
OFREMI
OBSERVATOIRE FRANÇAIS
DES RESSOURCES MINÉRALES
POUR LES FILIÈRES INDUSTRIELLES
FRANCE 2030

OFREMI's work on copper in the context of an overall deficit forecast

05/06/2025

Mathieu Leguérinel, BRGM/OFREMI, m.leguerinel@brgm.fr

And : Vincent d'Herbemont (IFPEN), Julien Dezombre (ADEME), Françoise Bodénan, Solène Touzé, Aurélien Reys et Antoine Lebrault (BRGM)

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About OFREMI

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French mineral intelligence centre - A public/private partnership

- OFREMI = Observatoire Français des REssources MInérales pour les filières industrielles
- 6 public institutions : BRGM, CEA, ADEME, IFPEN, IFRI and CNAM
- Public / private partnership to inform public bodies and industry sectors

OFREMI was created to inform the decisions of public authorities and industrial sectors and players across all value chains.

REINFORCE a global vision and sharing of issues

DECIPHER AND TRACK global supply chains

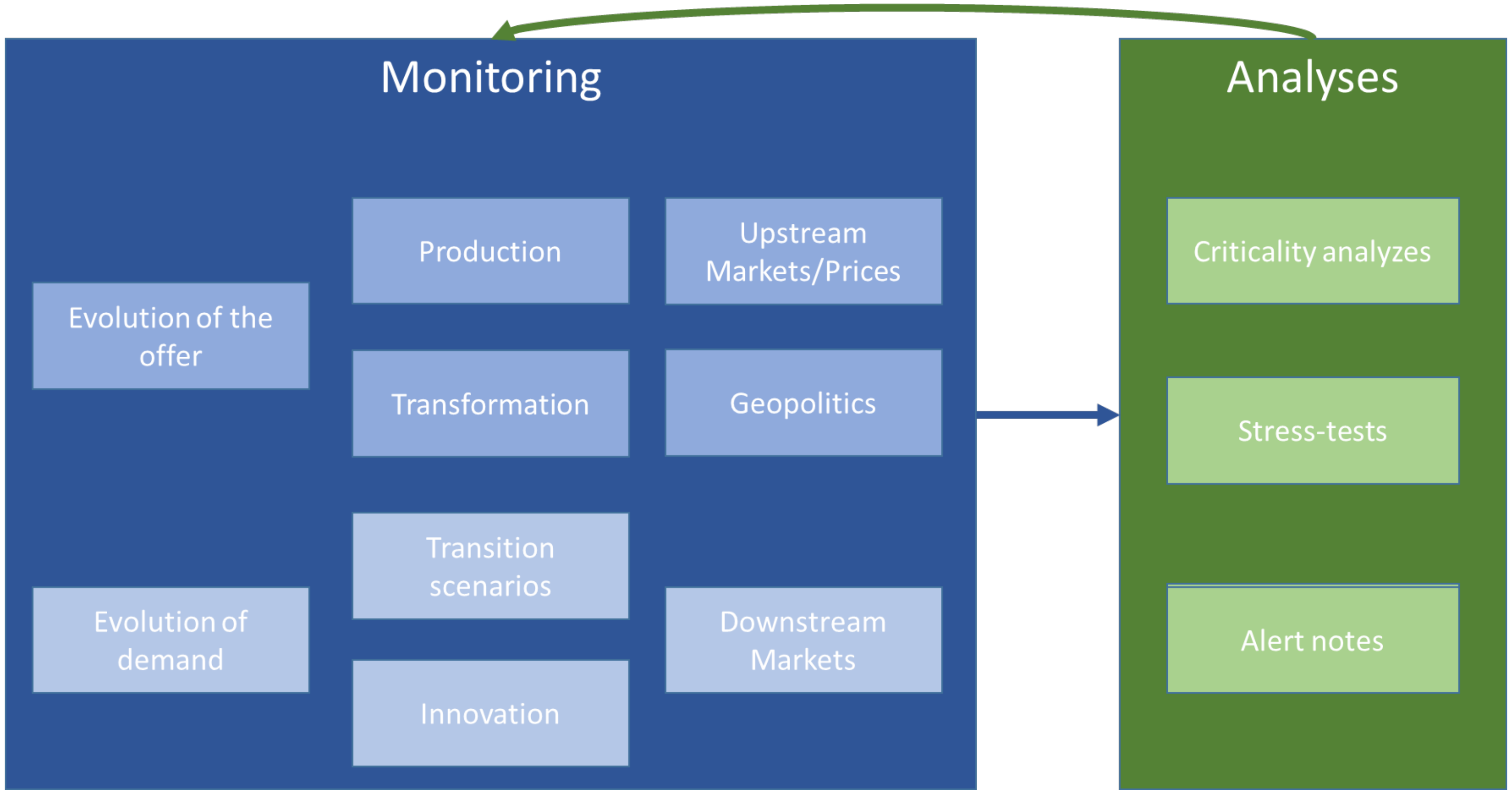
ASSESS the impacts of technological developments on the supply and demand of strategic raw materials

QUANTIFY supply and reputational risks (ESG)

PROPOSE mitigation or remediation actions (stress tests, risk analyses, etc.)

