costly and takes an extremely long time, and is sometimes even impossible.

13

3+

Disaster

Brazil, 2015. Breach of a tailings dam near an iron ore mine, which the Brazilian government qualified as "*the country's biggest ever environmental disaster*". The long-term pollution stretched as far as the Atlantic Ocean 650 km away.

14

3+



Disaster

Romania, 2000. Dam breach near a waste-rock processing plant.

The pollutants (including 115 tons of cyanide) destroyed almost all the flora and fauna in a nearby river over a distance of almost 600 km.

15

3+

Disaster

Canada, 2014. Dam breach near a copper and gold mine.

Mine tailings, containing hundreds of tons of lead, spilled into two lakes downstream.

16

3+

Tensions

China is the world's leading producer of rare earths and other metals, such as gallium and magnesium.

This represents a major geopolitical challenge.

17

3+

Conflicts

Tin, tantalum, gold and tungsten are known as **conflict minerals**, or **blood minerals**, because their exploitation can serve to fund armed conflicts, as in the Democratic Republic of Congo, for example.

18

3+

Conflict

Guatemala, since 2014. Local people are fighting against the reopening of a nickel mine, which they accuse of causing pollution and resulting in a land-grab in the region in which they live.

19

3+

Conflict

Papua New Guinea, 1989. The environmental and social conflict surrounding a copper and gold mine ended up turning into a civil war that would claim around 20,000 lives over the course of 10 years.

20

3+

Conflicts

In Chile, Peru and Argentina, the **demands on water** to produce copper and lithium are in conflict with the needs of the local populations.

21

3+

In France

There are still active mines in France: gold is mined in French Guiana, nickel in New Caledonia (6% of world production in 2023) and bauxite near Montpellier.

22

3+



In France

A lithium mine is scheduled to open in the Massif Central by 2027. It will be one of the largest in Europe.

23

3+

In France

Hundreds of former mines were not cleaned up when they closed.

Some of these are still a major source of pollution today.

24

3+

Geography

The Democratic Republic of Congo is the world's leading producer of cobalt (74% of production in 2023).

Cobalt is used in smartphone motherboards and batteries.

25

3+

Geography

Indonesia is the world's leading producer of nickel (50% of production in 2023).

Nickel is used in smartphone motherboards and casings.

26

3+

Recycling

Recycling electronic boards requires cutting-edge technologies and very expensive infrastructures.

27

3+

Recycling

Over 50% of base metals (copper, lead, iron, aluminum, etc.) and precious metals (gold, silver, platinum, etc.) are recycled.

28

3+

Recycling

Many metals, including rare earths, are virtually never recycled.

29

3+

Definition

The grade of an ore refers to the proportion or concentration of metal contained in the ore.

For example, the average grade of copper ore is about 0.6% (6 g of copper for 1 kg of ore).

30

3+



For information

In order to satisfy the global demand for metals, ores with lower and lower grades are being extracted.

Consequently, much more material needs to be extracted to produce the same quantity of metal.

31

3+

For information

Rare earths (not to be confused with rare metals!) are metals that are fairly abundant in the Earth's crust but with a very low grade.

32

3+

For information

Although there are many **underground** mines, the majority of mines today are operated as **open pits**.

33

3+

In pictures



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Mine de cuivre,
Roumanie

34

3+

In pictures



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Mine de coltan,
République Démocratique du Congo

35

3+

In pictures



Simonek, Image Libre de Droit, via iStockphoto

Mine de lithium,
États-Unis

36

3+

Risks

Gold mines often contain naturally-occurring mercury and arsenic, which are dangerous to health and the environment.

37

4+

Conflicts

The mining industry is the leading cause of environmental conflicts in the world.

In 2019, 50 environmental defenders were assassinated during conflicts involving the mining industry.

38

4+



Disaster

Brazil, 2019. Breach of a tailings dam at an iron ore mine, which resulted in 243 deaths, 27 missing people and hundreds of injuries.

The operator had to pay almost ₩6 billion in damages.

39

4+

Disaster

Hungary, 2010. Dam breach near an aluminum factory. Red mud flooded several villages, killing 10 people and injuring 286.

It was Hungary's worst ever industrial disaster.

40

4+

Recycling

There are very few factories capable of recycling the wide variety of metals contained in an electronic board, and none in France.

41

4+

Recycling

The main technical difficulties involved in recycling the metals contained in smartphones are:

- 1) identifying the metals concerned
- 2) separating them from the other metals.

42

4+

Recycling

Belgium, 2020. Due to the dust emitted by a metal recycling plant, the children in this neighborhood have blood lead levels that are considered dangerous.

43

4+

In France

A former gold mine near Carcassonne has caused major arsenic pollution problems. Among other things, the sale of vegetables produced in the region has been banned.

44

4+

In France

Several mining exploration projects (for gold, lithium, tin and other metals) are currently in progress or awaiting authorization in France.

45

4+

Geography

Russia is the world's leading producer of palladium (44% of production in 2023).

Palladium is used in smartphone motherboards.

46

4+



Geography

Australia is the world's leading producer of lithium (48% of production in 2023).

Lithium is used in smartphone motherboards and batteries.

47

4+

For information

Several metals are often exploited in the same mine.

For example, several mines produce both copper and zinc.

48

4+

Risks

Zinc mines often contain naturally-occurring mercury, arsenic and lead, which are dangerous to health and the environment.

49

5+

Tensions

A large proportion of the world's mines are located in countries with **water stress**, where the demand for fresh water exceeds the resources available.

50

5+

Geography

China is the world's leading producer of rare earths (69% of world production in 2023 compared to 98% in 2010).

Rare earths are used in smartphone motherboards and screens.

51

5+

Geography

The Democratic Republic of Congo is the world's leading producer of tantalum (41% of production in 2023).

Tantalum is used in smartphone motherboards.

52

5+

Geography

China is the world's leading producer of gallium (98% of production in 2023).

Gallium is used in smartphone motherboards.

53

5+

Geography

South Africa is the world's leading producer of platinum (67% of production in 2023).

Platinum is used in smartphone motherboards.

54

5+



Definition

A **slag heap** is an artificial hill formed by the accumulation of waste rock and tailings from a mine.

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5+

Definition

The term **world reserves** of a metal (e.g. copper) refers to the currently exploitable quantity of a given metal in the Earth's crust.

These reserves are very unevenly distributed around the world.

56

5+

For information

In France, the **Mining Code** defines the distinction between mines and quarries. The term **mine** is used when the material extracted is considered strategic, otherwise the term “**quarry**” is used.

57

5+

For information

Many metals used in the digital sector are **by-products**, i.e. they are recovered during the processing of other metals.

For example, gallium is a by-product of aluminum.

58

5+

For information

The average grade of ore varies greatly between the different types of metals: it is around 45% for iron (45 g of iron for 100 g of ore) but only 0.000008% for gold (8 g of gold for 10 tons of ore)!

59

5+

For information

Worldwide production quantities vary greatly from one metal to another: a few hundred tons a year for certain precious metals, but 100,000 times more for certain base metals!

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5+