French mineral intelligence centre - A public/private partnership

- Monitoring
  - Uses and consumption
  - Global production and resources
  - Substitutability
  - Recycling
  - Environmental analysis
  - Price
  - International trade restrictions, regulations
  - French production and resources
  - French industrial sector
- Analysis



→ Several subjects studied including **copper**

Copper market : fundamentals

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Diverse but fundamental uses for the global economy

- Demographic trends
  - Population growth
  - Rising living standards

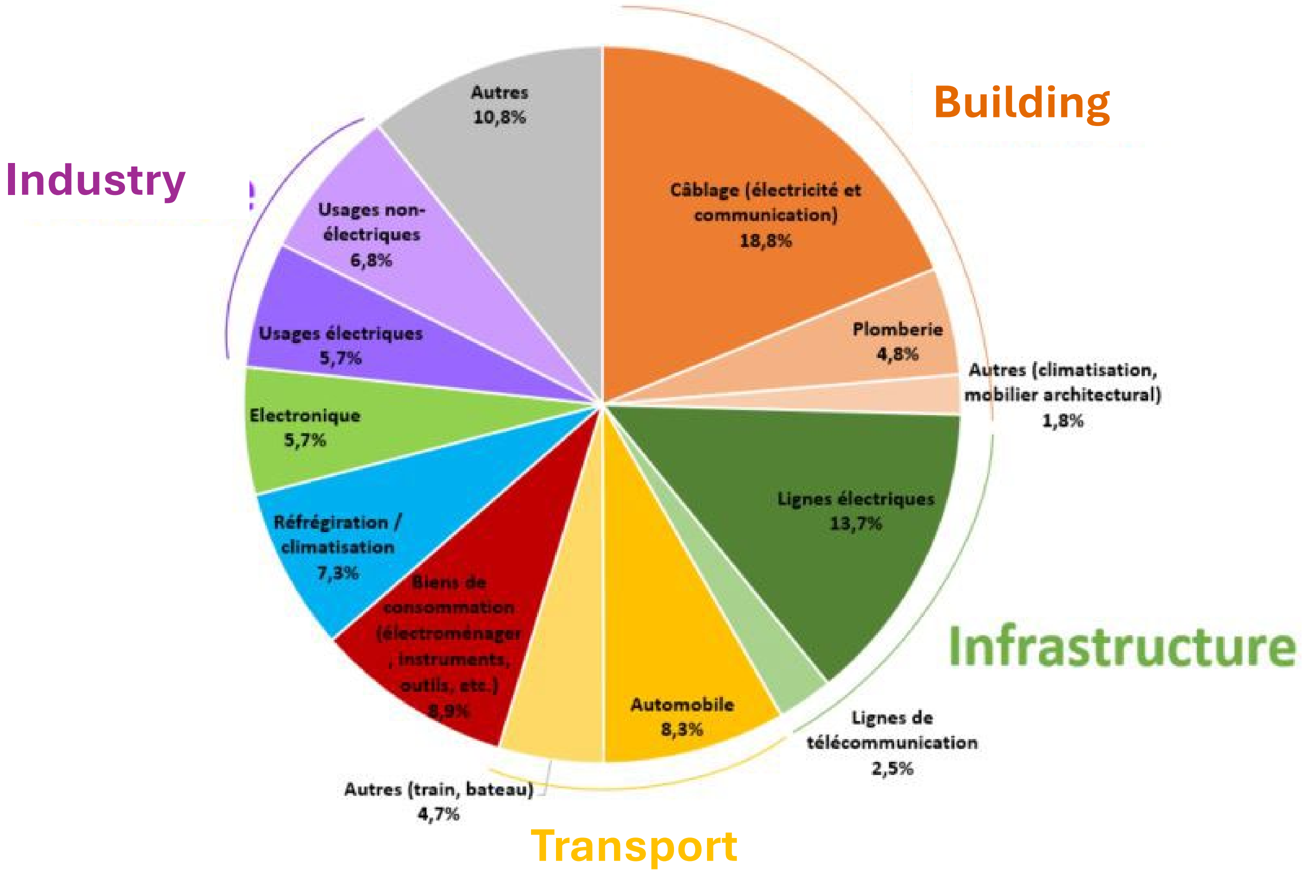
- Technological developments
  - Internet, robotics...

- Energy and digital transitions
  - Development of renewable energy,
  - Electrification of society...

Demand in 2024 : around. 33 Mt
(including « new scraps », around. 27,5 Mt without)

Main uses of copper in 2022

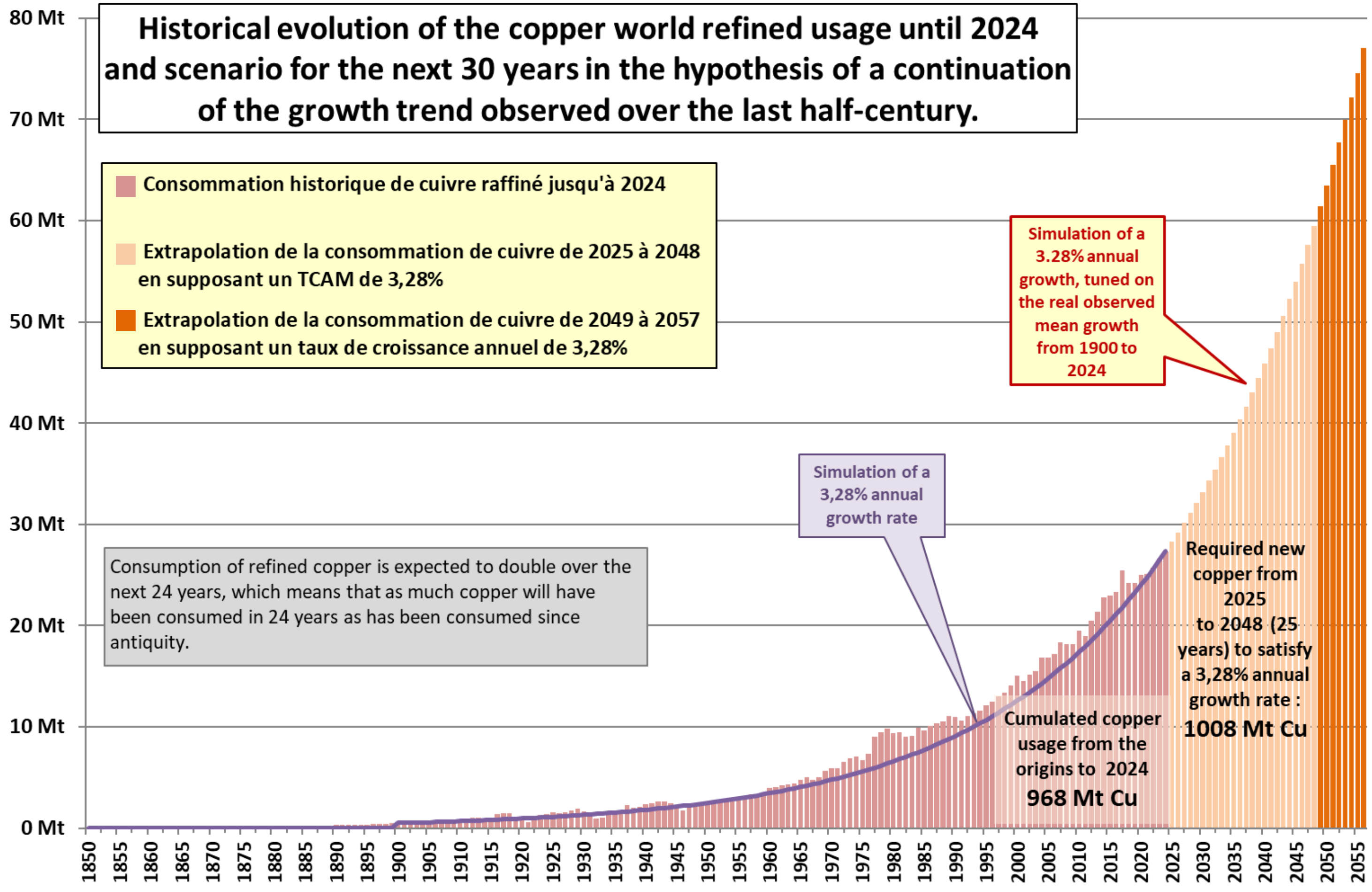
(source des données : International wrought copper council, 2023



Demand (~production) always continues to grow

- Demand [Antiquity-2024] < [2025-2048]
- Demand 2024 = 27,5 Mt
- Demand 2048 = 59 Mt
- Demand 2057 = 77 Mt

Impossible to meet this demand?



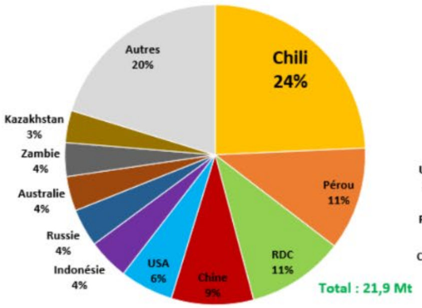
Sources : BRGM, USGS, ICSG

An increasing mining and metallurgical production

- Mining production dominated by South America
  - 39% of the world total
- Partial restructuring of the copper sector
  - Chile, Australia et USA in relative decline for 20 ans
  - Peru, DRC et China in relative increase for 20 ans
- Metallurgical production (anodes, cathodes)
  - Chine is the biggest player (48 et 43%)
  - South America only 10-12%
- 10 biggest societies produce 42% of the worldwide copper

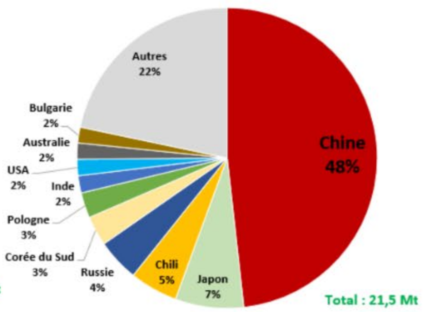
Mining producers in 2022

(source des données : ICSG, 2023)



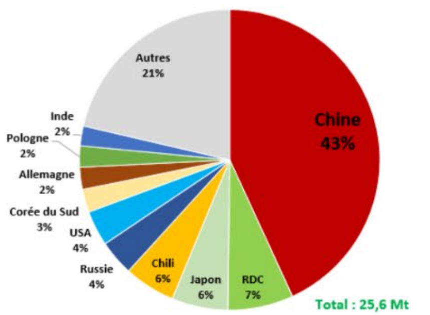
Blisters/Anodes producers in 2022

(source des données : ICSG, 2023)



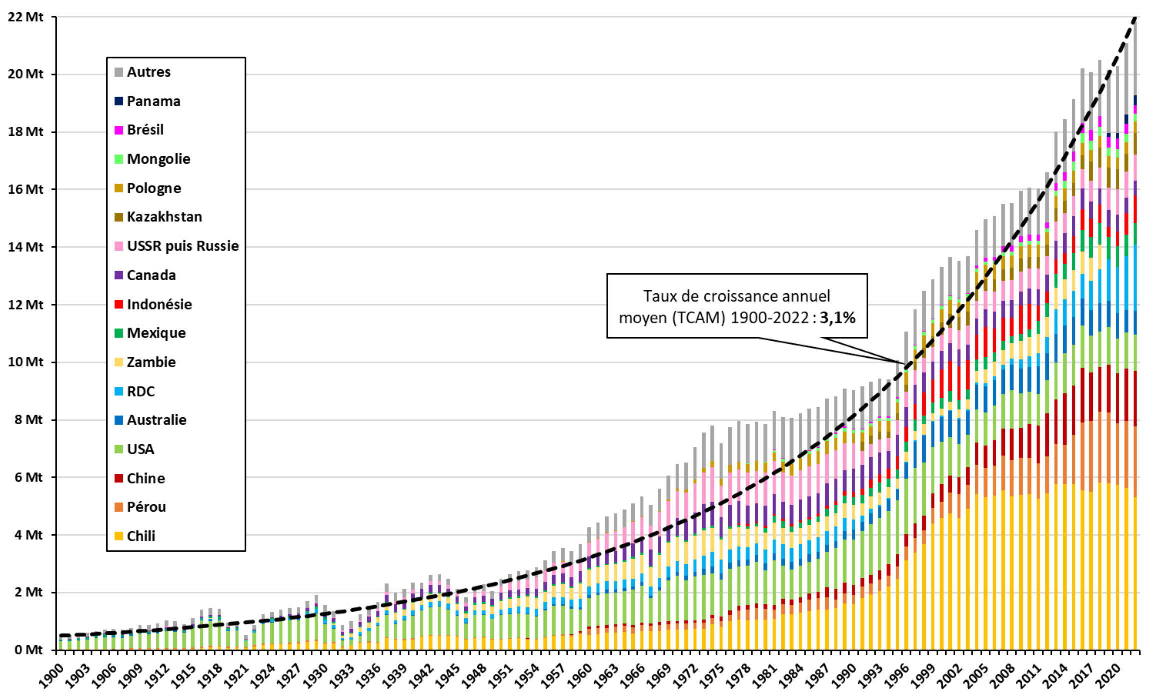
Cathodes producers in 2022

(source des données : ICSG, 2023)



Copper mining production since 1900

(Sources des données : AS3M, ICSG, Schmitz 1976)



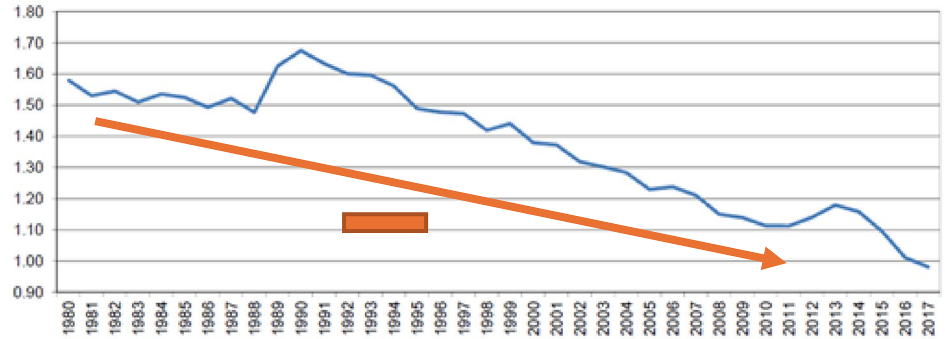
But it is facing a number of problems

- Falling grades in mined ores
  - Better parts of the deposits already mined
  - Technological factor (increased productivity)
  - Richest deposits already discovered

Teneur en Cu (%) :
- 1990 : 1,68
- 2017 : 0,62
- Mines récentes : 0,53
- Projets : 0,43

Cu grades (%)

Cu grade (%)



- Increase in fine particles in foundries/refineries
  - Adoption in 2013 of stricter standards for emissions of fine particles, SO 2 , As and Hg
  - Closure → compliance with standards = investment → reopening
  - By-products associated with Cu, such as Mo and Re, suffer from these closures

- But also
  - Increase in operating costs
  - Increase in the volume of sterile material and waste to be stored
  - Various forms of pollution
  - Increased consumption of water, energy, etc.
  - Increase in impurities (As, Bi, Te, Se, etc.)

Concentration en As dans les concentrés (%) :
- 2012 : 0,15
- 2016 : 0,22
- 2019 : 0,26

As grades (%)

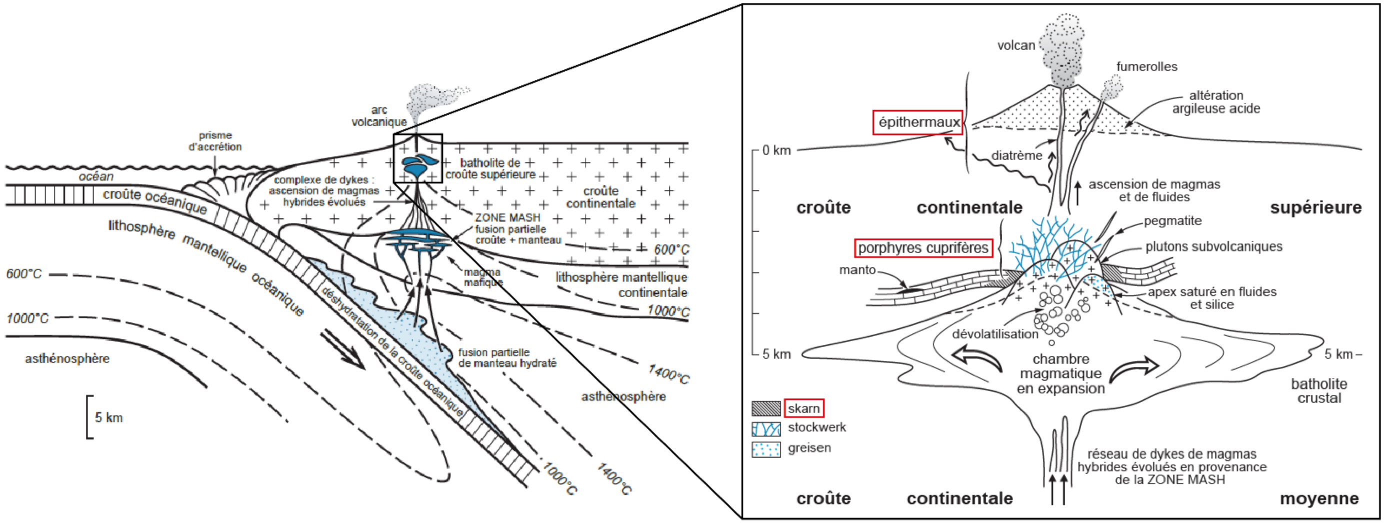
Porphyry copper deposits : the most dominant copper deposit

- Linked to a magmatic intrusion, near a subduction zone
  - Chile, USA, Indonesia, Peru, PNG…
- 75% of worldwide production
- Big tonnage, low copper grade
  - Often open-pit mining
- Co-products / by-products
  - Mo, Se, Au, Ag, Re…

Deposit type	Part des ressources mondiales en cuivre estimées en 2017 (%)	Teneur moyenne en cuivre (%)	Exemples
Porphyres cuprifères	73,5	0,45	Chuquicamata (Chili), Bingham Canyon (USA), Grasberg (Indonésie)
Sédimentaires	9,2	1,52	Copperbelt (RDC-Zambie), lubin (Pologne)
IOCG (fer-oxydes à cuivre et or)	7,5	0,71	Olympic Dam et Prominant Hill (Australie), Candelaria (Chili)
Complexes ignés lités	4,2	0,29	Sudbury (Canada), Norilsk (Russie)
Skarns cuprifères	1,9	0,70	Copper Canyon (USA)
Volcano-sédimentaires (VMS)	1,6	0,78	District du Rio Tinto (Espagne)
SEDEX (sédimentaire-exhalatifs)	0,6	0,39	Broken Hill et Mount Isa (Australie), Red Dog (USA)
Epithermaux	0,3	0,18	Lepanto (Philippines), El Indio (Chili)
Autres	0,9	0,59	

Sources des données : S. Northay et al., 2017

Simplified porphyry copper deposit model



Source : modifié d'après Jébrak et Marcoux, 2008

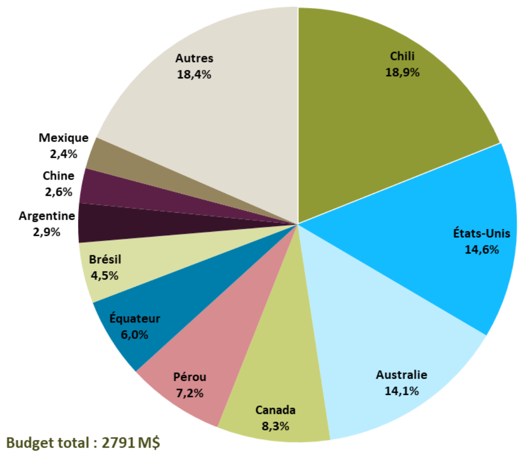
Escondida mine (BHP) in Chile

Exploration: budgets up, discoveries down

- More and more spending on expanding existing mines, to the detriment of discovering new deposits

Ranking of countries with the highest investment in 2022

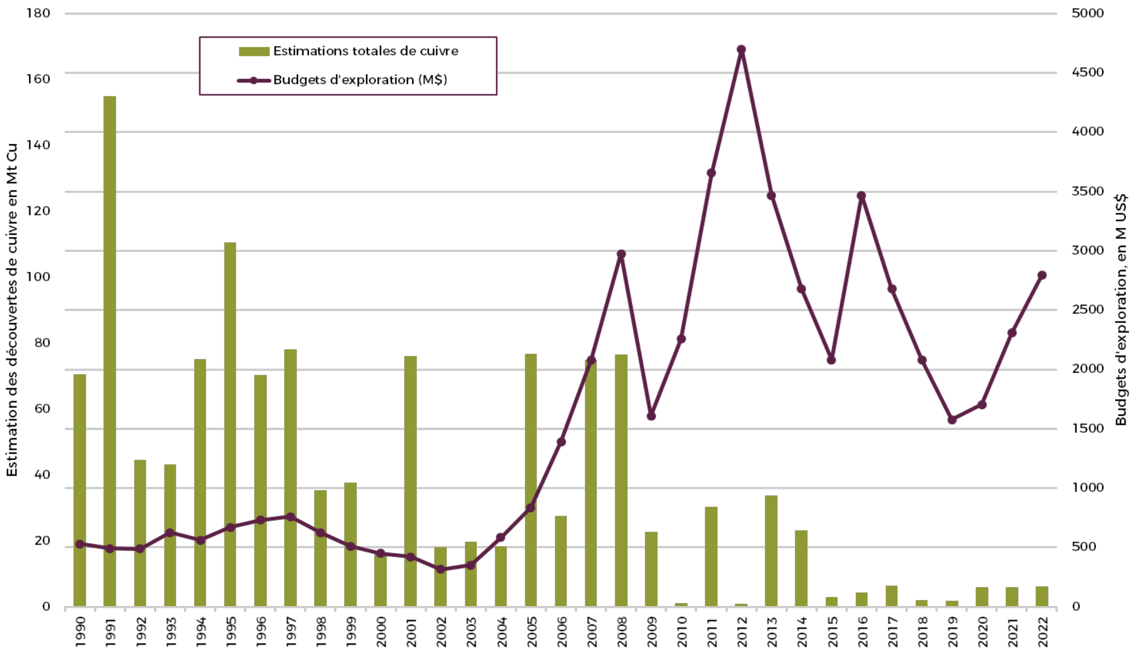
(Sources des données : S&P Global, 2023)



Copper discoveries and exploration budgets since 1990

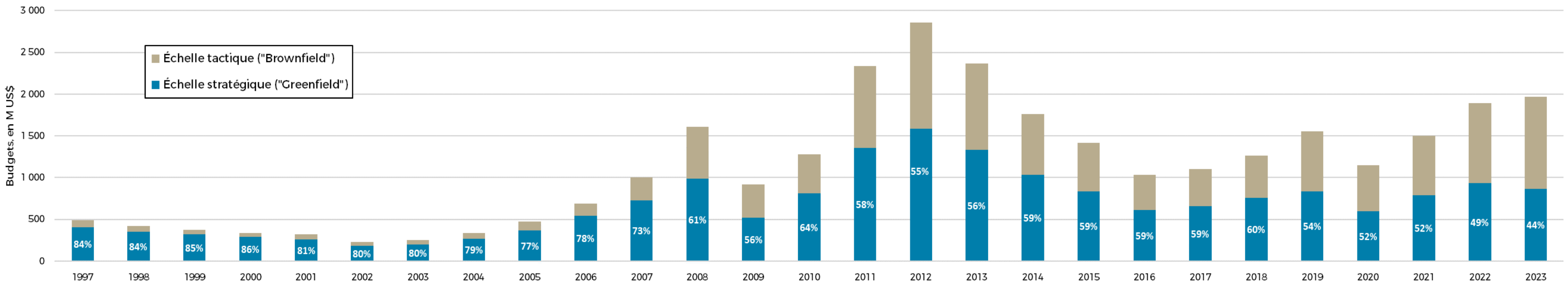
uniquement pour les projets contenant plus de 500 kt Cu de réserves, ressources ou productions passées

(Sources des données : S&P Global, 2023)



Exploration budgets since 1997

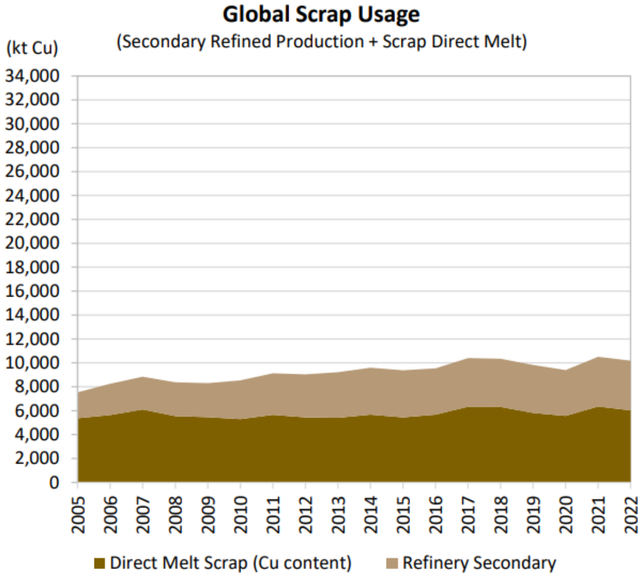
(Source des données : S&P Global, 2023)

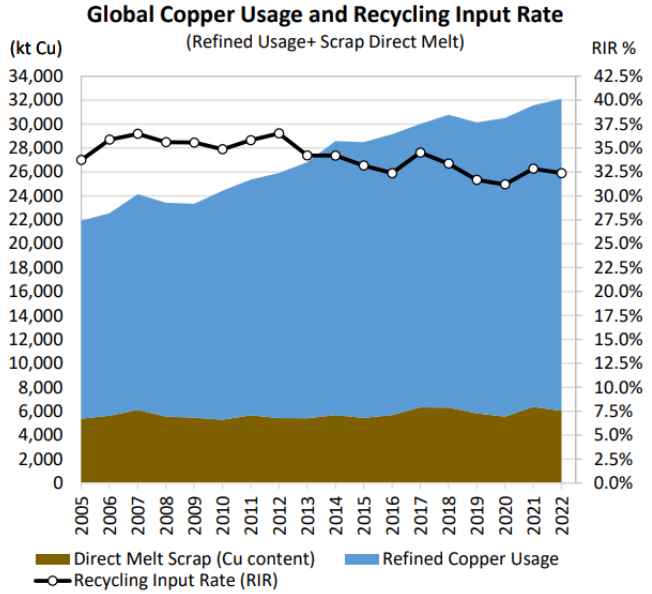


Which solutions ? There are several options available to business players

- Trust the free market (price impact tenable / quantities consumed negligible / speed of crises)
- Build up strategic stocks (potentially very high cost, e.g. scraps ?)
- Secure supplies via specialized contracts (offtake agreements)
- Develop substitution (by another product or technology?)
- Develop recycling (for part of the needs only, with specific constraints)
- Diplomacy on raw materials (cf. Japan/United States-Australia-Canada, etc.)
- (Re)building an integrated industrial sector (at what stage? what costs?)

Some figures on copper recycling
(source : ICSG)





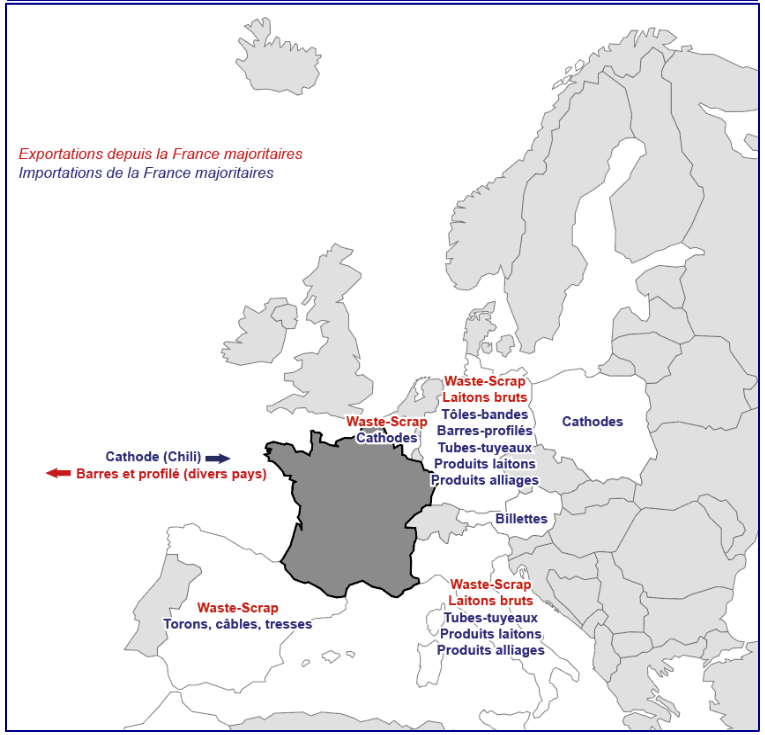
What about France ?

- Little-known but far from sufficient mining potential?
  - Historical mining production in France: 0.1 Mt in total
  - 530 known showings and deposits, but only 20 have had significant production (sulphide clusters, by-product of gold or fluorite, porphyries in rare cases)
  - Identified resources of 750 kt Cu

- Copper scrap is almost entirely exported
  - Exported mainly to neighbouring countries (higher content waste)
  - What about "low grade" or contaminated waste (e.g. lead)?

- French consumption to be (re)calculated?
  - Apparent use : around. 170 kt en 2022
  - Reel use : >500 kt ?

Main copper products imported into and exported from France, Europe and the rest of the world in 2022



Copper deposits in France

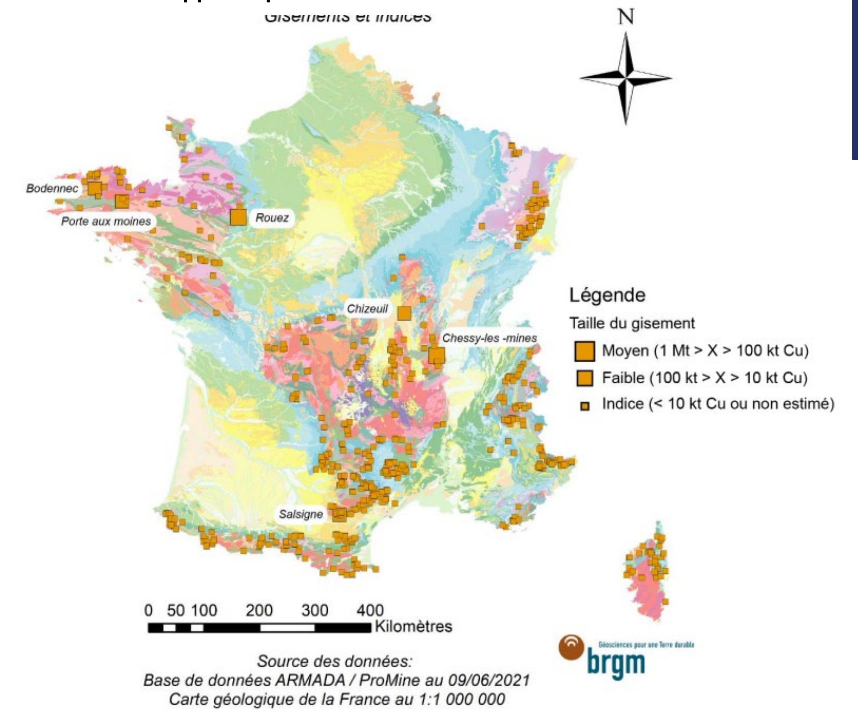


Figure 18 : Carte de distribution des gîtes de cuivre en France métropolitaine.

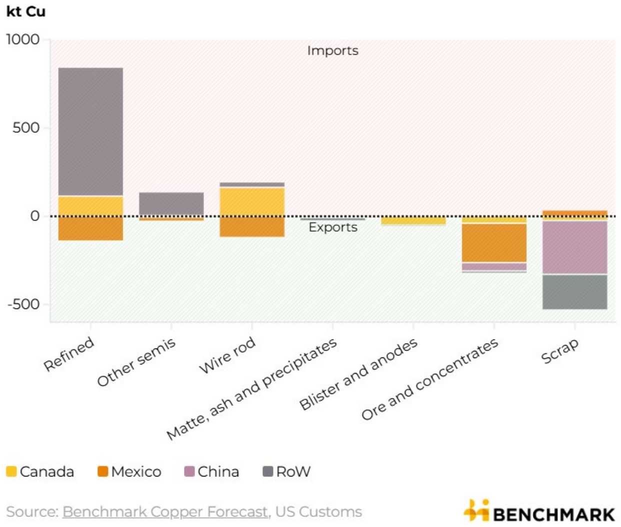
Source : Gourcerol et al., 2021, BRGM

> Cu mining opening time: 15-30 yr
> Opening probability: 1%
> Cost : X G$

Some news on copper market

Potential US tariffs on copper imports

- March 2025 : huge spread between CME et LME (>1000 $/t !)
  - Redirection of flows to the USA before the tax was introduced: 500 kt!
  - Emptying of LME stocks to export to the USA
  - Similar in China
- Strong US dependence on copper imports (50%)
  - Especially refined copper
- Growing tensions with China
  - USA exported 960 kt in 2024, 41% of which to China
  - Imports of US copper scrap represent 20% of total scrap imports
- Strong hydrometallurgy activity
  - SX-EX / total = 44%



Situation in China

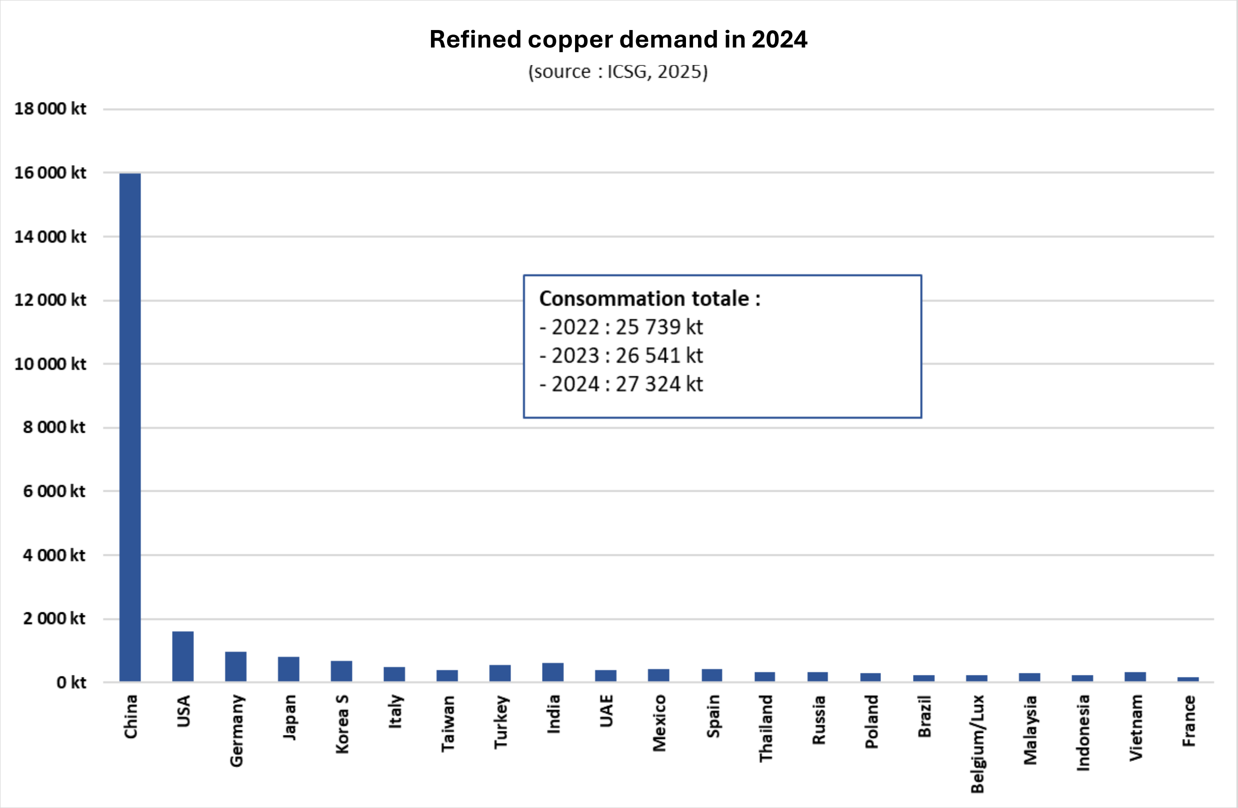
- With Chinese demand running out of steam, the government has taken action
  - Launch of a special action plan to boost demand, which is stalling somewhat in the construction sector (but not in ET, which should compensate)
  - Rebuilding strategic stocks
  - Major purchase by network operators to connect solar power plants

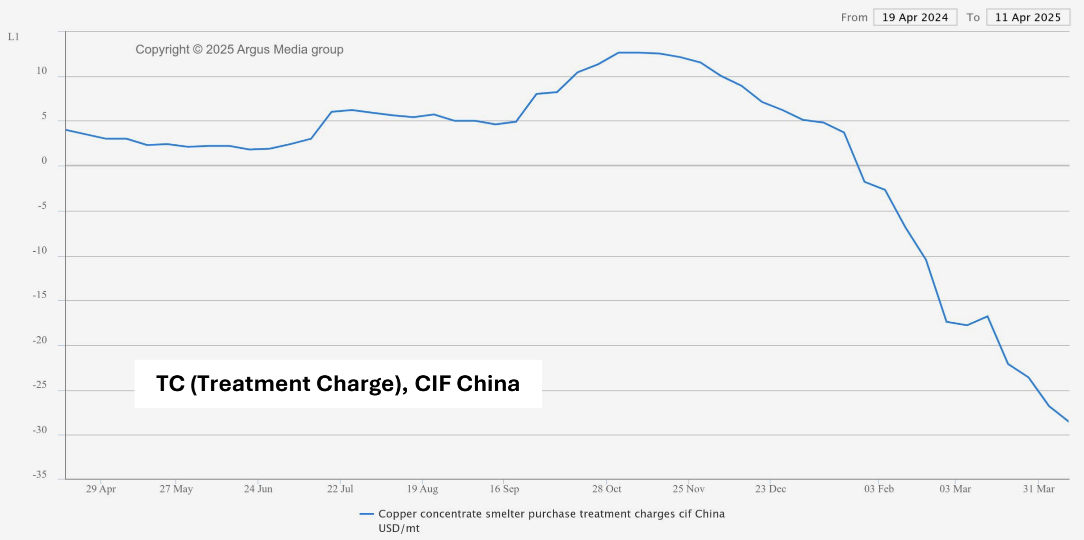
- Still a lack of copper concentrates
  - Smelter activity falls
  - TC/RC continue to fall
  - Ban on building new capacity without first securing supply
  - As a result of price differentials, Chinese players exported copper to LME warehouses, whose stocks were falling

Situation in DRC

- Recent flooding in Kamoa-Kakula mine

- Strong hydrometallurgy activity
  - SX-EX / total = 77%





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OFREMI copper work

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Objective : how can France reduce its dependency on primary copper imports by 2035-2040?

- What degree of dependence?
- Better use of waste?
- Building a smelter-refinery in France or in Europe?
- increase the EU smelter-refinery capacities for secondary copper
- Opening mines?
- ...

To answer this question, there are 4 objectives:

- **Objective 1** : Comparison of supply-demand scenario at the global scale
- **Objective 2** : France copper market understanding (demand, substitution, production...)
  - Understanding the French industrial sectors
  - Better understanding of the issues involved in copper substitution
  - Estimating 'real' French consumption as accurately as possible
- **Objective 3** : Copper processing and copper recycling
  - Extractive metallurgy
  - Recycling
- **Objective 4** : recommendations for all the copper stakeholders and decision makers

Work in progress

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Contact

www.ofremi.fr
direction@ofremi.fr
communication@ofremi.fr

Many thanks to :

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